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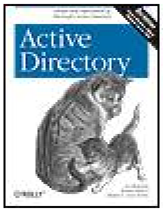

Active Directory, 3rd Edition

By Robbie Allen, Alistair G. Lowe-Norris,
Joe Richards

Publisher: O'Reilly
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Overview

Working with Microsoft's network directory service for the first time can be a headache for system and network administrators, IT professionals, technical project managers, and programmers alike. This authoritative guide is meant to relieve that pain. Instead of going through the graphical user interface screen by screen, O'Reilly's bestselling *Active Directory* tells you how to design, manage, and maintain a small, medium, or enterprise Active Directory infrastructure.

Fully updated to cover Active Directory for Windows Server 2003 SP1 and R2, this third edition is full of important updates and corrections. It's perfect for all Active Directory administrators, whether you manage a single server or a global multinational with thousands of servers.

Active Directory, 3rd Edition is divided into three parts. Part I introduces much of how Active Directory works, giving you a thorough grounding in its concepts. Some of the topics include Active Directory replication, the schema, application partitions, group policies, and interaction with DNS. Part II details the issues around properly designing the directory infrastructure. Topics include designing the namespace, creating a site topology, designing group policies for locking down client settings, auditing, permissions, backup and recovery, and a look at Microsoft's future direction with Directory Services. Part III covers how to create and manipulate users, groups, printers, and other objects that you may need in your everyday management of Active Directory.

If you want a book that lays bare the design and management of an enterprise or departmental Active Directory, then look no further. *Active Directory, 3rd Edition* will quickly earn its place among the books you don't want to be without.

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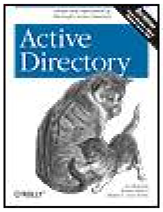

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Preface

Active Directory is a common repository for information about objects that reside on the network, such as users, groups, computers, printers, applications, and files. The default Active Directory schema supports numerous attributes for each object class that can be used to store a variety of information. Access Control Lists (ACLs) are also stored with each object, which allows you to maintain permissions for who can access and manage the object. Having a single source for this information makes it more accessible and easier to manage; however, to accomplish this requires a significant amount of knowledge on such topics as LDAP, Kerberos, DNS, multi-master replication, group policies, and data partitioning, to name a few. This book will be your guide through this maze of technologies, showing you how to deploy a scalable and reliable Active Directory infrastructure.

Windows 2000 Active Directory has proven itself to be very solid in terms of features and reliability, but after several years of real-world deployments, there was much room for improvement. When Microsoft released Windows Server 2003, they focused on security, manageability, and scalability enhancements. Windows Server 2003 R2 takes this evolution further and combines Windows Server 2003 Service Pack 1 with some feature packs, which makes Windows Server even more secure, manageable, and scalable and also adds considerable new functionality, such as a stand-alone LDAP server service and increased Unix system integration functions right in the box.

This book is an update to the very successful second edition. All of the existing chapters have been brought up to date with Windows Server 2003 R2 changes, as well as updates in concepts and approaches to managing Active Directory and script updates. There are three new chapters (Chapters 15, 18, and 24) to explain features or concepts not covered in the second edition, including an entire chapter on Active Directory Application Mode (ADAM) as well as a chapter on scripting common Active Directory related user and group tasks for Microsoft Exchange 2000/2003.

This book describes Active Directory in depth, but not in the traditional way of going through the graphical user interface screen by screen. Instead, the book sets out to tell administrators how to design, manage, and maintain a small, medium, or enterprise Active Directory infrastructure. To this end, the book is split up into three parts.

Part I introduces in general terms much of how Active Directory works, giving you a thorough grounding in its concepts. Some of the topics include Active Directory replication, the schema, application partitions, group policies, and interaction with DNS.

In Part II, we describe in copious detail the issues around properly designing the directory infrastructure. Topics include in-depth looks at designing the namespace, creating a site topology, designing group policies for locking down client settings, auditing, permissions, backup and recovery, and a look at Microsoft's future direction with Directory Services.

Part III is all about managing Active Directory via automation with Active Directory Service Interfaces (ADSI), ActiveX Data Objects (ADO), and Windows Management Instrumentation (WMI). This section covers how to create and manipulate users, groups, printers, and other objects that you may need in your everyday management of Active Directory. It also describes in depth how you can utilize the strengths of WMI and the .NET System.DirectoryServices namespace to manage Active Directory programmatically via those interfaces.

If you're looking for in-depth coverage of how to use the MMC snap-ins or Resource Kit tools, look elsewhere. However, if you want a book that lays bare the design and management of an enterprise or departmental Active Directory, you need look no further.

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Intended Audience

This book is intended for all Active Directory administrators, whether you manage a single server or a global multinational with a farm of thousands of servers. Even if you have a previous edition, you will find this third edition to be full of updates and corrections and a worthy addition to your "good" bookshelf: the bookshelf next to your PC with the books you really read that are all dog-eared with soda drink spills and pizza grease on them. To get the most out of the book, you will probably find it useful to have a server running Windows Server 2003 SP1 or R2 and the Support Tools and Resource Kit tools available so that you can check out various items as we point them out.

If you have no experience with VBScript, the scripting language we use in Part III, don't worry. The syntax is straightforward, and you should have no difficulty grasping the principles of scripting with ADSI, ADO, and WMI. For those who want to learn more about VBScript, we provide links to various Internet sites and other books as appropriate.

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Contents of the Book

This book is split into three parts.

Part I, Active Directory Basics

Chapter 1, *A Brief Introduction*

> Reviews the evolution of the Microsoft NOS and some of the major features and benefits of Active Directory.

Chapter 2, *Active Directory Fundamentals*

> Provides a high-level look at how objects are stored in Active Directory and explains some of the internal structures and concepts that it relies on.

Chapter 3, *Naming Contexts and Application Partitions*

> Reviews the predefined Naming Contexts within Active Directory, what is contained within each, and the purpose of Application Partitions.

Chapter 4, *Active Directory Schema*

> Gives you information on how the blueprint for each object and each object's attributes are stored in Active Directory.

Chapter 5, *Site Topology and Replication*

> Details how the actual replication process for data takes place between domain controllers.

Chapter 6, *Active Directory and DNS*

> Describes the importance of the Domain Name System (DNS) and what it is used for within Active Directory.

Chapter 7, *Profiles and Group Policy Primer*

> Gives you a detailed introduction to the capabilities of both user profiles and Group Policy Objects.

Part II, Designing an Active Directory Infrastructure

Chapter 8, *Designing the Namespace*

Introduces the steps and techniques involved in properly preparing a design that reduces the number of domains and increases administrative control through the use of Organizational Units.

Chapter 9, *Creating a Site Topology*

Shows you how to design a representation of your physical infrastructure within Active Directory to gain very fine-grained control over intrasite and intersite replication.

Chapter 10, *Designing Organization-Wide Group Policies*

Explains how Group Policy Objects function in Active Directory and how you can properly design an Active Directory structure to make the most effective use of these functions.

Chapter 11, *Active Directory Security: Permissions and Auditing*

Describes how you can design effective security for all areas of your Active Directory, in terms of both access to objects and their properties; it includes information on how to design effective security access logging in any areas you choose.

Chapter 12, *Designing and Implementing Schema Extensions*

Covers procedures for extending the classes and attributes in the Active Directory schema.

Chapter 13, *Backup, Recovery, and Maintenance*

Describes how you can back up and restore Active Directory down to the object level or the entire directory.

Chapter 14, *Upgrading to Windows Server 2003*

Outlines how you can upgrade your existing Active Directory infrastructure to Windows Server 2003.

Chapter 15, *Upgrading to Windows Server 2003 R2*

Outlines the process to upgrade your existing Active Directory to Windows Server 2003 R2.

Chapter 16, *Migrating from Windows NT*

Gives very basic guidelines on areas to think about when conducting a Windows NT 4.0 migration. This is only an introduction to the subject; readers looking for step-by-step guides or detailed studies of migration will need to look elsewhere.

Chapter 17, *Integrating Microsoft Exchange*

Covers some of the important Active Directory-related issues when implementing Microsoft Exchange.

Chapter 18, *Active Directory Application Mode (ADAM)*

Introduces Active Directory Application Mode (ADAM), now included with Windows Server 2003 R2, along with information on some of the upgrades from the RTW version of ADAM.

Chapter 19, *Interoperability, Integration, and Future Direction*

Looks into what methods exist now and will exist in the future for integrating Active Directory with other directories and data stores.

Part III, Scripting Active Directory with ADSI, ADO, and WMI

Chapter 20, *Scripting with ADSI*

Introduces ADSI scripting by leading you through a series of step-by-step examples.

Chapter 21, *IADs and the Property Cache*

Delves into the concept of the property cache used extensively by ADSI and shows you how to properly manipulate any attribute of any object within it.

Chapter 22, *Using ADO for Searching*

Demonstrates how to make use of a technology normally reserved for databases and now extended to allow rapid searching for objects in Active Directory.

Chapter 23, *Users and Groups*

Gives you the lowdown on how to rapidly create users and groups, giving them whatever attributes you desire.

Chapter 24, *Basic Exchange Tasks*

Tackles common Active Directory related user and group management tasks for Microsoft Exchange 2000/2003.

Chapter 25, *Shares and Print Queues*

Explains how other persistent objects such as services, shares, and printers may be manipulated; it also looks at dynamic objects, such as print jobs, user sessions, and resources.

Chapter 26, *Permissions and Auditing*

Describes how each object contains its own list of permissions and auditing entries that governs how it can be accessed and how access is logged. The chapter then details how you can create and manipulate permission and auditing entries as you choose. It closes with a complete script to enumerate the entire security descriptor for any Active Directory object including proper constant names for all values, perfect for anyone looking to script Active Directory delegation and wanting to know what values should be set.

Chapter 27, *Extending the Schema and the Active Directory Snap-ins*

Covers creation of new classes and attributes programmatically in the schema, and modification of the existing Active Directory snap-ins to perform additional customized functions.

Chapter 28, *Using ADSI and ADO from ASP or VB*

Goes into how you can extend the scripts that have been written by incorporating them into web pages or even converting them to simple VB programs.

Chapter 29, *Scripting with WMI*

Gives a quick overview of WMI and goes through several examples for managing a system, including services, the registry, and the event log. Accessing AD with WMI is also covered, along with the new TrustMon and Replication WMI Providers.

Chapter 30, *Manipulating DNS*

Describes how to manipulate DNS server configuration, zones, and resource records with the WMI DNS Provider.

Chapter 31, *Getting Started with VB.NET and System.Directory Services*

Starts off by providing some background information on the .NET Framework and then dives into several examples using the System.DirectoryServices namespace with VB.NET.

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Conventions Used in This Book

The following typographical conventions are used in this book:

`Constant width`

Indicates command-line elements, computer output, and code examples

`Constant width italic`

Indicates variables in examples and registry keys

`Constant width bold`

Indicates user input

Italic

Introduces new terms and indicates URLs, commands, file extensions, filenames, directory or folder names, and UNC pathnames

> Indicates a tip, suggestion, or general note. For example, we'll tell you if you need to use a particular version or if an operation requires certain privileges.

> Indicates a warning or caution. For example, we'll tell you if Active Directory does not behave as you'd expect or if a particular operation has a negative impact on performance.

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Acknowledgments

For the Third Edition (Joe)

I want to thank Robbie Allen for my introduction into the world of book-writing and for putting up with my often-grumpy responses to silly issues we encountered on this project. Truly, I wouldn't have worked on this book had it not been for Robbie; if I did not say it before, I am happy I had the opportunity to have this experiencethank you.

Thanks to Alistair for the first edition. I recall being involved with the decision to migrate a company o 200k+ users to W2K and realizing that I knew nothing about AD other than it was supposed to be "super-cool" and fixed everything that was broken in NT. "The Cat Book," the *only* book on AD around at the time, prepared me with the essential concepts and ideas to get started. After five years, I am happy to be able to give back some of what I have learned to that very same book.

Thanks to the folks who had the onerous task of finding the mistakes. I was lucky to have very knowledgeable reviewers who spent a lot of time reading every word (old and new) and bluntly telling me the issues. To Hunter Colman and Stuart Fuller: you guys were afraid you wouldn't add value. You were completely wrong; you added a lot of value. To Lee Flight: thanks for reviewing another edition of this book; your comments were invaluable. To Laura Hunter: I will never look at a comma the same way again; you helped the structure and flow immensely. To Ulf B. Simon-Weidner: your comments and ideas were a great help. Finally, thanks to Dean Wells, a great source of information, fear, and humorous English phrases. Dean couldn't review everything but he happily helped me out when I asked. He spent at least 90 minutes on the phone one night just discussing changes that needed to be made to a few pages of Chapter 5. All of these guys (and gal) are extremely knowledgeable, opinionated, and professional. It was an honor having them tell me what was screwed up. Thanks to my friend Vern Rottman for being an "unofficial" reviewer and running interference for me when I worked with him.

Thanks to the Microsoft Directory Service Developers: because of you, we have a "super-cool" DS. P.S. AD/AM rocks. Thanks to Dmitri Gavrilov for going above and beyond by responding to my unsolicited emails. Thanks to Stuart Kwan (of the Ottawa Kwan Clan) for being one of the most insanely energetic speakers and, at the same time, actually listening to what we thought was wrong and working to get corrections. I am thrilled that someday I will be able to run DCs without IE loaded. May your energizer battery never run out of juice. Thanks to Brett Shirley for telling me to correct stuff in Chapter 13 and writing the most brilliant parts of REPADMIN and being a killer JET Blue (ESE) dev. Thanks to Eric Fleischman for answering all the random AD questions from myself as well as everyone else at all hours of the day and night. Your answers, comments, thoughts, and insight into the actual questions themselves are all greatly appreciated.

Thanks to the activedir.org listserv crowd. Hands down, that list is the best Active Directory (and often Exchange) resource outside of Microsoft. It has helped me a lot.

Thanks to my family, great people I love without bound. Yes Dawn, even you.

And last but not least, thanks to my guardian angel, Di. She put up with a lot of griping from me, as well as the loss of my companionship for most of the summer as I sat in the corner typing away. Through it all, she always had a smile on her face and was willing to burn a grilled cheese sandwich for me as needed. She never once reminded me that I said I would tile the kitchen floor this summer. I'll start tiling next week, only three months late....

For the Second Edition (Robbie)

I would like to thank the people at O'Reilly for giving me the opportunity to work on this book. Special thanks goes to Robert Denn, who was a great editor to work with.

I would like to thank Alistair Lowe-Norris for providing such a solid foundation in the first edition. Whil there was a lot of new material to include, much of the information in the first edition was still pertinent and useful. He deserves a lot of credit since the first edition was done before Windows 2000 had even been released to the public, and there was virtually no information on Active Directory available.

Thanks to Alistair, Mitch Tulloch, and Paul Turcotte for providing very insightful feedback during the review process. Their comments rounded out the rough edges in the book.

And no acknowledgments section would be complete without recognition to my significant other, Janet. She was supportive during the many late nights and weekends I spent writing. I appreciate everything she does for me.

For the First Edition (Alistair)

Many people have encouraged me in the writing of this book, principally Vicky Launders, my partner, friend, and fountain of useful information, who has been a pinnacle of understanding during all the late nights and early mornings. Without you my life would not be complete.

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To Tony Lees, director of Avantek Computer Ltd., for being attentive, thoughtful, and the best all-round salesman I have ever met, many thanks for taking the time to get Leicester University onto the Windows 2000 RDP.

Thanks to Amit D. Chaudhary and Cricket Liu for reviewing parts of the book.

I also would like to thank everyone at O'Reilly, but especially my editor Robert Denn for his encouragement, patience, and keen desire to get this book crafted properly.

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Part I: Active Directory Basics

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Chapter 1. A Brief Introduction

Active Directory (AD) is Microsoft's network operating system (NOS) directory, built on top of Windows 2000 and Windows Server 2003. It enables administrators to manage enterprise-wide information efficiently from a central repository that can be globally distributed. Once information about users and groups, computers and printers, and applications and services has been added to Active Directory, it can be made available for use throughout the entire network to as many or as few people as you like. The structure of the information can match the structure of your organization, and your users can query Active Directory to find the location of a printer or the email address of a colleague. With Organizational Units, you can delegate control and management of the data however you see fit. If you are like most organizations, you may have a significant amount of data (e.g., thousands of employees or computers). This may seem daunting to enter in Active Directory, but fortunately Microsoft has some very robust yet easy-to-use Application Programming Interfaces (APIs) to help facilitate data management programmatically.

This book is an introduction to Active Directory, but an introduction with a broad scope. In Part I, we cover many of the basic concepts within Active Directory to give you a good grounding in some of the fundamentals that every administrator should understand. In Part II, we focus on various design issues and methodologies, to enable you to map your organization's business requirements into your Active Directory infrastructure. Getting the design right the first time around is critical to a successful implementation, but it can be extremely difficult if you have no experience deploying Active Directory. In Part III, we cover in detail management of Active Directory programmatically through scripts based on Active Directory Service Interfaces (ADSI), ActiveX Data Objects (ADO), and Windows Management Instrumentation (WMI). No matter how good your design is, unless you can automate your environment, problems will creep in, causing decreased uniformity and reliability.

Before moving on to some of the basic components within Active Directory, we will now review how Microsoft came to the point of implementing an LDAP-based directory service to support their NOS environment.

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1.1. Evolution of the Microsoft NOS

Network operating system, or "NOS," is the term used to describe a networked environment in which various types of resources, such as user, group, and computer accounts, are stored in a central repository that is controlled by administrators and accessible to end users. Typically, a NOS environment is comprised of one or more servers that provide NOS services, such as authentication, authorization, and account manipulation, and multiple end users that access those services.

Microsoft's first integrated NOS environment became available in 1990 with the release of Windows NT 3.0, which combined many features of the LAN Manager protocols and OS/2 operating system. The NT NOS slowly evolved over the next eight years until Active Directory was first released in beta in 1997.

Under Windows NT, the "domain" concept was introduced, providing a way to group resources based on administrative and security boundaries. NT domains are flat structures limited to about 40,000 objects (users, groups, and computers). For large organizations, this limitation imposed superficial boundaries on the design of the domain structure. Often, domains were geographically limited as well because the replication of data between domain controllers (i.e., servers providing the NOS services to end users) performed poorly over high-latency or low-bandwidth links. Another significant problem with the NT NOS was delegation of administration, which typically tended to be an all-or-nothing matter at the domain level.

Microsoft was well aware of these limitations and needed to re-architect their NOS model into something that would be much more scalable and flexible. For that reason, they looked to LDAP - based directory services as a possible solution.

1.1.1. Brief History of Directories

In general terms, a *directory service* is a repository of network, application, or NOS information that is useful to multiple applications or users. Under this definition, the Windows NT NOS is a type of directory service. In fact, there are many different types of directories, including Internet white pages, email systems, and even the Domain Name System (DNS). Although each of these systems have characteristics of a directory service, X.500 and the Lightweight Directory Access Protocol (LDAP) define the standards for how a true directory service is implemented and accessed.

In 1988, the International Telecommunication Union (ITU) and International Organization of Standardization (ISO) teamed up to develop a series of standards around directory services, which has come to be known as X.500. While X.500 proved to be a good model for structuring a directory and provided a lot of functionality around advanced operations and security, it was difficult to implement clients that could utilize it. One reason is that X.500 is based on the OSI (Open System Interconnection) protocol stack instead of TCP/IP, which had become the standard for the Internet. The X.500 Directory Access Protocol (DAP) was very complex and implemented a lot of features most clients never needed. This prevented large-scale adoption. It is for this reason that a group headed by the University of Michigan started work on a "lightweight" X.500 access protocol that would make X.500 easier to utilize.

The first version of the Lightweight Directory Access Protocol (LDAP) was released in 1993 as RFC 1487,[*] but due to the absence of many features provided by X.500, it never really took off. It wasn't until LDAPv2 was released in 1995 as RFC 1777 that LDAP started to gain popularity. Prior to LDAPv2, the primary use of LDAP was as a gateway between X.500 servers. Simplified clients would interface with the LDAP gateway, which would translate the requests and submit it to the X.500 server. The University of Michigan team thought that if LDAP could provide most of the functionality necessary to most clients, they could remove the middleman (the gateway) and develop an LDAP-enabled directory server. This directory server could use many of the concepts from X.500, including the data model, but would leave out all the overheard resulting from the numerous features it implemented. Thus, the first LDAP directory server was released in late 1995 by the University of Michigan team, and it turned into the basis for many future directory servers.

[*] You can look up the text of this RFC at http://www.ietf.org/rfc.html.

In 1997, the last major update to the LDAP specification, LDAPv3, was described in RFC 2251. It provided several new features and made LDAP robust enough and extensible enough to be suitable for most vendors to implement. Since then, companies such as Netscape, Sun, Novell, IBM, OpenLdap Foundation, and Microsoft have developed LDAP-based directory servers. Most recently, RFC 3377 was released, which lists all of the major LDAP RFCs. For a Microsoft whitepaper on their LDAPv3 implementation and conformance, see http://www.microsoft.com/windowsserver2003/techinfo/overview/ldapcomp.mspx.

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1.2. Windows NT Versus Active Directory

As we mentioned earlier, Windows NT and Active Directory both provide directory services to clients. Although both share some common concepts, such as Security Identifiers (SIDs) to identify security principals, they are very different from a feature, scalability, and functionality point of view. Table 1-1 contains a comparison of features between Windows NT and Active Directory.

Table 1-1. A comparison between Windows NT and Active Directory

Windows NT	Active Directory
Single-master replication is used, from the PDC master to the BDC subordinates.	Multimaster replication is used between all domain controllers.
Domain is the smallest unit of partitioning.	Naming Contexts are the smallest units of partitioning.
System policies can be used locally on machines or set at the domain level.	Group policies can be managed centrally and used by clients throughout the forest based on domain, site, or OU criteria.
Data cannot be stored hierarchically within a domain.	Data can be stored in a hierarchical manner using OUs.
Domain is the smallest unit of security delegation and administration.	A property of an object is the smallest unit of security delegation/administration.
Domain is a policy, replication, and security boundary.	Domain is a policy and replication boundary. Forest is the security boundary.
NetBIOS and WINS are used for name resolution.	DNS is used for name resolution. WINS may be required for applications or legacy clients.
Object is the smallest unit of replication.	Attribute is the smallest unit of replication. In Windows Server 2003 Active Directory, some attributes replicate on a per-value basis (such as the member attribute of group objects).
Maximum recommended database size for SAM is 40 MB.	Recommended maximum database size for Active Directory is 16 TB.
Maximum effective number of users is 40,000 (if you accept the recommended 40 MB maximum).	The maximum number of objects per forest is in the tens of millions. Microsoft has tested to 40 million objects.

Windows NT	Active Directory
Four domain models (single, single-master, multimaster, complete-trust) are required to solve per-domain admin-boundary and user-limit problems.	No domain models required as the complete-trust model is implemented. One-way trusts with external domains, forests, and Unix Kerberos realms can be implemented manually.
Schema is not extensible.	Schema is fully extensible.
Data can only be accessed through a Microsoft API.	Data can be accessed through a Microsoft API or through LDAP, which is the standard protocol used by directories, applications, and clients that want to access directory data. Allows for cross-platform data access and management.

First, Windows NT Primary Domain Controllers and Backup Domain Controllers have been replaced by Active Directory Domain Controllers. It is possible under Active Directory to promote member servers to Domain Controllers (DCs) and demote DCs to ordinary member servers, all without needing a reinstallation of the operating system; this is not the case under Windows NT. If you want to make a member server a DC, you can promote it using the *dcpromo.exe* wizard. *dcpromo* asks you a number of questions, such as whether you are creating the first domain in a domain tree or joining an existing tree, whether this new tree is part of an existing forest or a new forest to be created, and so on.

> UTOOLS provides a tool called UPromote through http://utools.com/UPromote.asp that allows you to demote NT4 DCs to member servers. Although this functionality is *not* supported by Microsoft, companies and universities have successfully used the product to demote NT4 BDCs from Active Directory domains. This is useful if for some reason you cannot upgrade or reinstall the operating system on the NT4 BDC.

Organizational Units are an important change with Active Directory. Under Windows NT , administration was delegated on a per-domain basis. Active Directory allows the administrators to define administration boundaries that encompass anything from the entire forest, domain, or Organizational Unit, all the way down to individual objects and attributes. This can significantly reduce the number of domains you require and offers far greater flexibility in your management choices.

Windows NT uses NetBIOS as its primary network communication mechanism, whereas Active Directory requires DNS and uses TCP/IP as its exclusive transport protocol. Under previous versions, administrators were required to maintain two computer lookup databases DNS for name resolution and WINS for NetBIOS name resolutionbut Active Directory no longer requires traditional NetBIOS name resolution. Instead, it relies on DNS. You may still encounter a need to install and run a WINS server. However, this would only be required for compatibility for applications such as Exchange or older legacy clients that still require NetBIOS name resolution.

The significant difference in replication is that Active Directory will replicate at the attribute and, in some cases, even the value level rather than object level. With Windows NT, if you changed the full name of a user object, the whole object had to be replicated out. In the same scenario with Active Directory, only the modified attribute will be replicated. This was further improved in Windows Server

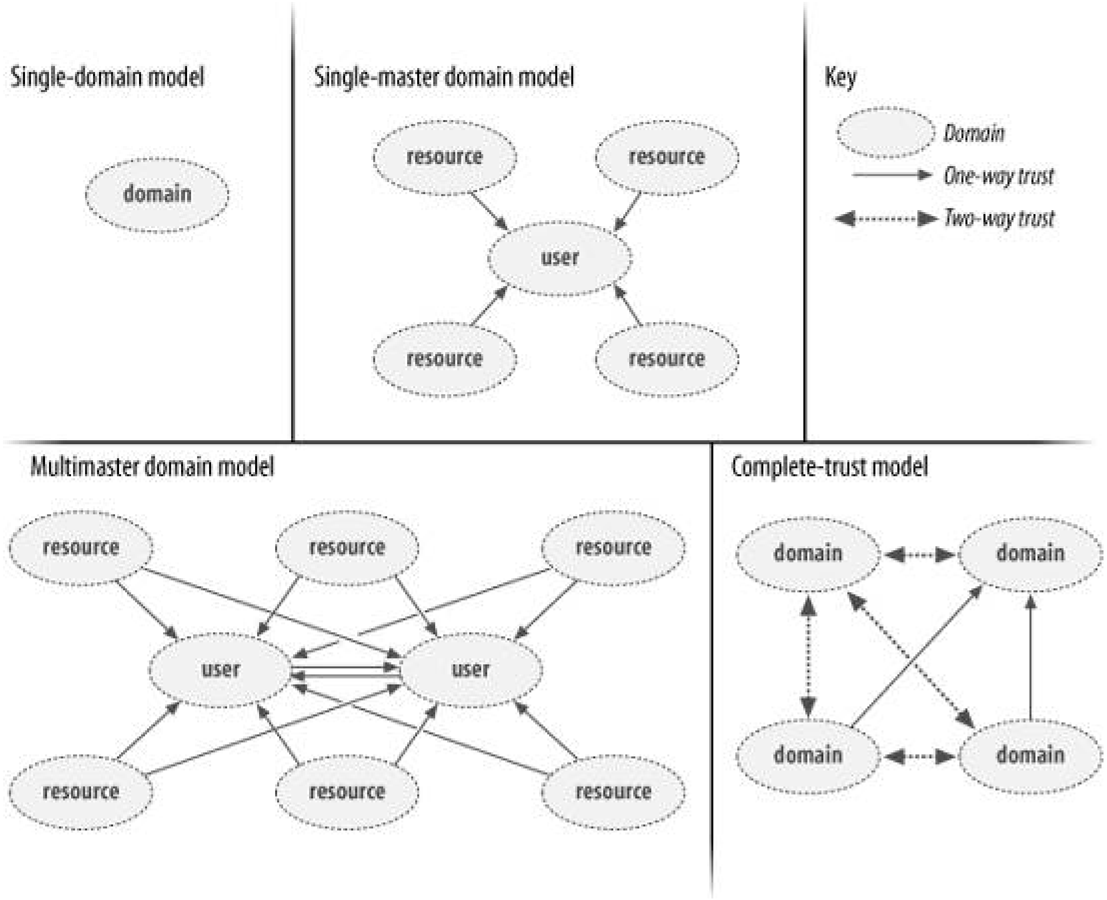
2003 Active Directory, where value-level replication was enabled for certain attribute types. This allowed common attributes like group membership to be replicated at the value level, so instead of replicating all members of a group, you only replicate the members that were added or removed. Coupled with some very clever changes to the way replication works, this means that you replicate less data for shorter periods, thereby reducing the two most important factors in replication. See Chapters 5 and 9 for more on replication.

The suggested maximum Windows NT Security Accounts Manager (SAM) database size was 40 MB, which was roughly equivalent to about 40,000 objects, depending on what proportion of computer, user, and group accounts you had in your domain. Many companies have gone above 75 MB for the SAM for one domain due to the huge number of groups that they were using, so this rule was never hard and fast as long as you understood the problems you were likely to experience if you went past the limit. Active Directory is based on the Extensible Storage Engine (ESE) database used by Exchange and was developed to hold millions of objects with a maximum database size of 16 TB. This should be enough for most people's needs, and the number of objects is only a recommended maximum limit. Remember, however, that this new database holds all classes of objects, not just the users, groups, and computers of the previous version's SAM. As more and more Active Directory-enabled applications are developed, more classes of objects will be added to the schema, and more objects will be added to the directory. To bring this into perspective, imagine that one of the world's largest aerospace companies has around half a million computers. Assuming an equivalent number of staff, this still uses only 10% of the maximum database capacity. However, when you begin to consider all the other objects that will be in Active Directory, including file shares, printers, groups, organizational units, domains, contacts, and so on, you can see how that percentage will increase.

For administrators of Windows NT , the significant increase in scalability may be the most important change of all. It was extremely easy to hit the 40 MB SAM limit within an NT domain, forcing you to split the domain. You ended up managing multiple domains when you really didn't want to; it was quite frustrating. None of the domains were organized into a domain tree or anything of the sort, so they had no automatic trusts between them. This meant that NT administrators had to set up manual trusts between domains, and these had to be initiated at both domains to set up a single one-way trust. As you added more domains, you ended up managing even greater numbers of trusts. There are four domain models that you could use as templates for your Windows NT design: the single-domain model, the single-master domain model, the multimaster domain model, and the complete-trust domain model. All four are shown in Figure 1-1. The most common model after the single-domain model is probably the multimaster domain model.

The single-domain model had, as the name implied, only one domain with a SAM smaller than 40 MB and no trusts. Where multiple domains were needed for resource access but the SAM was still less than 40 MB, the single-master domain model was used. The single-master domain model was made up of one user (or account) domain and multiple resource domains. The important point was that the resource domains had one-way trusts with the user domain that held all the accounts. Due to the one-way trusts, the administrators of the resource domains could set permissions as they wished to their own resources for any accounts in the user domain. This meant that one central set of administrators could manage the accounts, while individual departments maintained autonomy over their own resources. The multimaster model came into play when the SAM limitations were approached, when you needed to separate out user management to different administrative groups, or when you wanted to better control replication traffic geographically. The administrators of the user domain split the user accounts into two or more domains, giving them two-way (i.e., complete) trust between each other, and then each resource domain had to have a one-way trust with each user domain. Scaling this up, for a multimaster domain with 10 user domains and 100 resource domains, that's 90 trusts to make up the intrauser trusts and 1,000 separate resource-to-user trusts that must be manually set. Finally, in some cases, the complete-trust model was used where any domain could create accounts, and those accounts could be used to access shared resources to any other domain.

Figure 1-1. The four Windows NT domain models



By contrast, all Active Directory domains within a forest trust each other via transitive trusts . This results in an automatic complete-trust model within the forest. In Windows Server 2003 Active Directory, transitive forest trusts are also available so that all of the domains in two different forests can completely trust each other via a single explicit trust between the forest root domains.

> Windows NT had simple trusts. This means that if DomA trusted DomB, and DomB trusted DomC, there was no automatic connection between DomA and DomC.
>
> Active Directory gave us transitive trusts; with transitive trusts, if DomA trusted DomB, and DomB trusted DomC, DomA could trust DomC through the trust transitivity.

Finally, the Windows NT schema was not extensible. No new object types could be added to it, which was a significant limitation for most enterprises. When Microsoft products that extended Windows NTsuch as Terminal Server and File and Print for NetWarewere released, each had to store any attribute data that it wanted all together within one existing attribute. Under Active Directory, the schema is fully extensible, so any new products can extend the schema and add in objects and attributes as required.

> For more information on upgrading from Windows NT to Active Directory, take a look at Chapter 16.

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1.3. Windows 2000 Versus Windows Server 2003

Although the first version of Active Directory available with Windows 2000 was very stable and feature-rich, it still had room for improvement, primarily around manageability and performance. With Windows Server 2003, Microsoft has addressed many of these issues. To utilize these features, you have to upgrade your domain controllers to Windows Server 2003 and raise the domain and forest functional levels as necessary.

> Windows 2000 Active Directory introduced us to the concept of mixed mode and native mode. This was a domain concept that indicated whether or not all DCs in a domain were Windows 2000 and could therefore use new capability that wasn't available in Windows NT. Switching from mixed mode to native mode was a purposeful configuration change made by the domain administrators.
>
> Windows Server 2003 Active Directory further refined this by adding functional levels. It introduced both domain functional levels and forest functional levels. Like mixed mode and native mode, domain functional mode depends on the types of domain controllers in the forest. If you have all Windows Server 2003 domain controllers, you can switch Windows Server 2003 domain functional mode and gain access to many new functions. Microsoft also added new functions that could be used only if all domain controllers in the forest were upgraded to Windows Server 2003, so they added forest functional mode. When all DCs in the forest are upgraded, the enterprise administrators can increase the forest functional mode.

The difference between Windows 2000 Active Directory and Windows Server 2003 Active Directory is more evolutionary than revolutionary. The decision to upgrade to Windows Server 2003 is a subjective one, based on your needs. For example, if you have a lot of domain controllers and Active Directory sites, you may want to take advantage of the improvements with replication as soon as possible. Or perhaps you've been dying to rename a domain, a capability available in Windows Server 2003 Active Directory. On the whole, Microsoft added or updated more than 100 features within Active Directory, and we will now discuss some of the more significant ones.

> For information on upgrading to Windows Server 2003 from Windows 2000 , check out Chapter 14.

Some of the new features are available as soon as you promote the first Windows Server 2003 domain controller into an existing Windows 2000 Active Directory domain. In Table 1-2, the features available when you do so are listed, along with a description. Note that, with the exception of WMI Filtering for GPOs, these features will apply only to the Windows Server 2003 domain controllers in the domain.

Table 1-2. Windows 2000 domain functional level feature list

Feature	Description
Application partitions	You can create your own partitions to store data separately from the default partitions, and you can configure which domain controllers (DC) in the forest replicate it.
Global Catalog (GC); not required for logon (i.e., universal group caching)	Under Windows 2000, a DC had to contact a GC to determine universal group membership and subsequently to allow users to logon. This feature allows DCs to cache universal group membership so that it may not be necessary to contact a GC for logins.
MMC enhancements and new command-line tools	The new Active Directory Users and Computers console allows you to save queries, drag and drop, and edit multiple users at once, and it is much more efficient about scrolling through a large number of objects. In addition, several new command-line tools (*dsadd*, *dsmod*, *dsrm*, *dsquery*, *dsget*, and *dsmove*) come installed with the server, allowing for greater flexibility in managing Active Directory.
Install from media	Administrators can create new DCs for an existing domain by installing from a backup of an existing DC that resides on media such as a CD or DVD.
WMI filtering for GPOs	You can apply a WMI filter, which is a query that can utilize any WMI information on a client, to a GPO, and that query will be run against each targeted client. If the query succeeds, the GPO will continue to process; otherwise, it will stop processing. The feature requires clients to be Windows XP or better.
GC replication tuning	After an attribute has been added to the GC, a sync of the contents of the GC for every GC server will no longer be performed as it was with Windows 2000. This occurs only with Windows Server 2003 to Windows Server 2003 replication.

In Table 1-3, the features available in domains running the Windows Server 2003 functional level are listed. A domain can be changed to the Windows Server 2003 functional level when all domain controllers in the domain are running Windows Server 2003.

Table 1-3. Windows Server 2003 domain functional level feature list

Feature	Description
Domain controller rename	With Windows 2000, you had to demote, rename, and repromote a DC if you wanted to rename it. With Windows Server 2003 domains , you can rename DCs, and it requires only a single reboot.

Feature	Description
Logon timestamp replicated	Under Windows 2000, the lastLogon attribute contained a user's last logon timestamp, but that attribute was not replicated among the DCs. With Windows Server 2003, the lastLogonTimeStamp attribute is occasionally updated, by default every seven days, and will be replicated.
Quotas	Users and computers that have write access to AD can cause a Denial of Service (DOS) attack by creating objects until a DC's disk fills up. You can prevent this type of attack by using quotas. With a quota, you can restrict the number of objects a security principal can create in a partition, container, or OU. Windows Server 2003 DCs can enforce quotas even when not at the Windows Server 2003 domain functional level, but for it to be enforced everywhere, all DCs must be running Windows Server 2003.

In Table 1-4, the features available to forests running the Windows Server 2003 functional level are listed. A forest can be raised to the Windows Server 2003 functional level when all domains contained within the forest are at the Windows Server 2003 domain functional level.

Table 1-4. Windows Server 2003 forest functional level feature list

Feature	Description
Reuse of critical schema identification properties	This feature allows certain critical identification properties to become available for reuse in the event a schema extension was originally misdefined and has since been defuncted.
Forest trust	A forest trust is a transitive trust between two forest root domains that allows all domains within the two forests to trust each other. To accomplish something similar with Windows 2000, you would have to implement trusts between each domain in the two forests.
Per-value replication	This feature allows certain linked-value attributes to replicate on a per-value basis instead of a per-attribute basis (i.e., all values). This is vital for group objects because under Windows 2000, a change in the member attribute caused the entire set of values for that attribute to unnecessarily be replicated.
Improved replication topology generation	The Intersite Topology Generator (ISTG) and Knowledge Consistency Checker (KCC) have been greatly improved and will create more efficient replication topologies.
Dynamic auxiliary classes	This feature allows for dynamically assigned per-object auxiliary classes. Under Windows 2000, an object could only utilize auxiliary classes that were statically defined in the schema for its object class.

Feature	Description
Dynamic objects	Dynamic objects have a defined time to live (TTL) after which they will be removed from Active Directory unless the TTL is updated. This can help facilitate data management for short-lived objects.
`InetOrgPerson` class for users	The `inetOrgPerson` object class is a standard (RFC 2798) commonly used by directory vendors to represent users. With Windows Server 2003, you can use either the Microsoft-defined user object class or the `inetOrgPerson` object class for user accounts.
Domain rename	A domain can be renamed, which was not previously possible under Windows 2000. The impact to the environment is pretty significant (i.e., all member computers must be rebooted), and there are special considerations if Exchange is involved, so it should be done conservatively.

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1.4. Windows Server 2003 Versus Windows Server 2003 R2

Microsoft has consistently extended release dates for future versions of Windows Server, so they decided to release an interim version of Windows Server 2003, which includes Service Pack 1 as well as several new optional components. Some of these new optional components, such as Active Directory Application Mode (ADAM), are available via Web downloads, but Microsoft chose to package them on the R2 CD to make them available to a wider audience. In addition, some users question Microsoft's commitment to software that is only available from its web site; making the components part of the Core OS dispels any doubts on Microsoft's support position.

Service Pack 1 offers a considerable number of improvements for Windows Server 2003. As with Windows XP Service Pack 2 , many of the changes are security related correcting issues in Internet Explorer and offering new firewall functionality, Table 1-5 gives an overview of the Active Directory specific updates.

Table 1-5. Windows Server 2003 SP1 Active Directory enhancements

Feature	Description
Directory service backup reminders	Special messages logged to the Directory Service event log if directory partitions are not backed up.
Additional replication security and fewer replication errors	Replication metadata for domain controllers removed from the domain is now removed. This enhances directory security and eliminates replication error messages related to the deleted domain controllers.
Install from media improvements for installing DNS Servers	New option to include application directory partitions in the backup media eliminates the requirement for network replication of DomainDNSZone and ForestDNSZones application directory partitions before the DNS Server is operational.
Updated tools	Newer versions of *DcDiag*, *NTDSUtil*, *IADSTools.DLL*, *AdPrep*, and other tools to aid in management, updates, and troubleshooting.
Virtual server support	Official support for running domain controllers within Microsoft Virtual Server 2005. Additional logic was added to guard against directory corruption due to improper backup and restoration procedures.
Extended storage of deleted objects	Tombstone lifetime on new forests increased from 60 to 180 days. Existing forests are not modified.
Improved domain controller name resolution	To avoid replication failures due to DNS name-resolution issues, Windows Server 2003 with SP1 will request other variations of the server name that could be registered.

Feature	Description
Confidential attributes	Ability to mark attributes as confidential so they cannot be read without additional permissions granted. By default, any attribute marked confidential can only be read by trustees with full control access to the object; however, this can be delegated in a granular manner.
SID History attribute retained on object deletion	The SID History attribute has been added to the default list of attributes retained on an object tombstone. When the object is undeleted, the attribute will be restored with the object.
Operations master health and status reporting	Operations that require a FSMO domain controller that cannot be performed will generate Directory Service event log messages.
Drag and drop changes in Active Directory Users and Computers Console	Ability to disable drag and drop functionality in ADUC and display confirmation dialogs when initiating a move operation.

Although Service Pack 1 is certainly full of great updates that any domain administrator would want loaded on their domain controllers, the real meat in Windows Server 2003 R2 is in the optional components. If the optional components do not interest you, then R2 will probably not be an upgrade you will spend a lot of time on. Table 1-6 lists the various new components available in R2 specific to Active Directory.

Table 1-6. Windows Server 2003 R2 optional Active Directory-specific components

Feature	Description
Active Directory Application Mode (ADAM)	Standalone LDAP service that is Active Directory with the NOS-specific components and requirements stripped out.
Active Directory Federated Services (ADFS)	Standards-based technology that enables distributed identification, authentication, and authorization across organizational and platform boundaries.
Identity Management for UNIX (IMU)	Manage user accounts and passwords on Windows and Unix via NIS. Automatically synchronize passwords between Windows and Unix.

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1.5. Summary

This chapter is a brief introduction to the origins of Active Directory and some of the new features available in Windows Server 2003 and Window Server 2003 R2. The rest of the chapters in Part I cover the conceptual introduction to Active Directory and equip you with the skills necessary to gain the most from Parts II and III.

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Chapter 2. Active Directory Fundamentals

This chapter aims to bring you up to speed on the basic concepts and terminology used with Active Directory. It is important to understand each component of Active Directory before embarking on a design, or your design may leave out a critical element.

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2.1. How Objects Are Stored and Identified

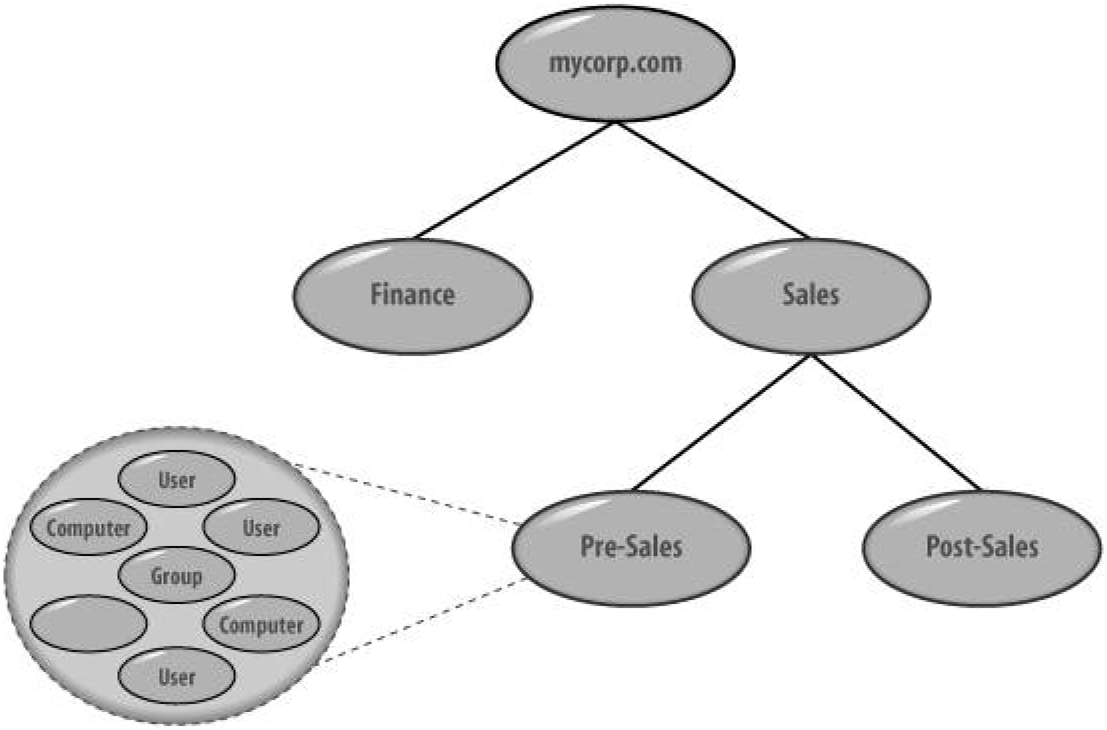
Data stored within Active Directory is presented to the user in a hierarchical fashion similar to the way data is stored in a file system. Each entry is referred to as an object. At the structural level, there are two types of objects : containers and non-containers, which are also known as leaf nodes. One or more containers branch off in a hierarchical fashion from a root container. Each container may contain leaf nodes or other containers. As the name implies, however, a leaf node may not contain any other objects.

> Although the data in Active Directory is presented hierarchically, it is actually stored in flat database rows and columns. The Directory Information Tree (DIT) file is an Extensible Storage Engine (ESE) database file. This answers the question "Does Active Directory use JET or ESE Database technology?" ESE *is* a JET technology.

Consider the parent-child relationships of the containers and leaves in Figure 2-1. The root of this tree has two children, Finance and Sales. Both of these are containers of other objects. Sales has two children of its own, Pre-Sales and Post-Sales. Only the Pre-Sales container is shown as containing additional child objects. The Pre-Sales container holds user, group, and computer objects as an example.[*] Each of these child nodes is said to have the Pre-Sales container as its parent. Figure 2-1 represents what is known in Active Directory as a domain.

[*] User, group, and computer objects are actually containers, as they can contain other objects such as printers. However, they are not normally drawn as containers in domain diagrams such as this.

Figure 2-1. A hierarchy of objects



The most common type of container you will create in Active Directory is an Organizational Unit (OU), but there are others as well, such as the one called Container. Each of these has its place, as we'll show later, but the one that we will be using most frequently is the Organizational Unit.

2.1.1. Uniquely Identifying Objects

When you are potentially storing millions of objects in Active Directory, each object has to be uniquely locatable and identifiable. To that end, objects have a Globally Unique Identifier (GUID) assigned to them by the system at creation. This 128-bit number is the Microsoft implementation of the UUID concept from Digital Equipment Corporation. UUIDs/GUIDs are commonly misunderstood to be guaranteed unique. This is not the case; the number is just statistically improbable to be duplicated before the year 3400 AD. In the documentation for the GUID creation API function, Microsoft says, "To a very high degree of certainty, this function returns a unique value." The object GUID stays with the object until it is deleted, regardless of whether it is renamed or moved within the Directory Information Tree (DIT).

Although an object GUID is resilient, it is not very easy to remember, nor is it based on the directory hierarchy. For that reason, another way to reference objects, called an ADsPath, is more commonly used.

2.1.1.1. ADsPaths

Hierarchical paths in Active Directory are known as ADsPaths and can be used to uniquely reference an object. In fact, ADsPath is a slightly more general term and is used by Microsoft to apply to any path to any of the major directories: Active Directory, Windows NT, Novell's NDS, and many others.

ADsPaths for Active Directory objects are normally represented using the syntax and rules defined in the LDAP standards. Let's take a look at how a path to the root of Figure 2-1 looks:

```
LDAP://dc=mycorp,dc=com
```

The path starts with a programmatic identifier (progID) of LDAP followed by a colon (:) and a double forward slash (//).

> You probably noted that we said the LDAP progID is most often used in an ADsPath, but that isn't always the case. ADsPaths to other directories can use other progIDs. We go into these other progIDs in more depth in Chapter 18.

In the previous ADsPath, after the progID, you represent the domain root, mycorp.com, by separating each part with a comma and prefixing each part with the letters "dc." If the domain had been called mydomain.mycorp.com, the ADsPath would have looked like this:

```
LDAP://dc=mydomain,dc=mycorp,dc=com
```

> DC stands for Domain Name Component and is used to specify domain or application partition objects. Application partitions are covered in Chapter 3.

A distinguished name (DN) is the name used to uniquely reference an object in a DIT. A relative distinguished name (RDN) is the name used to uniquely reference an object within its parent container in a DIT. For example, this is the ADsPath for the default Administrator account in the Users Container in the mycorp.com domain:

```
LDAP://cn=Administrator,cn=Users,dc=mycorp,dc=com
```

This is the DN of the same user (note the absence of the progID):

```
cn=Administrator,cn=Users,dc=mycorp,dc=com
```

This is the RDN of the user:

```
cn=Administrator
```

These paths are made up of names and prefixes separated by the equal sign (=). Another prefix that will become very familiar to you is OU, which stands for Organizational Unit. Here is an example:

```
cn=Keith Cooper,ou=Northlight IT Ltd,dc=mycorp,dc=com
```

All RDNs use a prefix to indicate the class of the object that is being referred to. Any object class that does not have a specific letter code uses the default of `cn`, which stands for Common Name. Table 2-1 provides the complete list of the most attribute types among the directory server implementations. The list is from RFC 2253 , and the full text can be found at http://www.ietf.org/rfc/rfc2253.txt.

Table 2-1. Attribute types from RFC 2253

Key	Attribute
`CN`	Common Name
`L`	Locality Name
`ST`	State or Province Name
`O`	Organization Name
`OU`	Organizational Unit Name
`C`	Country Name
`STREET`	Street Address
`DC`	Domain Component
`UID`	Userid

Active Directory supports using `CN`, `L`, `O`, `OU`, `C`, and `DC`. `CN` is used in the majority of cases.

2.1.1.2. Examples

Let's take a look at Figure 2-1 again. If all the containers were Organizational Units, the ADsPaths for Pre-Sales and Post-Sales would be as follows:

```
LDAP://ou=Pre-Sales,ou=Sales,dc=mycorp,dc=com
LDAP://ou=Post-Sales,ou=Sales,dc=mycorp,dc=com
```

And if you wanted to specify a user named Richard Lang, a group called My Group, and a computer called Moose in the Pre-Sales OU, you would use the following:

```
LDAP://cn=Richard Lang,ou=Pre-Sales,ou=Sales,dc=mycorp,dc=com
LDAP://cn=My Group,ou=Pre-Sales,ou=Sales,dc=mycorp,dc=com
LDAP://cn=Moose,ou=Pre-Sales,ou=Sales,dc=mycorp,dc=com
```

You can also reference a specific server by NetBIOS name or FQDN in the ADsPath as in the following example:

```
LDAP://server1/cn=Moose,ou=Pre-Sales,ou=Sales,dc=mycorp,dc=com
```

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2.2. Building Blocks

Now that we've shown how objects are structured and referenced, let's look at the core concepts behind

2.2.1. Domains and Domain Trees

Active Directory's logical structure is built around the concept of domains introduced in Windows NT 3.x a Directory, domains have been updated significantly from the flat and inflexible structure imposed by Win domain is made up of the following components:

- An X.500-based hierarchical structure of containers and objects
- A DNS domain name as a unique identifier
- A security service, which authenticates and authorizes any access to resources via accounts in the c domains
- Policies that dictate how functionality is restricted for users or machines within that domain

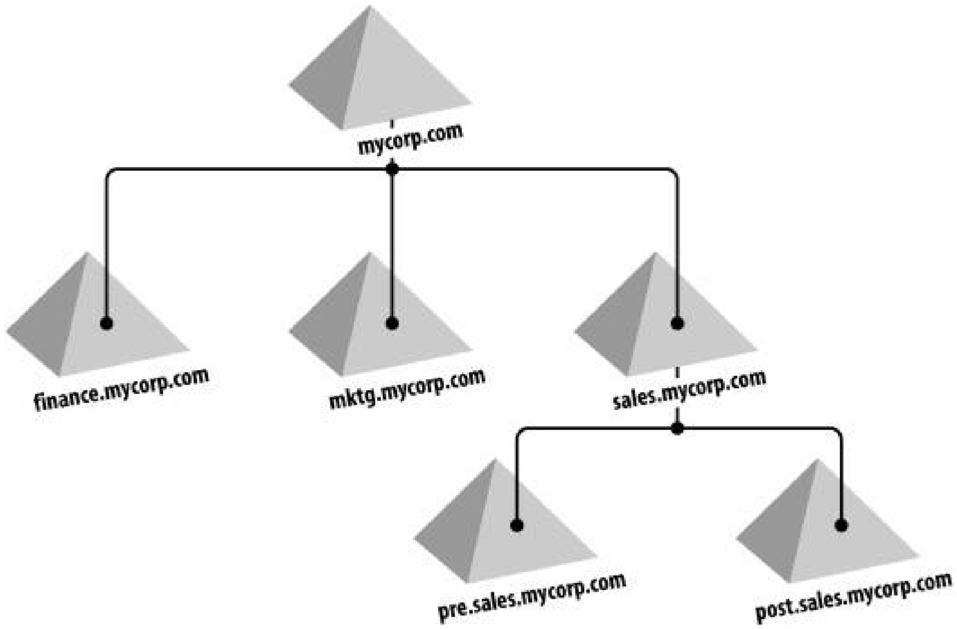
A domain controller (DC) can be authoritative for one and only one domain. Currently, it is not possible t single DC. For example, Mycorp Company has already been allocated a DNS domain name for their comp they decide that the first Active Directory domain that they are going to build is to be named mycorp.con domain in a series that needs to be created, and mycorp.com is in fact the root of a domain tree.

The mycorp.com domain itself, ignoring its contents, is automatically created as the root node of a hierar tree. This is literally a series of domains connected together in a hierarchical fashion, all using a contiguo Finance, Marketing, and Sales each want their own domain, the names become finance.mycorp.com , mk *sales.mycorp.com* . Each domain tree is called by the name given to the root of the tree; hence, this dom *mycorp.com* tree, as illustrated in Figure 2-2 . You can also see that we have added further domains belo sales.

You can see that in Mycorp's setup, we now have a contiguous set of domains that all fit into a neat tree. domain, it would still be a domain tree, albeit with only one domain.

Trees ease management and access to resources, as all the domains in a domain tree trust one another i In a transitive trust, if A trusts B and B trusts C, this implies that A trusts C as well. Put much more simp *finance.mycorp.com* can allow any user in the tree access to any of the resources in the finance domain t The object accessing the resource does not have to be in the same domain. This is equivalent to Windows

Figure 2-2. The mycorp.com domain tree



> Trust relationships do not compromise security, as they are just setting up the potential resources. Actual access permissions still have to be granted by administrators. This is granting access to `Everyone` or `Authenticated Users` on resources. Once a trust is estab trusted domain could be able to access those resources as well.

2.2.2. Forests

Now that you understand what a domain tree is, we move onto the next piece of the Active Directory stru domain tree was a collection of domains, a forest is a collection of one or more domain trees. These dom Configuration container and Schema, and the whole thing is connected together through transitive trusts domain, you have a forest. If you add any domains to the initial domain tree or add new domain trees, y

Forests are named after the domain that is created when creating a new forest, also known as the forest domain is important because it has special properties.

> In Active Directory, you can never remove the forest root domain. If you try to do so, th destroyed. Under Windows Server 2003 Active Directory, you can rename the forest ro cannot change its status as the forest root domain or make a different domain the root.

As we continue with Mycorp, we find that it has a subsidiary business called Othercorp. The DNS domain Othercorp is *othercorp.com* . In Othercorp's case, all you would need to do is create the root of the *other* the existing forest; thus, *othercorp.com* and *mycorp.com* can exist together and share resources. Individu their own forest, and in this scenario, you would want to employ a forest trust to provide seamless acces

A forest trust is a new type of trust in Windows Server 2003 that allows an administrator to create a singl way trust between two forest root domains. This trust allows all the domains in one forest to trust all the vice versa. Obviously, in this example, we wanted *othercorp.com* to be able to access *mycorp.com* 's reso doesn't have to be the case; each could have domain trees in its own separate forest with no communica forest containing the *mycorp.com* and *othercorp.com* domain trees is known as the *mycorp.com* forest, ir forest root.

> While multiple domain trees in a forest can be configured, you should seriously consider such a configuration before implementation. It can be confusing for troubleshooting effo working on an issue in the domain *othercorp.com* , but the configuration information for maintained in the `cn=configuration,dc=mycorp,dc=com` partition. This is especially true v resources not familiar with the implementation.

If you have business units that are independent and in fact wish to be isolated from each other, then you single forest. If you simply give each business unit its own domain, these business units are given the im autonomous and isolated from each other. However, in Active Directory, this level of autonomy and isola through separate forests . This is also the case if you need to comply with regulatory or legal isolation rec

> Building environments with separate forests has become popular in larger organizations impler separation of responsibilities. See:
>
> http://www.microsoft.com/technet/prodtechnol/windowsserver2003/technologies/directory/a
>
> for considerations for multiforest deployments.

2.2.3. Organizational Units

Having covered the large-scale (domains, trees, and forests) view of Active Directory, we'll now talk abou look inside an Active Directory domain, you will see a hierarchical structure of objects. This hierarchy is m as containers and objects that cannot. The primary type of container that you will create to house objects Unit. Another type of container, which is actually called a Container, can also be used to store a hierarchy

Although both can contain huge hierarchies of containers and objects, an Organizational Unit can have gr makes OUs the most significant structural component of a domain.

Let's illustrate this with an example. Imagine that you are the administrator of the *pre.sales.mycorp.com* have 500 users and 500 computer accounts in the domain. Most of the day-to-day account and machine the pre-sales engineers' section is currently undergoing restructuring and an extensive recruitment progr transferred in or hired from the outside. You would like to be able to give this group autonomy, by allowir to manage their own section of the tree, but it isn't a large enough requirement to justify creating anothe the associated domain controllers. You can instead create an Organizational Unit in your hierarchy called give the senior engineer authority over that Organizational Unit to create and delete accounts, change pa Organizational Units within the Pre-sales Engineers OU . Obviously, the permissions that the senior engin properly tailored so that he had control over only that Organizational Unit and not the *pre.sales.mycorp.c* You could do this manually or delegate control using the Delegation of Control wizard, discussed in more c

When you install an Active Directory domain, a number of default Containers (and one Organizational Un including the Users and Computers container and domain controller OU. If you try to create a new Contai no option to do so from within the Active Directory Users and Computers (ADUC) MMC snap-in. This also Locality, and Country container objects. This is intentional; in almost all cases, you would want to create of a Container. It is possible to create the other types of containers from within scripts and other LDAP to necessary. So, throughout this book, whenever we advocate creating hierarchies within domains, we alw After all, an Organizational Unit is just a superset of a Container, so there is nothing a Container can do t cannot.

Each forest has a child container called Configuration, which itself has a child container called Schema. Si Schema containers are not domain-naming contexts, they are not displayed in ADUC. There are additiona containers or, alternatively, you can view any container by specifically connecting to it directly using a to the Windows Support Tools. These containers are covered in more detail in Chapter 3 .

2.2.4. Global Catalog

The Global Catalog (GC) is a very important part of Active Directory because it is used to perform forest- implies, the Global Catalog is a catalog of all objects in a forest with a subset of attributes for each objec LDAP over port 3268, and with the GC:// progID in ADSI. The GC is read-only and therefore cannot be up

In multidomain forests, typically you first need to perform a query against the GC to locate the objects o a more directed query against a domain controller for the domain the object is in if you want to access al object.

The attributes that are available in the GC are members of the partial attribute set (PAS). You can add a PAS using tools such as the Active Directory Schema snap-in or by modifying the attributeSchema object schema.

> Under Windows 2000, adding an attribute to the PAS caused all GC servers in a forest to contents of the GC. This could have major replication and network traffic implications. F been resolved with Windows Server 2003 so that a GC resync no longer happens after a

2.2.5. Flexible Single Master of Operations (FSMO)

Even though Active Directory is a multimaster directory, there are some situations in which there should perform certain functions. In these cases, Active Directory nominates one server to act as the master for such functions that need to take place on one server only. The server that is the master for a particular f Flexible Single Master Operations (FSMO , pronounced "fizmo") role owner.

Of the five roles, three exist for every domain, and two apply to the entire forest. If there are 12 domains FSMO roles : 12 lots of 3 domain-wide FSMOs and 2 single forest-wide FSMOs. The number of different ro depending on whether you have domain controllers serving multiple roles, as is often the case.

The different FSMO roles are the following:

Schema Master (forest-wide)

The Schema Master role owner is the DC that is allowed to make updates to the schema. No other the schema. If you attempt to update the schema on a DC that doesn't hold the Schema FSMO, th schema role holder. The default FSMO Schema Master is the first server to be promoted in the fore

Domain Naming Master (forest-wide)

The Domain Naming Master role owner is the server that controls changes to the namespace. This domains and is required to rename or move domains within a forest, as well as authorize creation addition/removal of their replicas. Like the Schema Master, this role owner defaults to the first DC

PDC Emulator (domain-wide)

For backward-compatibility purposes, one Active Directory DC has to act as the Windows NT Prima This server acts as the Windows NT master browser, and it also acts as the PDC for down-level clie Controllers (BDCs). While doing this, it replicates the Windows NT SAM database to Windows NT 4.(though the PDC has very important legacy functions, don't be fooled into thinking that once you ha clients, it is no longer important. The PDC has other important functions: it attempts to maintain th account that is enforced by having the other DCs immediately forward any account password chan significance of this feature is in helping to support PDC-Chaining functions. PDC-Chaining occurs wl authenticate and the local DC doesn't think the password is correct. The local DC will then "chain" t the PDC to see if the PDC thinks the password is ok. The PDC is also the target of Group Policy Mar possibility for the same policy to be modified in different ways by different administrators on differe that the PDC in each domain is the primary time source for the domain and the PDC of the forest r source for the entire forest.

> The PDC-Chaining and the matching forwarding of the passwords to the PDC acro boundaries can be disabled by setting the `AvoidPdcOnWan` registry value to 1. This i key `HKLM\SYSTEM\CurrentControlSet\Services\Netlogon\Parameters` . If you susp isn't working, make sure this registry value isn't configured.

RID Master (domain-wide)

A Relative-Identifier (RID) Master exists per domain. Every security principal in a domain has a Sec system uses to uniquely identify that object for security permissions. In a way, this is similar to the but the SID is given only to security-enabled objects and is used only for security verification purpo authenticate using the SAM account name or Universal Principal Name (UPN) to reference an obje references you for authorization functions by the SID.

The server or workstation hosting those objects creates unique SIDs for standalone users, groups, NT/2000/XP workstations and Windows NT/2000/2003 servers in workgroups. In a domain, the SII entire domain. As each DC can create security-enabled objects, some mechanism has to exist so th created.

To keep conflicts from occurring, the RID Master maintains a large pool of unique RID values. Whe it is allocated a subset of 500 values from the RID pool for its own use. Whenever a DC needs to cre available value from its own RID pool to create the SID with a unique value.

In this way, the RID Master makes sure that all SIDs in a domain are unique RID values. When a W pool drops to 100 free values, the DC contacts the RID Master for another set of RID values. With W changed to 50% of the RID pool size, and the default RID pool size is 500 RIDs. The threshold is not Master can be unavailable to other DCs for a brief time without immediately impacting object creat charge of generating and maintaining a pool of unique values across the entire domain.

RID pool size can be configured by setting the RID Block Size value in the registry HKLM\SYSTEM\CurrentControlSet\Services\NTDS\RID values on the RID Master FSM recommended practice to set this value on *any* domain controller that could becor you do not have any inconsistencies in RID pool sizes after a RID Master FSMO tra

Infrastructure Master (domain-wide)

The Infrastructure Master is used to maintain references to objects in other domains, known as ph Domain B are members of a group in Domain A, the Infrastructure Manager on Domain A is used t phantom Domain B user members. These phantoms are not manageable nor even visible through backend construct to maintain consistency.

The Infrastructure FSMO role owner is used to continually maintain the phantoms whenever the ob or moved in the object's domain. When an object in one domain references an object in another dc reference by the GUID, the SID (for references to security principals), and the DN of the object bei Infrastructure FSMO role holder is the DC responsible for updating an object's SID and distinguishe object reference.

In a single-domain scenario, the Infrastructure FSMO has nothing to do, so it mak whether the FSMO role owner exists on a server that is also a GC. As soon as you domain, the FSMO role owner should be moved to a non-GC-hosting DC.

The Infrastructure FSMO is responsible for fixing up stale references from objects in its domain to c means references to objects that have been moved or renamed so that the local copy of the remot It does this by comparing its (potentially stale) naming data with that of a GC, which automatically updates for objects in all domains and hence has no stale data. The Infrastructure FSMO writes any and then replicates the updated information around to other DCs in the domain. However, if a GC a role, then by definition, that server hosting the GC will always be up to date and will therefore have notices that anything needs changing, it will never update any non-GC servers with Infrastructure u

If all DCs in the domain are also GCs, no server will have stale references, and the role is not significant.

FSMO roles can be transferred between domain controllers. You can transfer the Domain Naming FSMO w Domains and Trusts snap-in, the Schema FSMO with the Active Directory Schema snap-in, and the RID, Emulator FSMOs using the Active Directory Users and Computers snap-in. Alternatively, you can use the Windows 2000 Server and Windows Server 2003 platforms to perform transfers from a command line.

Although the AD snap-ins and *NTDSUTIL* can trivially transfer a role from one server to another while bot will be some cases in which a FSMO role owner becomes unavailable without previously transferring the r use *NTDSUTIL* to force an ungraceful transfer of the role to a server, known as seizing the role. When yo bringing the original FSMO role owner back online without first rebuilding the DC and removing the metad

To remove the metadata from the directory after a failed DCPROMO or if a domain cont cannot be repaired, see http://support.microsoft.com/default.aspx?scid=kb;en-us;216

If a server with a role becomes unavailable, another server is not automatically promot The administrator must move the role to a new owner manually.

One final word of warning: keep *NTDSUTIL* and other tools nearby on floppies or a mastered CD of utilitie familiar with using the tools in a test environment. If you lose one of the FSMO masters for a domain, yo you are in control of the situation and are promoting a new DC to be the relevant master, forcibly movin swiftly bringing back the DC that is the relevant master.

The fSMORoleOwner Attribute

The FSMO role owners are stored in Active Directory in different locations depending on the role. The DN holding the role is actually stored as the `fSMORoleOwner` attribute of various objects. For the *mycorp.com* are the containers that hold that attribute in the following order: PDC Role Owner, Infrastructure Master Schema Master, and Domain Naming Master:

```
LDAP://dc=mycorp,dc=com
LDAP://cn=Infrastructure,dc=mycorp,dc=com
LDAP://cn=RID Manager$,cn=System,dc=mycorp,dc=com
LDAP://cn=Schema,cn=Configuration,dc=mycorp,dc=com
LDAP://cn=Partitions,cn=Configuration,dc=mycorp,dc=com
```

The information in the attribute is stored as a DN, representing the NTDS Settings object of the domain the role owner. So, example contents for this attribute are:

```
 CN=NTDS Settings, CN=MYSERVER1, CN=Servers, CN=My Site, CN=Sites,
CN=Configuration, DC=mycorp, DC=com
```

> FSMO role placement has been a subject of some debate over the years. Some adminis placing each role on a different DC, while others advocate keeping all roles together. Fo keep the roles together on a single DC in each domain unless the load on the FSMO role splitting them up onto different servers. However, if you want to split them up, see http://support.microsoft.com/default.aspx?scid=kb;en-us;223346 for the latest guidan these roles.

2.2.6. Windows 2000 Domain Mode

Each Windows 2000 Active Directory domain is said to have one of two modes : mixed mode (the default mode domain allows servers running previous versions of Windows NT to exist as domain controllers in th domain supports only Windows 2000 or later domain controllers. Supporting a mixed-mode domain is ne to update Windows NT domains to Active Directory. A mixed-mode Active Directory domain emulates sor Windows NT domain. Remember that with previous versions of Windows NT, networks of servers used to Controller (PDC) for a domain that held a writeable copy of the accounts database, and zero or more Bac that held a read-only accounts database copied from the PDC. For an Active Directory network to suppor only one) of the Active Directory servers has to act as a PDC. That way, the old servers that look for a PD

The Windows NT PDC notifies the BDCs when a change occurs and the BDCs then request a copy of the a to get the relevant user, group, and computer accounts from Active Directory. While all accounts are pas each object are a much smaller subset of the total attributes that Active Directory now holds for these ty

Going from mixed mode to native mode is a simple, but one-way, change. Once you have decided to mov you simply connect to a DC with the Active Directory Domains and Trusts snap-in and change the mode u mode. After you have done this, the only way to go back is to reinstall all domain controllers of the doma made prior to the upgrade. Never upgrade to native mode unless you are certain that you will not require that domain.

> Moving any domain from mixed mode to native mode has no bearing in any way on any doesn't matter if it is the root domain or a sub-domain you are converting, because you ability of that domain to replicate data to older Windows NT servers within the domain, replicate and interact with Windows 2000 domain controllers in other domains.

The specific differences between mixed mode and native mode are shown in Table 2-2 .

Table 2-2. The differences between mixed mode and native

Action	Mixed mode	Native mode
Replication	PDC FSMO master sends updates to Windows NT BDCs; same DC acts like ordinary Active Directory DC when communicating with other Active Directory DCs. All Active Directory DCs use multimaster replication between themselves.	Only Active Directory multimaster replicatio
NetBIOS	Can't disable.	Can disable.

Action	Mixed mode	Native mode
Group functions	Windows NT Group Nesting rules; same scope group nesting disallowed for global and domain local groups. Domain local groups limited to DCs. Universal groups cannot be security enabled but can be nested in other universal groups. No conversion between group types nor scopes.	Windows AD Group Ne nesting allowed. Doma domain members. Uni enabled. Conversion b scopes allowed.
Account migration	`sIDHistory` is not available; cannot use *Movetree* or *ADMT* to move objects into the domain.	`sIDHistory` is availabl can be used.

One important difference between native-mode and mixed-mode domains has to do with groups. We'll g differences later in the chapter.

2.2.7. Windows Server 2003 Functional Levels

For the Windows Server 2003 release of Active Directory, Microsoft expanded on the domain mode conce levels . Whereas the domain modes applied only to domains, functional levels apply to both forests and d functional levels dictate what type of operating systems can assume the role of a domain controller in a c level also has an associated list of features that become available when the domain or forest reaches tha covered many of the features that are available for each functional level in Chapter 1 .

Functional levels are introduced into a domain and forest when the first domain controller running Window domain. By default, the domain functional level is set to "Windows 2000 Mixed," and the forest function le with domain modes under Windows 2000, functional levels can be set via the Active Directory Domains ar domain mode, once a functional level has been "elevated" to a higher status, it cannot be changed back.

Tables 2-3 and 2-4 show the operating systems that are supported by the various domain and forest func

Table 2-3. Domain functional levels

Functional level	Supported domain controller OS
Windows 2000 Mixed	Windows NT 4.0 Windows 2000 Windows Server 2003
Windows 2000 Native	Windows 2000 Windows Server 2003
Windows Server 2003 Interim	Windows NT 4.0 Windows Server 2003
Windows Server 2003	Windows Server 2003

Table 2-4. Forest functional levels

Functional level	Supported domain controller OS
Windows 2000	Windows NT 4.0 Windows 2000 Windows Server 2003
Windows Server 2003 Interim	Windows NT 4.0 Windows Server 2003
Windows Server 2003	Windows Server 2003

> For more information on upgrading to Windows Server 2003, check out Chapter 14 .

2.2.8. Groups

Active Directory supports three group scopes: domain local, domain global, and universal. Each of these differently based on which Windows 2000 domain mode or Windows Server 2003 functional level your for further, each group scope can have two types: distribution and security.

The type is the easiest bit to define. If the type is distribution, the group's SID is not added to a user's se that it cannot be used for Windows security purposes. These groups are generally used as a messaging li mail or send instant messages to all at once), though it is possible to use them for security groups for LD use Windows security. These groups are used in Exchange for Distribution Lists. Security groups, by cont logon, and the SIDs of any groups the user is a member of are added to the user's security token. Securi used for mailing lists.

> In the move from Exchange 5.5 to Exchange 2000, Exchange security was changed to u Windows security. Any Distribution Lists used to secure any Exchange resources, such a folders, or calendars will automatically be made into a security-enabled group by Excha confusing to administrators because it doesn't take an administrator to initiate the conv enabled user can do it.

The three different scopes of mailing lists and security groups result from the legacy of Windows NT and Global groups and domain local groups are the direct descendants of Windows NT groups; the membersh available from domain controllers of the domains they are created in. Universal groups are a new type of their membership is available from domain controllers of the domains they are created in, as well as all G Universal and global groups can be used in ACLs on any resource in the forest or in trusting domains. Do used in ACLs in the domain they are created in.

In order to fully understand how groups work in Active Directory, we will explain the following items in th

- How Windows NT groups have a bearing on Active Directory
- Which groups are available in mixed, native, and Windows Server 2003 functional levels
- Which security principals each group may contain in mixed, native, and Windows Server 2003 functi
- How you can nest groups across domain boundaries
- What options are available to you for converting between different group scopes in mixed, native, ar functional levels

To start with, let's take a look at how Windows NT handles groups.

2.2.8.1. Groups in Windows NT

Back in Windows NT, domains could have two scopes of groups : domain local and global. Both were secu group could contain users and global groups. The global group could contain only users. Both could have Member servers and workstations had local groups that were similar to domain local groups in that they v contain users or global groups. Administrators typically took advantage of the fact that global groups cou local groups. Users went into global groups, and local groups were given access to resources on local mac domain local groups were given access to resources on domain controllers. Then you simply put the globa local or domain local groups to assign the permissions.

Windows NT groups are still important in Windows 2000 mixed domains, since down-level Windows NT BD groups from the Active Directory PDC FSMO role owner. During an upgrade of a PDC from Windows NT to domain local and global groups are migrated to Active Directory domain local security groups and global s still appear as domain local and global groups to any Windows NT BDCs.

2.2.8.2. Group availability in various functional levels

Table 2-5 shows the groups that you can have at the various functional levels.

Table 2-5. Group availability at the various functional le

Scope of group	Type of group	Available in W2K Mixed	Available in W2K Native	Availabl
Domain local	Security	Yes	Yes	Yes
Domain global	Security	Yes	Yes	Yes
Universal	Security	No	Yes	Yes
Domain local	Distribution	Yes	Yes	Yes
Domain global	Distribution	Yes	Yes	Yes
Universal	Distribution	Yes	Yes	Yes

At first, the only difference appears to be that universal security groups are not available in Windows 200 group is available in all domain functional levels. The complexity lies in what each group may contain, an mode of your domain and which domain the group you wish to add comes from.

2.2.8.3. Group nesting in different functional levels

You have a Windows 2000 mixed-mode domain, and you want to create and then nest some groups. Tab describe the available options.

Table 2-6. Windows 2000 mixed-mode restrictions on group member

Scope	Type	Can contain domain local		Can contain domain global		Ca
		Distribution groups	Security groups	Distribution groups	Security groups	Di gr
Domain local	Distribution groups	Yes	Yes	Yes	Yes	Ye
	Security groups	No	No	Yes	Yes	Ye
Domain global	Distribution groups	No	No	Yes	Yes	No
	Security groups	No	No	No	No	No
Universal	Distribution groups	No	No	Yes	Yes	Ye
	Security groups	Not available	Not available	Not available	Not available	No

Two points to note: first, universal security groups are evidently not available in mixed mode, which corre Second, domain global security groups can only contain users in mixed mode.

When you convert a domain to Windows 2000 Native or Windows Server 2003 functional level, certain gr do not lose any group nesting options that you had in mixed mode. The new options can be summarized

- Domain local security groups can contain domain local security and domain local distribution groups members can contain domain local security groups.
- Domain global security groups can contain domain global security and domain global distribution gr
- Universal security groups become available.

Let's look at this summary using a table. Consider Table 2-7 , with the extra options available only in Win Windows Server 2003 emphasized in bold.

Table 2-7. Windows 2000 Native and Windows Server 2003 restrictions on g on group scope

		Can contain domain local		Can contain domain global		Ca
Scope	Type	Distribution groups	Security groups	Distribution groups	Security groups	Di gr
Domain local	Distribution groups	Yes	Yes	Yes	Yes	Ye
	Security groups	Yes	Yes	Yes	Yes	Ye
Domain global	Distribution groups	No	No	Yes	Yes	No
	Security groups	No	No	Yes	Yes	No
Universal	Distribution groups	No	No	Yes	Yes	Ye
	Security groups	No	No	Yes	Yes	Ye

Although these tables are fine, there is one other complicating factor that needs to be taken into account membership.

2.2.8.4. Group membership across domain boundaries

Restrictions for all groups are shown in Tables 2-8 and 2-9 . Two items are listed as "Special," which signi Windows 2000 Mixed, and distribution and security groups in Windows 2000 Native and Windows Server

Table 2-8. Restrictions on group membership based on grou

Group scope	Can contain users and computers from		Can contain domai
	Same domain	Different domain	Same domain
Domain local groups	Yes	Yes	Special
Domain global groups	Yes	No	No
Universal groups	Yes	Yes	No

Table 2-9. Restrictions on group membership based on d

Group scope	Can contain domain global groups from		Can contain uni
	Same domain	Different domain	Same domain
Domain local groups	Yes	Yes	Yes
Domain global groups	Special	No	No
Universal groups	Yes	Yes	Yes

Tables 2-8 and 2-9 work in conjunction with Tables 2-6 and 2-7 . You would normally check which groups Table 2-6 or 2-7 (if any) and then cross reference with Tables 2-8 and 2-9 to identify what options you ha

2.2.8.5. Converting groups

Converting groups from one scope to another is available only in Windows 2000 Native and Windows Ser limits on what groups can be converted based on the existing members of the group and the current type former should be fairly obvious based on the existing restrictions shown in Table 2-7 . The conversion pro group members would not be valid members of the new group type once the conversion had taken place to Windows 2000 Native or Windows Server 2003 mode, you gain the ability to convert between groups b

- Security groups can be converted to distribution groups.
- Distribution groups can be converted to security groups.
- A domain local group can be converted to a universal group provided that the domain local group is another domain local group.
- A domain global group can be converted to a universal group provided that the domain global group domain global groups.
- A universal group can be converted to a domain global group provided all members in the group are group existed in.
- A universal group can be converted to a domain local group.

> The benefit of converting a distribution group to a security group is probably obvious; y for Windows security purposes. The benefit of converting a security group to a distributi so obvious. The most useful aspect of this conversion is that you can safely disable a se whether or not it is being used. Previously, if you didn't know whether a group was bein to delete it and hope that nothing broke. If anything did break, you found yourself figur the group or trying to figure out how to use a new group. Now you can simply convert t distribution group, and if anything breaks, you simply change the group back into a secu restoring the old functionality.

2.2.8.6. Wrap-up

Although this all looks complicated, using the tables helps a lot. Ultimately you need to decide how long y 2000 mixed mode before going to Windows 2000 Native or Windows Server 2003 so that you can decide looking for. You also have to consider in Windows 2000 Native and Windows Server 2003 that the more u larger the GC, and the longer members of those groups will take to log on. Chapters 8 and 10 explain mo groups in your designs.

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2.3. Summary

In this chapter, we've gone over the groundwork for some of the main internals of Active Directory. We covered such concepts as domains, trees, forests, Organizational Units, the Global Catalog, FSMOs, Windows 2000 domain modes, and Windows Server 2003 functional levels. We then delved into how groups work in Active Directory and what features are available under the various domain modes and functional levels.

With this information under our belts, let's now take a look at how data is organized in Active Directory with Naming Contexts and Application Partitions.

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Chapter 3. Naming Contexts and Application Partitions

Due to the distributed nature of Active Directory, it is necessary to segregate data into partitions. If data partitioning were not used, every domain controller would have to replicate all the data within a forest. Often it is advantageous to group data based on geographical or political requirements. Think of a domain as a big data partition, which is also referred to as a naming context (NC). Only domain controllers that are authoritative for a domain need to replicate all of the information within it. On the other hand, there is some Active Directory data that must be replicated to all domain controllers. There are three predefined naming contexts within Active Directory:

- A Domain Naming Context for each domain
- The Configuration Naming Context for the forest
- The Schema Naming Context for the forest

Each of these naming contexts represents a different aspect of Active Directory data. The Configuration NC holds data pertaining to the configuration of the forest or forest-wide applications such as the objects representing naming contexts, LDAP policies, sites, subnets, MS Exchange, and so on. The Schema NC contains the set of object class and attribute definitions for the types of data that can be stored in Active Directory. Each domain in a forest also has a Domain NC, which contains data specific to the domainfor example, users, groups, computers, etc.

In Windows Server 2003 Active Directory, Microsoft extended the naming context concept by allowing user-defined partitions called application partitions. Application partitions can contain any type of object except for security principals. The major benefit of application partitions is that administrators can define which domain controllers replicate the data contained within these partitions. Application partitions are not restricted by domain boundaries, as is the case with Domain NCs; they can exist on any domain controller running Windows Server 2003 or later in a forest, regardless of the domain the DC hosts.

You can retrieve a list of the naming contexts and application partitions a specific domain controller maintains by querying its RootDSE entry. You can view the RootDSE by opening the LDP utility, which is available from the Windows Support Tools. Select Connection → Connect from the menu, enter the name of a domain controller, and click OK. The following attributes pertain to naming contexts and application partitions:

`namingContexts`

List of DNs of all the naming contexts and application partitions maintained by the DC `defaultNamingContext`

DN of the Domain NC the DC is authoritative for

`configurationNamingContext`

DN of the Configuration NC

`schemaNamingContext`

DN of the Schema NC

`rootNamingContext`

DN of the Domain NC for the forest root domain

In this chapter, we will review each of the three predefined naming contexts and describe the data contained within each, and then cover application partitions and example uses.

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3.1. Domain Naming Context

Each Active Directory domain is represented by a Domain NC, which holds the domain-specific data. The root of this NC is represented by a domain's distinguished name (DN) and is typically referred to as the NC head. For example, the mycorp.com domain's DN would be dc=mycorp,dc=com. Each domain controller in the domain replicates a copy of the Domain NC.

Table 3-1 contains a list of the default top-level containers found in a Domain NC. Note that to see all of these containers with the Active Directory Users and Computers (ADUC) snap-in, you must select View → Advanced Features from the menu. Alternatively, you can browse all of these containers with the ADSI Edit tool available in the Windows Support Tools on any Windows Server 2003 or Windows 2000 CD.

Table 3-1. Default top-level containers of a Domain NC

Relative distinguished name	Description
cn=Builtin	Container for predefined built-in local security groups. Examples include Administrators, Users, and Account Operators.
cn=Computers	Default container for computer objects representing member servers and workstations. You can change the default container used in Windows Server 2003 with the *redircmp.exe* utility.
ou=Domain Controllers	Default organizational unit for computer objects representing domain controllers.
cn=ForeignSecurityPrincipals	Container for placeholder objects representing members of groups in the domain that are from a domain external to the forest.
cn=LostandFound	Container for orphaned objects. Orphaned objects are objects that were created in a container that was deleted from another domain controller within the same replication period.
cn=NTDS Quotas	Container to store quota objects, which are used to restrict the number of objects a security principal can create in a partition or container. This container is new in Windows Server 2003.
cn=Program Data	Container for applications to store data instead of using a custom top-level container. This container is new in Windows Server 2003.
cn=System	Container for miscellaneous domain configuration objects. Examples include trust objects, DNS objects, and group policy objects.

Relative distinguished name	Description
`cn=Users`	Default container for user and group objects. You can change the default container used in Windows Server 2003 with the *redirusr.exe* utility.

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3.2. Configuration Naming Context

The Configuration NC is the primary repository for configuration information for a forest and is replicated to every domain controller in the forest. The root of the Configuration NC is found in the Configuration container, which is a sub-container of the forest root domain. For example, the mycorp.com forest would have a Configuration NC located at `cn=configuration,dc=mycorp,dc=com`.

Table 3-2 contains a list of the default top-level containers found in the Configuration NC.

Table 3-2. Default top-level containers of the Configuration NC

Relative distinguished name	Description
`cn=DisplaySpecifiers`	Container that holds display specifier objects, which define various properties and functions of the Active Directory MMC Snap-ins.
`cn=Extended-Rights`	Container for extended rights (`controlAccessRight`) objects.
`cn=ForestUpdates`	Contains objects that are used to represent the state of forest and domain functional level changes. This container is new in Windows Server 2003.
`cn=LostandFoundConfig`	Container for orphaned objects.
`cn=NTDS Quotas`	Container to store quota objects, which are used to restrict the number of objects that security principals can create in a partition or container. This container is new in Windows Server 2003.
`cn=Partitions`	Contains objects for each naming context, application partition, and external reference.
`cn=Physical Locations`	Contains location objects (`physicalLocation`), which can be associated with other objects to denote location of the object.
`cn=Services`	Store of configuration information about services such as FRS, Exchange, and even Active Directory itself.
`cn=Sites`	Contains all of the site topology and replication objects. This includes `site`, `subnet`, `siteLink`, `server`, and `ntdSConnection` objects, to name a few.
`cn=WellKnown Security Principals`	Holds objects representing commonly used foreign security principals, such as `Everyone`, `Interactive`, and `Authenticated Users`.

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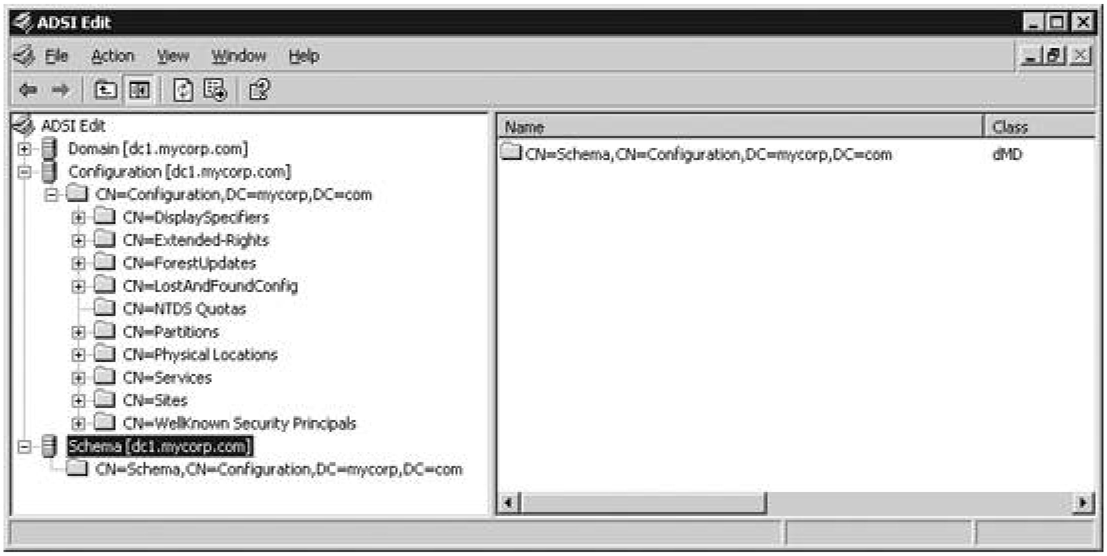
3.3. Schema Naming Context

The Schema NC contains objects representing the classes and attributes that Active Directory supports. The schema is defined on a forest-wide basis, so the Schema NC is replicated to every domain controller in the forest. The root of the Schema NC can be found in the Schema container, which is a sub-container of the Configuration container. For example, in the mycorp.com forest, the Schema NC would be located at `cn=schema,cn=configuration,dc=mycorp,dc=com`.

> Although the Schema container appears to be a child of the Configuration container, it is actually a separate naming context in its own right. Figure 3-1 shows how the Schema and Configuration NCs are segregated in the ADSI Edit tool.

Figure 3-1. ADSI Edit view of the Configuration and Schema naming contexts



ADSI Edit
- Domain [dc1.mycorp.com]
- Configuration [dc1.mycorp.com]
  - CN=Configuration,DC=mycorp,DC=com
    - CN=DisplaySpecifiers
    - CN=Extended-Rights
    - CN=ForestUpdates
    - CN=LostAndFoundConfig
    - CN=NTDS Quotas
    - CN=Partitions
    - CN=Physical Locations
    - CN=Services
    - CN=Sites
    - CN=WellKnown Security Principals
- Schema [dc1.mycorp.com]
  - CN=Schema,CN=Configuration,DC=mycorp,DC=com

Name	Class
CN=Schema,CN=Configuration,DC=mycorp,DC=com	dMD

You may be wondering why the schema isn't just contained within the Configuration NC. As we covered in Chapter 2, there is a Schema FSMO role that is the single master for updates to schema objects. The Schema FSMO role is necessary due to the highly sensitive nature of the schema. Schema modifications need to be processed prior to any updates that utilize the schema. The mechanism to most easily guarantee this with the replication model AD uses is to put the schema into its own partition so it can replicate separately prior to other changes.

Unlike the Domain and Configuration NCs, the Schema NC does not maintain a hierarchy of containers or organizational units. Instead, it is a single container that has `classSchema`, `attributeSchema`, and `subSchema` objects. The `classSchema` objects define the different types of classes and their associated attributes. The `attributeSchema` objects define all the attributes that are used as part of `classSchema` definitions. There is also a single `subSchema` instance that represents the abstract schema as defined in the LDAPv3 RFC (http://www.ietf.org/rfc/rfc2254.txt).

> Chapters 4 and 12 deal with the schema in more depth.

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3.4. Application Partitions

Application partitions are a new feature in Windows Server 2003. They enable administrators to create areas in Active Directory to store data on specific DCs they choose rather than on every DC in a domain or forest. You can define which domain controllers hold a copy of each application partition, known as a replica. There is no limitation based on domain or site membership, which means that you can configure any domain controller running Windows Server 2003 or later within a forest to hold any application partition replica. The existing site topology will be used to automatically create the necessary connection objects to replicate among the servers that hold replicas of an application partition. Domain controllers will also register the necessary SRV records (explained in more detail in Chapter 6), so that clients can use the DC locator process to find the optimal domain controller for an application partition, just as they would for a domain.

There are a few limitations to be aware of with application partitions :

- Application partitions cannot contain security principals, which most notably includes `user`, `inetOrgPerson`, `group`, and `computer` objects. Any other type of object can be created in an application partition.
- None of the objects contained in an application partition are replicated to the global catalog. Even if a domain controller that holds a replica of an application partition is also a global catalog server, the domain controller will not return any objects from the application partition during a global catalog search.
- Objects in an application partition cannot be moved outside the partition. This is different than objects contained in domains, which can be moved between domains.
- The Domain Naming FSMO must be on a Windows Server 2003 domain controller to create an application partition. After the application partition has been created, you can move the Domain Naming FSMO back to a Windows 2000 domain controller if necessary.

Application partitions are named similarly to domains. For example, if you created an application partition called "apps" directly under the *mycorp.com* domain, the DNS name would be *apps.mycorp.com* and the distinguished name would be `dc=apps,dc=mycorp,dc=com`. Application partitions can be rooted under domains, as shown in the previous example, nested under other application partitions (for example, `dc=sales,dc=apps,dc=mycorp,dc=com`), or as part of a new domain tree (for example, `dc=apps,dc=local`). For more information on creating and managing application partitions, check out the *NTDSUTIL* utility.

Application partitions tend to store dynamic datadata with a limited lifespan. See the next section for more on this. Dynamic data from network services such as DNS, Dynamic Host Configuration Protocol (DHCP), Common Open Policy Service (COPS), Remote Access Service (RAS), and RADIUS can all reside in a partition in AD. This allows uniformity of access from applications via a single methodology. This enables developers to write to a special area only available on specific servers rather than into a domain partition that is replicated to every DC. In fact, application partitions will allow multiple versions of COM+ applications to be installed and configured on the same computer, resulting in more cost-effective management of server applications.

The availability of Active Directory Application Mode (ADAM) has given administrators another option for storing directory data outside of the normal domain-naming contexts while still using Windows security and authentication. Instead of putting the application data in an application partition, you can instead place it in a dedicated ADAM instance. This allows you to offload administrative control to application owners or other administrators, as well as lessening the chance of an application negatively impacting a domain controller's primary NOS function. We discuss ADAM specifics in Chapter 18.

3.4.1. Storing Dynamic Data

Although application partitions give administrators more control over how to replicate application data, the problem of data cleanup still exists. That is, applications that add data to Active Directory are not always good about cleaning it up after it is no longer needed. That's why the ability to create dynamic data was also added as a feature in Windows Server 2003 Active Directory. Dynamic objects are objects that have a time-to-live (TTL) value that determines how long the object will exist before being automatically deleted by Active Directory. Dynamic objects typically have a fairly short life span (i.e., days). An example use of dynamic objects is an e-commerce web site that needs to store user session information temporarily. Because a directory is likely going to be where the user profile information resides, it can be advantageous to use the same store for session-based information, which is generally short-lived. The default TTL that is set for dynamic objects is 1 day, but can be configured to be as short as 15 minutes.

> The default TTL and minimum TTL can be modified by changing the `DynamicObjectDefaultTTLSeconds` and `DynamicObjectMinTTLSeconds` values in the `ms-DS-Other-Settings` attribute of the `CN=Directory Ser-vice,CN=Windows NT,CN=Services,CN=Configuration,DC=`...object.

To create a dynamic object, you simply have to add `dynamicObject` to the `objectClass` attribute when creating the object. Microsoft has specifically disabled the ability to add this objectClass to existing objects for safety reasons. This is why you cannot convert existing static objects into dynamic objects. The `entryTTL` attribute can also be set at creation time to set the TTL to something other than the one-day default. To prevent a dynamic object from being automatically deleted, you can "refresh" the object by resetting the `entryTTL` attribute for the object to a new TTL value (time in seconds).

> Dynamic objects do not get tombstoned like normal objects when they are deleted. A tombstone is not needed since the TTL mechanism allows them to be immediately removed from all domain controllers simultaneously.

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3.5. Summary

In this chapter, we covered how objects are grouped at a high level into naming contexts and application partitions, which are used as replication boundaries. The Domain NC contains domain-specific data such as users, groups, and computers. The Configuration NC contains forest-wide configuration data such as the site topology objects and objects that represent naming contexts and application partitions. The Schema NC contains all the schema objects that define how data is structured and represented in Active Directory. Application partitions were introduced in Windows Server 2003 Active Directory as a way for administrators to define their own grouping of objects and, subsequently, replication boundaries. Storage of DNS data for AD-integrated DNS zones is the classic example of when it makes sense to use application partitions, due to the increased control they give you over which domain controllers replicate the data. Dynamic objects are also new to Windows Server 2003 Active Directory. This allows you to create objects that have a time-to-live (TTL) value; after the TTL expires, Active Directory automatically deletes the object.

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Chapter 4. Active Directory Schema

The schema is the blueprint for data storage in Active Directory. Each object in Active Directory is an instance of a class in the schema. A user object, for example, exists as an instance of the user class. Attributes define the pieces of information that a class, and thus an instance of that class, can hold. Syntaxes define the type of data that can be placed into an attribute. As an example, if an attribute is defined with a syntax of Boolean, it can store True or False as its value.

Active Directory contains many attributes and classes in the default schema, some of which are based on standards and some of which Microsoft needed for its own use. However, the Active Directory schema was designed to be extensible, so that administrators could add any classes or attributes they deemed necessary. In fact, extending the schema is not a difficult task; it is often more difficult to design the changes that you would like to incorporate. Schema design issues are covered in Chapter 12, and in Chapter 27, we cover how to extend the schema programmatically. In this chapter, we're concerned only with the fundamentals of the schema.

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4.1. Structure of the Schema

The Schema Container is located in Active Directory under the Configuration Container. For example, the distinguished name of the Schema Container in the mycorp.com forest would be `cn=schema,cn=Configuration,dc=mycorp,dc=com`. You can view the contents of the container directly by pointing an Active Directory viewer such as *ADSIEdit* or *LDP* at it. You can also use the Active Directory Schema MMC snap-in, which splits the classes and attributes in separate containers for easy viewing, even though in reality all the schema objects are stored directly in the Schema Container.

The schema itself is made up of two types of Active Directory objects: classes and attributes. In Active Directory, these are known respectively as `classSchema` (Class-Schema) and `attributeSchema` (Attribute-Schema) objects. The two distinct forms of the same names result from the fact that the `cn` (Common-Name) attribute of a class contains the hyphenated easy-to-read name of the class, and the `lDAPDisplayName` (LDAP-Display-Name) attribute of a class contains the concatenated string format that is used when querying Active Directory with LDAP or ADSI. In the schema, the `lDAPDisplayName` attribute of each object is normally made by capitalizing the first letter of each word of the Common-Name, and then removing the hyphens and concatenating all the words together. Finally, the first letter is made lowercase.[*] This creates simple names like user, as well as the more unusual `sAMAccountName` and `lDAPDisplayName`. We'll specify the more commonly used LDAP display name format from now on.

[*] Names defined by the X.500 standard don't tend to follow this method. For example, the Common-Name attribute has an LDAP-Display-Name of cn, and the Surname attribute has an LDAP-Display-Name of sn.

Whenever you need to create new types of objects in Active Directory, you must first create a `classSchema` object, defining the class of the object and the attributes it contains. Once the class is properly designed and added to the schema, you can then create objects in Active Directory that use the class. Alternatively, if you want to add a new attribute to an object, you must first create the `attributeSchema` object and associate the attribute with whatever classes you want to use it with.

Before we delve into what makes up an Active Directory class or attribute, we need to explain how each class that you create is unique not just within your Active Directory but also throughout the world.

4.1.1. X.500 and the OID Namespace

Active Directory is based on LDAP, which was originally based on the X.500 standard created by the ISO (International Organization for Standardization) and ITU (International Telecommunications Union) organizations in 1988. To properly understand how the Active Directory schema works, you really need to understand the basics of X.500; we'll run through them next.

The X.500 standard specifies that individual object classes in an organization can be uniquely defined using a special identifying process. The process has to be able to take into account the fact that classes can inherit from one another, as well as the potential need for any organization in the world to define and export a class of their own design.

To that end, the X.500 standard defined an Object Identifier (OID) to uniquely identify every schema object. This OID is composed of two parts:

- One to indicate the unique path to the branch holding the object in the X.500 treelike structure
- Another to uniquely indicate the object in that branch

OID notation uses integers for each branch and object, as in the following example OID for an object:

```
1.3.6.1.4.1.3385.12.497
```

This uniquely references object 497 in branch 1.3.6.1.4.1.3385.12. The 1.3.6.1.4.1.3385.12 branch is contained in a branch whose OID is 1.3.6.1.4.1.3385, and so on.

> Each branch within an OID number also corresponds to a name. This means that the dotted notation 1.3.6.1.4.1, for example, is equivalent to *iso.org.dod.internet.private.enterprise*. As the names are of no relevance to us with Active Directory, we don't cover them in this book.

This notation continues today and is used in the Active Directory schema. If you wish to create a schema object, you need to obtain a unique OID branch for your organization. Using this as your root, you can then create further branches and leaf nodes within the root, as your organization requires.

The Internet Assigned Numbers Authority (IANA) maintains the main set of root branches. The IANA says of itself:

The central coordinator for the assignment of unique parameter values for Internet protocols. The IANA is chartered by the Internet Society (ISOC) and the Federal Network Council (FNC) to act as the clearinghouse to assign and coordinate the use of numerous Internet protocol parameters. The Internet protocol suite, as defined by the Internet Engineering Task Force (IETF) and its steering group (the IESG), contains numerous parameters, such as Internet addresses, domain names, autonomous system numbers (used in some routing protocols), protocol numbers, port numbers, management information base object identifiers, including private enterprise numbers, and many others. The common use of the Internet protocols by the Internet community requires that the particular values used in these parameter fields be assigned uniquely. It is the task of the IANA to make those unique assignments as requested and to maintain a registry of the currently assigned values. The IANA is located at and operated by the Information Sciences Institute (ISI) of the University of Southern California (USC).

You can find the IANA web page at http://www.iana.org.

You can request an OID namespacei.e., a root OID number from which you can create your own branchesdirectly from the IANA if you like. These numbers are known as Enterprise Numbers. The entire list of Enterprise Numbers assigned by the IANA can be found at http://www.iana.org/assignments/enterprise-numbers/. This list of numbers is updated every time a new one is added. At the top of the file, you can see that the root that the IANA uses is 1.3.6.1.4.1. If you look down the list, you will see that Microsoft has been allocated branch 311 of that part of the tree, so Microsoft's OID namespace is 1.3.6.1.4.1.311. Leicester University's OID namespace is 1.3.6.1.4.1.3385. As each number also has a contact email address alongside it in the list, you can search through the file for any member of your organization that has already been allocated a number. It is likely that large organizations that already have an X.500 directory or that have developed SNMP MIBs will have obtained an OID.

> In addition to Enterprise Numbers, country-specific OIDs can be purchased as well. An organization's Enterprise Number registration has no bearing on whether it has obtained a country-based OID namespace to use. If you don't see the company listed in the Enterprise Numbers list, don't be fooled; the organization could still have a number.
>
> For example, Microsoft has been issued the Enterprise Number 1.3.6.1.4.1.311, yet all of its new schema classes use a U.S.-issued OID namespace of 1.2.840.113556 as their root. The 1.2.840 part is uniquely allotted to the United States. In other words, Microsoft has obtained two OID namespaces that it can use but is choosing to use only the U.S.-issued namespace.

If you want to obtain an Enterprise Number, fill in the online form at http://www.isi.edu/cgi-bin/iana/enterprise.pl. If this URL changes, you can navigate to it from the main IANA web page.

To assist customers in using properly assigned Enterprise Numbers, Microsoft has made a part of their namespace available for use. You can obtain an Enterprise Number from Microsoft's namespace by following the instructions at http://msdn.microsoft.com/certification/ad-registration.asp. At present, you send an email containing your company name, contact name, email address, phone number, schema prefix, and alternate prefix (in case your initial prefix is already taken) to schemreg@microsoft.com. If you have an Enterprise Number from another source, you should still send an email to this address and register your Enterprise Number and prefix. This can help prevent collisions on prefix names with other companies, and also allows you to register for `linkIDs` used in linked attributes.

> Companies who do not intend to produce schema updates for use outside of their own forests may not see a benefit in registering their prefix. The benefit for them comes into play if they find out someone else has already registered that name, or if some software vendor tried to register the name and they see it is already registered. For example, say you have the company MyCorp Financial Services that extends their schema with attributes with names such as `mycorpAttrib1`, `mycorpAttrib2`, etc. Then they purchase an application from MyCorp Software Solutions, who also chose to use attribute names of `mycorpAttrib1`, `mycorpAttrib2`, etc. MyCorp Financial Services would be in a very bad position. Their only option would be changing all previous uses of the attributes so it could be used by the application; otherwise, they can't use the application that they have purchased.

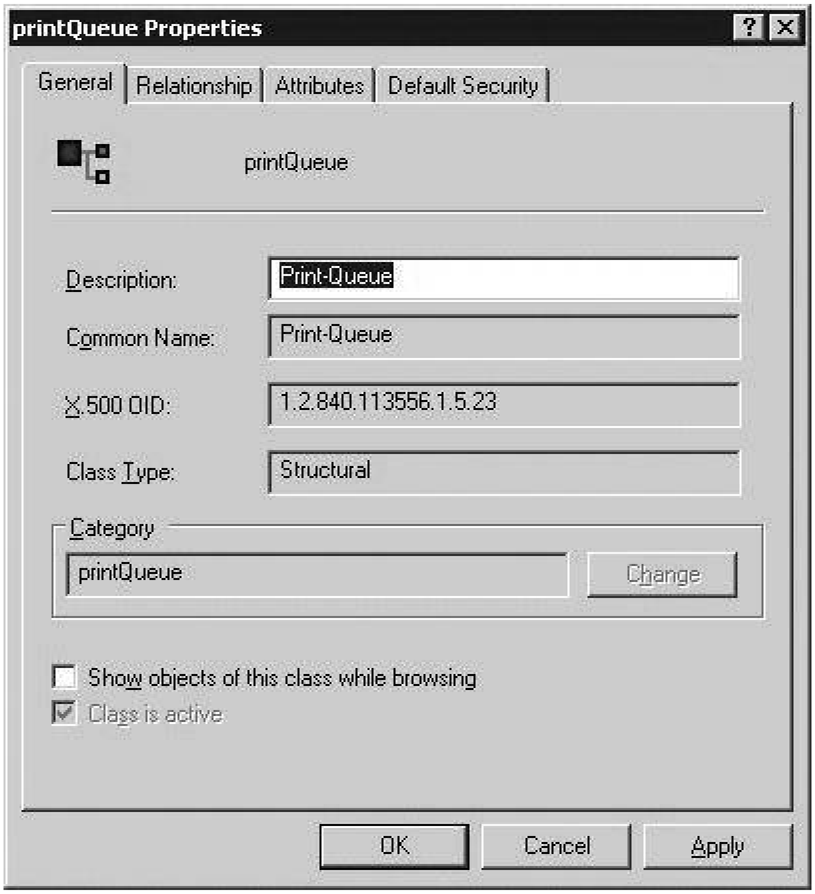
Once an organization has an OID namespace, it can add unique branches and leaves in any manner desired under the root. For example, Leicester University could decide to have no branches underneath and just give any new object an incrementing integer starting from 1 underneath the 1.3.6.1.4.1.3385 root. Alternatively, they could decide to make a series of numbered branches starting from 1, each corresponding to a certain set of classes or attributes that they wish to create. Thus, the fifth object under the third branch would have an OID of 1.3.6.1.4.1. 3385.3.5.

> The range of values in any part of an OID namespace for the Active Directory schema goes from 1 to 268,435,455, i.e., from 2*0* through 2*28* - 1.

This limitation has caused issues with schema extensions for some companies in Australia. Australia has the OID 1.2.36, and according to the Australia Standards document MP-75, companies may use their Australian Company Number (excluding leading zeros) to formulate their OID without needing to request an OID. Unfortunately the ACN is nine digits, so it could easily exceed the limitation listed above. This has been filed as a bug and Microsoft is aware of the issue.

To reinforce this point, let's look at a couple of examples directly from the Active Directory schema. If you open the Active Directory Schema snap-in, you can look at the schema class OIDs very easily. Navigating through the classes when we open the property page for the `printQueue` class, we get Figure 4-1. You can see that the unique OID is 1.2.840.113556.1.5.23. This tells us that the number is a defined part of Microsoft's object class hierarchy.

Figure 4-1. printQueue Schema class properties



printQueue

Description: Print-Queue

Common Name: Print-Queue

X.500 OID: 1.2.840.113556.1.5.23

Class Type: Structural

Category

printQueue

□ Show objects of this class while browsing

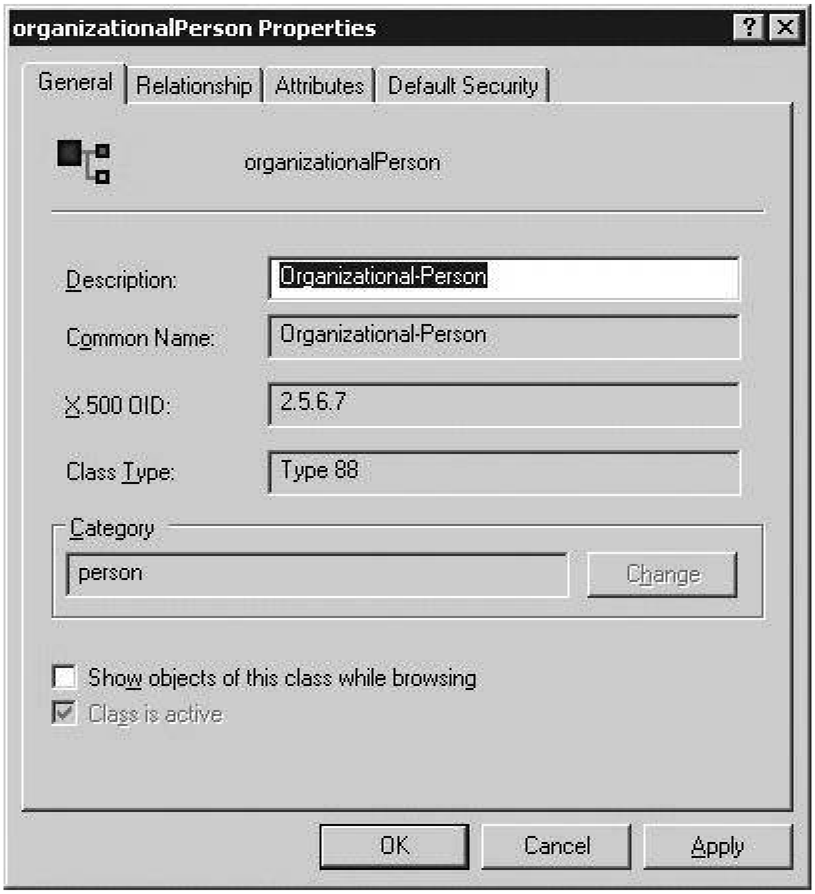
☑ Class is active

Figure 4-2 shows the property page for the organizationalPerson class. Here, you can see that the unique OID 2.5.6.7 is very different, because within the original X.500 standard, a set of original classes was defined. One of these was organizationalPerson, and this is a copy of that class. Microsoft included the entire base X.500 classes within Active Directory.

> The OID numbering notation has nothing to do with inheritance. Numbering a set of objects a certain way does nothing other than create a structure for you to reference the objects. It does not indicate how objects inherit from one another.

Let's dissect an example attribute and class to see what they contain. With that information, you will be able to see what is required when you create a new schema object.

Figure 4-2. organizationalPerson Schema class properties



organizationalPerson

Description: Organizational-Person

Common Name: Organizational-Person

X.500 OID: 2.5.6.7

Class Type: Type 88

Category: person

☐ Show objects of this class while browsing

☑ Class is active

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4.2. Attributes (attributeSchema Objects)

Just as class information is stored in Active Directory as instances of the class called classSchema, attributes are represented by instances of the class called attributeSchema. As with all objects, the attributeSchema class has a number of attributes that can be set when specifying a new instance. The attributeSchema class inherits attributes from the class called top. However, most of the top attributes are not really relevant here. Table 4-1 shows the defining attributes of an instance of the attributeSchema class (i.e., an attribute) that can be set.

Table 4-1. The defining attributes of an attributeSchema object instance

Attribute	Syntax	Mandatory	Multivalued	Description
accessCategory	Integer	No	No	Used by the system.
attributeId	OID	Yes	No	The OID that uniquely identifies this attribute.
attributeSecurityGUID	GUID	No	No	GUID used to tie an attribute to a property set.
attributeSyntax	OID	Yes	No	Half of a pair of properties that define the syntax of an attribute. This one is an OID.
classDisplayName	Unicode string	No	No	The name displayed when viewing instances of the attribute.
cn	Unicode string	Yes	No	The Relative Distinguished Name (RDN).
defaultHidingValue	Boolean	No	No	Whether the object is to be hidden or displayed within tools by default.
description	Unicode string	No	No	A description of the attribute.
extendedCharsAllowed	Boolean	No	No	Whether extended characters are allowed in the value of this attribute.
isDefunct	Boolean	No	No	Whether the attribute is marked as disabled (i.e., unusable) in Active Directory.
isEphemeral	Boolean	No	No	Used by the system.

Attribute	Syntax	Mandatory	Multivalued	Description
isMemberOfPartialAttributeSet	Boolean	No	No	Whether the attribute is held in the GC.
isSingleValued	Boolean	Yes	No	Whether this attribute is multivalued.
lDAPDisplayName	Unicode string	Yes	No	The name by which LDAP clients identify this attribute.
linkID	Integer	No	No	Whether the attribute is linked with another attribute (e.g., memberOf and member).
mAPIDisplayType	Integer	No	No	The integer by which MAPI clients identify this attribute.
objectClass	OID	Yes	Yes	This will hold the values attributeSchema and top to indicate that the value is an instance of those classes.
oIDType	Integer	No	No	Used by the system.
oMObjectClass	Octet string	No	No	Used by the system.
oMSyntax	Integer	Yes	No	Half of a pair of properties that define the syntax of an attribute. This one is an integer.
rangeLower	Integer	No	No	For strings, this is the minimum character length; for integers, it is the minimum value; otherwise, it is unused. It must be less than rangeUpper.
rangeUpper	Integer	No	No	For strings, this is the maximum character length; for integers, it is the maximum value; otherwise, it is unused.
schemaFlags	Integer	No	No	Used by the system.
schemaFlagsEx	Integer	No	No	Used by the system.
schemaIDGUID	Octet string	Yes	No	Globally Unique Identifier (GUID) to uniquely identify this attribute.
searchFlags	Integer	No	No	Integer with various bit flags that specify search and indexing information.

Attribute	Syntax	Mandatory	Multivalued	Description
systemFlags	Integer	No	No	Integer with bit flags that define additional properties for the attribute.
systemOnly	Boolean	No	No	If true, once the initial value has been set, only the system can create instances of this attribute. Administrators cannot create instances of the attribute if this is set, but they can add this attribute to new or existing classes as required. The default is false.

The syntax of an attribute indicates the type of data that it holds, which we'll cover in a moment. The "Mandatory" column indicates whether the attribute must be set when initially creating an attributeSchema object. Attributes that are not mandatory do not have to be set when creating the object and can be defined later, if they are needed at all. The "Multivalued" column indicates whether the particular attribute can accept an array of values or whether it accepts only a single value; there are no multivalued attributes here other than objectClass.

4.2.1. Dissecting an Example Active Directory Attribute

The userPrincipalName (UPN) attribute is used on user objects to provide a unique method of identifying each user across a forest. Users can log on to a workstation in any domain in the forest using the UPN if they so desire. The UPN attribute , in fact, accepts valid RFC 822 (email) addresses, so the UPN for user *tpood* in the *emea.mycorp.com* domain could be tpood@mycorp.com or tpood@emea.mycorp.com, or even tpood@logon.local. In fact, any UPN suffix, such as @mycorp.com, can be used in a forest. The only requirement is that the UPN value for a user is unique across all users in a forest.

> Active Directory does not enforce uniqueness of a UPN when it is set. If two different users in the same forest are assigned the same UPN, neither will be able to log on using the UPN.

To dissect the attribute, we need to find out what values had been set for it. Perhaps the easiest way to do this is to use *ADSIEdit* from the Windows Support Tools, which can be installed from a Windows Server CD by running *\Support\Tools\setup.exe*. Table 4-2 shows the values of attributes that have been set for the userPrincipalName attribute.

Table 4-2. userPrincipalName's attributes

Attribute lDAPDisplayName	Attribute syntax	Attribute value
adminDescription	CASE_IGNORE_STRING	User-Principal-Name
adminDisplayName	CASE_IGNORE_STRING	User-Principal-Name
attributeID	CASE_IGNORE_STRING	1.2.840.113556.1.4.656
attributeSecurityGUID	OCTET_STRING	GUID for Public Information property set
attributeSyntax	CASE_IGNORE_STRING	2.5.5.12
cn	CASE_IGNORE_STRING	User-Principal-Name
distinguishedName	DN_STRING	cn=User-Principal-Name, cn=Schema, cn=Configuration,dc=mycorp,dc=com
instanceType	INTEGER	4
isMemberOfPartialAttributeSet	BOOLEAN	True
isSingleValued	BOOLEAN	True
lDAPDisplayName	CASE_IGNORE_STRING	userPrincipalName
name	CASE_IGNORE_STRING	User-Principal-Name
nTSecurityDescriptor	SECURITY_DESCRIPTOR	Binary representation of the Security Descriptor for the attribute.
objectCategory	DN_STRING	cn=Attribute-Schema, cn=Schema, cn=Configuration, dc=mycorp,dc=com
objectClass	CASE_IGNORE_STRING	top; attributeSchema (two values of a multivalued attribute)
objectGUID	OCTET_STRING	<GUID>
oMSyntax	INTEGER	64
schemaIDGUID	OCTET_STRING	<GUID>
searchFlags	INTEGER	1 (Indexed)
showInAdvancedViewOnly	BOOLEAN	True
systemFlags	INTEGER	18 (Category 1 attribute, replicated to GC)
systemOnly	BOOLEAN	False
uSNChanged	LARGE_INTEGER	USN when last changed
uSNCreated	LARGE_INTEGER	USN when created
whenChanged	UTC_TIME	Time when last changed on this DC
whenCreated	UTC_TIME	Time when created

We can see that the name of the attribute is User-Principal-Name (adminDescription, adminDisplayName, cn, name), that it is an instance of the attributeSchema class (ob-jectCategory and objectClass), that it inherits attributes from both top and attri-buteSchema (objectClass), and that the UPN attribute is not visible to casual browsing (showInAdvancedViewOnly).

The userPrincipalName attributes show the following:

- It is to be stored in the GC (isMemberOfPartialAttributeSet and systemFlags).
- It is to be indexed (searchFlags).
- It has an OID of 1.2.840.113556.1.4.656 (attributeID).
- When binding to it with ADSI, we should use userPrincipalName (lDAPDisplayName).
- Instances can be created by anyone (systemOnly).
- It stores single (isSingleValued) Unicode strings (attributeSyntax and oMSyntax).

In Figure 4-3, you can see many of the values for the UPN attribute. We have indicated which attributes are changed by checking or unchecking each checkbox.

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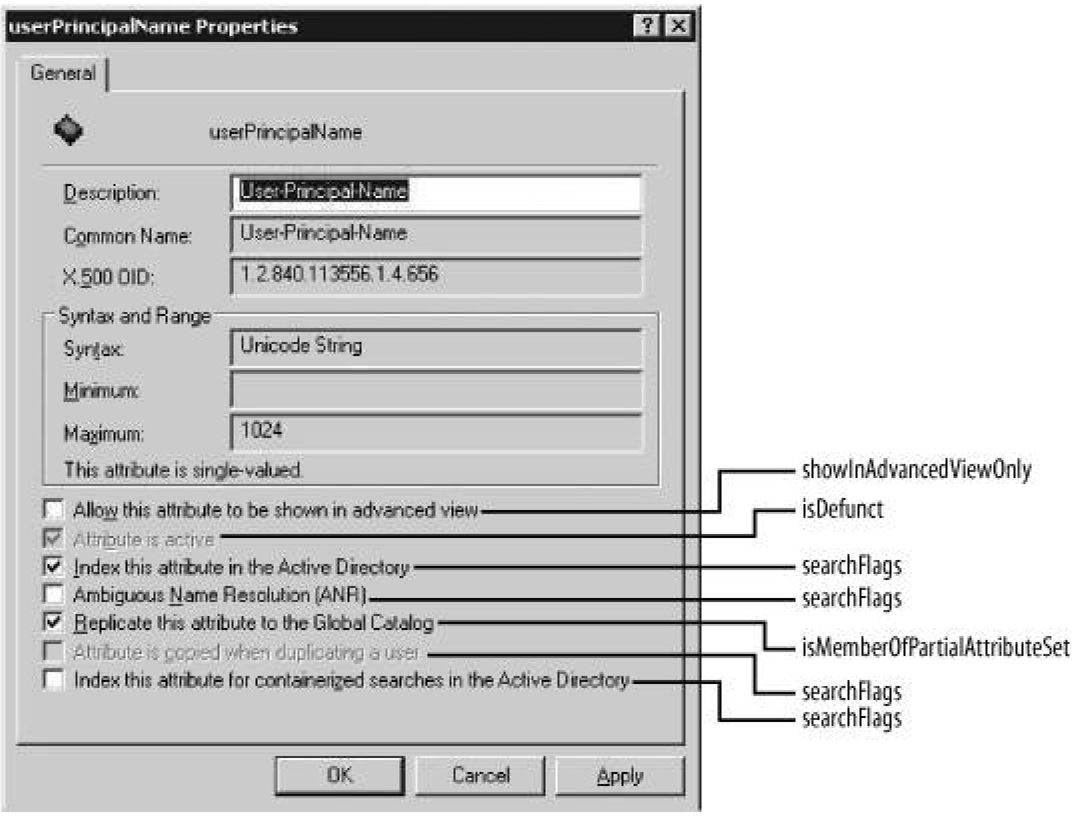
4.3. Attribute Properties

There are several properties on attributes that have significant and varied impact on attribute use and functionality. Here we give a little more detailed information on a few of these attributes that you need to understand when modifying the schema.

Figure 4-3. The UPN attribute as viewed by the Active Directory Schema snap-in



userPrincipalName Properties

General

userPrincipalName

Description: User-Principal-Name

Common Name: User-Principal-Name

X.500 OID: 1.2.840.113556.1.4.656

Syntax and Range

Syntax: Unicode String

Minimum:

Maximum: 1024

This attribute is single-valued.

☐ Allow this attribute to be shown in advanced view

☑ Attribute is active

☑ Index this attribute in the Active Directory

☐ Ambiguous Name Resolution (ANR)

☑ Replicate this attribute to the Global Catalog

☐ Attribute is copied when duplicating a user

☐ Index this attribute for containerized searches in the Active Directory

4.3.1. Attribute Syntax

The syntax of an attribute represents the kind of data it can hold; people with a programming background are probably more familiar with the term "data type." Unlike attributes and classes, the supported syntaxes are not represented as objects in Active Directory. Instead, Microsoft has coded these syntaxes internally into Active Directory itself. Consequently, any new attributes you create in the schema must use one of the predefined syntaxes.

Whenever you create a new attribute, you must specify its syntax. To uniquely identify the syntax among the total set of 21 syntaxes, you must specify 2 pieces of information: the OID of the syntax and a so-called OM syntax. This pair of values must be set together and correctly correlate with Table 4-3. More than one syntax has the same OID, which may seem strange; and to distinguish between different syntaxes uniquely, you thus need a second identifier. This is the result of Microsoft requiring some syntaxes that X.500 did not provide. Table 4-3 shows the 21 expanded syntaxes, including the name of the syntax with alternate names followed in parentheses.

Table 4-3. Syntax definitions

Syntax	OID	OM syntax	Description
Address	2.5.5.13	127	Used internally by the system
Boolean	2.5.5.8	1	True or false
Case-insensitive string	2.5.5.4	20	A string that does not differentiate between uppercase and lowercase
Case-sensitive string	2.5.5.3	27	A string that differentiates between uppercase and lowercase
Distinguished name	2.5.5.1	127	The Fully Qualified Domain Name (FQDN) of an object in Active Directory
DN-Binary	2.5.5.7	127	Octet string with binary value and DN. Format: B:<char count>:<binary value>:<object DN>
DN-String	2.5.5.14	127	Octet string with string value and DN. Format: S:<char count>:<string value>:<object DN>
Generalized-Time	2.5.5.11	24	ASN1.1 time format. e.g 20040625234417.0Z
Integer (enumeration)	2.5.5.9	10	A 32-bit number
Integer (integer)	2.5.5.9	2	A 32-bit number
Large integer	2.5.5.16	65	A 64-bit number
NT Security Descriptor	2.5.5.15	66	A Security Descriptor (SD)
Numeric string	2.5.5.6	18	A string of digits
Object ID	2.5.5.2	6	OID
Octet string (Octet-String)	2.5.5.10	4	A byte string
Print case string (IA5-String)	2.5.5.5	22	A normal printable string
Print case string (Printable-String)	2.5.5.5	19	A normal printable string

Syntax	OID	OM syntax	Description
Replica-Link	2.5.5.10	127	Replication information
SID	2.5.5.17	4	A security identifier (SID)
Undefined	2.5.5.0	N/A	Not a valid syntax
Unicode	2.5.5.12	64	A wide string
UTC-Time	2.5.5.11	23	The number of seconds elapsed since 1 January 1970

Most of these are standard programming types. If you're not sure which syntax to use, take a look at a preexisting attribute and see if you can find an appropriate syntax for the attribute you wish to create. For example, the `userPrincipalName` attribute has an `attributeSyntax` of 2.5.5.12 and an `oMSyntax` of 64, so it must contain Unicode strings.

4.3.2. System Flags

The `systemFlags` attribute is an often overlooked but important attribute. The attribute is a series of bits representing how the attribute should be handled. The bits are cumulative so if bits 0 and 1 are set, the attribute will have the value of 3. New bit values can be defined any time that Microsoft updates the directory service binaries. This attribute is configured both on schema definitions of attributes and classes as well as on objects instantiated throughout the forest. This can be confusing but the various bits in the attribute can mean various things depending on the object the attribute applies to. Table 4-4 lists only the values for `systemFlags` on `attributeSchema` and `classSchema` objects.

Table 4-4. System flag values for class and attributes objects

Value	Description
1 (0x0001)	Attribute is not replicated.
2 (0x0002)	Attribute will be replicated to the global catalog. This value should only be set by Microsoft; do not use. Instead, use `isMemberOfPartialAttributeSet` attribute for adding attributes to PAS.
4 (0x0004)	Attribute is constructed , not stored in the database.
16 (0x0010)	Category 1 attribute or class. Category 1 objects are classes and attributes that are included in the base schema with the system. Note that not all classes and attributes included in the base schema are marked as category 1.
134217728 (0x08000000)	The schema object cannot be renamed.

4.3.2.1. Constructed attributes

Most attributes are directly stored in the Active Directory database. Constructed attributes are the exception and handled by the directory service to offer special functionality. This functionality can range from telling you approximately how many objects are contained directly under a container type object (msDS-Approx-Immed-Subordinates) to telling you the types of objects that can be instantiated under a given object (possibleInferiors) to telling you which attributes you have write access to on a given object (allowedAttributesEffective), and many other things. These attributes, because they are special, have some rules you should be aware of. These attributes:

- Should not be replicated. They are constructed by each directory instance separately.
- Cannot be used in server-side sorting.
- Generally cannot be used for queries. The attribute aNR is an exception here as it is used for constructing the special ANR queries detailed in the section on search flags.
- May require a BASE scope query to be retrieved for some constructed attributes ; e.g., tokenGroups can only be returned with a BASE scope query.

4.3.2.2. Category 1 objects

Category 1 objects are a subset of the attributes and classes that come with ADAM or Active Directory. They are marked with a special bit flag so that Microsoft can track and protect them from certain types of modifications.

4.3.3. Search Flags

The searchFlags attribute is generally known as the attribute used to control indexing , but it is a little more involved than that. As indicated by the name, searchFlags is similar to systemFlags in that it is a series of bits representing how the attribute should be handled. Unlike systemFlags, searchFlags are only set on schema attribute definitions. See Table 4-5 for all of the values as of Windows Server 2003 R2 and ADAM R2.

Table 4-5. Search flag bits

Value	Description
1 (0x0001)	Create an index for the attribute. All other index-based flags require this flag to be enabled as well. Marking linked attributes to be indexed has no effect.
2 (0x0002)	Create an index for the attribute in each container. This is only useful for one-level LDAP queries.
4 (0x0004)	Add attribute to Ambiguous Name Resolution (ANR) set. ANR queries are primarily used for Exchange and other address book tools. ANR attributes must be indexed and must be either UNICODE or Teletex string attribute syntax.

Value	Description
8 (0x0008)	Preserve this attribute in a tombstone object. This flag controls what attributes are kept when an object is deleted.
16 (0x0010)	Copy this value when the object is copied. This flag doesn't do anything in Active Directory; tools such as Active Directory Users and Computers that copy objects can look at this flag to determine what attributes should be copied.
32 (0x0020)	Create tuple index. Tuple indexing is useful for medial searches. A medial search has a wildcard at the beginning or in the middle of the search string. For example, the medial search (`drink=*coke`) would match Cherry Coke, Diet Coke, etc. This flag requires Windows Server 2003 or ADAM. V1.0.
64 (0x0040)	Create subtree index. This index is only available in ADAM R2 and is designed to increase performance of VLV queries. See the section "ADAM Schema" in Chapter 18.
128 (0x0080)	Mark attribute as confidential. Only users with both read property *and* Control Access right to the attribute so marked can view it when it is so marked. This is a new feature as of Windows Server 2003 SP1. SP1 domain controllers will not allow you to mark Category 1 attributes with this flag.

4.3.3.1. Indexed attributes

Attribute indexing is available to boost performance of queries. When an attribute is indexed, the values are placed in a special table in a sorted order so that a query using the attribute can be completed by looking at a subset of all the information in the directory. The type of index created can be modified by additional bit flags configured in the `searchFlags` attribute. There are several points to know about indexes:

- A query that contains bitwise operations on an indexed attribute diminishes the usefulness of the index. A bitwise operation can't be directly looked up in the index table and the entire set of values in the index will have to be enumerated and tested.

- A query that contains a NOT of an indexed attribute negates the use of the index for that portion of the query. A NOT of an attribute requires enumerating all objects in the search scope to determine which objects don't have the attribute or which objects have permissions applied that disallow the trustee to view the attribute value.

- Linked attributes, due to internal implementation details, cannot be indexed. You can set the flag, but it will not create an index. This seems disheartening but all hope is not lost. Linked attributes are actually implicitly linked. Fortunately, Microsoft made this realization, and in Windows Server 2003 AD and ADAM, added the necessary logic to use these implicit indexes.

- It is often assumed that indexes cannot be built or do not work well for attributes with multiple values or non-unique values. This is incorrect. In the early days of the original Active Directory beta, there was concern about multiple values and non-unique values but the issues surrounding them were cleared up. This topic is most often raised in regards to the `objectClass` attribute and is stated as the reason why the attribute wasn't indexed by default by Microsoft. Although Microsoft didn't index `objectClass`, it is an excellent candidate to be indexed and, in fact, early betas of the next server operating system have `objectClass` indexed.

4.3.3.2. ANR

Ambiguous Name Resolution is used for address book look-ups. It allows a single small query to be expanded into searching as many fields as the administrator would like searched so that users can enter a single piece of information and hopefully find all possible "hits" on the value they are interested in. When an ANR query such as:

```
    (anr=hansknecht)
```

is submitted, the Active Directory Query Processor expands the simple filter into a more complex OR wildcard filter that contains all attributes marked as part of the ANR set. The specified filter on a default ADAM installation would expand that simple query to:

```
(|
    (displayName=hansknecht*)
    (physicalDeliveryOfficeName=hansknecht*)
    (proxyAddresses=hansknecht*)
    (name=hansknecht*)
)
```

A Windows Server 2003 Active Directory domain with Exchange Server 2003 installed would expand the query to:

```
(|
    (displayName=hansknecht*)
    (mail=hansknecht*)
    (givenName=hansknecht*)
    (legacyExchangeDN=hansknecht)
    (msDS-AdditionalSamAccountName=hansknecht*)
    (mailNickname=hansknecht*)
    (physicalDeliveryOfficeName=hansknecht*)
    (proxyAddresses=hansknecht*)
    (name=hansknecht*)
    (sAMAccountName=hansknecht*)
    (sn=hansknecht*)
)
```

As you can see, a very simple query can quickly be expanded into a very large query. For this reason, you should avoid adding additional ANR attributes.

4.3.3.3. Preserve attribute in tombstone

When a delete request is processed for an object, the object is not immediately deleted. Instead, the object is stripped of most of its attributes and moved to the *Deleted Objects* container of the partition the object exists in, where it remains for the length of the tombstone period. This allows the delete operation to replicate to all domain controllers holding a copy of the object. The attributes that are retained when an object is tombstoned are configured through a combination of the `searchFlags` setting and some hard-coded internal functionality. The *preserve on tombstone* `searchFlags` setting is configurable by administrators so they can choose to add more attributes to what is kept on a tombstoned object. The purpose of keeping more attributes on tombstones is directly related to the new capability available in ADAM and Windows Server 2003 Active Directory to reanimate tombstoned objects. The more attributes you allow the directory to retain on the tombstoned object, the fewer attributes you have to recover through other means after the object is reanimated.

Unfortunately, not all attributes can successfully be added to the tombstone when the proper `searchFlags` bit is set. The most obvious examples are linked attributes. Linked attributes are handled differently, and there is no way to force them to be retained. If you configure a linked attribute to be preserved, AD will simply ignore the setting. This is unfortunate, as it means that critical information such as group membership must be either manually maintained in an additional attribute that can survive the tombstone process, or else the group membership must be maintained outside of AD.

While some attributes won't survive the tombstone regardless of what you set, some attributes will survive the tombstone but will not survive the reanimation process.

The attribute `pwdLastSet` attribute, for example, falls into this category. When you reanimate an object with `pwdLastSet`, even though the attribute may be preserved in the tombstone, it will be overwritten when the object is reanimated. Unfortunately, Microsoft has not documented what can and cannot survive a tombstone and subsequent reanimation. So make sure you test any attributes you have configured to be retained to make sure they can actually be reanimated. You don't want to first discover that information wasn't kept when you try to restore a critical object.

4.3.3.4. Tuple index

When you create an index, it is optimized for direct look-ups and, if the attribute syntax supports it, trailing wildcardse.g., `(name=joe*)`. If you use medial queriesthat is, queries with wildcards anywhere but the end of the string such as `(name=*oe)`performance tends to be rather less than optimal. Generally, this is OK, but in the cases where an important application is being significantly impacted due to poor medial query performance, you may want to consider enabling a tuple index for the attribute. This is just like enabling a normal index; you simply enable another bit to specify that a tuple index should be created.

A tuple index is considered an expensive index, and it will increase the DIT size more than a "normal" index. In addition, new attribute insertion performance will be impacted slightly. The performance hit will not be so much you would notice it on a single attribute insertion, but large bulk insertions could be impacted more significantly.

4.3.3.5. Confidential

A new bit for the searchFlags attribute was defined for Windows Server 2003 Service Pack 1: the confidential attribute flag. Any attribute that has this flag enabled requires two permissions in order to be viewed by a trustee. The trustee needs *read property* for the attribute and also needs *control access* for the attribute. This functionality was put into place primarily to protect sensitive user attributes such as social security numbers and other personal information. By default, only the administrators and account operators have full control on all user objects, which means they will be able to view any confidential attributes . Anyone else who has full control over a user object will also be able to view the confidential data, so this is yet another reason to not grant excessive rights in the directory. Obviously, if you have domain controllers in the domain (or GCs in the forest if you are dealing with a PAS-enabled attribute) that are not running Windows Server 2003 Service Pack 1, then any attributes marked as confidential will still be viewable on those DCs or GCs.

This capability was added as a workaround to issues that exist in the current security model in Active Directory. Unfortunately, there are a large number of explicit read property grant permissions on objects in Active Directory that are terribly difficult to easily override. This new flag allows you to step in despite all the default grant permissions and quickly deny access to an attribute.

This new function was welcomed with open arms in the Active Directory community until administrators started to realize that Microsoft purposely crippled the functionality by not allowing you to set Category 1 attributes as confidential. Category 1 attributes are many of the attributes defined in the default AD schema, and that list of attributes contains many of the attributes you probably want to make confidential such as telephone numbers, addresses, employee IDs, etc. It seems the intent is simply to give AD administrators a way to better secure additional attributes they add to the directory, which drastically reduces the usefulness of this capability for companies that stick to the default schema.

As mentioned, modification of searchFlags to enable confidential functions on Category 1 attributes is strictly disallowed by Windows Server 2003 SP1 domain controllers. If you try to change searchFlags on one of these DCs so that the confidential flag is set, you will get either an "Unwilling to perform" or a poorly worded "The search flags for the attribute are invalid. The ANR bit is valid only on attributes of Unicode or Teletex strings" error for your troubles.

If you are adamant about setting a Category 1 attribute as confidential, there is an option available. You can move the Schema FSMO to a non-SP1 domain controller and change searchFlags for the attribute on that domain controller. The validation is only performed on SP1 domain controllers, and once the value is set on any domain controller, it will replicate to the rest of the forest. Keep in mind that if you do this, you are directly going against the wishes of Microsoft for what should be set as confidential, which could have impact on the supportability of your environment. If you do choose to go forward, at the very least, avoid the attributes with systemFlags bit 1 (value 2) set. Those attributes are some of the most critical attributes in the directory, and it is quite unsafe to manipulate them.

This new capability is almost wholly underwhelming for ADAM. The default security descriptors on all ADAM base schema objects are configured with no explicit ACEs. The result is very few explicit read property grant permissions on objects when they are instantiated, which means you can more easily secure attributes with inherited deny permissions.

Next, we need to discuss the tools that Microsoft has made available with Service Pack 1 to handle granular delegation to trustees to view confidential attributes. The answer is easy: *none*. In order to grant a trustee the ability to view a specific confidential attribute on an attribute, a grant ACE with control access permission for the specific attribute needs to be added to the ACL of the object.[*]The GUI tools available for assigning permissions not only do not have the ability to assign this type of permission, they can't even display the permission if something else grants it. The command-line tool *dsacls.exe* is only marginally better; it can display the permission, but cannot grant the permission. The best that the GUI and *dsacls.exe* tool can do is assign either full control to the object or ALL control access rights to the object, but neither of these is optimal if you prefer to give minimum rights necessary to get the job done. In Windows Server 2003 SP1, the only way to set granular permissions to view a specific confidential attribute is to write a custom program or script to handle the delegation.

> Windows Server 2003 R2 does supply a GUI tool to handle this delegation. The new version of *LDP* which is loaded in the *%windir%\adam* directory when you install R2 ADAM has a new ACL editor. This version of updated version of *LDP* is also available in the free download of ADAM SP1.

4.3.4. Property Sets and attributeSecurityGUID

Property sets are described in our Chapter 11 discussion on Active Directory security. We mention them here because the creation, modification, and identification of property sets involve the schema partition. Part of the information for a property set is maintained in the configuration container in the `cn=extended-rights` sub-container, and the rest is maintained in the schema.

The property sets are defined in the `cn=extended-rights` sub-container as `controlAc-cessRight` objects. Two of the attributes of the `controlAccessRight` object link it to the schema. The first attribute is the `appliesTo` attribute; the second is the `rightsGuid`. The `appliesTo` attribute is the string representation of the `schemaIDGUID` attribute of the `classSchema` objects that the property set applies to. The `rightsGuid` is the string representation of the binary GUID stamped on the `attributeSecurityGUID` attribute of `attributeSchema` objects to identify them as members of the property set.

4.3.5. Linked Attributes

Microsoft allows distinguished name attributes with `attributeSyntax` values of 2.5.5.1, 2.5.5.7, and 2.5.5.14 to be linked to attributes with an `attributeSyntax` of 2.5.5.1. These are called linked attributes and consist of a forward link and a back link. An example of a pair of linked attributes is `member` and `memberOf`.

Attributes are linked by setting the `linkID` attributes of two `attributeSchema` objects to valid link values. The values must be unique for all `attributeSchema` objects. The value of the forward link is a

[*] Confused? Check out the security chapters, and this will become clear.

positive even value and the back link is the forward linkID value plus one to make it a positive odd value. Attributes must be linked when they are first defined in the schema.

You can use any random linkID values as long as they result in a unique linkID pair however, it is *highly* recommended that you either auto-generate linkIDs or request linkIDs from Microsoft for your use. Requesting linkIDs from Microsoft is quite easy once you have registered a schema prefix and Enterprise ID with Microsoft. Simply go to the web page http://msdn.microsoft.com/certification/ADLinkID.asp and follow the instructions.

If you don't want to request linkIDs from Microsoft and you are using Windows Server 2003 AD or ADAM, you have the alternate safe option of letting the directory service create a linkID pair for you. Microsoft has not, to this point, officially documented this new capability. However, a Microsoft employee named Eric Fleischman has documented the capability on his blog at http://blogs.technet.com/efleis/archive/2004/10/12/241219.aspx. The process is quite simple; however, the linkID pairs created are specific to the directory in which they are created. Do not copy the linkID pair values to other Active Directory or ADAM instances; auto-generate new links in the new instances instead.

To auto-generate linkID pair values, you first create the forward link attribute with any standard mechanism for extending the schema; for the linkID attribute, you must specify the OID value 1.2.840.113556.1.2.50. After the forward link attribute is created, you must refresh the schema cache. The next step is the creation of the back link attribute, for the linkID attribute, you must specify the lDAPDisplayName of the forward link. Finally, you must refresh the schema cache again. As you can see, the process is indeed quite simple and painless.

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4.4. Classes (classSchema Objects)

Schema classes are defined as instances of the classSchema class. Table 4-6 shows the most important attributes that you may wish to set.

Table 4-6. The defining attributes of a classSchema object instance

Attribute	Syntax	Mandatory	Multivalued	Description
auxiliaryClass	OID	No	Yes	The list of Auxiliary (or 88-Class) classes that this object inherits attributes from.
Cn	Unicode	Yes	No	The Relative Distinguished Name (RDN).
defaultHidingValue	Boolean	No	No	Whether the object should be hidden or displayed within the MMCs by default.
defaultSecurityDescriptor	Octet string	No	No	The Security Descriptor to assign to new instances of this class. Note that this SD is applied to new instances of the class if and only if an SD is not specifically provided and set during the creation of the instance.
Description	Unicode string	No	No	A description of the attribute.
governsID	OID	Yes	No	The OID that uniquely identifies objects of this class.
lDAPDisplayName	Unicode	No	No	The name by which LDAP clients identify this class.
mayContain	OID	No	Yes	The list of attributes that are optional for this class.
mustContain	OID	No	Yes	The list of attributes that are mandatory for this class.
nTSecurityDescriptor	NT-Security	Yes	Yes	Security Descriptor on the classSchema object itself. For example, setting an SD allows

Attribute	Syntax	Mandatory	Multivalued	Description
nTSecurityDescriptor	Security Descriptor	Yes	Yes	you to govern who can actually create instances of the object and who cannot.
objectClass	Object	Yes	Yes	The class that this object is an instance of; i.e., classSchema.
objectClassCategory	Integer	Yes	No	0 = 88-Class 1 = Structural 2 = Abstract 3 = Auxiliary
possSuperiors	OID	No	Yes	The list of classes that this object can be created within; e.g., user objects can be created within Organizational Unit objects.
rDNAttID	OID	No	No	The attribute that indicates what two-letter-prefix (cn=, ou=, dc=) is used to reference the class. You should use only cn here unless you have a very solid idea of what you are doing and why.
schemaIDGUID	Octet string	Yes	No	Globally Unique Identifier (GUID) to uniquely identify this class.
subClassOf	OID	Yes	No	The class that this one inherits from; the default is top.
systemAuxiliaryClass	OID	No	Yes	System version of auxiliaryClass.
systemFlags	Integer	No	No	Integer with bit flags that define additional properties for the class.
systemMayContain	OID	No	Yes	System version of mayContain.
systemMustContain	OID	No	Yes	System version of mustContain.
systemOnly	Boolean	No	No	If True, once the initial value has been set, only the system can create and modify instances of this class. The default is False.
systemPossSuperiors	OID	No	Yes	System version of possSuperiors.

4.4.1. Object Class Category and Inheritance

Classes are special in that they can inherit from one another. For example, let's say that we wanted to store two new types of objects in the schema, representing a marketing user and a finance user, respectively. These users both need all the attributes of the existing `user` class as a base. However, the finance user needs seven special attributes, while the marketing user needs three. The extra attributes required by both users do not match in any way. In this example, we can create a Marketing-User class, a Finance-User class, and 10 distinctly new attributes. However, rather than having to specify that the Marketing-User and Finance-User classes have each of the attributes of the original `user` class individually, all we need to do is specify that the new classes inherit from the `user` class by setting the `subClassOf` attribute to `user`. When we do this, both of the new classes inherit every single attribute that the `user` class had. We can then add the extra attributes to each class and we have two new classes. It really is that simple.

> You have another option when using Windows Server 2003 Forest Functional Mode or ADAM to resolve this issue. First, define the additional attributes and then create two auxiliary classes and assign the attributes to the classes. Then you can dynamically assign the auxiliary classes to users on ad-hoc basis. This is far more flexible in that you can easily reconfigure individual users as necessary. If a user moves from Marketing to Finance, using special inherited classes would require deleting the user and recreating the user with the finance-user class. With dynamic auxiliary classes, you would simply clear the marketing attributes, remove the Marketing auxiliary class, and add the Finance auxiliary class and attributes.

You can think of the Active Directory schema as a treelike structure, with multiple classes branching down or inheriting from one base class at the top that has the attributes all objects need to begin with. This class, unsurprisingly enough, is called `top`, which was originally defined in the X.500 spec. Some classes inherit directly from `top`, while others exist much lower down the tree. While each class may have only one parent in this layout, each class may also inherit attributes from other classes. This is possible because you can create three categories of `classSchema` object, also known as the `objectClassCategory` : *structural*, *abstract*, and *auxiliary*.

Structural

> If a class is structural, you can directly create objects of its type in Active Directory. The user and group classes are examples of structural classes.

Abstract

> It is possible that you would want to create a class that inherits from other classes and has certain attributes, but that is not one you will ever need to create instances of directly. This type of class is known as abstract. For example, let's say that the Marketing-User and Finance-User were to be the first of a number of structural classes that had a common structure. In that case, you could create an abstract class to be used as the basis of other structural classes. Abstract classes can inherit from other classes, can have attributes defined on them directly,

and in all other ways act like structural classes, except that instances of them cannot be directly created as objects in Active Directory.

Auxiliary

An auxiliary class is used to store sets of attributes that other classes can inherit. Auxiliary classes are a way for structural and abstract classes to inherit collections of attributes that do not have to be defined directly within the classes themselves. It is primarily a grouping mechanism.

The X.500 specifications indicate that an auxiliary class cannot inherit from a structural class, and an abstract class can inherit only from another abstract class.

> To comply with the X.500 standards, there are actually four types of `objectClassCategory`. While objects are required to be classified as one of structural, abstract, or auxiliary by the 1993 X.500 specifications, objects defined before 1993 using the 1988 specifications are not required to comply with these categories. Such objects have no corresponding 1993 category and so are defined in the schema as having a special category known as the 88-Class.

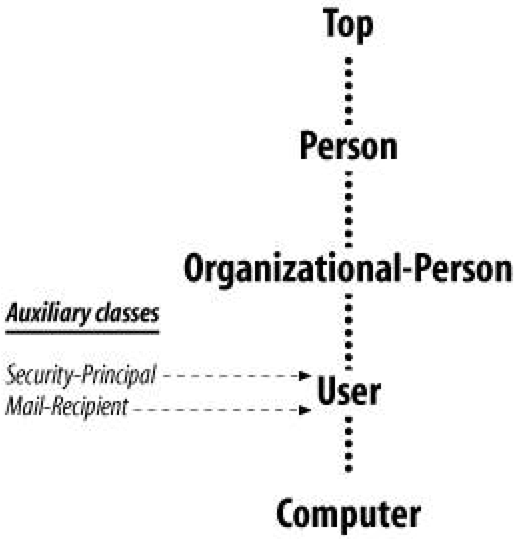
Let's take a look at the `user` and `computer` classes, which are used to create user and computer accounts, respectively, within Active Directory. The `computer` class (OID: 1.2.840.113556.1.3.30) and `user` class (OID: 1.2.840.113556.1.5.9) are each structural, which means that you can instantiate objects of those classes directly in Active Directory. The `computer` class inherits from the `user` class, so the `computer` class is a special type of user in a way. The `user` class inherits from the `organizationalPerson` abstract class (OID: 2.5.6.7). This means that the total attributes available to objects of class `computer` include not only the attributes defined specifically on the `computer` and `user` classes themselves, but also all the attributes that are inherited from the `organizationalPerson` class. The `organizationalPerson` class is a subclass of the `person` abstract class (OID: 2.5.6.6), which is a subclass of the abstract `top` class (OID: 2.5.6.0). There are no classes above `top`; it is the root class.

The `user` class that Microsoft needed to define in Active Directory had to be more than just the sum of the X.500 standard parts. After all, Microsoft uses Security Identifiers (SIDs) to identify users, and these were not contained in the original X.500 standards. So, to extend the attributes that make up a user, Microsoft defined some auxiliary classes and included these in the user class makeup. The auxiliary classes are `mailRecipient` and `securityPrincipal`. `mailRecipient` is a collection of attributes that allow a user to hold information relating to the email address and mail account associated with that user. The `securityPrincipal` attribute is used to hold the SID and other user-related security attributes that Microsoft needed.

Figure 4-4 indicates how the `computer` class is made up from a number of other classes.

If you were to use a tool such as *ADSIEdit*, you could see the inheritance and class relationships quite clearly. For example, looking at the `objectClass` attribute of any user object, you would see that the values held in this attribute were `top`, `person`, `organizationalPerson`, and `user`. In other words, this attribute indicates that each user object inherits attributes from all these classes. Similarly, for any computer object, the `objectClass` attribute holds `top`, `person`, `organizationalPerson`, `user`, and `computer`. If you were to look at the `subclassOf` attribute on the `computer` class object itself in the schema, you would see the `user` class. The `user` class has a `subClassOf` attribute that indicates organizationalPerson, and so on.

Figure 4-4. The computer class



4.4.2. Dissecting an Example Active Directory Class

Let's now look at the user class in a little more depth. Using a tool like *ADSIEdit* , we can see the values of each attribute for the user classSchema object. Table 4-7 contains the attributes and values.

Table 4-7. Attributes and values for the user class

User attribute's LDAP-Display-Name	User attribute's syntax	Value contained in user's attribute
adminDescription	CASE_ IGNORE_ STRING	User
adminDisplayName	CASE_ IGNORE_ STRING	User
cn	CASE_ IGNORE_ STRING	User
defaultHidingValue	BOOLEAN	False
defaultObjectCategory	DN_STRING	cn=person, cn=schema, cn=configuration, dc=mycorp, dc=com

User attribute's LDAP-Display-Name	User attribute's syntax	Value contained in user's attribute
defaultSecurityDescriptor	CASE_ IGNORE_STRING	SDDL text-encoded representation of the default security descriptor
distinguishedName	DN_STRING	cn=User, cn=Schema, cn=Configuration, dc=mycorp, dc=com
governsID	CASE_ IGNORE_STRING	1.2.840.113556.1.5.9
instanceType	INTEGER	4
lDAPDisplayName	CASE_ IGNORE_STRING	user
name	CASE_ IGNORE_STRING	User
nTSecurityDescriptor	SECURITY_DESCRIPTOR	Binary representation of the Security Descriptor for the class
objectCategory	DN_STRING	cn=Class-Schema, cn=Schema, cn=Configuration, dc=mycorp, dc=com
objectClass	CASE_ IGNORE_STRING	top; classSchema (two values of a multivalued attribute)
objectClassCategory	INTEGER	1
objectGUID	OCTET_ STRING	<GUID>
rDNAttID	CASE_ IGNORE_STRING	cn
schemaIDGUID	OCTET_ STRING	<GUID> that uniquely identifies this class
showInAdvancedViewOnly	BOOLEAN	True
subClassOf	CASE_ IGNORE_STRING	organizationalPerson
systemAuxiliaryClass	CASE_ IGNORE_STRING	securityPrincipal mailRecipient
systemFlags	INTEGER	16 (Category 1 class)
systemMayContain	CASE_ IGNORE_STRING	Various attributes. See discussion.
systemOnly	BOOLEAN	False
systemPossSuperiors	CASE_ IGNORE_STRING	builtinDomain organizationalUnit domainDNS
uSNChanged	LARGE_INTEGER	USN when last changed
uSNCreated	LARGE_INTEGER	USN when created
whenChanged	UTC_TIME	Time when last changed
whenCreated	UTC_TIME	Time when created

You can see the following about the user class:

- The name of the class is User (adminDescription, adminDisplayName, cn, name).
- It is an instance of the classSchema class (objectCategory and objectClass).
- It inherits attributes from both top and classSchema (objectClass).
- This object class has a security descriptor governing who can access and manipulate it (nTSecurityDescriptor).
- The instances of the user class are visible in normal browsing (defaultHidingValue).
- The user class itself is not hidden from casual browsing (showInAdvancedViewOnly).
- The user class has an OID of 1.2.840.113556.1.5.9 (governsID).
- It can have instances created by anyone (systemOnly).
- It inherits attributes not only from top and classSchema but also from security-Principal and mailRecipient (objectClass and systemAuxiliaryClass).
- When connecting to instances of the class via LDAP, the two-letter prefix used should be cn (rDNAttID).
- The user class is a direct subclass of the organizationalPerson class (subClassOf).
- This class can be created directly under only three different parents in Active Directory (systemPossSuperiors).
- The class is structural (objectClassCategory).
- A default Security Descriptor should be applied to new instances of the user class if one is not specified on creation (defaultSecurityDescriptor).
- There are a large number of attributes that instances of the user class can have values for (systemMayContain). Values include:

```
accountExpires
msDS-User-Account-Control-Computed
aCSPolicyName
msIIS-FTPDir
adminCount
msIIS-FTPRoot
badPasswordTime
mSMQDigests
badPwdCount
mSMQDigestsMig
businessCategory
mSMQSignCertificates
codePage
mSMQSignCertificatesMig
```

```
controlAccessRights
msNPAllowDialin
dBCSPwd
msNPCallingStationID
defaultClassStore
msNPSavedCallingStationID
desktopProfile
msRADIUSCallbackNumber
dynamicLDAPServer
msRADIUSFramedIPAddress
groupMembershipSAM
msRADIUSFramedRoute
groupPriority
msRADIUSServiceType
groupsToIgnore
msRASSavedCallbackNumber
homeDirectory
msRASSavedFramedIPAddress
homeDrive
msRASSavedFramedRoute
homePhone
networkAddress
initials
ntPwdHistory
lastLogoff
o
lastLogon
operatorCount
lastLogonTimestamp
otherLoginWorkstations
lmPwdHistory
pager
localeID
preferredOU
lockoutTime
primaryGroupID
logonCount
profilePath
logonHours
pwdLastSet
logonWorkstation
scriptPath
mail
servicePrincipalName
manager
terminalServer
maxStorage
unicodePwd
mobile
userAccountControl
mS-DS-CreatorSID
userCertificate
msCOM-UserPartitionSetLink
userParameters
msDRM-IdentityCertificate
```

```
userPrincipalName
msDS-Cached-Membership
userSharedFolder
msDS-Cached-Membership-Time-Stamp
userSharedFolderOther
msDS-Site-Affinity
userWorkstations
```

4.4.2.1. How inheritance affects mustContain, mayContain, possSuperiors, and auxiliaryClass

Let's look at the `mustContain`, `mayContain`, `auxiliaryClass`, `possSuperiors`, and their system attribute pairs. You can see that the only values that are set are `systemPossSuperiors`, `systemMayContain`, and `systemAuxiliaryClass`. These were the values set on the initial creation of the user class and cannot be changed. Note that there were no mandatory attributes set at the creation of the original class because the `systemMustContain` attribute is not listed. If you later wished to add an extra set of attributes or a new optional attribute to the user class, you could use `auxiliaryClass` or `mayContain` and modify the base definition. This occurs if, for example, you use the Active Directory Connector (ADC) to link your Active Directory and a Microsoft Exchange 5.5 schema. When you install the ADC for the first time in a forest, it extends the schema to include new Exchange objects and attributes, as well as modifying existing Active Directory objects to include new Exchange-relevant attributes. If you were to do this, the user class would be directly modified to include three of these Exchange-related auxiliary classes in the `auxiliaryClass` attribute: `msExchMailStorage`, `msExchCustomAttributes`, and `msExchCertificateInformation`. The ADC is discussed more fully in Chapter 17.

The attributes that are required when you create a new user are not listed in the `mustContain` attribute. That's because `objectSID`, `sAMAccountName`, and the other attributes are inherited from other classes that make up this one. The `mustContain` attributes can be defined directly in `auxiliaryClass`, `systemAuxiliaryClass`, or `subClassOf`, or they can be defined on the classes inherited from further up the tree. Both `sAMAccountName` and `objectSID`, for example, are defined on the `securityPrincipal` class.

> Do not mistake attributes that a class must contain with the attributes that you must explicitly set on object instantiation. Unfortunately there is no effective way to programmatically determine what attributes you need to set on an object when you create an instance of the class. Some of the attributes that an object must contain are system-owned and can only be set by the system, other attributes are optional and will be populated automatically, and finally some attributes are actually required to be specified by the objects creator. To confuse the situation even more, various versions of the OS or ADAM change the requirements.

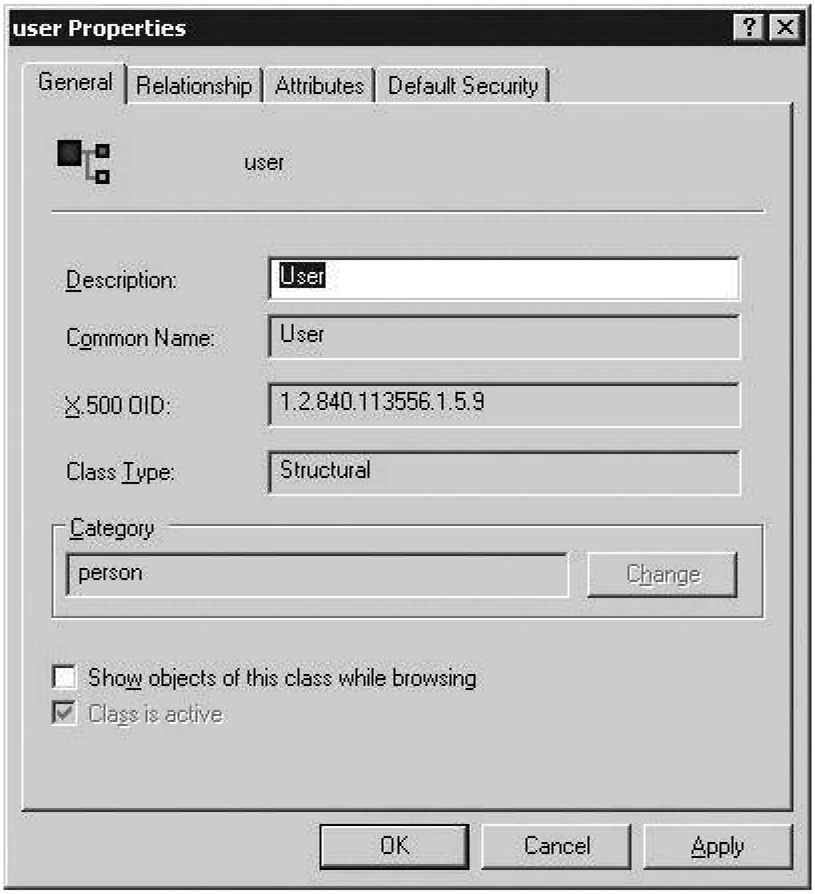
The same principle applies to the `mayContain` attribute. The entire set of these attributes is available only when you recurse back up the tree and identify all the inherited `mayContain` attributes on all inherited classes.

The `possSuperiors` attribute, on the other hand, can be made up of only those items defined directly on the class, those defined on the class in the `subClassOf` attribute, or any inherited classes defined on any other subClassOf attributes up the subClassOf tree. If that was too confusing, try this: an instance of the user class can have possSuperiors from itself, from the organizationalPerson class defined in the subClassOf attribute, from the person class (the organizationalPerson class's subClassOf attribute), and from top (the person class's subClassOf attribute).

4.4.2.2. Viewing the user class with the Active Directory Schema snap-in

Take a look at Figure 4-5. This shows the user class viewed with the Active Directory Schema snap-in. You can see the relevant general user data.

Figure 4-5. User class schema entry general settings



user

Description: User

Common Name: User

X.500 OID: 1.2.840.113556.1.5.9

Class Type: Structural

Category: person

□ Show objects of this class while browsing

☑ Class is active

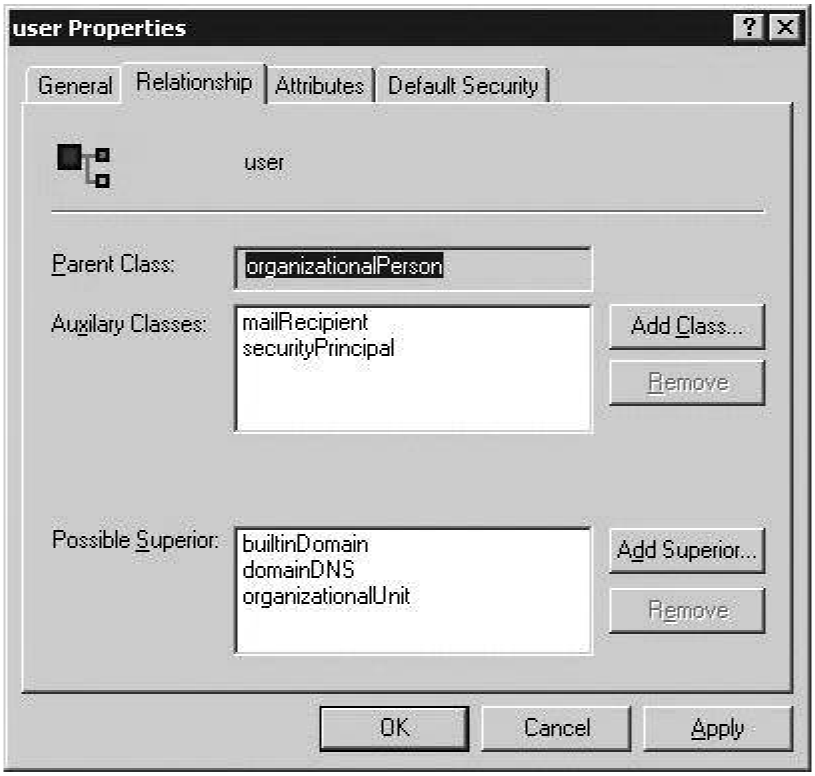
Notice that quite a bit of it is not configurable after the initial configuration, including:

```
governsID
subClassOf
schemaIDGUID
systemMustContain
```

```
    rDNAttID
    systemPossSuperiors
    objectClassCategory
    systemMayContain
    systemOnly
    systemAuxiliaryClass
    objectClass
    subClassOf
```

To see the so-called relationship settings (subClassOf, auxiliaryClass, systemAuxili-aryClass, possSuperiors, systemPossSuperiors), look at Figure 4-6. In this screen, you can see that the user class in this schema is inheriting attributes from the two auxiliary classes.

Figure 4-6. User class schema entry relationship settings



user

Parent Class: organizationalPerson

Auxilary Classes: mailRecipient, securityPrincipal

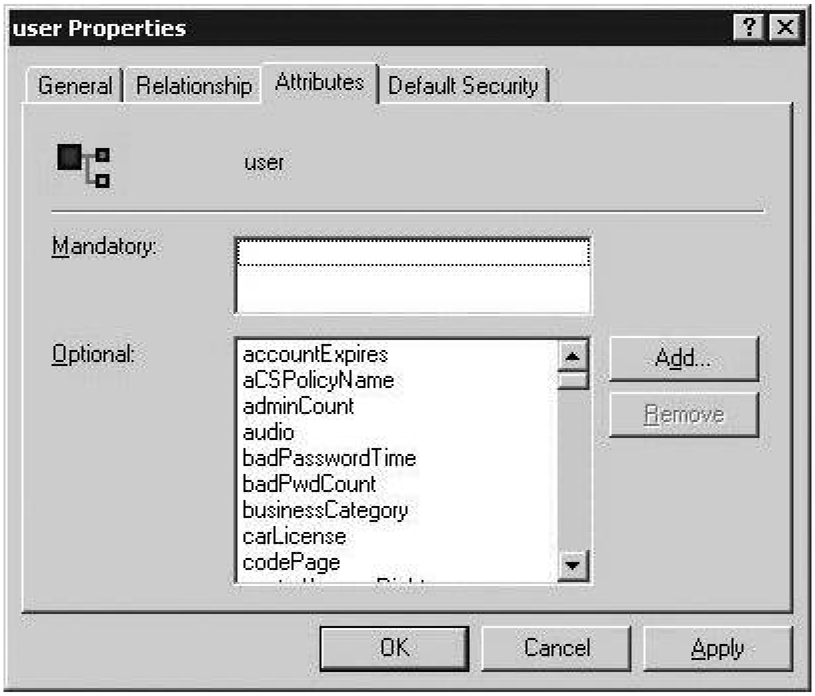
Possible Superior: builtinDomain, domainDNS, organizationalUnit

The third and final screen is the Attributes tab for the user class and is displayed in Figure 4-7. This shows the mustContain, systemMustContain, mayContain, and system-MayContain attributes of the user class.

4.4.3. Dynamically Linked Auxiliary Classes

With Windows 2000, auxiliary classes were statically linked to structural classes via the auxiliaryClass and systemAuxiliaryClass attributes. This went against how most directory services implemented auxiliary classes, which typically allowed dynamically assigned auxiliary classes on instances of objects. A new feature in Windows Server 2003 is the ability to dynamically assign auxiliary classes to individual objects instead of to an entire class of objects in the schema. Having the dynamic auxiliary class mechanism provides much more flexibility for application developers who may want to utilize existing structural and auxiliary classes but do not want to extend the schema to define such relationships.

Figure 4-7. User class schema entry attribute settings



user

Mandatory:

Optional:
accountExpires
aCSPolicyName
adminCount
audio
badPasswordTime
badPwdCount
businessCategory
carLicense
codePage

Dynamic linking of auxiliary classes requires Windows Server 2003 Forest Functional Mode.

To dynamically link an auxiliary class to an object, you only need to modify the objectClass attribute of the object to include the name of the auxiliary class. Any auxiliary class can be used, provided that all mustContain and systemMustContain attributes contained within the auxiliary class are set at the same time. You can also remove a dynamically linked auxiliary class by clearing any values that have been set for attributes defined by the auxiliary class and then removing the auxiliary class name from the object's objectClass attribute.

Now let's illustrate why dynamically linking auxiliary classes is a good idea. Assume we have a forest with several domains, each representing divisions within a company. Each division manages its own user objects. One of the divisions, named Toasters, wants to assign additional attributes to their user objects. These new attributes would only apply to employees within the Toasters division. Under

Windows 2000, the only way to accomplish this would be to create the new attributes in the schema, create a new auxiliary class, and include the new attributes in the auxiliary class. At that point, the new auxiliary class could be added to the `auxiliaryClass` of the user `classSchema` object. That means every user object contained within the forest would then have the new attributes. If each division wanted to do something similar, you can see how the number of attributes on all user objects within the forest could grow very quickly and unnecessarily. With Windows Server 2003, you would still create the new attributes and auxiliary classes in the schema, but you would not modify the `auxiliaryClass` of the user object. Instead, each division would dynamically link their auxiliary class to *their* user objects. This provides for a cleaner and much more efficient implementation than was possible under Windows 2000.

> When you dynamically link an auxiliary class to an object, the auxiliary class is listed in the `objectClass` listing for the object. When an auxiliary class is statically linked, the auxiliary class is not listed in the `objectClass` listing. This can cause issues with applications that determine available attributes on an object and only look at the schema definitions of an object class or at the `objectClass` attribute of the object itself.

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4.5. Summary

In this chapter, we've shown you how the internal blueprint for all objects in Active Directory, known as the schema, was derived from the X.500 directory service. We explained the purpose of the OID numbering system and how it can be used. We then detailed how an attribute and its syntax are structured in the schema as `attributeSchema` objects, using the `userPrincipalName` attribute as an example. We showed how attributes are added to classes by detailing how classes are stored in the schema as instances of `classSchema` objects. To make this more clear, we dug into the details of the user class to see how it was constructed. Finally, we covered how auxiliary classes can be dynamically linked in Windows Server 2003 and why it is significant.

Chapter 12 builds on what you've learned here to demonstrate how you can design and implement schema extensions.

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Chapter 5. Site Topology and Replication

This chapter introduces a major feature of Active Directory: multi-master replication. Active Directory was one of the first LDAP-based directories to offer multi-master replication. Most directories replicate data from a single master server to subordinate servers. This is how replication worked in Windows NT 4.0 as an example. Obviously, there are several potential problems with a single-master replication scheme, including single point of failure for updates, geographic distance from master to clients performing the updates, and less efficient replication due to single originating location of updates. Active Directory replication addresses these issues, but with a price. To get the benefit of a multi-master replication, you must first create a site topology that describes the network and helps define how domain controllers should replicate with each other. In large environments, building and maintaining a site topology can be a significant amount of overhead.

This chapter looks at the basics of how sites and replication work in Active Directory. InChapter 9, we'll describe the physical infrastructure of a network layout using sites. We'll also discuss in that chapter how the Knowledge Consistency Checker (KCC) sets up and manages the replication connections and details on how to effectively design and tailor sites, site links, and replication in Active Directory.

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5.1. Site Topology

The Active Directory site topology is the map that describes the network connectivity, Active Directory Replication guidelines, and locations for resources as it relates to the Active Directory forest. The major components of this topology are sites, subnets, site links, and connection objects. These are all Active Directory objects that are maintained in the forest's configuration container to allow the information to be locally available on all domain controllers so the DCs can properly communicate.

5.1.1. Subnets

A *subnet* is a portion of the IP space of a network. Subnets are described by their IP network address combined with a subnet mask measured in bits. For instance, the subnet mask 255.255.255.0 is a 24-bit subnet mask. If you have a 24-bit mask for the 10.5.21.0 network, your subnet object would be described as 10.5.21.0/24. The subnet objects in Active Directory are a logical representation of the subnets in your environment; they may, but do not necessarily have to, reflect your actual physical subnet definitions. For example, you may have a building that has two 24-bit subnets of 10.5.21.0 and 10.5.22.0, which for the purposes of Active Directory could be included in a single AD subnet of 10.5.21.0/23, which specifies a 23-bit subnet mask.

You define this subnet information in the directory because the only key available for determining relative location on a network is the IP addresses of the machines. The subnets are in turn associated with sites. Without these definitions, there is no way for a machine to make an efficient determination of what distributed resources it should try to use. By default, no subnets are defined in Active Directory.

Adding Subnets to a Site in the Sites and Services Snap-in

When adding subnets to sites via the Sites and Services snap-in, you must enter the name of the subnet in the form network/bits masked; e.g., 10.186.149.0/24 is network 10.186.149.0 with subnet mask 255.255.255.0.

The bits masked in the subnet name are the number of bits set in the subnet mask for that subnet. It can be between 0 and 32. The subnet mask is made up of four octets or bytes (four sets of eight bits). To convert the subnet mask to bits, convert each octet from the subnet mask to binary. The subnet mask 255.255.255.0 is 11111111.11111111.11111111.00000000 in binary, which uses 8+8+8 bits (i.e., 24) to define the subnet mask. A subnet mask of 255.255.248.0 would be 11111111.11111111.11111100.00000000, which is 8+8+5, or 21.

If subnets and IP addresses mean very little to you, check out Chuck Semeria's article

"Understanding IP Addressing: Everything You Ever Wanted To Know" at http://www.3com.com/other/pdfs/infra/corpinfo/en_US/501302.pdf.

5.1.2. Sites

Active Directory *sites* are generally defined as a collection of well-connected AD subnets. You use sites to group subnets together into a logical collection to help define replication flow and resource location boundaries. Active Directory uses sites directly to generate its replication topology and also to help clients find the "nearest" distributed resources to use in the environment such as DFS shares or domain controllers. The client's IP address is used to determine which Active Directory subnet they belong to and then that in turn is used to look up their AD site. The site information can then be used to perform DNS queries via the DC Locator service to determine the closest domain controller or global catalog.

Most members of a domain dynamically determine their site when they start up, and this is verified throughout the day. This allows administrators to make modifications to the site topology and have it properly take effect in relatively short order with the least amount of manual work. Domain controllers, on the other hand, select their site when they are promoted and will not automatically change unless they are demoted and re-promoted. If an administrator wants a DC to become part of another site so that it can cover the DC or GC requirements for that site or if it has had its IP address changed and should logically be in another site, the DC must be moved through administrative action to that new site.

By default, there is one site defined in Active Directory, the *Default-First-Site-Name* site. If there are no subnets objects defined, all members of the domain are "magically" assumed to be part of this initial site or any other single defined site if you have replaced the default site with another site. Once there are multiple site objects or after subnet objects are defined and assigned, the "magic" feature goes away and subnet objects must be defined for the subnets clients and servers reside in. There is nothing special about this initial site other than it is the first one created; you can rename as you see fit. You can even delete it as long as you have created at least one other site and moved any domain controllers located within the Default-First-Site-Name to another site.

Multiple sites can be defined for a single physical location. This can allow you to better segregate what resources are used for what requestors. For instance, it is common practice in large companies to build a separate site just to harbor the Microsoft Exchange Servers and the Global Catalogs that are used to respond to Exchange and Outlook queries. This allows an administrator to easily control which GCs are used without having to hard code preferred GC settings into Exchange. You can define the subnets as small as you need them including down to a single IP address (32-bit subnet) to place them in the proper site.

A *supernet* is a term used to describe a single subnet that encompasses one or more smaller subnets into a single Active Directory subnet object. For example, you may define a subnet object of 10.0.0.0/8, as well as many subnets in the same space with larger subnet masks, such as 10.1.0.0/16, 10.1.2.0/24, or even 10.1.2.209/32. When Active Directory works out which subnet a machine is associated with, it chooses the most specific subnet defined. So if the IP address is 10.1.2.209, the subnet 10.1.2.209/32 would be used; but if the IP address were 10.2.56.3, the 10.0.0.0/8 subnet would be used.

You may be wondering why someone would do this. The supernet objects can be assigned to any site just like any other subnet object. This means you can assign these "catchall" subnets to hub-based sites for machines that are running from subnets that are not otherwise defined. This causes the machines to use the hub resources versus randomly finding and selecting resources to use.

5.1.3. Site Links

Site links allow you to define what sites are connected to each other and the relative cost of the connection. When you create a site link, you specify which sites are connected by this link and what the cost or metric of the connection is in a relative costing model. For instance, three sitesA, B, and Ccould be connected to each other, but because you understand the underlying physical network, you feel all traffic should be routed through the A site. This would require you to configure to two site links : A to B and A to C. If at a later time, additional physical network connections are established between B and C, you could set up one more site link and connect B and C together. If you configure all three site links with an equal cost, say 100, traffic would flow across the B to C link instead of from B to A to C. This is because the total cost to use the B to C link would be 100 and the total cost to use the B to A to C route would be 200, which is more expensive. If you preferred traffic to still flow through Site A, your total cost from B to A to C and the reverse should be lower than your cost from B to C, so you would need to set the B to C link cost to something greater than 200, like 300. Then that link would only be used if the connection could not go through Site A for some reason.

Site links can come in two replication flavors: IP and SMTP. An IP site link actually represents an RPC-style replication connection. This is by far the most commonly used type of site link and in fact, the default site link created by Active Directory is an IP site link called *DEFAULTIPSITELINK* . The other site link type, SMTP site links, are a special SMTP-based (think email) replication site link. It is used to communicate with sites that have very poor or unreliable network connections that cannot support an RPC replication connection. Due to security concerns, however, only certain naming contexts can be replicated across SMTP site links; specifically, the configuration NC, schema NC, and read-only global catalog NCs. You cannot replicate a writeable domain partition or an application partition over an SMTP site link.

Besides defining which replication protocols should be used and which sites should be replicating with what other sites, site links control domain controller and global catalog coverage of sites that do not have local DCs or GCs. If, for instance, you have Sites A, B, and C, where Site A has a DC for Dom1 and Dom2, but Site B only has a DC for Dom1, and Site C has a DC for Dom2, how does a client decide which DC it should use for a domain that doesn't have a domain controller in the local site? Logically, you can look at it and say "If someone needs to log on to Dom1 while in Site C, then the client should talk to Site A." Active Directory cannot make this intuitive leap; it needs to work with cold hard numbers, and that is what the site link metrics do: give the directory the information needed to make the calculations to determine which sites a given domain controller should cover in addition to its own site.

5.1.4. Connection Objects

The final piece of the topology puzzle is the *connection object*. A connection object specifies which domain controllers replicate with which other domain controllers, how often, and which naming contexts are involved. Unlike sites, subnets, and site links, which you generally need to manually configure, connection objects are generally managed by the domain controllers themselves. The idea is that you should logically construct the site topology with good definitions for sites, subnets, and site links, and Active Directory can figure out the best way to interconnect the actual domain controllers within and between the sites.

It isn't always possible to allow AD to manage all of these connections, but it is a very good goal to work towards. It is most often a problem that you have to tackle when you are dealing with very large Branch Office designs that involve hundreds or thousands of remote WAN sites connecting back to a network hub. If you find yourself in a situation where you think you need to make your own connections, it would probably be a good idea to download the Branch Office Guide Whitepaper and be very familiar with its contents because you can wreak havoc with your Active Directory Replication when you start messing with connection objects. You can download the Branch Office Guide Whitepaper from the following Microsoft web site: http://www.microsoft.com/downloads/details.aspx?FamilyId=9353A4F6-A8A8-40BB-9FA7-3A95C9540112.

5.1.5. Knowledge Consistency Checker (KCC)

In all but the smallest deployments such as Small Business Server (SBS) or other single-site environments, administrators should create a site topology in Active Directory that maps relatively closely to the physical network. Unfortunately, Active Directory is not intelligent enough to look at the network and build its own complex topologies to optimize replication and resource location for every company installing Active Directoryit needs your help. Creating a site topology is discussed in Chapter 9.

Once you have set up your site, subnet, and site link objects, an Active Directory process called the *Knowledge Consistency Checker* (KCC) takes that information and automatically generates and maintains the connection objects that describe which naming contexts (NC) should be replicated between what domain controllers as well as how and when. The KCC has two separate algorithms it uses to determine what connection objects are needed: intrasite and intersite. The intrasite algorithm is designed to create a minimal latency ring topology *for each naming context* that guarantees no more than three hops between any two domain controllers in the site. As DCs, GCs, and domains are added and removed within a site, the KCC adds and removes connections between the domain controllers as necessary to maintain this minimal hop topology. It is quite simple to visualize when dealing with a single domain and a small number of domain controllers but gets extremely difficult to visualize as you add many domain controllers and additional domains. The intersite algorithm, on the other hand, is not a minimum hop algorithm; it simply tries to keep the sites connected via a spanning tree algorithm so that replication can occur and then simply follows the site link metrics for making those connections. It is quite possible for the KCC to generate a replication topology that forces a change to replicate through eight sites to get from one end of the topology to the other. If you are unhappy with the site connections made by the KCC for the intersite topology because they don't align with your network connections, it is almost certainly related to how the site links are configured. A well-designed site topology will help the KCC generate an intelligent and efficient collection of connection objects for replication. We cover the KCC in greater depth later in Chapter 9.

5.1.6. Site and Replication Management Tools

Obviously, as more sites and connections are created, the replication topology can get very large. Microsoft provides the *Active DirectorySites and Services* MMC snap-in (*dssite.msc*) to help manage the topology. It allows you to drill down into the Sites Container , which holds all the site topology objects and connection objects. The Sites Container is located directly under the Configuration Container. With Sites and Services, you can create new sites, subnets, links, and connections, as well as set replication schedules and metrics for each link and so on.

Other replication-related tools available in the Windows Support Tools are:

RepAdmin

A command-line tool for administering replication

ReplMon

A graphical utility for managing and monitoring replication

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5.2. Data Replication

Microsoft has introduced a number of new terms for Active Directory replication , and most of them will be completely unfamiliar to anyone new to Active Directory. To properly design your replication topology, you should understand the basics of how replication works, but you also need to understand how replication works using these new terms, which are used throughout both Microsoft's documentation and its management tools. As you read the rest of this chapter, refer as needed back to the definitions of the terms that are presented. Do not be disappointed if it doesn't all sink into your brain comfortably on your first or even fifth read of the material. Even experienced administrators have been known to debate how this all works and the proper terms for the various structures and processes.

5.2.1. A Background to Metadata (Data That Governs the Replication Process)

Active Directory replication enables data transfer between NCs on different DCs without ending up in a continuous replication loop or missing any data. To make this process work, each NC holds a number of pieces of information that specifically relate to replication within that particular NC. That means that the replication data for the Schema NC is held in the Schema NC and is separate from the replication data for the Configuration NC, which is held in the Configuration NC. This is done this way because all replication is naming-context based. When a domain controller is pulling changes from another domain controller, it does it one naming context at a time in a serial fashion.

5.2.1.1. Update Sequence Numbers (USN) and highestCommittedUSN

Each domain controller maintains its own separate Update Sequence Numbers (USN) . A USN is a 64-bit value that is assigned to each atomic update transaction and meaningful only in relation to the domain controller the update was performed on. Each separate update transaction will generate an incrementing sequential USN value. A single USN could represent the change of every attribute on an object or a single attribute on a single object.

While some directory systems use timestamps to control replication and what needs to be propagated from server to server, Microsoft chose to use USN values. The fact that these values increment sequentially completely avoids the issues of the DCs having their clocks set backwards or being out of synch with their replication partners. Each domain controller maintains its highest combined USN for all naming contexts in the `highestCommittedUSN` value of the `RootDSE`.

USNs are used to uniquely identify each update that has taken place in an NC on a particular DC regardless of the update type. It is highly improbable that the same USNs will ever represent the same change on two different domain controllers. This allows you to request individual changes based on particular USNs from a specific domain controller but does not allow for directory comparison between DCs based on similar USN values. The change of the description to "joe's computer" on a computer account named *Cerberus* may be USN 23865 on one domain controller but could be USN 4078 on another and USN 673459234 on yet another.

> Although time isn't used as the basis for replication in Active Directory, it is still incredibly important. All authentication between domain controllers for replication is Kerberos based, and Kerberos has a maximum time skew requirement between hosts. In a default forest, if a domain controller deviates from the common time of all of the other domain controllers by more than five minutes, that domain controller will no longer be able to replicate with other domains controllers.

That means it is critically important for all domain controllers to have a consistent time but, fortunately, it doesn't mean the time has to be correct. It is far better to have all domain controllers share an incorrect time than it is to have some domain controllers having the right time and some others being off by an hour. In this case, it is consistency that is important, not quality.

Thankfully, Microsoft included a time synchronization service in all Windows machines since Windows 2000. Every machine in a forest except for the forest root PDC and its designated failover should not have a specific time server configured; that way, each machine will maintain time synchronization with the Active Directory Forest. The forest root PDC (and its designated failover) should be configured to use some trustworthy NTP host. This could be a host inside or outside of your local network; the machines simply need to be able to occasionally contact it for updates. The time server values can be viewed and modified with the NET TIME command.

5.2.1.2. Originating updates versus replicated updates

Replication distinguishes between two types of update:

Originating update (write)

> This term defines the point of origin for a particular updatei.e., on which domain controller did the change initially occur.

Replicated update (write)

> This term defines the opposite of an originating updatei.e., the change in question did not begin here; it was replicated from another domain controller.

So if you use the Active Directory Users and Computers snap-in to create five users on DC A, DC A's USN is incremented five times, once for each originating update. If DC A receives six more changes from DC B, DC A's USN is incremented six more times, once for each of the six replicated updates.

> If an Active Directory database transaction is abortedi.e., fails to completethe associated USN value is not assigned to any object or reused in any way. The USN continues incrementing as changes occur.

5.2.1.3. DSA GUID and Invocation ID

Each domain controller has a GUID called the *DSA GUID*. This DSA GUID is used to uniquely identify a domain controller and is the `objectGUID` of the *NTDS Settings* object for the DC in the configuration container. This GUID does not change unless the domain controller is demoted and re-promoted. The Active Directory database (*NTDS.DIT*) also has a GUID. This latter GUID is used to identify the server's Active Directory database in replication calls and is called the *Invocation ID*; it is stored in the `invocationId` attribute of the *NTDS Settings* object for the DC. The Invocation ID is changed any time Active Directory is restored on that DC or any time the DSA GUID is changed.

> This change of GUID makes sure that the other DCs on the network realize that this is a new database instance and create new high-watermark vector and up-to-dateness vector entries in their respective tables for it. This allows changes that occurred after the backup to be replicated back to newly restored database to bring it properly up to date. Without this step, any changes originated on the restored DC after the backup completed that had replicated out to the rest of the Directory would never replicate back to this DC once it was restored. This is because the replication partners would assume the DC already had those changes since it was the master of the changes in the first place.

5.2.1.4. High-watermark vector (direct up-to-dateness vector)

The high-watermark vector (HWMV) is a table maintained independently by every domain controller to assist in efficient replication of a naming context. Specifically, it is used to help the DC determine where it last left off when replicating the NC with a specific partner.

There is one table for every naming context the local DC maintains a replica of, so at a minimum every domain controller would have at least three tables, one each for the schema, the configuration, and the domain NCs. Each table stores the highest USN of the updates the local DC has received from each direct partner it replicates with for the given NC. The USN values are used to determine where replication should begin with each partner on the next replication cycle. This allows the local DC to request the most recent updates from a given replication partner for each NC.

When the local DC initiates replication for an NC with one of its partners, the high USN for that partner from the local DCs high-watermark vector for the NC is one of the pieces of information sent to the source DC. The source DC compares that value with its current highest USN for the NC to help determine what changes should be sent to the local DC. This logic is further refined by the up-to-dateness vector, as described in the next section.

5.2.1.5. Up-to-dateness vector

The up-to-dateness vector (UTDV) is a table maintained independently by every domain controller to assist in efficient replication of a naming context. Specifically, it is used for replication dampening to reduce needless replication traffic and endless replication.

There is one table for every naming context the local DC maintains a replica of, so again, at a minimum every DC will have at least three of these tables. Each table stores the highest originating update USN the local DC has received from every other domain controller that has ever existed in the forest. In Windows Server 2003, an additional column of information was added to the table to represent the last time the local domain controller last successfully completed a replication cycle with the given source DC for the NC. This was added to assist in locating replication issues.

The up-to-dateness vector is used in conjunction with the high-watermark vector to reduce replication traffic. When the replication request for an NC is passed to a source partner, the destination DCs up-to-dateness vector for the NC is also in the request. The source partner can then zero in on changes that it hasn't previously sent and then further filter out any changes that the destination may have already received from other replication partners. In this way, it guarantees that a single change is not replicated to the same DCs multiple times; this is called *propagation dampening*.

5.2.1.6. Recap

The following list summarizes the important points of this section:

- Active Directory is split into separate naming contexts, each of which replicates independently.
- Within each NC, a variety of metadata is held.

For each NC on a DC, a high-watermark vector is maintained that contains one entry for each of its replication partners for this NC. The values in this table for the replication partners are updated only during a replication cycle.

For each NC on a DC, an up-to-dateness vector is maintained that contains one entry for every domain controller that has ever made an originating write within this NC. Each entry consists of three values: the Originating-DSA-GUID, Originating-USN, and a timestamp indicating the last successful replication with the originating DC. These values are updated only during a replication cycle.

5.2.2. How an Object's Metadata Is Modified During Replication

> To minimize the use of abbreviations, the terms DC and server are used interchangeably. The terms property and attribute are also used interchangeably.

To see how the actual data is modified during replication, consider a four-step example:

1. An object (a user) is created on Server A.
2. That object is replicated to Server B.
3. That object is subsequently modified on Server B.
4. The new changes to that object are replicated back to Server A.

This four-step process is shown in Figure 5-1. The diagram depicts the status of the user object on both Server A and Server B during the four time periods that represent each of the steps.

Now use Figure 5-1 to follow a discussion of each of the steps.

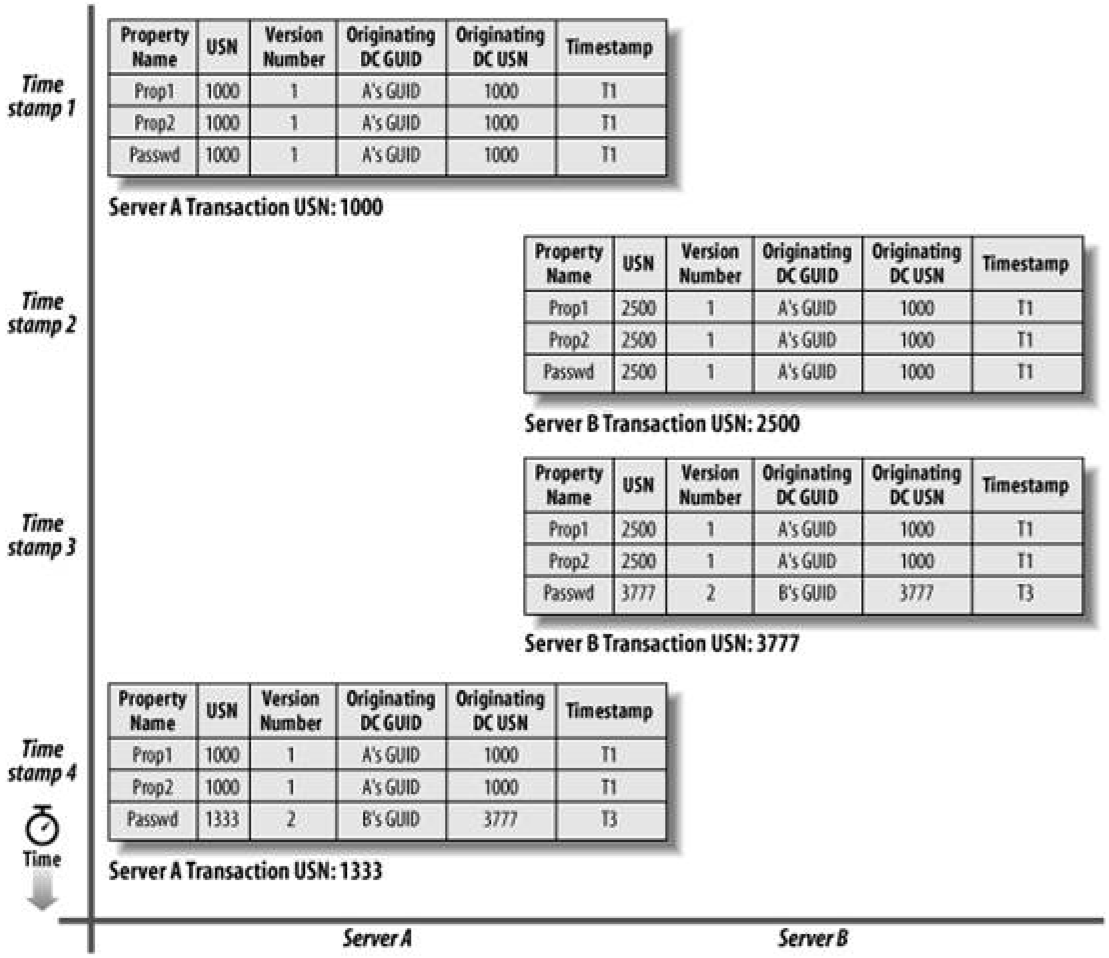
5.2.2.1. Step 1: Initial creation of a user on Server A

When you create a user on Server A, Server A is the originating server. During the Active Directory database transaction representing the creation of the new user on Server A, a USN (1000) is assigned to the transaction. The user's uSNCreated and uSNChanged properties are automatically set to 1000 (the USN of the transaction corresponding to the user creation). All of the user's properties are also initialized with a set of data, as follows:

- The property's value(s) is/are set according to system defaults or parameters given during user creation.
- The property's USN is set to 1000 (the USN of this transaction).
- The property's version number is set to 1.
- The property's timestamp is set to the time of the object creation.
- The property's originating-server GUID is set to the GUID of Server A.
- The property's originating-server USN is set to 1000 (the USN of this transaction).

This tells you that the user was created during transaction 1000 on this server (uSNCreated = 1000). It also tells you that the user was last changed during transaction 1000 (uSNChanged = 1000). You know that the properties for the user have never been modified from their original values (property version numbers = 1), and these values were set at transaction 1000 (property's USN = 1000). Finally, you know that each property was last set by the originating server, Server A, during transaction 1000 (originating-server GUID and originating-server USN).

Figure 5-1. How metadata is modified during replication



Property Name	USN	Version Number	Originating DC GUID	Originating DC USN	Timestamp
Prop1	1000	1	A's GUID	1000	T1
Prop2	1000	1	A's GUID	1000	T1
Passwd	1000	1	A's GUID	1000	T1

Server A Transaction USN: 1000

Property Name	USN	Version Number	Originating DC GUID	Originating DC USN	Timestamp
Prop1	2500	1	A's GUID	1000	T1
Prop2	2500	1	A's GUID	1000	T1
Passwd	2500	1	A's GUID	1000	T1

Server B Transaction USN: 2500

Property Name	USN	Version Number	Originating DC GUID	Originating DC USN	Timestamp
Prop1	2500	1	A's GUID	1000	T1
Prop2	2500	1	A's GUID	1000	T1
Passwd	3777	2	B's GUID	3777	T3

Server B Transaction USN: 3777

Property Name	USN	Version Number	Originating DC GUID	Originating DC USN	Timestamp
Prop1	1000	1	A's GUID	1000	T1
Prop2	1000	1	A's GUID	1000	T1
Passwd	1333	2	B's GUID	3777	T3

Server A Transaction USN: 1333

The preceding example showed two per-object values and five per-property values being changed. While uSNChanged and uSNCreated are real properties on each object in AD, properties of an object can only have values and cannot hold other properties, such as a version number.

In reality, all of the per-property replication metadata (Property Version Number, Time-Changed, Originating-DC-GUID, Originating-USN, Property-USN) for every property of any object is encoded together as a single byte string and stored as replPropertyMetaData, a non-replicated attribute of the object.

A property's metadata can be seen by using the *RepAdmin*, *ADSIEdit*, or *LDP* tools.

5.2.2.2. Step 2: Replication of the originating write to Server B

Later, when this object is replicated to Server B, Server B adds the user to its copy of Active Directory as a replicated write. During this transaction, USN 2500 is allocated, and the user's uSNCreated and uSNChanged properties are modified to correspond to Server B's transaction USN (2500).

This tells you that the user was created during transaction 2500 on this server (uSNCreated = 2500). It also tells you that the user was last changed during transaction 2500 (uSNChanged = 2500). You know that the properties for the user have never been modified from their original values (property version numbers = 1), and that these values were set at transaction 2500 (property's USN = 2500). Finally, you know that each property was last set by the originating server, Server A, during transaction 1000 (originating-server GUID and originating-server USN).

5.2.2.3. Step 3: Password change for the user on Server B

Now an originating write (a password change) occurs on Server B's replicated-write user. Some time has passed since the user was originally created, so the USN assigned to the password change transaction is 3777. When the password is changed, the user's uSNChanged property is modified to become 3777. In addition, the password property (and only the password property) is modified in the following way:

- The password value is set.
- The password's USN is set to 3777 (the USN of this transaction).
- The property's version number is set to 2.
- The property's timestamp is set to the time that transaction 3777 occurred.
- The property's originating-server GUID is set to the GUID of Server B.
- The property's originating-server USN is set to 3777 (the USN of this transaction).

Looking at the user object, you can now see that the object was last changed during transaction 3777 and that the transaction represented a password change that originated on Server B.

5.2.2.4. Step 4: Password change replication to Server A

This step is similar to step 2. When Server A receives the password update during replication, it allocates the change transaction a USN of 1333.

> Remember that updates occur at the property level and not the object level, so only the password is sent and not the entire `user` object.

During transaction 1333, the user's uSNChanged property is modified to correspond to Server A's transaction USN.

This tells you that the user was created during transaction 1000 on this server (uSNCreated = 1000). It also tells you that the user was last changed during transaction 1333 (uSNChanged = 1333). You know that all but one of the properties for the user have retained their original values (property version numbers = 1), and these values were set at transaction 1000 (property's USN = 1000). Finally, you know that all but one of the properties were last set by the originating server, Server A, during transaction 1000 (originating-server GUID and originating-server USN). The password was modified for the first time since its creation (password version number = 2) during transaction 1333 (password's USN = 1333), and it was modified on Server B during transaction 3777 (originating-server GUID and originating-server USN).

That's how object and property metadata is modified during replication . Let's now take a look at exactly how replication occurs.

> If you are duplicating this step-by-step walkthrough on real domain controllers, you will have noticed two discrepancies.
>
> The first is that after the replication from Server A to Server B, the `cn` attribute will actually show that the originated write came from Server B. This is a backend implementation detail, and it is the only case where this type of discrepancy occurs.
>
> The second is that a password change actually updates several attributes, not just one. The attributes involved are `dBCSPwd`, `unicodePwd`, `ntPwdHistory`, `lmPwdHistory`. This is another backend implementation detail. For most attributes, when you specifically update a single attribute, only that attribute gets modified and replicated; passwords are handled as a special case.

5.2.3. The Replication of a Naming Context Between Two Servers

In the following examples, there are five servers in a domain: Server A, Server B, Server C, Server D, and Server E. It doesn't matter what NC they are replicating or which servers replicate with which other servers (as they do not all have to replicate with one another directly), because the replication process for any two servers will be the same nonetheless. Replication is a five-step process:

1. Replication with a partner is initiated.
2. The partner works out what updates to send.
3. The partner sends the updates to the initiating server.
4. The initiating server processes the updates.
5. The initiating server checks whether it is up to date.

5.2.3.1. Step 1: Replication with a partner is initiated

Replication occurs between only two servers at any time, so let's consider Server A and Server B, which are replication partners . At a certain point in time indicated by the replication schedule on Server A, Server A initiates replication for a particular NC with Server B and requests any updates that it doesn't have. This is a one-way update transfer from Server B to Server A. No new updates will be passed to Server B in this replication cycle, as this would require Server B to initiate the replication.

Server A initiates the replication by sending Server B a request to replicate along with five pieces of important replication metadata; i.e., data relating to the replication process itself. The five pieces are:

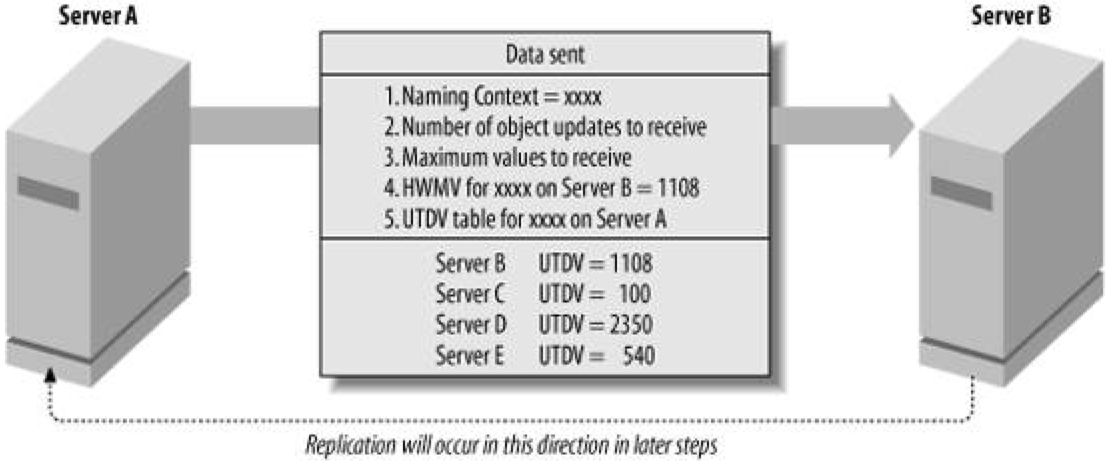
- The name of the NC that Server A wishes to receive updates for
- The maximum number of object updates that Server A wishes to receive during this replication cycle
- The maximum number of values that Server A wishes to receive during this replication cycle
- USN for Server B from Server A's high-watermark vector for this NC
- Server A's up-to-dateness vector for this NC

The maximum object updates and property values are very important in limiting network bandwidth. If one server has had a huge volume of updates since the last replication cycle, limiting the number of objects replicated out in one replication packet means that network bandwidth is not inordinately taken up by replicating those objects in one huge packet. Instead, the replication is broken down into smaller packets over the course of the replication cycle. Once a replication cycle has started for a naming context, it will replicate all changes regardless of how many packets are needed or how long it will take unless the connection between the domain controllers fails outright.

> "Once a replication cycle has started for a naming context, it will replicate all changes regardless of how many packets are needed or how long it will take unless the connection between the domain controllers fails outright." Whether you realize it or not, this implies that when you set up replication schedules for site links, you can specify when replication can start, but you *cannot* specify when it will stop. Replication will continue until it is completed or the physical connection between the domain controllers is broken. This is generally not an issue unless you have a very slow connection between a WAN site and a hub site and you configure the site link to not replicate during normal business hours to conserve bandwidth for users. As long as the number and size of the changes do not exceed what can be replicated in the evening to the WAN site, you are fine; the moment you exceed that magic set of values, however, your replication cycle will take all night and continue into business hours regardless of the schedule.

This step is illustrated in Figure 5-2, which shows that while the initiation of the replication occurs from an NC denoted as xxxx on Server A (where xxxx could represent the Schema, the Configuration, an application partition, or any domain NC), the actual replication will occur later from Server B to Server A.

Figure 5-2. Initiating replication with Server B for NC xxxx


Server A
Server B
Data sent
1. Naming Context = xxxx
2. Number of object updates to receive
3. Maximum values to receive
4. HWMV for xxxx on Server B = 1108
5. UTDV table for xxxx on Server A
Server B UTDV = 1108
Server C UTDV = 100
Server D UTDV = 2350
Server E UTDV = 540
Replication will occur in this direction in later steps

5.2.3.2. Step 2: The partner works out what updates to send

Server B receives all this metadata and works out which updates it needs to send back for this NC. First, Server B determines its own highest committed USN for its copy of the NC and then compares that to the USN Server A submitted from its HWMV. Assuming that there have been some updates, Server B instantly knows how many updates have occurred since Server A last replicated with Server B. This has to be true, as Server A's HWMV would have been updated with Server B's highest committed USN for the NC during the last replication cycle. So, any difference between the two USNs must represent changes on Server B since the last replication, and Server B knows which individual USNs Server A is missing. Assuming also for now that the number of updates does not exceed the maximums specified by Server A in its metadata, Server B can supply all of the missing updates to Server A.

However, this entire set of updates may not need to go to Server A if Server A has had some of them replicated already from other servers. Server B now needs some way of knowing which updates Server A has already seen, so that it can remove those items from the list of updates to send. That's where the UTDV comes in. For each update that could potentially be sent, Server B checks two pieces of data attached to the object that was updated: the DSA GUID of the server that originated the update (the Originating-DC-GUID) and the USN associated with that update (the Originating-USN) on the originating server. For example, a password change to a user may have been replicated to Server B and recorded as USN 1112, but it may in fact have originated on Server D as USN 2345. Server B cross-references the originating server's GUID with Server A's UTDV to find the highest originating write USN for the originating server. If the USN recorded in the UDTV for the originating server is equal to or higher than the USN attached to the update on Server D, Server A must have already seen the update. This has to be true, because Server A's UTDV is used to indicate the highest originating-writes that Server A has received.

Let's say that Server B has four updates for Server A: one originating write (Server B USN: 1111) and three replicated writes (Server B USNs 1109, 1110, and 1112). The reason there are four is that 1112 is the last update made on Server B in this example, and the USN in Server A's HWMV for xxxx on Server B from Figure 5-1 is 1108. So look for updates starting at 1109 up to the last update on Server B, which is 1112. The first two replicated writes (Server B USNs 1109 and 1110) originated on Server E (Server E USNs 567 and 788), and one (Server B USN 1112) originated on Server D (Server D USN 2345). This is shown in Table 5-1.

Table 5-1. Potential updates to be sent

Server B USN	Originating DC GUID	Originating DC USN
1109	Server E's GUID	567
1110	Server E's GUID	788
1111	Server B's GUID	1111
1112	Server D's GUID	2345

According to Figure 5-2, Server A already has Server D's 2345 update because the USN in Server A's UTDV for Server D is 2350. So, both Server A and Server B already have Server D's 2345 update, and there is no need to waste bandwidth sending it over the network again. The act of filtering updates that have already been seen to keep them from being continually sent between the servers is known as propagation dampening.

Now that you know how the high-watermark vector and up-to-datemess vector help Server B to work out what updates need to be sent, let's look at the exact process that Server B uses to work out what data is required.

When Server B receives a request for updates from Server A, it starts by making a copy of its up-to-dateness vector for Server A. Having done that, it puts the table to one side, so to speak, and does a search of the entire NC for all objects with a uSNChanged value greater than the USN value from Server A's high-watermark vector entry for Server B. This list is then sorted into ascending uSNChanged order.

Next, Server B initializes an empty output buffer to which it will add update entries for sending to Server A. It also initializes a value called Last-Object-USN-Changed. This will be used to represent the USN of the last object sent in that particular replication session. This value is not an attribute of any particular object, just a simple piece of replication metadata. Server B then enumerates the list of objects in ascending uSNChanged order and uses the following algorithm for each object:

- If the object has already been added to the output buffer, Server B sets Last-Object-USN-Changed to the uSNChanged property of the current object. Enumeration continues with the next object.
- If the object has not already been added to the output buffer, Server B tests the object to see if it contains changes that need to be sent to the destination. For each property of the current object, Server B takes the Originating-DC-GUID of that property and locates the USN that corresponds to that GUID from Server A's UTDV. From that entry, Server B looks at the Originating-USN. If the property's Originating-USN on Server B is greater than Server A's UTDV entry the property needs to be sent.

If changes need to be sent, an update entry is added to the output buffer. Server B sets Last-Object-USN-Changed to the uSNChanged property of the current object. Enumeration continues with the next object.

If no changes need to be sent, Server B sets the Last-Object-USN-Changed to the uSNChanged of the current object. Enumeration continues with the next object.

During the enumeration, if the requested limit on object update entries or values is reached, the enumeration terminates early and a flag known as More-Data is set to true. If the enumeration finishes without either limit being hit, then More-Data is set to false.

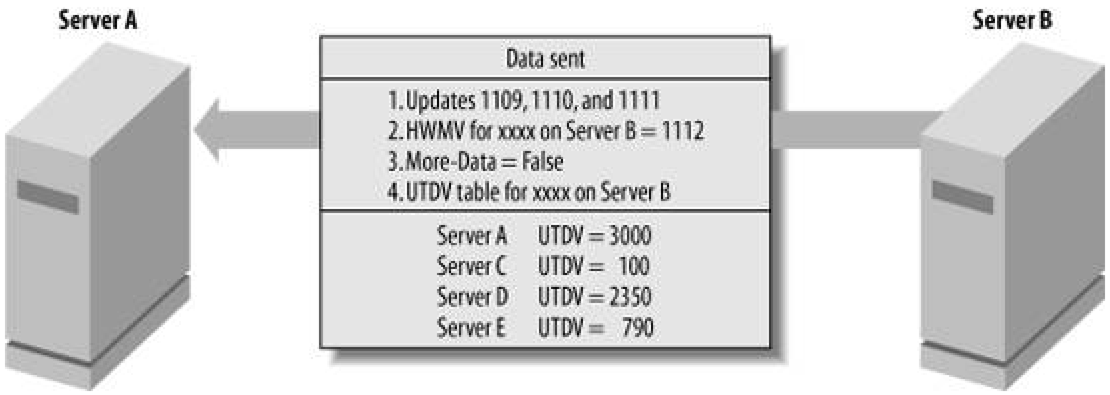
5.2.3.3. Step 3: The partner sends the updates to the initiating server

Server B identifies the list of updates that it should send back based on those that Server A has not yet seen from other sources. Server B then sends this data to Server A. In addition, if More-Data is set to false, one extra piece of metadata is sent back as well. The returned information from Server B is:

- The output buffer updates from Server B
- Server B's Last-Object-USN-Changed value (i.e., the value for Server A to insert into the high-watermark vector for the NC for Server B)
- The More-Data flag
- Server B's up-to-date vector for this NC (sent only when More-Data set to false)

This is shown in Figure 5-3.

Figure 5-3. Server B sends the updates to Server A for NC xxxx



Data sent

1. Updates 1109, 1110, and 1111
2. HWMV for xxxx on Server B = 1112
3. More-Data = False
4. UTDV table for xxxx on Server B

Server A	UTDV = 3000
Server C	UTDV = 100
Server D	UTDV = 2350
Server E	UTDV = 790

> If Server B calculates that Server A is already up to date and requires no updates, only the last two pieces of metadata are returned to Server A. This can occur if the highest committed USN for the NC on Server B is identical to the HWMV entry passed by Server A; i.e., no updates have occurred since the last replication cycle. This also can occur if Server B's highest committed USN for the NC has changed but Server A has already seen all of the originating updates through replication with other partners. In both cases, just the metadata is returned.

5.2.3.4. Step 4: The initiating server processes the updates

Server A receives the data. For each update entry it receives, Server A allocates a USN and starts a database transaction to update the relevant object in its own copy of the Active Directory database. The object's uSNChanged property is set to the USN of this transaction. The database transaction is then committed. This process continues for each update entry that was received.

After all the update entries have been processed, the USN in Server A's high-watermark vector for Server B is set to the Last-Object-USN-Changed received from Server B. In other words, Server A now knows that it is up to date with Server B, up to the last change just sent over.

The Last-Object-USN-Changed that Server A receives allows it to know the last update that Server B has made. This will be used in the next replication cycle. In the previous example, the highest update sent across to Server A is USN 1111. Server B's USN 1112 update is not actually sent since Server A has already seen it. However, the Last-Object-USN-Changed returned by Server B with the data would still be 1112 and not 1111.

5.2.3.5. Step 5: The initiating server checks whether it is up to date

Server A now checks the More-Data flag. If More-Data is set to true, Server A goes back to step 1 to start replication with Server B again and request more updates. If More-Data is set to false, every update must have been received from Server B, and finally Server A's up-to-dateness vector is itself updated.

The up-to-dateness vector allows Server A to identify which originating updates Server B has seen and thus by replication which originating updates it has now seen. Server A does not replace its up-to-dateness vector with the one it was sent. Instead, it checks each entry in the received table and does one of two things. If the entry for a server is not listed in its own UTDV, it adds that entry to the table. This allows Server A to know that it has now been updated to a certain level for a new server. If the entry for a server is listed in Server A's UTDV, and the value received is higher, it modifies its own copy of the table with the higher value. After all, it has now been updated to this new level by Server B, so it had better record that fact.

Table 5-2 shows Server A's up-to-dateness vector and high-watermark vector for the xxxx Naming Context before step 1 and after step 5.

Table 5-2. State of UTDV and HWMV for Server A before and after updates

	HWMV for Server B	Server B UTDV	Server C UTDV	Server D UTDV	Server E UTDV
Before step 1	1108	1108	100	2350	540
After step 5	1112	1111	100	2350	790

5.2.3.6. Recap

The following main points summarize replication between naming contexts:

- The high-watermark vector is used to detect updates that need to be sent between replication partners.
- The up-to-dateness vector is used in propagation dampening to filter the updates so that only updates that the initiating server has not seen are transmitted from a partner.
- The uSNChanged property on each object is used to identify which objects might need to be sent out as updates to the initiating server.

> You can force manual replication of a particular NC on a DC if you choose, using the Sites and Services snap-in. Browse to the connection object that you want to replicate over, right-click it, and select Replicate Now.

5.2.4. How Replication Conflicts Are Reconciled

While the replication process is usually fine on its own, there are times when conflicts can occur because two servers perform irreconcilable operations between replication cycles. For example, Server A creates an object with a particular name at roughly the same time that Server B creates an object with the same name under the same parent container. Both can't exist at the same time in Active Directory, so what happens to the two objects? Does one get deleted or renamed? Do both get deleted or renamed? What about an administrator moving an object on Server D to an Organizational Unit while at the same time on Server B that Organizational Unit is being deleted? What happens to the soon-to-be orphaned object? Is it deleted along with the Organizational Unit or moved somewhere else entirely? Consider a final example: if an admin on Server B changes a user's password while the user himself changes his password on Server C, which password does the user get?

All of these conflicts need to be resolved within Active Directory during the next replication cycle. The exact reconciliation process and how the final decision is replicated back out depend on the exact conflict that occurred.

5.2.4.1. Conflict due to identical property change

In this case, the server starts reconciliation by looking at the version numbers of the two properties. Whichever property has the higher version number wins the conflict. If the property version numbers are equal, the server checks the timestamps of both properties. Whichever property was changed at the later time wins the conflict. If the property timestamps are equal, the GUIDS from the two originating servers are checked. As GUIDs must be unique, these two values have to be unique, so the server arbitrarily takes the property change from the originating server with the higher GUID as the winner of the conflict.

> All replication metadata timestamps for Active Directory are in Universal Time Coordinated (UTC), which is more commonly known as Greenwich Mean Time (GMT) or Zulu time.

5.2.4.2. Conflict due to a move or creation of an object under a now-deleted parent

This is a fairly easy conflict to resolve. In this case, the parent is deleted, but the object is moved to the *Lost and Found* Container, which was specially set up for this scenario. The ADsPath of the Lost and Found Container for *Mycorp* is:

```
LDAP://cn=LostAndFound,dc=mycorp,dc=com
```

5.2.4.3. Conflict due to creation of objects with names that conflict

The server starts reconciliation by looking at the version numbers of the two objects. Whichever object has the higher version number wins the conflict. If the object version numbers are equal, the server checks the timestamps of both objects. Whichever object was changed at the later time wins the conflict. If both object timestamps are equal, the GUIDS from the two originating servers are checked. The server once again takes the object change from the originating server with the higher GUID as the winner of the conflict.

In this case, however, the object that failed the conflict resolution is not lost or deleted; instead, the conflicting attribute is modified with a known unique value. That way, at the end of the resolution, both objects exist, with one having its conflicting name changed to a unique value. The unique name consists of the following format: *<ObjectName><LineFeed>CNF:< ObjectGUID>*.

> This same logic is only used for the RDN naming value of the object (usually the `cn` attribute). It is not used for cleaning up other values that are normally required to be unique such as the `sAMAccountName`.

5.2.4.4. Replicating the conflict resolution

Let's say that Server A starts a replication cycle. First, it requests changes from Server B and receives updates. Then Server A requests changes from Server C and receives updates. However, as Server A is applying Server C's updates in order, it determines that a conflict has occurred between the updates recently applied by Server B. Server A resolves the conflict according to the preceding guidelines, and finds in Server C's favor. Now, while Server A and Server C are correct, Server B still needs to be updated with Server C's value.

To do this, when Server B next requests updates from Server A, it receives, among others, the update that originated on Server C. Server B then applies the updates it receives in sequence, and when it gets to the update that originated on Server C, it detects the same conflict. Server B then goes through the same conflict resolution procedure that Server A did and comes to the same result. Server B then modifies its own copy of the object to accommodate the change.

Additional problems can occur when changes are made on a server and it goes down prior to replicating the changes. If the server never comes back up to replicate changes, those changes are obviously lost.

> Alternatively, if the server comes back up much later and attempts to replicate those changes back to Active Directory, there is a much greater chance of conflict resolution (with that server failing the conflict, if many of the changes that were made on that server have subsequently been made in Active Directory more recently on other servers.) This isn't a problem, but is something you need to be aware of.

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5.3. Summary

We have now looked at the importance of the site topology in Active Directory and how that relates to your physical network. We have also considered the metadata that governs the replication process, how the system keeps track of changes to objects and properties automatically, how data is replicated among servers including propagation dampening, and how conflicts are reconciled.

In Chapter 9, we take this knowledge further and show you how Active Directory manages and automatically generates the replication connections that exist both within and between sites. With that knowledge, we can move on to the design principles for sites and links in Active Directory.

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Chapter 6. Active Directory and DNS

One of the big advantages of Active Directory over its predecessor, Windows NT, is the reliance on the Domain Name System (DNS) as opposed to the Windows Internet Naming Service (WINS) for name resolution. DNS is the ubiquitous, standards-based naming service used on the Internet. WINS, on the other hand, never garnered industry support and was typically used only to support Windows NT NOS environments.

The good news is that with Active Directory, the dependencies on WINS have been eliminated, but the potentially bad news is that Active Directory has a lot of dependencies on the DNS infrastructure. It is only potentially bad based on the flexibility of your DNS environment. Often, the groups that manage DNS and Active Directory within an organization are different, and getting the two teams to agree on implementation can be difficult due to political turf battles or technology clashes.

> Although Active Directory doesn't need WINS, or, more accurately, NetBIOS Name Resolution, many other Microsoft technologies, including Exchange 2000/2003, do need it. Implementing Active Directory doesn't necessarily guarantee that you won't be running WINS anymore.

The intent of this chapter is to provide you with a good understanding of how Active Directory uses DNS, and a description of some of the options for setting it up within your organization. We will briefly touch on some DNS basics but will not go into much depth on how to configure and administer the Windows DNS server. For more information on those topics, we highly recommend *DNS on Windows 2003* by Matt Larson, Cricket Liu, and Robbie Allen (O'Reilly).

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6.1. DNS Fundamentals

DNS is a hierarchical name resolution system. It is also the largest public directory service deployed. Virtually every company uses DNS for name resolution services, including hostname to IP address, IP address to hostname, and hostname to alternate hostname (aliases). DNS is a well-documented standard that has been around since the early days of the Internet. The following RFCs cover some of the basics of DNS:

- RFC 1034, "Domain Names - Concepts and Facilities"
- RFC 1035, "Domain Names - Implementation and Specification"
- RFC 1912, "Common DNS Operational and Configuration Errors"
- RFC 1995, "Incremental Zone Transfer in DNS"
- RFC 1996, "A Mechanism for Prompt Notification of Zone Changes (DNS NOTIFY)"
- RFC 2181, "Clarifications to the DNS Specification"

There are three important DNS concepts that every Active Directory administrator must understand. Zones are delegated portions of the DNS namespace, resource records contain name resolution information, and dynamic DNS allows clients to add and delete resource records dynamically.

6.1.1. Zones

A *zone* is a collection of hierarchical domain names, the root of which has been delegated to one or more name servers. For example, let's say that the *mycorp.com* namespace was delegated to the name server *ns1.mycorp.com*. All domain names contained under *mycorp.com* that *ns1.mycorp.com* was authoritative for would be considered part of the *mycorp.com* zone. A subset of the *mycorp.com* zone could be delegated to another server; for example, *mycorp.com* could delegate *subdomain1.mycorp.com*, to the name server *ns2.mycorp.com*. At that point, *subdomain1.mycorp.com* becomes its own zone for which *ns2.mycorp.com* is authoritative.

6.1.2. Resource Records

A *resource record* is the unit of information in DNS. A zone is essentially a collection of resource records . There are various resource record types that define different types of name lookups. Table 6-1 lists some of the more common resource record types.

Table 6-1. Commonly used resource record types

Record type	Name	Description
A	Address Record	Maps a hostname to an IP address
PTR	Pointer Record	Maps an IP address to a hostname
CNAME	Alias Record	Maps an alias to a hostname
MX	Mail Exchanger Record	Specifies a mail route for a domain
NS	Name Server Record	Specifies name servers for a given domain
SOA	Start of Authority Record	Contains administrative data about a zone, including the primary name server
SRV	Service Record	Maps a particular service (e.g., LDAP) to one or more hostnames

One important resource record to note is the SRV record type. SRV records are used extensively by domain controllers and Active Directory clients to locate servers that have a particular service. We will describe how Active Directory uses these records in more detail later in the chapter. It is also important to note that SRV records are dependent upon A records. Each SRV record provides a variety of details about each service it represents (LDAP, for example), including the computers on which the services run. SRV records achieve this by maintaining a pointer to the fully-qualified name of the A records that represent the computers running the service.

6.1.3. DDNS

Dynamic DNS, defined in RFC 2136, is a method for clients to send requests to a DNS server to add or delete resource records in a zone. Having this capability has greatly increased the supportability of DNS in large environments. Before DDNS, the primary means to update a zone was by either directly editing a text-based zone file or via a vendor-supported GUI, such as the Windows DNS MMC snap-in.

RFC 2136 can be found at http://www.ietf.org/rfc/rfc2136.txt.

Active Directory takes full advantage of DDNS to ease the burden of maintaining all of the resource records it requires. Each domain controller can have anywhere from a few dozen to a few hundred associated resource records depending on the size of the Active Directory site topology. Any time the site topology changes, one or more domain controllers may need to change some or all of the resource records previously registered. Because of this dynamic nature of the Active Directory resource records, in a large environment, it could easily take a person working full time to manually maintain all of the records.

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6.2. DC Locator

One of the fundamental issues for clients in any NOS environment is finding the most optimal domain controller (DC) to authenticate against. The process under Windows NT was not very efficient and could cause clients to authenticate to domain controllers in the least optimal location. With Active Directory, clients use DNS to locate domain controllers via the DC locator process. To illustrate at a high level how the DC locator process works, we will describe an example where a client has moved from one location to another and needs to find a DC for the domain it is a member of.

Securing Your Dynamic Updates

The RFC that defined Dynamic DNS, RFC 2136, did not provide for a security model to secure updates from clients. As you might expect, this is a very serious limitation to wide-scale adoption. To address this problem, RFC 2137, "Secure Dynamic Update," was created. Unfortunately, RFC 2137 was not very practical in implementation and tended to be overly complex. Later, RFC 2535, "Domain Name System Security Extensions," defined a public key-based method for securing DNS requests, commonly known as DNSSEC. RFC 3007 was then created, which rendered RFC 2137 obsolete and updated RFC 2535 to provide a more flexible method to secure update requests. Many DNS server products have only recently started to provide support for these RFCs, and only time will tell whether they will become widely adopted. Check out the following for more information on RFC 2535 and 3007:

- http://www.ietf.org/rfc/rfc2535.txt
- http://www.ietf.org/rfc/rfc3007.txt

Although Windows Server 2003 provides support for some of the resource record types defined in RFC 2535, such as KEY, SIG and NXT, it does not provide full compliance, such as message signing and verification. The approach Microsoft takes to providing secure dynamic updates is by using ACLs in Active Directory. Zones that are Active Directory Integrated (described later in the chapter) store their DNS data in Active Directory. You can then set ACLs on the DNS-related objects in Active Directory to permit or deny users to update records. By default, authenticated computers in a forest can make new entries in a zone, and only the computer that created an entry is allowed to modify the data associated with that entry.

1. A client previously located in Site A is moved to Site B.

2. When the client initially boots up, it thinks it is still in Site A, so it retrieves from the cache the last DC it used, most likely from Site A, and proceeds to contact it.

3. The DC in Site A receives the request and determines that the IP address is for Site B and determines that the client should now be using a DC that services Site B. If the server does not service clients in Site B, it will return the client's new site in the reply and tell the client that it isn't the closest DC.

4. The client will then perform a DNS lookup to find all DCs that service Site B.

5. The client then contacts a DC servicing Site B. Three things can happen at this point:

    a. The DC servicing Site B can respond and authenticate the client.

    b. The DC might fail to respond (it could be down), at which point the client will attempt to use a different DC in Site B.

    c. All DCs servicing Site B fail to respond and the client then performs a DNS lookup to find all DCs that service the domain despite what sites they cover and uses any one of them to authenticate.

The two main things that are needed to support an efficient DC locator process are proper definition of the site topology in Active Directory and the presence of all the necessary Active Directory-related resource records in DNS. In the next section, we will describe the purpose of the resource records used in Active Directory.

> For a more detailed description of how the DC locator process works, including the specific resource records that are queried during the process, check out Microsoft Knowledge Base (KB) article 247811, "How Domain Controllers Are Located in Windows," and Microsoft KB article 314861, "How Domain Controllers Are Located in Windows XP," at http://support.microsoft.com.

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6.3. Resource Records Used by Active Directory

When you promote a domain controller into a domain, a file containing the necessary resource records fo to function correctly within Active Directory is generated in *%SystemRoot%\System32\Config\netlogon.*
.

The contents of the file will look something like the following for a DC named *moose.mycorp.com* in the *mycorp.com* domain with IP address 10.1.1.1. We've reordered the file a bit to group records of similar purpose together. Note that some lines may wrap due to their length.

```
mycorp.com. 600 IN A 10.1.1.1
 ec4caf62-31b2-4773-bcce-7b1e31c04d25._msdcs.mycorp.com. 600 IN CNAME moose.mycorp
com.
gc._msdcs.mycorp.com. 600 IN A 10.1.1.1
_gc._tcp.mycorp.com. 600 IN SRV 0 100 3268 moose.mycorp.com.
_gc._tcp.Default-First-Site-Name._sites.mycorp.com. 600 IN SRV 0 100 3268 moose.
mycorp.com.
_ldap._tcp.gc._msdcs.mycorp.com. 600 IN SRV 0 100 3268 moose.mycorp.com.
_ldap._tcp.Default-First-Site-Name._sites.gc._msdcs.mycorp.com. 600 IN SRV 0 100 
moose.mycorp.com.
_kerberos._tcp.dc._msdcs.mycorp.com. 600 IN SRV 0 100 88 moose.mycorp.com.



 _kerberos._tcp.Default-First-Site-Name._sites.dc._msdcs.mycorp.com. 600 IN SRV 0 
 88 moose.mycorp.com.
_kerberos._tcp.mycorp.com. 600 IN SRV 0 100 88 moose.mycorp.com.
_kerberos._tcp.Default-First-Site-Name._sites.mycorp.com. 600 IN SRV 0 100 88 moo
mycorp.com.
_kerberos._udp.mycorp.com. 600 IN SRV 0 100 88 moose.mycorp.com.
_kpasswd._tcp.mycorp.com. 600 IN SRV 0 100 464 moose.mycorp.com.
_kpasswd._udp.mycorp.com. 600 IN SRV 0 100 464 moose.mycorp.com.
_ldap._tcp.mycorp.com. 600 IN SRV 0 100 389 moose.mycorp.com.
_ldap._tcp.Default-First-Site-Name._sites.mycorp.com. 600 IN SRV 0 100 389 moose.
mycorp.com.
_ldap._tcp.pdc._msdcs.mycorp.com. 600 IN SRV 0 100 389 moose.mycorp.com.
 _ldap._tcp.97526bc9-adf7-4ec8-a096-0dbb34a17052.domains._msdcs.mycorp.com. 600 IN
0 100 389 moose.mycorp.com.
_ldap._tcp.dc._msdcs.mycorp.com. 600 IN SRV 0 100 389 moose.mycorp.com.
_ldap._tcp.Default-First-Site-Name._sites.dc._msdcs.mycorp.com. 600 IN SRV 0 100 
moose.mycorp.com.
```

Although it may look complicated, it isn't. Let's go through what these records actually mean, splitting th records up into sections for ease of understanding. To start with, the first record is for the domain itself:

```
mycorp.com. 600 IN A 10.1.1.1
```

Each DC attempts to register an A record for its IP address for the domain it is in. A quick and easy way t get a list of all the domain controllers in a domain is to simply look up the A record for the domain name. will now walk through that query to show the domain controllers that have registered an A record for the *mycorp.com* domain:

```
> nslookup mycorp.com
Server:  moose.mycorp.com
Address:  10.1.1.1

Name:    mycorp.com
Addresses:  10.1.1.1, 10.1.1.2, 10.1.1.3

> nslookup 10.1.1.1
Server:  moose.mycorp.com
Address:  10.1.1.1

Name:    moose.mycorp.com
Addresses:  10.1.1.1

> nslookup 10.1.1.2
Server:  moose.mycorp.com
Address:  10.1.1.1

Name:    deer.mycorp.com
Addresses:  10.1.1.2

> nslookup 10.1.1.3
Server:  moose.mycorp.com
Address:  10.1.1.1

Name:    elk.mycorp.com
Addresses:  10.1.1.3
```

Next, we have the following record:

```
ec4caf62-31b2-4773-bcce-7b1e31c04d25._msdcs.mycorp.com.  600  IN  CNAME
moose.mycorp.com.
```

This is an alias or canonical name (CNAME) record. It is contained under the _msdcs subdomain, which is used by domain controllers to intercommunicate. The record is comprised of the GUID for the server, whi is an alias for the server itself. DCs use this record if they know the GUID of a server and want to determ its address.

Next, we have this A record:

```
gc._msdcs.mycorp.com. 600 IN A 10.1.1.1
```

This is registered only if the DC is a Global Catalog server. You can query *gc._msdcs.mycorp.com* to obta list of all the Global Catalog servers in the forest in much the same way you could query the domain nam get a list of all the domain controllers for a domain.

The remaining records are of type SRV . The SRV record type was defined in RFC 2052, "A DNS RR for Specifying the Location of Services (DNS SRV)." The full text can be found at http://www.ietf.org/rfc/rfc2052.txt . Simply put, SRV records allow you to specify server(s) on your netw that should be used for specific protocols. These records also allow you to remap the port numbers for individual protocols or the priority in which certain servers are used.

There a few more Global Catalog specific records shown next:

```
_gc._tcp.mycorp.com. 600 IN SRV 0 100 3268 moose.mycorp.com.
_gc._tcp.Default-First-Site-Name._sites.mycorp.com. 600 IN SRV 0 100 3268 moose.
mycorp.com.
_ldap._tcp.gc._msdcs.mycorp.com. 600 IN SRV 0 100 3268 moose.mycorp.com.
_ldap._tcp.Default-First-Site-Name._sites.gc._msdcs.mycorp.com. 600 IN SRV 0 100 :
moose.mycorp.com.
```

One interesting thing to note about SRV records is the seventh field, which designates the port used to contact the service on that host. In every case above, 3268 is used, which corresponds to the Global Cata port. You may have also noticed the entries that contain Default-First-Site-Name. Each Global Catalog se registers site-specific records so clients can find the optimal Global Catalog based on their site membersh See the "Site Coverage " sidebar for more information.

NLTEST is part of the Windows Support Tools.

The next few SRV records are for Kerberos authentication (port 88) and the Kpasswd process (port 464), which allows users to change passwords via Kerberos:

```
_kerberos._tcp.dc._msdcs.mycorp.com. 600 IN SRV 0 100 88 moose.mycorp.com.
_kerberos._tcp.Default-First-Site-Name._sites.dc._msdcs.mycorp.com. 600 IN SRV 0 1
88 moose.mycorp.com.
_kerberos._tcp.mycorp.com. 600 IN SRV 0 100 88 moose.mycorp.com.
_kerberos._tcp.Default-First-Site-Name._sites.mycorp.com. 600 IN SRV 0 100 88 moos
mycorp.com.
_kerberos._udp.mycorp.com. 600 IN SRV 0 100 88 moose.mycorp.com.
_kpasswd._tcp.mycorp.com. 600 IN SRV 0 100 464 moose.mycorp.com.
_kpasswd._udp.mycorp.com. 600 IN SRV 0 100 464 moose.mycorp.com.
```

Site Coverage

You can create sites in the Active Directory site topology that do not have domain controllers located within the site. In this situation, the domain controllers that have the best connections as defined by the site links will "cover" for that site. When a DC covers for a site, it will add site-specific SRV records so that it will advertise itself as a DC that can handle queries for clients in the site. To see a list of the sites that a particular DC is covering for, run the following NLTEST command and replace *dc01* with the name of the DC you want to query:

```
c:\> nltest /dsgetsitecov /server:dc01
```

Just as with the Global Catalog SRV records, there may be more of the site-specific Kerberos records for additional sites the DC covers.

The rest of the SRV records are used to represent a domain controller for a particular domain and site. O record to note is the *_ldap._tcp.pdc._msdcs.mycorp.com* . entry, which is registered by the DC that is ac as the PDC Emulator for the domain. No other FSMO roles are registered in DNS .

```
_ldap._tcp.mycorp.com. 600 IN SRV 0 100 389 moose.mycorp.com.
 _ldap._tcp.Default-First-Site-Name._sites.mycorp.com. 600 IN SRV 0 100 389 moose.
mycorp.com.
_ldap._tcp.pdc._msdcs.mycorp.com. 600 IN SRV 0 100 389 moose.mycorp.com.
 _ldap._tcp.97526bc9-adf7-4ec8-a096-0dbb34a17052.domains._msdcs.mycorp.com.  600  IN
0 100 389 moose.mycorp.com.
_ldap._tcp.dc._msdcs.mycorp.com. 600 IN SRV 0 100 389 moose.mycorp.com.
 _ldap._tcp.Default-First-Site-Name._sites.dc._msdcs.mycorp.com. 600 IN SRV 0 100
moose.mycorp.com.
```

Based on all these records, you can obtain a lot of information about an Active Directory environment by doing simple DNS queries. Some of the information you can retrieve includes:

- All Global Catalog servers in a forest or a particular site
- All Kerberos servers in a domain or a particular site
- All domain controllers in a domain or a particular site
- The PDC Emulator for a domain

6.3.1. Overriding SRV Record Registration

There may be times when you do not want domain controllers or global catalogs publishing some or all of their records outside of the site they are in, or maybe you do not want them publishing any records at all. For example, you may have domain controllers that should be dedicated to an application like Microsoft Exchange that runs in the site where the domain controllers are located, or you may have domain contro that are dedicated to just replicating Active Directory for backups. You have two options for configuring t you can use the DnsAvoidRegisterRecords registry entry or you can use netlogon system settings in the administrative templates of the group policy applied to domain controllers. Both mechanisms give you th option of specifying which records should and shouldn't be registered. For more details on configuring thi option, see "DNS Support for Active Directory Tools and Settings" at http://www.microsoft.com/technet/prodtechnol/windowsserver2003/library/TechRef/4d8388e6-6ba0-4f b1d9-525bf949fa76.mspx .

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6.4. Delegation Options

Now that we've covered what Active Directory uses DNS for, we will review some of the options for setting up who is authoritative for the Active Directory-related zones. Ultimately, the decision boils down to whether you want to use your existing DNS servers or different servers, such as the domain controllers, to be authoritative for the zones. There are many factors that can affect this decision, including:

- Political turf battles between the AD and DNS teams
- Initial setup and configuration of the zones
- Support and maintenance of the zones
- Integration issues with existing administration software and practices

We will look at each of these factors as they apply to delegating the AD zones. Other slight variations of these options do exist, but we will discuss only the basic cases.

6.4.1. Not Delegating the AD DNS Zones

The first impulse of any cost-conscious organization should be to determine whether their existing DNS servers can be authoritative for the AD zones. That could entail manually populating all the necessary resource records required by each DC if the current DNS implementation doesn't support dynamic updates. While this sounds fairly trivial, there are several issues to be aware of.

6.4.1.1. Political factors

By utilizing the existing DNS servers for the AD DNS zones , the AD administrators will likely not have the same level of control as they would if the zones were delegated and managed by them. Although it does limit the scope of control for a crucial service used by Active Directory, some AD administrators may find it a blessing!

6.4.1.2. Initial setup and configuration

The initial population of the AD resource records can be burdensome depending on how you manage your resource records and how easy it will be for you to inject new ones. For example, domain controllers try to register their resource records via DDNS on a periodic basis. Many organizations do not allow just any client to make DDNS updates due to the potential security risks. For that reason, you'll need to configure your existing DNS servers to allow the domain controllers to perform DDNS updates. And unless you restrict which zones the domain controllers can send DDNS updates for, it opens a potential security hole. If a domain controller can update any zone, an AD administrator could conceivably perform individual updates for any record in any zone while logged onto that DC. This should not typically be a problem, but depending on how paranoid the DNS administrators are, it could be a point of contention.

6.4.1.3. Support and maintenance

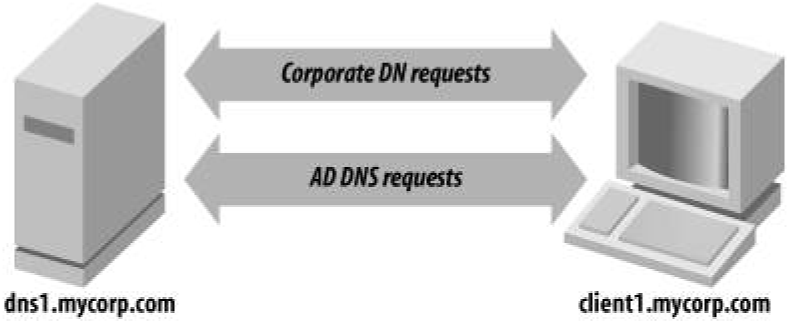
Assuming the existing DNS servers are stable and well supported (as they tend to be in most organizations), name resolution issues should not be a problem for AD DCs or other clients that are attempting to locate a DC via DNS. Ongoing maintenance of the DC resource records can be an issue, as pointed out previously. Each time you promote a new DC in the forest, you'll need to make sure it is allowed to register all of its records via DDNS. The registration of these records could be done manually, but due to the dynamic nature of the AD resource records, they would have to be updated on a very frequent basis (potentially multiple times a day). Yet another option is to programmatically retrieve the *netlogon.dns* file from each domain controller on a periodic basis and perform the DDNS updates from a script. In large environments, the manual solution will probably not scale, and either DDNS or a programmatic solution will need to be explored.

6.4.1.4. Integration issues

When Windows 2000 Active Directory was first released in 1999, this was more of a problem than it is today, but older versions of DNS server or administration software may not support SRV records or underscores in zone names (e.g., *_msdcs.mycorp.com*). Upgrading to the latest versions should be a priority in this case.

Figure 6-1 shows how the client request process is straightforward when the AD DNS zones are not delegated. Clients point at the same DNS servers they always have.

Figure 6-1. Client request flow when the AD DNS zones are not delegated



6.4.2. Delegating the AD DNS Zones

While at first glance it may seem pretty straightforward to support AD DNS zones in your existing

DNS infrastructure, it can cause difficulties depending on your environment. Perhaps the most straightforward option is simply to delegate the AD zones to the domain controllers to manage. And if you use AD-integrated DNS zones, the maintenance becomes even easier. After you've done the initial creation of the zones by promoting a DC and adding the DNS service, the records are stored in AD and distributed to the other DCs via replication.

6.4.2.1. Political factors

These days, many medium and large organizations have a central DNS team that manages and supports name resolution. If you make the decision to delegate the AD DNS zones to domain controllers, for example, a significant part of name resolution for your clients will not be done on the existing corporate servers. This can make the DNS administrators uncomfortable, and rightly so.

6.4.2.2. Initial setup and configuration

The initial setup to delegate the AD DNS zones is straightforward. An NS record and any necessary glue recordsfor example, an A record for the server to which you're delegatingneed to exist on the parent zone pointing to the servers that will be authoritative for the zones. The rest of the configuration must be done on the servers that are going to support the AD DNS zones. If that is one or more domain controllers, you will only need to add the DNS service and create the zone(s) on those servers.

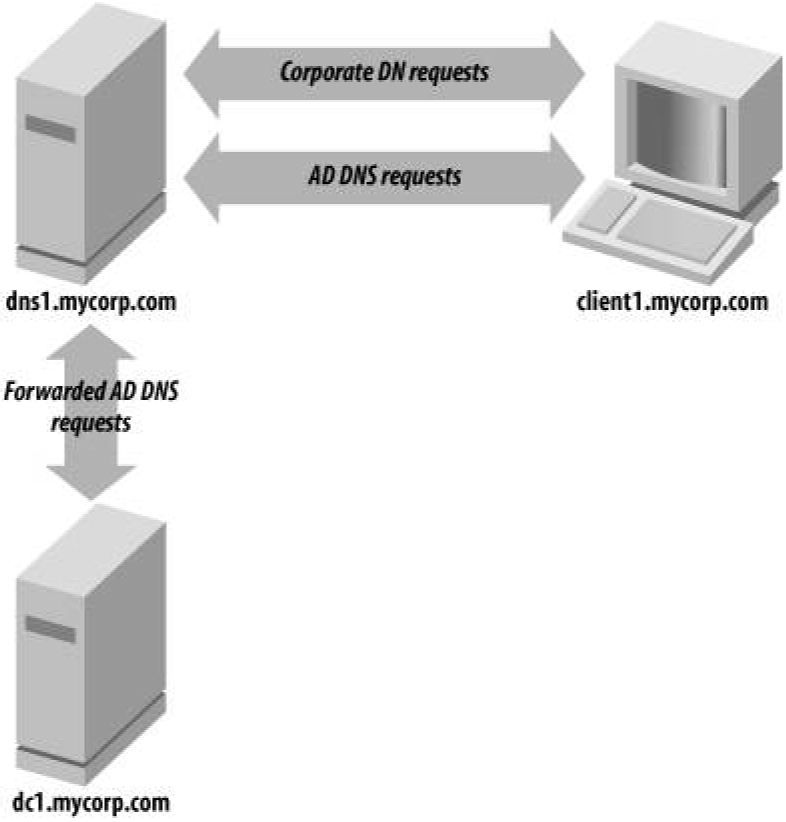
6.4.2.3. Support and maintenance

Especially if you are using AD-integrated zones, ongoing support and maintenance of the AD DNS zones is very minimal. In fact, since the domain controllers can use DDNS to update each other, this is one of the primary benefits of using this method.

6.4.2.4. Integration issues

Unless you already run Windows DNS Server, it is unlikely you'll be able to manage the AD DNS zones in the same manner as your primary DNS. Figure 6-2 illustrates that by delegating the AD DNS zones, you can still have clients point to the same DNS servers they do today. A variation of this approach would be to point the clients at the AD DNS servers and configure forwarding as described in the next section.

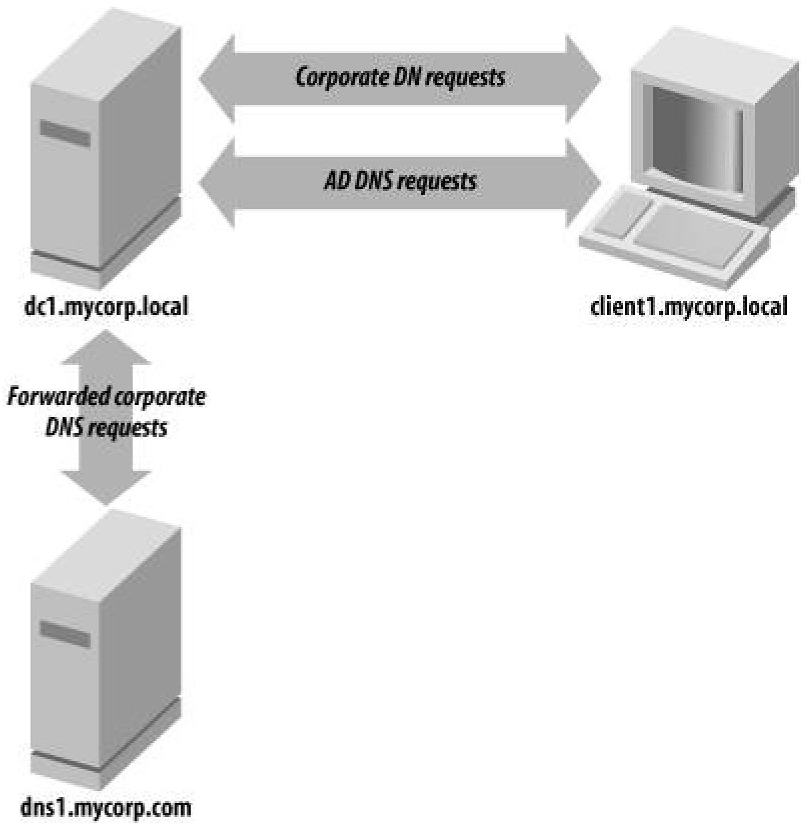
Figure 6-2. Client request flow when delegating the AD DNS zones



6.4.3. DNS for Standalone AD

Another scenario that is worth mentioning is creating a standalone Active Directory environment. By standalone, we mean an environment that can be set up without requiring your DNS administrators to either create or delegate zones on the corporate DNS servers. This is often needed when setting up lab or test forests, which may be short-lived. Figure 6-3 shows that the resolver for the clients must be pointed to the AD DNS servers in this scenario or they will not be able to locate any domain controllers for the forest.

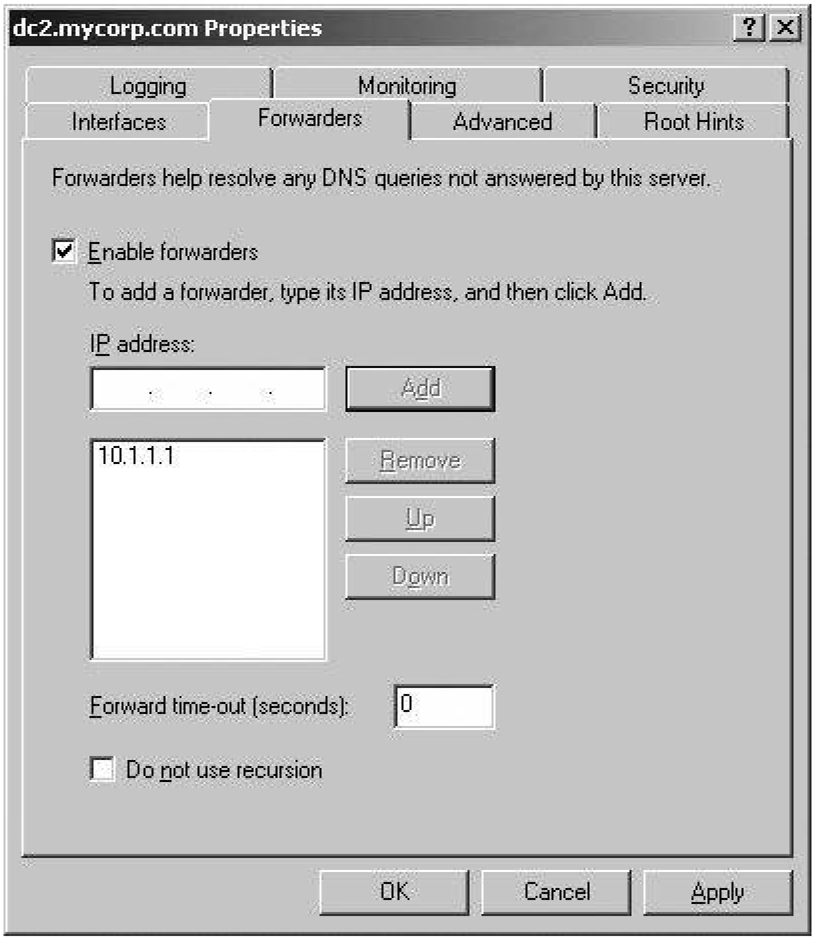
Figure 6-3. Client request flow in a standalone AD environment



To set up a standalone environment, you simply need to install the DNS service on one or more domain controllers in the forest, add the DNS zones for the AD domains (for example, *mycorp.local*), and then configure the DNS server to forward unresolved queries to one or more of your existing corporate DNS servers. Figures 6-4 and 6-5 show the screens from the DNS MMC snap-in for Windows 2000 and Windows Server 2003, respectively, that allow you to configure forwarders. Finally, you need to configure any clients of the *mycorp.local* forest to point their primary DNS resolver at the IP address of *dc1.mycorp.local*. When client1 makes a DNS request, it would first be sent to *dc1.mycorp.local*. If dc1 can resolve, it will return a response; if not, it will forward the query to *dns1.mycorp.com*. *Dns1.mycorp.com* will reply with an answer to dc1, who will then send the reply to client1.

The great thing about this configuration is that it requires nothing to be set up on the existing DNS servers. Since you will need to modify the DNS resolvers that clients point to, you may want to look at using a Group Policy Object (GPO). In Windows Server 2003, you can configure client DNS settings through GPOs for Windows Server 2003 servers and Windows XP workstations. The new settings allow you to control things such as client DNS suffix, DNS resolvers, and DDNS behavior.

Figure 6-4. Forwarders configuration screen in the Windows 2000 DNS MMC snap-in



dc2.mycorp.com Properties

Forwarders help resolve any DNS queries not answered by this server.

☑ Enable forwarders

To add a forwarder, type its IP address, and then click Add.

IP address:

10.1.1.1

Forward time-out (seconds): 0

□ Do not use recursion

In this scenario, if the clients do not point at *dc1.mycorp.local* as their first resolver, they will never be able to contact the *mycorp.local* forest. The reason is that the corporate name servers do not know about the *mycorp.local* namespace since it was not delegated.

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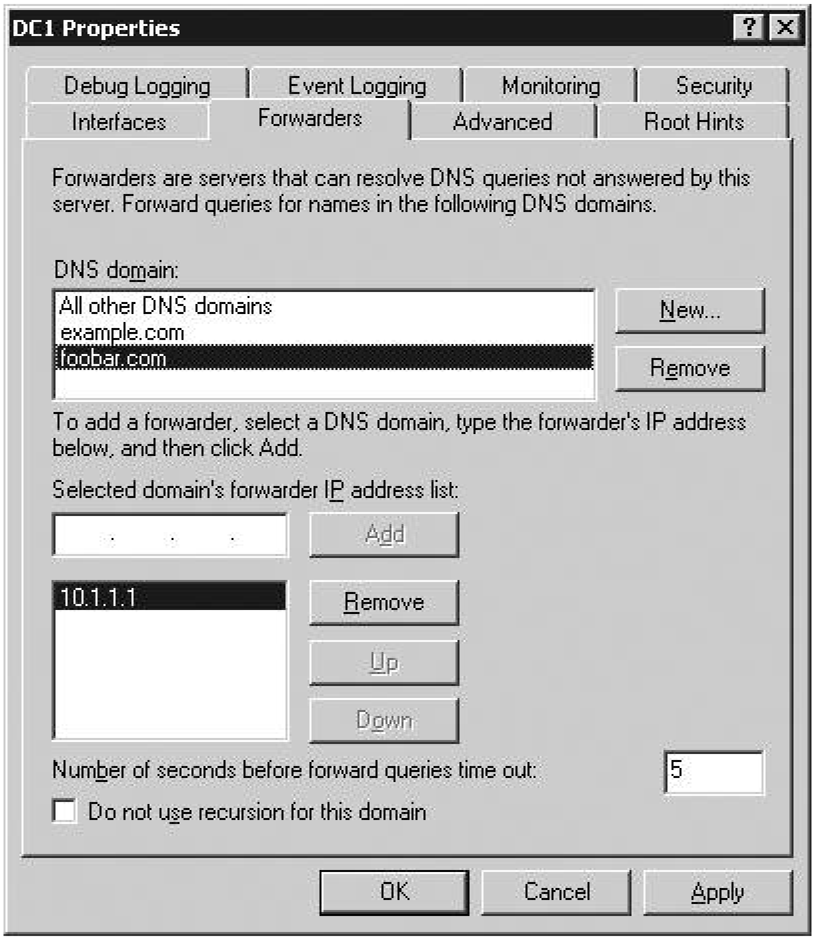
6.5. Active Directory Integrated DNS

If you've decided to host your AD DNS zones on your domain controllers, you should strongly consider using AD-integrated zones. This section will explain some of the benefits of using AD-integrated DNS versus standard primary zones.

Figure 6-5. Forwarders configuration screen in the Windows Server 2003 DNS MMC snap-in



Forwarders are servers that can resolve DNS queries not answered by this server. Forward queries for names in the following DNS domains.

DNS domain:

All other DNS domains
example.com
foobar.com

To add a forwarder, select a DNS domain, type the forwarder's IP address below, and then click Add.

Selected domain's forwarder IP address list:

10.1.1.1

Number of seconds before forward queries time out: 5

□ Do not use recursion for this domain

Conditional Forwarding

Conditional forwarding is a new feature available in Windows Server 2003 that gives administrators much more flexibility in how forwarding is handled than was available under Windows 2000. Figure 6-4 shows the forwarders configuration screen in the Windows 2000 MMC snap-in. It allows you to set up one or more IP addresses to forward all requests that cannot be handled by the local DNS server. Figure 6-5 shows the same configuration screen, but on Windows Server 2003. As you can see, we configured forwarding based on the domain name being queried:

- If the query is for *foobar.com*, forward to 10.1.1.1.
- If the query is for *example.com*, forward to 10.1.2.1.
- If the query is for any other zone, forward to 10.1.3.1.

Conditional forwarding allows you to create a more efficient resolution topology, particularly for corporate networks using disjointed namespaces, by sending queries directly to servers responsible for the individual zones instead of using only recursive queries to the Internet.

In the normal world of DNS, you have two types of name servers: primary and secondary (a.k.a. slaves). The primary name server for a zone holds the data for the zone in a file on the host and reads the entries from there. Each zone typically has only one primary. A secondary gets the contents of its zone from the primary that is authoritative for the zone. Each primary name server can have multiple secondary name servers. When a secondary starts up, it contacts its primary and requests a copy of the relevant zone via zone transfer. The contents of the secondary file are then dynamically updated over time according to a set scheme. This is normally a periodic update or triggered automatically by a message from the primary stating that it has received an update. This is a very simplified picture, as each name server can host multiple zones, allowing each server to have a primary role for some zones and a secondary for others.

Each type of server can resolve name queries that come in for the zones that it hosts. However, if a change must be made to the underlying contents of the DNS file, it has to be made on the primary name server for that zone. Secondary name servers cannot accept updates.[*]

[*] This isn't strictly true. Although slaves cannot process updates, they can and do forward updates that they receive to the primary name server.

Another option available with Active Directory and Windows DNS server is to integrate your DNS data into Active Directory. Effectively, this means that you can store the contents of the zone file in Active Directory as a hierarchical structure. Integrating DNS into Active Directory means that the DNS structure is replicated among all DCs of a domain; each DC holds a writeable copy of the DNS data. The DNS objects stored in Active Directory could be updated on any DC via LDAP operations or through DDNS against DCs that are acting as DNS servers. This effectively makes the entire set of DCs act like primary name servers, where each DC can write to the zone and issue authoritative answers for the zone. This is a far cry from the standard model of one primary name server and one or more secondary name servers, which has the obvious downside of a single point of failure for updates to DNS.

There is a possible issue when using integrated DNS with Windows 2000 domain controllers called the DNS "Island" Issue. Active Directory requires proper DNS resolution to replicate changes, and when using integrated DNS, the domain controllers replicate DNS changes through Active Directory replication. This is the classic chicken and egg problem; it can be avoided with proper configuration. The issue occurs when a forest root domain controller configured as a name server points at itself for DNS resolution. If the DC changes its IP address, the DNS records will successfully be updated locally. However, unless the other DCs point at that same DC for their DNS resolution, they cannot resolve the DCs IP address, so replication fails and no other DC gets the IP address change. The forest root domain controller has effectively been segregated from the rest of the forest and becomes its own replication island. To avoid this issue, the forest root domain controllers that are name servers should be configured to point at root servers other than themselves.

6.5.1. Replication Impact

While AD-integrated DNS has many advantages, the one potential drawback is how DNS data gets replicated in Active Directory. Under Windows 2000, AD-integrated zones are stored in the System container for a domain. That means that every domain controller in that domain will replicate that zone data regardless of whether the domain controller is a DNS server or not. For domain controllers that are not DNS servers, there is no benefit to replicating the data. Fortunately, there is a better alternative in Windows Server 2003, using application partitions as described in the next section.

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6.6. Using Application Partitions for DNS

Application partitions, as described in Chapter 3, are user-defined partitions that have customized replication scope. Domain controllers that are configured to contain replicas of an application partition will be the only servers that replicate the data contained within the partition. One of the benefits of application partitions is that they are not limited by domain boundaries. You can configure domain controllers in completely different domains to replicate an application partition. It is for these reasons that application partitions make a lot of sense for storing AD-integrated DNS zones. No longer do you have to store DNS data within the domain context and replicate to every domain controller in the domain, even if only a handful are DNS servers. With application partitions, you can configure Active Directory to replicate only the DNS data between the domain controllers running the DNS service within a domain or forest.

When installing a new Windows Server 2003 Active Directory forest, the default DNS application partitions are created automatically. If you are upgrading from Windows 2000, you can manually create them by using the DNS MMC snap-in or the *dnscmd.exe* utility. There is one default application partition for each domain and forest. When configuring an AD-integrated zone in a Windows Server 2003 forest, you have several options for storing the DNS data. These options are listed in Table 6-2.

Table 6-2. Active Directory Integrated DNS zone storage options

Distinguished name	Replication scope

cn=System,*DomainDN*
Example:
cn=System,dc=amer,dc=mycorp,dc=com
	To all domain controllers in the domain. This is the only storage method available under Windows 2000.

dc=domaindnszones,*DomainDN*
Example:
dc=domaindnszones,dc=amer, dc=mycorp,dc=com
	To domain controllers in the domain that are also DNS servers.

dc=forestdnszones,*ForestDN*
Example:
dc=forestdnszones,dc=mycorp,dc=com
	To domain controllers in the forest that are also DNS servers.

AppPartitionDN Example: dc=dnsdata,dc=mycorp,dc=com	To domain controllers that have been configured to replicate the application partition.

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6.7. Summary

Active Directory relies heavily on DNS. In fact, Microsoft has shifted completely away from WINS for name resolution within the NOS in favor of standards-based DNS. The DC locator process is a core DNS-based function used within Active Directory to help domain controllers and clients locate domain controllers that have certain properties, such as residing in a particular site or being a Global Catalog server or PDC emulator. Deciding how to manage the AD DNS zones can be a difficult decision, with each option having its own advantages and disadvantages. If you delegate the zones to domain controllers, AD-integrated zones can save a lot of time in maintenance and upkeep. In Windows Server 2003, you can use application partitions to replicate AD-integrated zones to only the domain controllers that are acting as DNS servers. This can greatly reduce replication traffic in some situations compared to Windows 2000 Active Directory, which replicated DNS data to every domain controller in a domain regardless of whether it was a DNS server.

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Chapter 7. Profiles and Group Policy Primer

Profiles and group policies are large topics, and they are worth treating properly so that you get the most from them in your environment. The goal of policy-based administration is for an administrator to define the environment for users and computers once by defining policies, and then rely on the system to enforce those policies. Under Windows NT, this could be very challenging, but with Active Directory group policies, the capability is much more readily available. This chapter is the introduction to the subject of user profiles and group policies. Chapter 10 then shows how policies work in Active Directory, how to design an OU structure to incorporate them effectively, and how to manage them with the Group Policy Management Console, a new MMC snap-in available for Windows XP and Windows Server 2003 computers.

In Windows NT, system policies had a number of limitations:

- They were set at the domain level.
- They were not secure.
- They could apply only to users, groups of users, or computers.
- They tended to set values until another policy specifically unset them.
- They were limited to desktop lockdown.

The scope and functionality of Active Directory group policies is much greater than system policies:

- They can be applied to individual clients, sites, domains, and Organizational Units.
- They are highly secure.
- They can apply to users, computers, or groups of either.
- They can set values and automatically unset them in specified situations.
- They can do far more than just a desktop lockdown.

With group policies, an administrator can define a large number of detailed settings to be enforced on users throughout the organization and be confident that the system will take care of things. Let's take a simple example from Leicester University. Administrators wanted the Systems Administrator toolset to be available on workstations they worked from. While they could install these tools on their own PCs, they also wanted the tools to follow them around the network and be available from any PC that they chose to log on from. However, they didn't want to leave these tools installed on that PC when they logged off. Prior to Active Directory, the administrators would have had to arrive at a client, log on, install the toolset, do whatever was required at a client, uninstall the toolset, and finally log off. This would be a considerable chore when working with a large number of machines. Active Directory group policies can be used to specify that the toolset is to be automatically installed on any client that an administrator logs on to. That way, an administrator could go straight to the Start menu and find the tools available. When the group policy goes out of scope, the same group policy would uninstall the toolset from the machine.

Let's take another example. At Leicester University, a central logon script was used for every user. This is no different than under Windows NT. However, extra logon scripts for some sets of users were also applied based on which Organizational Unit the users were in. So some users get more than one logon script depending on where in Active Directory their accounts reside. That's a significant step forward from Windows NT, but the possibilities don't end there. A logoff script was also specified to run when a user logged off the system. Workstations also can have scripts, but instead of executing at logon and logoff, these scripts run at startup and shutdown. Want to install a new Dynamic Link Library (DLL) on all clients? You could use a startup script to do it. Have a desire to start a normally disabled service on a series of workstations? You could create a startup script that starts that service and then apply that script through group policy. Of course, as you've probably guessed, this startup script runs in addition to any other startup scripts, such as a central script for all workstations. So, rather than a single user logon script available for Windows NT, we now have multiple user logon/logoff scripts and multiple workstation startup/shutdown scripts, all of which can be customized using any of the data within Active Directory. And with Windows Server 2003 Active Directory, you can even use WMI filtering, which allows you to use any of the vast amount of data available in WMI to specify criteria for when group policies are applied.

Let's consider a final example. You are required to set the `RunOnce` registry key value for every client in your organization so that they can all receive an organization-wide company video broadcast from the chairman and CEO. You can set up a simple group policy with the customized registry changes configured and apply it to every computer in your organization. At present, this functionality may seem no different from what you could have achieved with Windows NT system policies. You apply these changes one evening, and the next morning, 20,000 workstations across your network can be rebooted so that they receive this policy on startup. The group policy applies and the settings are changed. However, if about an hour after you made the change you realize that one of the values in the registry needs to be changed again, you don't want to force 20,000 clients to reboot again as was necessary under Windows NT. And with Active Directory, you don't have toyou can make the change and know that periodically all workstations refresh their policy and will get the new value.

With examples like these, it becomes quite easy to see the power of group policies. While some of the examples can be accomplished under Windows NT, it would require a lot more time and effort to achieve than with Active Directory's group policy.

Now that we've covered a few examples, let's dive into the details of profiles and group policies.

Group policies are normally referred to simply as GPOs, or *Group Policy Objects*.

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7.1. A Profile Primer

Profiles and group policies are tightly related, but they serve completely different functions. To make things clear, we'll cover the essentials of profiles so that you can understand how to manipulate them using group policies.

Consider a Windows XP workstation with a newly created account for a user named Richard Lang with the username RLang. When Richard logs on to the client, the system creates a profile directory for him, corresponding to his username, in the *Documents and Settings* directory. If Richard were to log on to a Windows NT workstation or to a Windows 2000 workstation that was upgraded from a previous version of Windows NT, the profile would be created under the *%systemroot%\Profiles*[*] directory. On a fresh Windows 2000 install or within Windows XP, the profiles would be created under *%systemdrive%\Documents and Settings*.

Inside this directory, the system places a file called *NTUSER.DAT*, along with various other data files. Let's concentrate on the *NTUSER.DAT* file for a moment. This file contains what is known generally as the user portion of the registry. All Windows-based operating systems have a registry that consists of two parts: the so-called user portion represented by the file *NTUSER.DAT* (or *USER.DAT* on Windows 9*x* systems) and the system or computer portion of the registry, which is stored in *%systemroot%\system32\config*. The user part of the registry holds information indicating what screensaver should be used for that user; what colors, background, and event sounds are set; where the user's *My Documents* folder points to; and so on. The system portion of the registry holds hardware device settings, installed software information, and so on. When a user logs on to a client, the combined effects of the settings for the machine held in the system portion of the registry and the settings for the user held in the user portion of the registry take effect.

When you use a tool such as *REGEDIT.EXE* or *REGEDT32.EXE* to examine the registry on a machine, both portions of the registry are opened and displayed together for you to look at within one tool.

> The two registry tools were developed with different requirements in mind, but with Windows Server 2003, they have been merged. The *REGEDIT* tool was developed initially for Windows 9x clients and allowed for management of the Windows 9x datatypes and rapid searching for any key or value that contains a given word or phrase. *REGEDT32*, on the other hand, was designed to support the extra datatypes present in Windows NT and Windows 2000. However, *REGEDT32* had an awful search mechanism that allowed searches only through keys. In Windows Server 2003, *REGEDIT* was updated to support many of the features present in *REGDT32*. Now if you run *REGEDT32*, you will bring up the *REGEDIT* interface.

Figure 7-1 shows a view of the registry on a Windows XP client when viewed from *REGEDIT*. The

[*] *%systemroot%* is the system environment variable that refers to the location of the Windows operating system files. If Windows NT were installed on drive C: in the normal way, *%systemroot%* would be *C:\WINNT*. The *%systemdrive%* variable contains the drive letter of the drive the operating system was installed on.

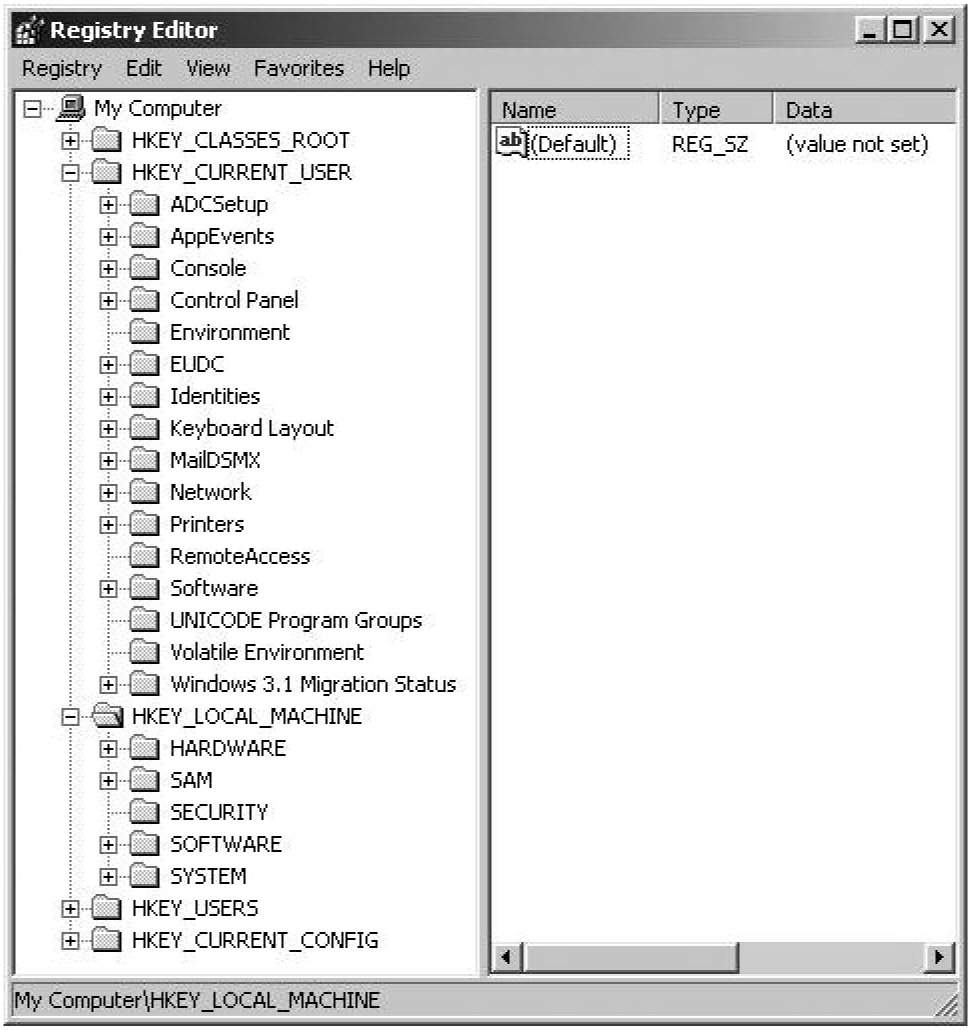
screenshot also shows the five registry hives (as they are known) available to Windows XP. The two important hives are HKEY_LOCAL_MACHINE, also known as HKLM, which corresponds to the system part of the registry, and HKEY_CURRENT_USER, also known as HKCU, which corresponds to the user portion of the registry.

When Richard logs on to the local client for the first time, the file *NTUSER.DAT* is copied from the Default User profile directory that already exists on the machine under *Documents and Settings*. During Richard's first logon, the system also creates a series of directories under Richard's profile directory with names like *My Documents*, *Start Menu*, *Desktop*, and so on. If Richard ever places an icon on the desktop or saves a file from *NotePad* to the *My Documents* folder, the data is placed inside the relevant folders in Richard's profile. The *Start Menu* folder holds the Start menu structure that Richard sees when he clicks the Start button.

7.1.1. The Default User and All User Folders

The default contents placed inside all of the folders in Richard's profile come directly from the same folders in the Default User profile. When Richard logs on, however, he may see icons or folders inside *My Documents*, *Start Menu*, and *Desktop* that do not appear in his own profile directories. These extra items are displayed as if they were part of Richard's profile, but they are part of the All Users profile that also resides on the computer. In fact, the settings from the *AllUsers\NTUSER.DAT* file also are available to Richard. The All Users profile is a great way of adding new items to every user's profile on the client without having to add each item manually. During installation, NT-aware software tends to ask whether the installation is just for the user installing the software or for all users of the client. If the software is told that it is for all users, it modifies the All Users profile.

Figure 7-1. A REGEDIT view of the registry on a Windows XP Professiona client



Name	Type	Data
(Default)	REG_SZ	(value not set)

My Computer\HKEY_LOCAL_MACHINE

To recap, when Richard logs on for the first time, a profile directory called *Documents and Settings\Rlang* is created for him, and everything from the *Documents and Settings\Default User* profile is copied into it. Richard's profile now contains an *NTUSER.DAT* file that contains all of his user settings, as well as a series of folders representing his Desktop, Start Menu, and My Documents folder, among others. In addition to any files or folders copied from the Default User profile, Richard also seamlessly sees all of the items corresponding to the *Documents and Settings\All Users* profile, although they will not exist in his own *Rlang* directory hierarchy. He also may not be able to remove or delete these files and shortcuts if he doesn't have the permission to do so.

7.1.2. Logging On Locally to the Workstation

Windows 2000 and later machines store much more data in Richard's profile than Windows NT or Windows 9x would. In addition, more registry keys have been added to both portions of the registry to enable much more fine-grained control over what happens in a profile. We'll have more to say about that later.

If Richard logs off and then on again, the system will detect that he already has a profile folder on the workstation and will continue to use that rather than create a new one. That is why when Richard creates a desktop file and logs off and on again, the file is still visible on Richard's desktop. If Richard logs off and an administrator logs on and installs software, the software is likely to install itself into the All Users profile, adding folders and files and changing the registry as required. When the administrator logs off and Richard logs back on, the new software in the All Users profile will be available to him as if it were part of his own profile; this includes providing any All Users *NTUSER.DAT* HKCU registry settings that he may need for the application.

> As the registry settings are held in the All Users profile, you might think that Richard cannot change them. This is not the case. As soon as he changes a setting, the system writes it out to his own registry, and this will override any future value for that setting from the All Users profile. Richard's profile will thus contain only the customizations that override the defaults passed in from the All Users profile.

7.1.3. Logging On to the Domain

Now let's say that Richard instead logs on to a Windows NT or Active Directory domain. If you set the system up in the standard manner, when Richard logs on to the domain for the first time, he is given a profile directory on the local workstation that he logs on to. In exactly the same manner as a logon to the workstation itself, this new profile is made from the Default User and All User profiles on the workstation. When Richard logs off, his profile stays at the workstation. If he then logs on to the domain from another workstation, he has a new profile created for him on that workstation. If Richard then logs off from this workstation and logs on at another, he gets a third profile created. Finally, if he logs back on to the first workstation, he will get the profile that he used there last. This default scenario is very limiting, and domain-based logins provide three key profile technologies for domain usage. You need to be aware of these technologies to manipulate profiles to work in a better manner for your organization:

- Roaming profiles
- Cached profile deletion
- Relocation of the Default User profile

Having profiles stored on each workstation makes little sense. It would make a lot more sense to store the profiles centrally and have them accessible from anywhere on the network. Roaming profiles make this possible. Under Windows NT, you simply filled in the relevant profile field for a user in the User Manager for Domains tool and pointed the new location at a share configured for that user. Under Active Directory, you use the Active Directory Users and Computers (ADUC) tool, but the concept is the same. If you did this for Richard, the system would detect at his first logon that he did not currently have a roaming profile, and his profile would be created on the workstation as before. However, when he logged out, his profile would be copied to the network location to become his roaming profile. Then when he logged back on again from anywhere on the network, including Terminal Service connections, his new profile on the network share would be downloaded to the workstation for him to use. This "download on logon and upload on logout" process continues throughout the lifetime of the account, provided the account's profile property is not deleted.

7.1.4. Cached Profile Deletion

One problem can come up with this scenario. First, if Richard logs on at a hundred workstations throughout the life of the account, a hundred copies of his profile at various stages of development wil exist, one on each of the hundred workstations. To combat this, administrators can set a registry key on the workstations that forces them to discard the profile after the roaming profile upload on logout. The key is held in the system part of the registry and is the same in Windows NT as in Windows 2000 and Windows XP. Setting it to a DWORD value of 1 turns it on.

HKLM\SOFTWARE\Microsoft\WindowsNT\CurrentVersion\Winlogon\DeleteRoamingCache

This setting needs to be applied to all the computers from which you wish to delete cached profiles . The fastest way to implement such a change in an Active Directory environment is to use a GPO, unless you relish changing the registry manually on every client. You simply make this one change centrally and then have it roll out to all computers that you wish to affect. Under Active Directory, you do not even need to know that this is the key in the registry that is being modified, as this is one of the many default computer configuration options that are available from the GUI, which hides the actual registry keys and values that you are changing.

7.1.5. A Server-Based Default User Profile

If you want to change a setting in the user portion of the registry or add a new icon to the desktop for all new users, you ordinarily need to modify the Default User profile on every client. In large environments, this is really an unacceptable solution. The simpler solution would be to store a centrally located copy of the Default User profile that the users automatically download on first logon. That way, if you need to make a change, you need to make it only on the centrally stored copy and not on every client. This can be achieved by placing the Default User profile in the *NETLOGON* share. Previously, we said that when the user logs on to the domain for the first time, the system copies the Default User profile from the client workstation. That is, in fact, true only when a Default User profile does not exist in the *NETLOGON* share; if a central Default User profile does reside in the *NETLOGON* share, that is used in creating the user's own profile.

> By default, the directory that NETLOGON actually refers to under Windows NT is *%systemroot%\system32\repl\import\scripts,* and under Active Directory, the directory location is *%systemroot%\SYSVOL\<ADDomainName>\SCRIPTS*.

The basic point is that while Windows 2000 and Windows XP profiles may be stored under different locations, store more data, and be more customizable than Windows NT profiles, they work on the same principles as their direct predecessors.

This is not true when comparing Windows NT system policies and Active Directory group policies. We'll now cover some of the capabilities of group policies that were not available in previous versions of Windows.

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7.2. Capabilities of GPOs

GPOs can be edited using the Group Policy Object Editor (GPOE), formerly the Group Policy Editor (GPE) The GPOE is limited to managing a single GPO at a time and cannot be used to link a GPO. For this reaso Group Policy Management Console (GPMC) MMC snap-in, which was released around the same time as W web download from:

http://www.microsoft.com/windowsserver2003/downloads/featurepacks/default.mspx

The GPMC provides a single interface to manage all aspects of GPOs, including editing (through the GPOE policies (RSOP), and linking to domains, sites, and OUs. We will cover these tools in much more detail in C

Most settings in a GPO have three states: enabled, disabled, and unconfigured. By default, all settings in unconfigured settings are ignored during application, so the GPO comes into play only when settings have Each setting needs to be configured as enabled or disabled before it can be used. In some cases, the opti parameters, while in other cases, a host of information must be entered to configure the option; it all dep itself does.

> Enabling and disabling most options is fairly straightforward. However, due to Microsoft names of certain settings for GPOs , you actually can have the choice of enabling or disa names such as "Disable Access to This Option." By default, this setting isn't in use, but disable option (i.e., enable the option) or enable the disable option (i.e., disable the opt make sure you know which way the setting is applied before you actually go through wi

GPOs can apply a very large number of changes to computers and users that are in Active Directory. The together within the GPOE under the three headings of Software Settings, Windows Settings, and Adminis two sets of these headings, one under Computer Configuration and one under User Configuration. The ite differ, as the settings that apply to users and to computers are not the same.

Some of the settings under Administrative Templates might seem to make more sense if they were grou sections. However, the Administrative Templates section holds data that is entirely generated from the A) files in the system volume; so, it makes more sense to include all the ADM data together. ADM files con available for each setting, including explanations that are shown on the various property pages in the GP

> ADM files can be added and removed by right-clicking either Administrative Template location Add/Remove Templates. Comprehensive information on customizing GPOs and adding in your on Microsoft's web site. For Windows 2000, check out:
>
> http://www.microsoft.com/windows2000/techinfo/howitworks/management/grouppolw
>
> and for Windows Server 2003, check out:
>
> http://www.microsoft.com/technet/prodtechnol/windowsserver2003/technologies/man

In Windows Server 2003 Active Directory, Microsoft extended the capabilities of GPOs significantly. Over added, some of which cover new areas, such as the netlogon process, DNS configuration, networking Qo services. We'll now give an overview of the main categories of settings available with GPOs and provide a of the main capabilities of each.

7.2.1. Group Policy Refresh Frequency

By default, Windows workstations and members servers refresh their policy every 90 minutes; domain c every five minutes. In order to avoid having all machines retrieving the policy at once from the domain c offset interval added to the refresh period on every machine. This offset interval, by default, is 30 minute member servers and 0 minutes on domain controllers. Both the refresh interval and offset interval are co settings, you can modify the registry of a computer or you can edit the Group Policy that applies to the c are in the Group Policy section of the System portion of the Administrative Templates. See the sections " (Computer) " and "Administrative templates (user) ."

The registry entries for computer policy are under the `HKLM\Software\Policies\Microsoft\Windows\Syste` are listed in Table 7-1 .

Table 7-1. Computer Group Policy refresh registry value

Registry value name	Description
`GroupPolicyRefreshTime`	REG_DWORD refresh interval for domain members. Valid range: 064,8
`GroupPolicyRefreshTimeOffset`	REG_DWORD offset interval for domain members. Valid range: 01,440
`GroupPolicyRefreshTimeDC`	REG_DWORD refresh interval for domain controllers. Valid range: 064
`GroupPolicyRefreshTimeOffsetDC`	REG_DWORD offset interval for domain controllers. Valid range: 01,44

The registry entries for user policy are under the `HKCU\Software\Policies\Microsoft\Windows\System` key listed in Table 7-2 .

Table 7-2. User Group Policy refresh registry values

Registry value name	Description
`GroupPolicyRefreshTime`	REG_DWORD refresh interval for users. Valid range: 0-64,800 minutes.
`GroupPolicyRefreshTimeOffset`	REG_DWORD offset interval for users. Valid range: 0-1,440 minutes.

7.2.2. Software Installation Settings (Computer and User)

GPOs provide the ability to deploy applications automatically to users or computers. These applications c repaired, and removed simply using GPOs and their interaction with a technology called the Microsoft Ins

To comply with the Windows 2000 or Windows Server 2003 logo program, in which an application gets the

"Designed for Windows 2000" logo or equivalent, each application must ship with an installation routine th Windows Installer (MSI) technology. During creation of a software application, the author can now creat descendant of the original *SETUP.EXE* files that used to be created. The MSI contains all the data requirec application and then some. It knows about the files that are required by the application, including notes s numbers, and it maintains a host of other information including language settings, where to install the ap critical to the functional operation of the application, and so on. On any system that has the Microsoft Wi installed, the MSI file can be run as if it were an executable file, and the application will install accordingly

The administrator can customize the defaults for the MSI file to tailor the exact settings for the applicatio rather than C: or installing Spanish and Polish support in addition to English. The process of customizing known as creating a transform. The transform is used by the installer service to make sure that the MSI f items in the correctly configured way.

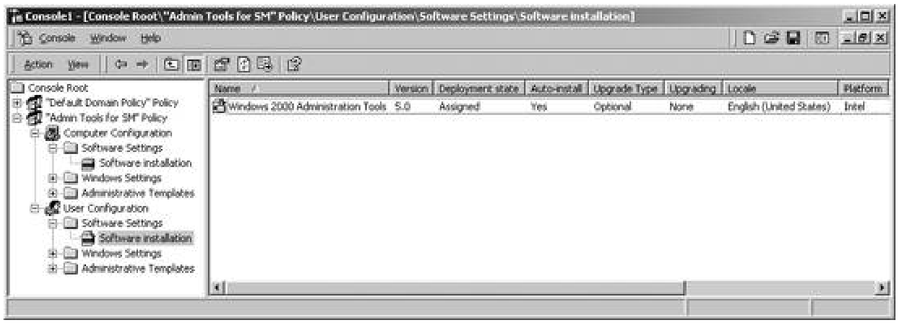
That's not all, though: this technology has a lot more to it. First, it has the capability to self-repair applica user accidentally deletes one or more of the core files required for the application to work. When the user application, the application first checks with the MSI and any transform files to make sure that no critical data is copied to the appropriate locations, and only then is the application started. This effectively brings repairing applications.

Applications can also be deployed using GPOs so that users get them as soon as they log on or when they Add/Remove programs dialog. You can even tell the MSI to auto-install on any client PC that attempts to that an MSI-aware application can read.

While the Microsoft Windows Installer service is very useful and its configuration will become second natu goes on, the actual technology itself is not really covered within this book. If you want to find out more o service and how you can write your own MSI files for both existing and new applications, check out the Ir http://www.installshield.com , for the newer version of the InstallShield tool that compiles MSI files, or se http://search.microsoft.com/us/dev/default.asp , for the phrase "Windows Installer."

Microsoft Windows Installer files are inserted into a GPO from the Software Installation node. Figure 7-2 s GPOs added into it, and one expanded in the scope pane to show the two Software Installation parts.

Figure 7-2. Software Installation settings for a GPO


Console1 - [Console Root\"Admin Tools for SM" Policy\User Configuration\Software Settings\Software installation]
Console
Window
Help
Action
View

Console Root
"Default Domain Policy" Policy
"Admin Tools for SM" Policy
Computer Configuration
Software Settings
Software installation
Windows Settings
Administrative Templates
User Configuration
Software Settings
Software installation
Windows Settings
Administrative Templates

Name /	Version	Deployment state	Auto-install	Upgrade Type	Upgrading	Locale	Platform
Windows 2000 Administration Tools	5.0	Assigned	Yes	Optional	None	English (United States)	Intel

Software Installation is listed under both the computer and user sections of the GPO, and thus you can d both computers and users through the two different parts of the GPO. In Figure 7-2 , this GPO is deployin Administration tools as an assigned application to all users that receive this GPO. If you remember the ex chapter, this GPO is used to auto-install the Systems Administration tools onto any client that certain sys We know that it auto-installs because that is one of the configured options enabled in the GPOE in Figure 7

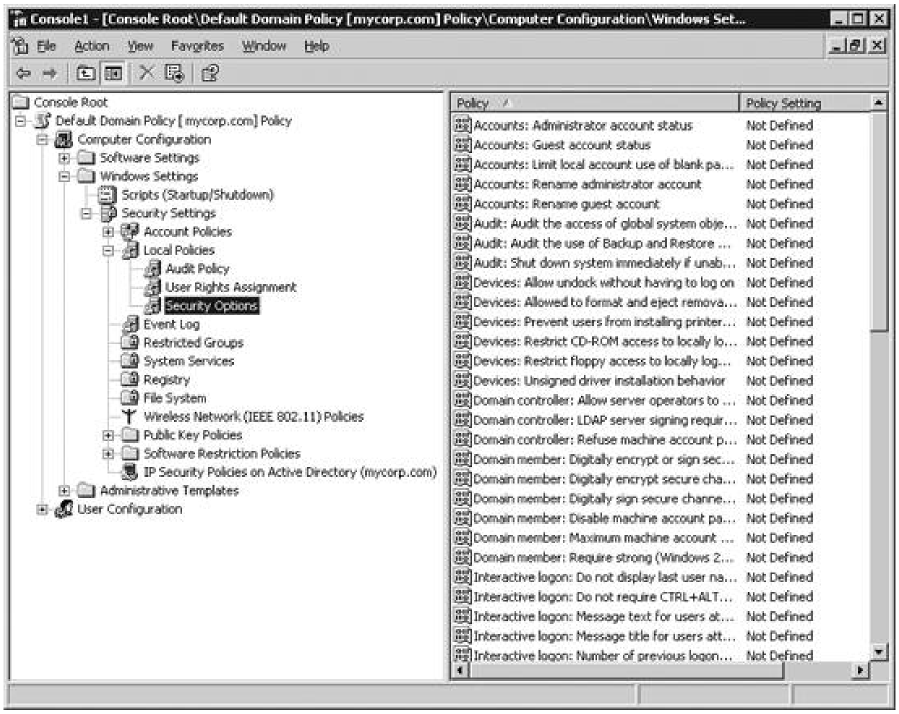
Microsoft Installer applications can be found in the next section.

7.2.3. Windows Settings (Computer)

This part of a GPO holds startup and shutdown scripts as well as security settings. In Figure 7-3 , the GPC Domain Policy installed by default on creation of a domain. This GPO applies to all computers in the doma make to this GPO will affect DCs, member servers, and ordinary workstations alike.

Startup and shutdown scripts can be configured to execute asynchronously or synchronously. They can u other ActiveX scripting host language, or even plain old CMD/BAT files that you may already be familiar v parameters to the scripts by configuring the parameters into the GPO.

Figure 7-3. Computer Security settings and scripts


Console1 - [Console Root\Default Domain Policy [mycorp.com] Policy\Computer Configuration\Windows Set...
File
Action
View
Favorites
Window
Help

- Console Root
  - Default Domain Policy [mycorp.com] Policy
    - Computer Configuration
      - Software Settings
      - Windows Settings
        - Scripts (Startup/Shutdown)
        - Security Settings
          - Account Policies
          - Local Policies
            - Audit Policy
            - User Rights Assignment
            - Security Options
          - Event Log
          - Restricted Groups
          - System Services
          - Registry
          - File System
          - Wireless Network (IEEE 802.11) Policies
          - Public Key Policies
          - Software Restriction Policies
          - IP Security Policies on Active Directory (mycorp.com)
      - Administrative Templates
    - User Configuration

Policy	Policy Setting
Accounts: Administrator account status	Not Defined
Accounts: Guest account status	Not Defined
Accounts: Limit local account use of blank pa...	Not Defined
Accounts: Rename administrator account	Not Defined
Accounts: Rename guest account	Not Defined
Audit: Audit the access of global system obje...	Not Defined
Audit: Audit the use of Backup and Restore ...	Not Defined
Audit: Shut down system immediately if unab...	Not Defined
Devices: Allow undock without having to log on	Not Defined
Devices: Allowed to format and eject remova...	Not Defined
Devices: Prevent users from installing printer...	Not Defined
Devices: Restrict CD-ROM access to locally lo...	Not Defined
Devices: Restrict floppy access to locally log...	Not Defined
Devices: Unsigned driver installation behavior	Not Defined
Domain controller: Allow server operators to ...	Not Defined
Domain controller: LDAP server signing requir...	Not Defined
Domain controller: Refuse machine account p...	Not Defined
Domain member: Digitally encrypt or sign sec...	Not Defined
Domain member: Digitally encrypt secure cha...	Not Defined
Domain member: Digitally sign secure channe...	Not Defined
Domain member: Disable machine account pa...	Not Defined
Domain member: Maximum machine account ...	Not Defined
Domain member: Require strong (Windows 2...	Not Defined
Interactive logon: Do not display last user na...	Not Defined
Interactive logon: Do not require CTRL+ALT...	Not Defined
Interactive logon: Message text for users at...	Not Defined
Interactive logon: Message title for users att...	Not Defined
Interactive logon: Number of previous logon...	Not Defined

The Security Settings portion of the GPO is by far the larger of the two sections covered by the Windows displayed in Figure 7-3 cover the following areas:

Account Policies

These policies allow you to apply settings that govern how accounts on the system work.

> The settings for the following three policies are unique among the Group Policy Se user accounts, they can only be applied domain wide in the domain policy; they ca values for different Organizational Units in a domain. This is why you need to cons in the namespace design if you need to apply different Password, Account Lockout to different sections of your organization. The settings for Password Policy and Acc can be applied to Organizational Units, but this only impacts the policy of local use machines that reside in those OUs.

Password Policy

These settings allow you to specify policy settings for passwords, such as how many days a p expiration.

Account Lockout Policy

These settings allow you to specify how many bad authentication attempts a user is allowed account. You also specify how long the account should stay locked out.

Kerberos Policy

This setting is domain-wide only, so it can only be set in the Default Domain Policy. It allows Kerberos security and ticketing policies that apply to the domain.

Local Policies

These policies directly affect the operation of a local machine, be it a workstation or a DC:

Audit Policy

These policies list items that, when enabled, will write audit entries for success and/or failure any machine that is affected. In other words, if you enable Audit Logon Events (Failure) in th failed logon attempts on any machine within that domain are logged to the security event log

User Rights Assignment

While permissions are used to allow or deny access to an object in Active Directory or a part give special abilities to an account or the operating system, such as whether the machine can only across the network, whether an account can add workstations to a domain, and whethe of the operating system and manipulate devices at a low level. These items used to be availa NT's User Manager, but a few more items have been added to accommodate the changes to Server 2003.

Security Options

These settings, which are displayed in the results pane of Figure 7-3 , allow configuration of s computers throughout your organization.

Event Log

These settings allow you to set various properties of the three main event logs (security, applicatio maximum size, how long to retain the logs, and so onon any computer that receives this policy.

Restricted Groups

This allows you to indicate specific groups on any computer that receives this policy and controls w groups, as well as which groups those groups can be a member of themselves.

System Services

This setting allows you to manipulate services that may be running on any machine that receives tl permissions for access to those services. The permissions include who can start, stop, and change default state of the service (i.e., Automatic, Manual, or Disabled).

Registry

This setting allows you to specify permissions and auditing properties on a registry key on any com policy. If you want to audit successful and unsuccessful accesses to the HKEY_USERS key for comp Organizational Unit only, you do so by adding an entry to a GPO that affects that Organizational Ur

File System

This setting allows you to specify permissions and auditing properties on a file or directory on any c policy. If you want to set read, write, and change access permissions to the *C:\WINNT* or *C:\WINN* every computer in one specific Organizational Unit only, you do so by adding an entry to a GPO tha Unit.

IP Security Policies on Active Directory

This allows you to configure whether a server requires use of IP Security (IPSec) when clients atter server or whether it just requests IPSec if the client is capable. From the client side, this setting all client will always use IPSec or whether it will use IPSec only when a server requests it. All aspects c from here. This can also be used to block traffic from machines, IP addresses, or entire subnets, or specific ports. This can be extremely useful if, for instance, you are combating a virus that uses sor

Public Key Policies

This location allows you to set all manner of Public Key Infrastructure (PKI) settings that are now n Directory. Administrators can specify that the system has a trusted certificate list that it considers r automatically pass certificates of a certain type out to users or computers without their interventio the administrator as default) can be made Recovery Agents and thus gain the permission to use ar certificates to decrypt that user's encrypted data. As these settings are specific to a GPO, and a GP

location in Active Directory, this allows you to set out a number of different policy settings that app
tree as required.

Software Restriction Policies (new in Windows Server 2003 Active Directory)

With these settings, you can restrict which applications can run on client machines. You can restrict
file type or even by user. Another interesting aspect of the software restriction policies is that if you
can prevent clients from opening the file that is known to have a virus.

Wireless Network (new in Windows Server 2003 Active Directory)

This allows you to manage the wireless clients on your network by configuring the SSID, WEP, encr
802.1*x* settings.

7.2.4. Administrative Templates (Computer)

The computer settings include the following components.

7.2.4.1. Windows components

NetMeeting

This contains one setting, which is to disable remote desktop sharing via NetMeeting.

Internet Explorer

Several settings here allow an administrator to dictate whether IE can auto detect missing compon
well as what its security zone settings are. Windows Server 2003 Service Pack significantly added t
settings, such as control over the Security tab and Advanced tab.

Application Compatibility (new in Windows Server 2003 Active Directory)

This allows you to enable/disable application compatibility and configure other settings, as well as di
applications.

Event Viewer (new in Windows Server 2003 SP1 Active Directory)

This allows you to configure the link for additional information in the event viewer.

Internet Information Services (new in Windows Server 2003 Active Directory)

This contains one setting that allows an admin to disallow installation of IIS.

Security Center (new in Windows Server 2003 SP1 Active Directory)

This contains one setting that allows you to enable/disable Security Center for domain PCs.

Task Scheduler

Ordinary logged-on domain users normally can manipulate the task scheduler on a machine. As an want this, or you may want to set certain tasks and not allow users to delete them. These options a and deletion of tasks, prevent the running or stopping of tasks on an ad-hoc basis, prevent schedu do not appear anywhere other than the user's Start menu, and so on.

Terminal Services (new in Windows Server 2003 Active Directory)

This section contains a number of settings that allow controlling and configuring of Terminal Service

Windows Explorer (new in Windows Server 2003 SP1 Active Directory)

This contains one setting that allows you to turn off shell protocol protected mode.

Windows Installer

These settings allow an administrator to configure a number of Microsoft Installer options that will a installed on this computer. These include options such as whether to disable the use of MSI files on all MSI files with elevated privileges (i.e., whether to install using the local SYSTEM account that ha folders on the machine's disks, which the user may have no rights to), how much logging is to be d

Windows Messenger (new in Windows Server 2003 Active Directory)

With this section, you can enable Windows Messenger to run on system startup or disable it from ru

Windows Media Digital Rights Management (new in Windows Server 2003 Active Directory)

This contains one setting that when set, disallows Windows Media DRM from going out and updatin or acquiring licenses.

Windows Movie Maker (new in Windows Server 2003 SP1 Active Directory)

This is a single setting to disallow Windows Movie Maker from running.

Windows Update (new in Windows Server 2003 Active Directory)

The two settings contained in this section allow you to enable or disable the Windows Update servic server to use for updates instead of downloading updates directly from Microsoft.

Windows Media Player (new in Windows Server 2003 Active Directory)

Several policy settings for controlling Windows Media Center including automatic update control.

System

The settings contained directly under this heading allow configuration of various system componen the other headings:

User Profiles (new in Windows Server 2003 Active Directory)

This section contains settings related to local and roaming user profiles. It includes configurir profiles, slow network detection, and whether roaming policies are allowed on systems.

Scripts (new in Windows Server 2003 Active Directory)

You can define various properties about login script execution. This includes settings to contr visible and whether to run scripts synchronously or asynchronously.

Logon

This section includes a number of items related to controlling the system during a user logon applications to run, disable the Run Once registry key, and disable the Getting Started screer

Disk Quotas

This section contains settings that allow you to turn on disk quotas at any machines that rec manipulate a variety of settings.

NetLogon (new in Windows Server 2003 Active Directory)

These new settings give you a lot of control over how the netlogon process works. You can c thinks it is a member of and various DC discovery settings.

Group Policy

This is one of the most significant areas, as it contains settings that govern how the compute are going to implement group policy such as refresh frequency, etc. The contents are shown

Remote Assistance (new in Windows Server 2003 Active Directory)

This setting allows you to configure whether technical support can take control of client mach

System Restore (new in Windows Server 2003 Active Directory)

System Restore is a new feature of Windows XP that lets clients restore their system to a kn section contains settings for disabling system restore and its configuration.

Error Reporting (new in Windows Server 2003 Active Directory)

These settings control whether error reports about system or application failures are sent to

Windows File Protection (new in Windows Server 2003 Active Directory)

This controls the behavior of the Windows File Protection process that protects system files fr corrupted.

Remote Procedure Call (new in Windows Server 2003 Active Directory)

These settings configure various properties of the Remote Procedure Call service.

Windows Time Service (new in Windows Server 2003 Active Directory)

This section allows you to configure the NTP client, including time server, polling intervals, ar

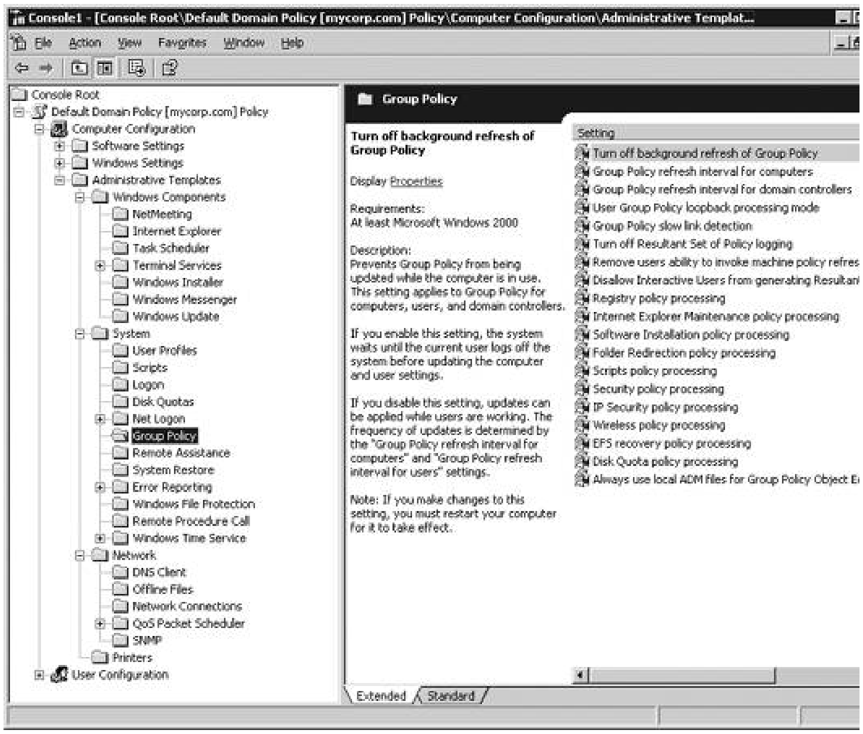
Internet Communications Management (new in Windows Server 2003 SP1 Active Directory)

This section allows you to disable various Windows components from going to the Internet fo features.

Distributed COM (new in Windows Server 2003 SP1 Active Directory)

This section allows you to specify some Component Object Model (COM) security settings.

Figure 7-4. Computer administrative template



Turn off background refresh of Group Policy

Display Properties

Requirements:
At least Microsoft Windows 2000

Description:
Prevents Group Policy from being updated while the computer is in use. This setting applies to Group Policy for computers, users, and domain controllers.

If you enable this setting, the system waits until the current user logs off the system before updating the computer and user settings.

If you disable this setting, updates can be applied while users are working. The frequency of updates is determined by the "Group Policy refresh interval for computers" and "Group Policy refresh interval for users" settings.

Note: If you make changes to this setting, you must restart your computer for it to take effect.

Setting
- Turn off background refresh of Group Policy
- Group Policy refresh interval for computers
- Group Policy refresh interval for domain controllers
- User Group Policy loopback processing mode
- Group Policy slow link detection
- Turn off Resultant Set of Policy logging
- Remove users ability to invoke machine policy refres
- Disallow Interactive Users from generating Resultan
- Registry policy processing
- Internet Explorer Maintenance policy processing
- Software Installation policy processing
- Folder Redirection policy processing
- Scripts policy processing
- Security policy processing
- IP Security policy processing
- Wireless policy processing
- EFS recovery policy processing
- Disk Quota policy processing
- Always use local ADM files for Group Policy Object E

Network

These settings control various network-related properties, such as DNS client settings, QoS setting
mention a few:

Microsoft Peer-to-Peer Networking Service (new in Windows Server 2003 SP1 Active Directory)

This section allows you to disable or configure Microsoft Peer-to-Peer Networking service con
Name Resolution Protocol.

DNS Client (new in Windows Server 2003 Active Directory)

A much-needed addition to group policy, the DNS Client settings allow you to configure the p
suffix search order, and dynamic DNS update settings. A single policy setting version of this s
System grouping of policy settings in Windows 2000.

Offline Files

This section contains a large set of values that govern exactly how files and folders are to be
machine when it is offline. You can turn offline folders on and off, set the cache size to be us
synchronization is to occur, and so on.

Network Connections

This location has one key that determines whether users can enable, disable, and configure t network connection from any Windows-based computer that this policy applies to. Shared ac their system as an Internet gateway for a small network of machines, providing network serv resolution to that network. In Windows 2000, this was named "Network and Dial-up Connecti

QoS Packet Scheduler (new in Windows Server 2003 Active Directory)

Windows XP and Windows Server 2003 contain the ability to set QoS for network traffic. This configure various QoS parameters.

SNMP (new in Windows Server 2003 Active Directory)

This contains SNMP configuration settings, including community strings, who can query SNMI destinations.

Background Intelligent Transfer Service (new in Windows Server 2003 SP1 Active Directory)

This section contains a couple of policies for limiting BITS.

Printers

This location has a series of keys that provide a number of new options for printers, dictating whet all from a computer, whether they can be auto-published into Active Directory, and so on.

Printer objects in Active Directory have a large number of attributes that can and will be regularly s the attribute called Location: users can search for printers based on location from a simple pop-up choose Search...For Printers from the Start menu on a Windows client. Users also can search for "p use of a location-tracking feature. Location tracking lets you design a location scheme for your ent number, floor number, building name, city, country, and so on, and assign computers and printers Location tracking overrides the standard method of locating and associating users and printers, wh subnet mask of a computer to estimate its physical location and proximity to other computers. GPC workstation to search as if it were in a specific location (i.e., forcing your own value for location wh for printers nearby), as well as turning on location tracking and its associated options.

7.2.4.2. Windows settings (user)

Although this section contains only a few settings, the contents are likely to become very familiar to you. logoff scripts, allows you to redirect core system folders to network areas from the normal hard disk loca specify IP security policies. Figure 7-5 shows a snapshot of the contents.

Folder Redirection

This is a very useful setting that is easy to understand and manage. It allows an administrator to r *My Pictures* , *Application Data* , *Desktop* , and *Start Menu* locations from their defaults. For exampl at Leicester University, but they didn't want the *My Documents* folder to roam with the user becaus folders and files it could contain. In other words, downloading and uploading *My Documents* could s considerably. So instead, they redirected the user's *My Documents* folder (and the *My Pictures* fold paths. That way, whenever an application such as Microsoft's Office 2000 attempts to save a docum folder, the file is saved to the *My Documents* folder located in the home folder.

This part of the GPO is different from the others in that it doesn't contain settings as such. Instead, right-clicked and the Properties item selected from the drop-down menu that appears. This brings u settings window for that folder. This window allows you to redirect all users who receive this GPO to grained control so that users who are members of a certain group get Folder A, users who are mem Folder B, and so on. You can then specify other settings, such as whether the existing folder is to b takes effect and whether the folder is moved back when the policy stops being in effect.

> The main problem with these settings stems from the fact that you can't use envi the strings because the GPO will take effect before environmental variables are se set of users who are to have their *My Documents* redirected to folders that corres usernames, there is no way of getting the usernames into the folder path using th variable as there is for profiles.

If you do want to redirect but don't want the hassle of doing it this way, edit the relevant keys in th locations to point the folders elsewhere. Note that both must be edited for the process to take effec

- *HKCU\Software\Microsoft\Windows\CurrentVersion\Explorer\Shell Folders*
- *HKCU\Software\Microsoft\Windows\CurrentVersion\Explorer\UserShell Folders*

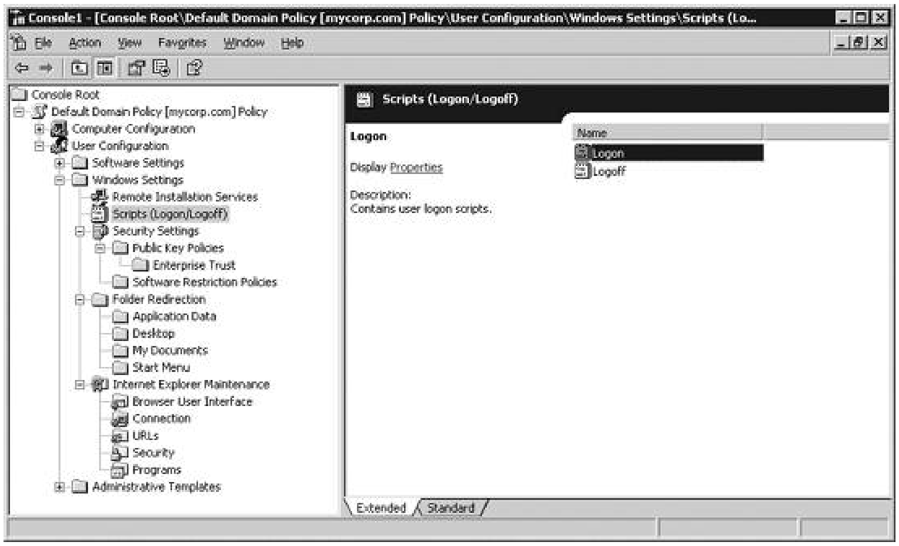
Scripts (Logon/Logoff)

This is where you can specify the user logon and logoff scripts. Whether these are executed synchr specified in the User Configuration Administrative Templates section of the GPO.

Security Settings ⟶ *Public Key Policies*

These settings correspond to those held under Windows Settings in the computer portion of the GP

Figure 7-5. Windows settings (user)



Description:
Contains user logon scripts.

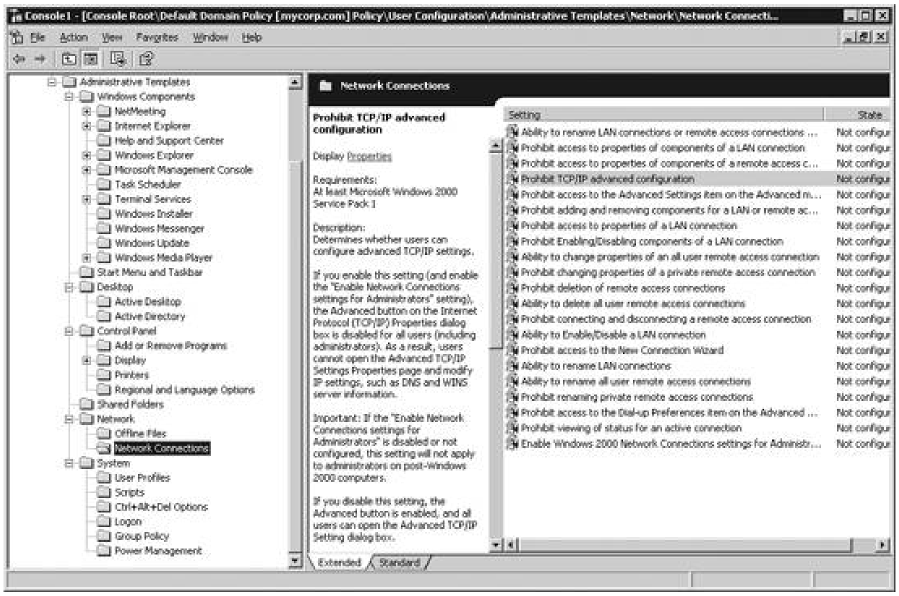
7.2.4.3. Administrative templates (user)

This is the core of the settings that will govern how the administrator controls a system's look and feel fo geared to various lockdowns that you may wish to perform on a user's account; if you do not wish to locl most of these settings will not be of much use. If roaming profiles are turned on, these settings roam wit client. Figure 7-6 shows the full branch expanded.

Start Menu & Taskbar

> This location is used when the administrator wishes to customize how the Start menu and the task policy applies to. Here you can disable various options on the Start menu, such as the Control Pane shutdown button, and can also remove various items, such as Run, Search, or Favorites, entirely if

Figure 7-6. Administrative templates (user)



Prohibit TCP/IP advanced configuration

Display Properties

Requirements:
At least Microsoft Windows 2000 Service Pack 1

Description:
Determines whether users can configure advanced TCP/IP settings.

If you enable this setting (and enable the "Enable Network Connections settings for Administrators" setting), the Advanced button on the Internet Protocol (TCP/IP) Properties dialog box is disabled for all users (including administrators). As a result, users cannot open the Advanced TCP/IP Settings Properties page and modify IP settings, such as DNS and WINS server information.

Important: If the "Enable Network Connections settings for Administrators" is disabled or not configured, this setting will not apply to administrators on post-Windows 2000 computers.

If you disable this setting, the Advanced button is enabled, and all users can open the Advanced TCP/IP Setting dialog box.

Setting	State
Ability to rename LAN connections or remote access connections ...	Not configur
Prohibit access to properties of components of a LAN connection	Not configur
Prohibit access to properties of components of a remote access c...	Not configur
Prohibit TCP/IP advanced configuration	Not configur
Prohibit access to the Advanced Settings item on the Advanced m...	Not configur
Prohibit adding and removing components for a LAN or remote ac...	Not configur
Prohibit access to properties of a LAN connection	Not configur
Prohibit Enabling/Disabling components of a LAN connection	Not configur
Ability to change properties of an all user remote access connection	Not configur
Prohibit changing properties of a private remote access connection	Not configur
Prohibit deletion of remote access connections	Not configur
Ability to delete all user remote access connections	Not configur
Prohibit connecting and disconnecting a remote access connection	Not configur
Ability to Enable/Disable a LAN connection	Not configur
Prohibit access to the New Connection Wizard	Not configur
Ability to rename LAN connections	Not configur
Ability to rename all user remote access connections	Not configur
Prohibit renaming private remote access connections	Not configur
Prohibit access to the Dial-up Preferences item on the Advanced ...	Not configur
Prohibit viewing of status for an active connection	Not configur
Enable Windows 2000 Network Connections settings for Administr...	Not configur

Desktop

Like the last item, this section is used to lock down the desktop. Here you can remove the various Places, as well as configure whether the desktop settings themselves can be changed and whether logout. Active Desktop is configured (or disabled) from here.

Control Panel

Add/Remove Programs

This allows you to set how the control panel is customized for an individual user. You can disa some of the options, or even force the system to bypass the addition of other software but st the system by going straight to the Components menu.

Display

This can be used to disable individual tabs on the Display control panel, so that users cannot screensaver, or the settings for their display (such as display drivers), which, as administrato immense problems.

Printers

Here you can disable the adding or deleting of printers, as well as decide whether to hide var Add Printer wizard.

Regional and Language Options (new to Windows Server 2003)

This allows you to restrict users to a certain language.

Shared Folders (new in Windows Server 2003 Active Directory)

This heading contains two settings that determine whether users can publish shared folders and DF

Network

Offline Files

These settings allow the administrator to govern how cached files for offline access actually c settings control whether the files are automatically synchronized at logoff, how much event l space can be used up by the offline cache, and so on.

Network Connections

This section allows the administrator to configure how RAS and LAN connections will work for the full list of options.

System

A few extra settings live directly under this heading, as they don't fit under any other category. The interpret two-digit years, whether to disable the Windows registry editors (*REGEDT32.EXE* and *REG* allow only a specified list of programs to run for a user.

User Profiles (new in Windows Server 2003 Active Directory)

With these settings, you can limit a user's profile size and exclude directories in a roaming pr

Scripts (new in Windows Server 2003 Active Directory)

You can define various properties about login script execution. This includes settings to contr and whether to run scripts synchronously or asynchronously.

Ctrl+Alt+Del Options (new in Windows Server 2003 Active Directory)

With these settings, you can disable one or more buttons that are available when a user ente

Logon

These settings allow an administrator to specify whether logon/logoff scripts run visibly and w synchronously.[*] Administrators can also disable the Lock Workstation, Task Manager, Chan buttons on the Windows Security screen that you get when you press Ctrl-Alt-Del while logge

[*] You can't run a logon script synchronously if it needs to interact with the user's environment. Synch finish prior to environment variables being set and prior to the user's profile being loaded. For exampl

number of new mail messages a user has in a synchronous logon script by reading the user's name fr profile, as the user is not yet fully logged on when the script runs. The solution is to run the script asy

Group Policy

As it was in the Computer section of Administrative Templates, this is one of the most signific configuration data that governs how group policies apply to users. For example, it allows you slow link is detected, how often the user section of this GPO is refreshed, and whether GPOs PDC Emulator FSMO role owner (described in Chapter 2) or from any DC.

Power Management (new in Windows Server 2003 Active Directory)

This contains one setting that allows you to configure whether a user is prompted for their pa hibernate or suspend/standby.

Internet Communications Management (new in Windows Server 2003 SP1 Active Directory)

This section allows you to disable various Windows components from going to the Internet fo features.

7.2.5. Windows Components

NetMeeting

These settings can control virtually every aspect of NetMeeting to include what can be shared, whe used, whether the whiteboard can be used, whether directory services can be used, whether files c many more.

Internet Explorer

Numerous settings are available to customize Internet Explorer, including look and feel, security zo

Application Compatibility (new in Windows Server 2003 Active Directory)

A single setting that disallows use of 16-bit applications.

Help and Support Center (new to Windows Server 2003 Active Directory)

A single setting that controls if the "Did You Know" content will be shown by the Help and Support (was been removed in Windows Server 2003 SP1 Active Directory.

Windows Explorer

These settings relate to how the shell and desktop look and feel. You can customize whether specif

Computer or Entire Network in *My Network Places*) are displayed, decide whether certain normal r whether to disable workgroup contents in *My Network Places* or remove the Folder Options menu f blocked, or change the default settings (such as changing the maximum number of recent documer higher value).

Windows Explorer ⟶ *Common Open File Dialog*

This setting allows administrators to tailor the dialog box that is displayed automatically by prograr browse to and open a file. For example, you can specify whether the Back button or the Common F icons representing History, Desktop, Favorites, *My Documents* , and *My Network Places* are display

Microsoft Management Console

While you may use the MMC to create your own consoles, you may wish users to be able to use on create new ones. Alternatively, you may want to allow users to create consoles but limit them to or settings allow you to do either.

Management Console ⟶ *Restricted/Permitted Snap-ins*

This section contains the entire set of snap-ins that are available by default. Administrators use thi gaining access to individual snap-ins or explicitly permit them to use each one. As with all settings, are unconfigured, which means all users get all snap-ins.

Management Console ⟶ *Restricted/Permitted* ⟶ *Extension Snap-ins*

Some snap-ins can come with *extensions* , which are extra sets of configurable options that you ca functionality to the snap-in. This section contains a list of all permitted extensions and allows you t you wish.

Management Console ⟶ *Restricted/Permitted* ⟶ *Group Policy*

These items correspond to the headings that we've been going through here. You can decide, for e of users access only to the Administrative Templates (User) section that we're discussing here. And access to manipulate GPOs, but the MMC allows them to see only the Software Installation (User) a (Computer) parts. This effectively blocks their ability to manage parts of policies that you, as the a rights to.

Task Scheduler

This contains settings to allow the administrator to configure the ability of users to use the task sch Administrators can disable the ability to create new tasks, prohibit viewing existing tasks, or limit c

Terminal Services (new in Windows Server 2003 Active Directory)

These settings control user Terminal Services sessions, including time limits for active, idle, and dis

Windows Installer

This area contains configuration settings for users relating to the software packages in MSI form th user. For example, the administrator can configure whether applications are always deployed with order locations are searched for MSI packages (used when a user requests a list of packages or a u with an unknown extension), and whether the ability to roll back a failed installation is enabled or c

Windows Messenger (new in Windows Server 2003 Active Directory)

With this section, you can enable Windows Messenger to run at login or disable it from running alto

Windows Update (new in Windows Server 2003 Active Directory)

This heading contains one setting that allows you to disable Windows Update from running.

Windows Movie Maker (new in Windows Server 2003 SP1 Active Directory)

A single setting to disallow Windows Movie Maker from running.

Windows Media Player → User Interface (new in Windows Server 2003 Active Directory)

These two settings allow you to force a particular Windows Media Player skin to be used and hide tl player is in skin mode.

Windows Media Player → Playback (new in Windows Server 2003 Active Directory)

This section contains a single setting that allows you to prevent downloading of new codecs.

Windows Media Player → Networking (new in Windows Server 2003 Active Directory)

These settings allow you to configure the networking options, including HTTP Proxy, MMS Proxy, ar

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7.3. Additional Resources

Microsoft is constantly adding more capability to group policies and have a great deal of documentation available to help you understand the settings and troubleshoot issues. For further documentation, reference the following documents:

- Group Policy Infrastructure White Paper:

  http://www.microsoft.com/downloads/details.aspx?FamilyID=d26e88bc-d445-4e8f-aa4e-b9c27061f7ca

- Group Policy Object Infrastructure Management:

  http://www.microsoft.com/downloads/details.aspx?FamilyID=43090fae-e22a-4b6f-abc7-487a58b303a5

- Group Policy Settings Reference for Windows Server 2003 with Service Pack 1:

  http://www.microsoft.com/downloads/details.aspx?FamilyID=7821c32f-da15-438d-8e48-45915cd2bc14

- Troubleshooting Group Policy in Microsoft Windows Server:

  http://www.microsoft.com/downloads/details.aspx?FamilyID=b24bf2d5-0d7a-4fc5-a14d-e91d211c21b2

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7.4. Summary

Hopefully we've given you a good idea of just how powerful GPOs are in Active Directory. We've now covered the basics of what profiles can do and how modifications to a centralized profile make a lot of sense and are easy to manage. We've also taken a very in-depth look at the diverse sort of registry, user interface, file permission, and system changes that can be made using GPOs. In Chapter 10, we'll cover how to design and manage your GPOs. Finally, we provided a list of documents to help you learn more about the GPO settings available and how to troubleshoot issues.

This concludes our initial introduction to Active Directory. In Part II, we will dive into some of the important issues around designing and maintaining an Active Directory environment.

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Part II: Designing an Active Directory Infrastructure

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Chapter 8. Designing the Namespace

The basic emphasis of this chapter is on reducing the number of domains that you require for Active Directory while gaining administrative control over sections of the Active Directory domain namespace using Organizational Units. This chapter aims to help you create a domain namespace design. That includes all the domains you will need, the forest and domain-tree hierarchies, and the contents of those domains in terms of Organizational Units and even groups.

When designing a forest, remember that there are often multiple good answers to forest design for any given company. There is no "best" design for all situations. Microsoft has provided great flexibility in what can be done, which can turn around and bite you with indecision on how you should implement. It isn't unusual for two engineers to have two very different designs for the same company that are both good for completely different reasons. Simply document all recommended designs and let the decision makers decide together which one will be the best for long-term operations. Overall, the best solutions are usually the simplest solutions. In most cases, you will want to choose single forest designs over multiforest designs, single tree designs over multitree designs, and single domain designs over multidomain designs. The design example shown here is simply that: an example. The company in question could have designed their Active Directory infrastructure in a number of ways, and this is one of them.

There are a number of restrictions that you have to be aware of when beginning your Active Directory design. We will introduce you to them in context as we go along, but here are some important ones:

- Too many Group Policy Objects (GPOs) means a long logon time as the group policies are applied to sites, domains, and Organizational Units. This obviously has a bearing on your Organizational Unit structure, as a 10-deep Organizational Unit tree with GPOs applying at each branch will incur more GPO processing than a 5-deep Organizational Unit tree with GPOs at each branch. However, if a 10-deep and 5-deep OU structures both contained only two levels with GPOs, they would both incur the same GPO processing.

- Under Windows 2000, you cannot rename a domain once it has been created. Fortunately, with Windows Server 2003, this limitation has been removed, although the rename process is tedious. You can even rename forest root domains once you've reached the Windows Server 2003 forest functional level. If you are running Exchange, however, there are additional considerations and limitations for domain renames.

- You can never remove the forest root domain without destroying the whole forest in the process. The forest root domain is the cornerstone of your forest.

- The Schema Admins and Enterprise Admins groups exist in the forest root domain only. So if you are migrating from a previous version of NT with an in-place upgrade, be cognizant of the fact that the administrators of the first domain you migrate have immediate control over these groups and over Active Directory.

- Lack of a regional global catalog is problematic. Imagine that you have 20 printers in your office in Sweden and 12 printers in your office in Brazil. The users in Sweden will never need to print to the printers in Brazil, and the users in Brazil will never need to print to the printers in Sweden. However, by default, details of all printers are published in the GC. Thus, whenever changes are made to printers in Sweden, all the changes get replicated to the GCs on the Brazil servers because the GC replicates all of its data to all GCs within the forest. If you do not want printer information in your GCs, you can create an application partition to host printer data and replicate it to designated domain controllers.

- Multiple domains cannot be hosted on a single DC. Imagine three child domains under a root domain located in the United States, each of which corresponds to one of three business units. Now imagine that you have a small office of 15 people in Eastern Europe or Latin America with a slow link to the United States offices. These 15 users are made up of three sets of five; each set of five users belongs to one of the three business units/domains. If you decide that the inter-site link is too slow and you would like to install a local DC for these three domains at the remote site, you will need to install and support three separate DCs, one for each domain.

- The forest, not the domain, is the security boundary for Active Directory. Anyone with high-level access rights on any domain controller in any forest can negatively impact or take control of any other DC or domain in the forest.

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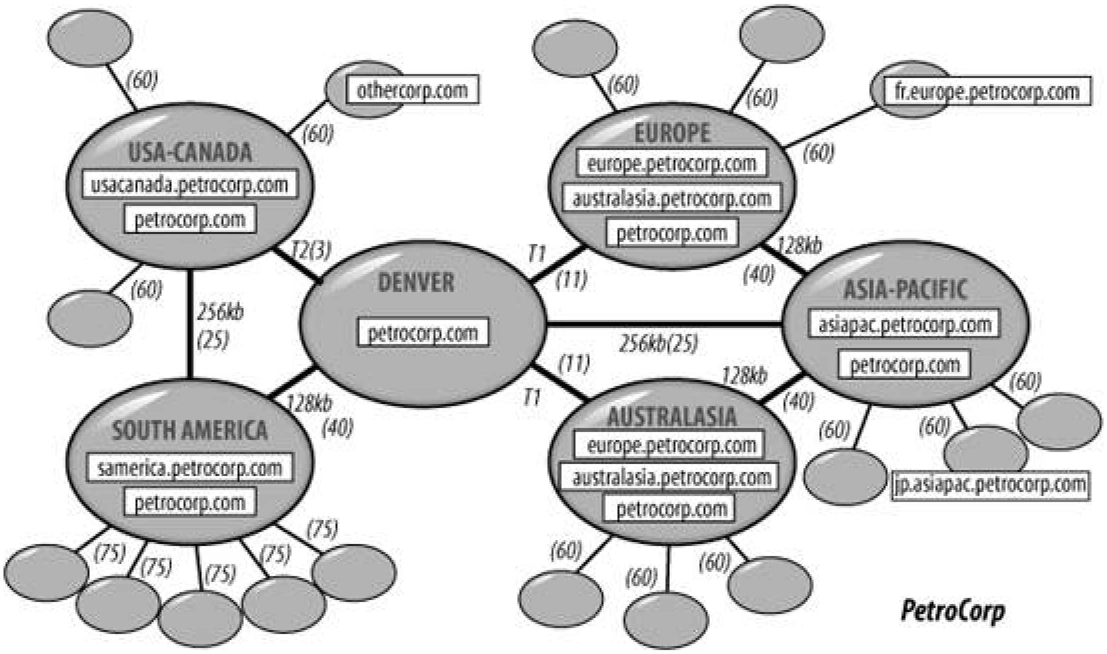
8.1. The Complexities of a Design

Active Directory is a complex beast, and designing for it isn't easy. Take a look at a fictitious global company called PetroCorp, depicted in Figure 8-1.

Figure 8-1. The sites and servers of a company called PetroCorp



Here you can see a huge network of sites linked with various network connections across wide area networks. A variety of domains seems to exist for *othercorp.com* and *petrocorp.com*, and as each one of those square boxes represents a single domain controller, you can see that some of the servers will need to replicate data across those WAN links. *petrocorp.com*, for example, seems to need to replicate to all the major sites, since it has domain controllers (DCs) in each of those sites.

Take a look at Figure 8-2, which shows a much more complex hierarchy.

It's possible to see the users and computers in all the Organizational Units in this view, and the structure seems to be set up so that Group Policy Objects (GPOs, represented by trapezoids) can be applied to various portions of the tree. These GPOs could be anything from what menus appear on the screen to what applications can be run to what hardware is available for each user.

Following is a discussion of the principles and processes that will help you create complicated designs like these to mirror the complexities in your own organization.

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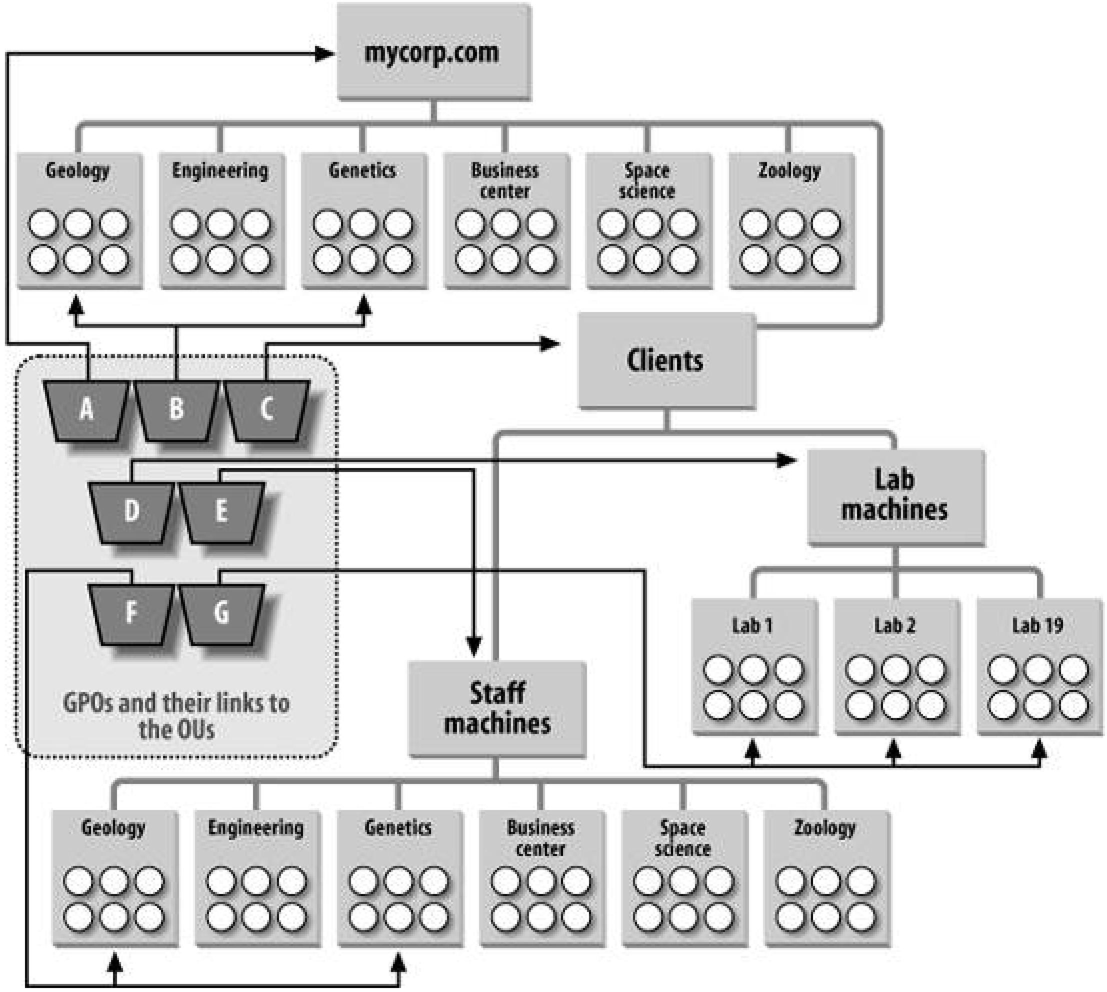
8.2. Where to Start

Before you sit down to make your design, you will need to obtain some important pieces of information. You will need a copy of your organizational structure, since this is effectively the document that explains how your organization's business units fit together in the hierarchy. Next you will need a copy of the geographical layout of your company. This includes the large-scale picture in continents and countries and also the individual states, counties, or areas in which you have business units. Third, you will need a copy of the network diagram, indicating the speeds of connection between the various sites. Finally, you need a copy of any diagrams and information on any systems that will need to interface to Active Directory, such as existing X.500 and LDAP directories, so that you can take them into account. Once you've gathered the information, you can sit down and plan your design .

Figure 8-2. A complex domain tree showing GPOs


mycorp.com
Geology
Engineering
Genetics
Business center
Space science
Zoology
Clients
A
B
C
D
E
F
G
Lab machines
Lab 1
Lab 2
Lab 19
Staff machines
GPOs and their links to the OUs
Geology
Engineering
Genetics
Business center
Space science
Zoology

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8.3. Overview of the Design Process

The namespace design process takes place in three stages:

Design of the domain namespace

During the first stage, you deal with the namespace design itself. That means calculating the number of domains you need, designing the forest and tree structure, and defining the naming scheme for workstations, servers, and the network as a whole.

Design of the internal domain structure

During the second stage, you need to concentrate on the internal structure of each domain that you have previously noted. Here you also need to use your business model as a template for the internal structure and then move on to consider how administration and other rights will be delegated. The internal structure can also be modified depending on how you intend to use Group Policy Objects; this will be covered in Chapter 10.

Global catalog design

During the third stage, you work out your designs for the global catalog (GC).

> When you are finished with your design, you can implement it by setting up a test forest in a lab environment. This will enable you to get a better feel for how the design actually works and whether there is anything you have failed to consider. We can't stress enough the use of a test environment.

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8.4. Domain Namespace Design

The first stage in your design is to work out the domain, domain tree, and forest configuration of your network. The best way to do this is to make a first pass at designing the domains and then structure them together into a single tree or a series of trees. Before we start, however, let's take a look at our objectives for this part of the design.

8.4.1. Objectives

There are two objectives for the design of the domain namespace:

- Designing Active Directory to represent the structure of your business
- Minimizing the number of domains by making much more use of the more flexible Organizational Units

8.4.1.1. Represent the structure of your business

You need to make Active Directory look as much like your business structure as possible, whether that structure is geographical or organizational. In a geographical structure, your business runs itself as self-contained units within each geographical site. In this model, people at those sites handle administration for each site. Under the organizational or political model, the business is based on a series of departments that have members from a number of different geographical sites. With this structure, the organization ordinarily has a head office for all departments at one location, but that is not always the case.

In the former model, finance units based in France and Australia would be separate finance departments. In the latter model, France and Australia would have geographical finance branches of a larger finance department controlled from a head office.

It doesn't matter to Active Directory which model you choose, except that the intention is to mirror the structure of your business in the Active Directory design. If your business crosses both of these boundaries, it becomes less clear-cut. To make your design simpler to understand, you should choose to go with one model or the other; we would not suggest a mix-and-match approach unless you can definitely rationalize it, adequately represent it on paper, and delegate administration effectively.

If you already have a large investment in a TCP/IP infrastructure with organization or geographically-centered DNS zones, or you if have a large existing Exchange organization, you can use this as the basis of your design. Simply stated, if your DNS or Exchange setup is based on one model, go with that model for your Active Directory design. It should be obvious that it will be easier for an administrator to think about both areas if the designs are based on the same model.

8.4.1.2. Minimize the number of domains

Remember that implementing Active Directory presents an opportunity to reduce the number of domains you support. Each forest can store tens of millions of objects, which is more than enough for all the users, groups, and computers in most organizations. So size isn't a consideration. Each domain can also be partitioned using Organizational Units, allowing you to delegate different administrators for each Organizational Unit in a domain if you so desire. You do not have to create a new domain if you wish to delegate administration over a part of the system. These two aspects of Active Directory tend to eliminate a number of sizing and permission problems associated with traditional NT installations.

> If you're an experienced NT domain designer, start trying to push from your mind the tendency to create multiple domains. Think in terms of multiple Organizational Units instead.

8.4.2. Step 1: Decide on the Number of Domains

Start by imagining that every object is to be stored in one domain. This will give you a much simpler layout for administration. It doesn't matter what the domain is called for now; just label it as your organization's main/sole domain.

Now expand the number of domains that you have by adding other domains that you can give specific justification for. While the number of objects and delegation of administration are not good reasons for creating new domains, there are three main reasons that would require more domains:

- The need to isolate replication
- A requirement for a unique password, account lockout, or Kerberos domain policy
- A requirement for keeping a Windows NT domain other than as a security boundary (the domain is not a security boundary)

If you can match any of these criteria, write down a new domain for that area.

There are good reasons to add domains to the design, but there are also good reasons to not add domains. You should weigh these against the requirements listed previously to determine which are most important. Some reasons to not deploy an additional domain include:

Forest complexity

Each domain requires more DCs and more policy management.

Application complexity

Applications may no longer be able to search a single domain for information. Many Unix- and JAVA-based LDAP applications are generally written to have a single simple hierarchy and may not be able to be configured to work with a multidomain forest without serious work.

Exchange issues

Microsoft Exchange 2000 and 2003 have several issues with multidomain forests around user and group object updates. The protocols used in Exchange/Outlook just weren't designed for proper multidomain operation.

8.4.2.1. Isolated replication

While replication is mainly discussed in the next chapter, it does have a bearing on domain design. If you have a headquarters and a branch office connected via a slow link, and you don't want to use up any bandwidth at all in replicating domain directory data from the main domain to the branch office, you need to consider creating a separate domain for the branch office. This will ensure that only limited traffic is replicated between both offices. In fact, this will be limited to the GC, configuration, and Schema information only.

So if you want to really minimize traffic down a link, create a new domain for the remote office. In most cases, this isn't necessary. Also, you can use Application Partitions to store application-specific data and only replicate it to your regional sites.

A slow link in an ideal case is defined as a 256 KB link with 128 KB spare capacity. However, each organization will need to make its own decision about what it will accept as a minimum for a slow link; the value could be 64 KB or 1 MB. As we are only drafting the namespace and physical site/replication designs and then coming back to revise both using the combined data, the exact figure for a slow link in your organization is not important right now.

8.4.2.2. Unique domain policy

In Chapter 7 and Chapter 10, we explain the basics of GPOs and how to properly design them. For now, the important thing to understand is that policies are Active Directory objects that reference a number of settings that can be applied to users or computers. These settings are things like a fixed desktop, a certain core set of applications, the ability of users to perform a shutdown, and so on. If you're coming from a Windows NT background, these are Windows NT system policies on a much grander scale. GPOs can be applied to various parts of your Active Directory structure. If you create an Organizational Unit called Finance and then decide that it needs special settings, you can create a GPO and assign it to the OU. Then the computer settings and user settings in the GPO will be applied to all computers and users in the Finance OU.

We now need to look at what settings have to be applied on a domain-by-domain basis. Here's a list of what types of settings can be set only on a domain-wide basis:

- Password policies, such as password length, password expiry interval, and so forth. This is effectively the same as for Windows NT 4.0.
- Account lockout policies, such as lockout threshold, lockout duration, and so forth. Again, this is the same as for NT 4.0.
- Kerberos policies.
- Encrypted file system recovery policies.
- Public key encryption policies.
- Certificate authorities.

If you know that your organization already has three different password schemes that cannot be reconciled and must be maintained, you will need three domains . If a special department or geographical area needs special encryption, security safeguards, certificates, and so on, you may have another candidate for a domain.

8.4.2.3. In-place upgrade of current domain

Many organizations have large existing Windows NT infrastructures and will be planning to migrate at some point. During the design of your migration to Active Directory, you will need to consider the option of merging old Windows NT domain hierarchies into single domains. This is known as collapsing old domain structures . However, even though AD usually requires fewer domains than Windows NT since it can accommodate more objects and allow delegation of administration without domains, organizations may wish to retain some of their current domains.

If your organization has a domain that you feel should not be removed for some reason, you need to indicate it on the list of domains. Then when it comes time to implement your Active Directory rollout, you can do an in-place upgrade on the existing domain rather than bringing it into an existing AD domain.

8.4.2.4. Final notes

You now should have your first draft of the list of domains that you think you will need. There is one more very important point on this subject. Domains are very inflexible and unforgiving, and due to the fact that you can host only a single domain on a domain controller, each domain means one more domain controller[*] you have to support. Depending on how many domain controllers you would have to deploy for a domain, you can greatly decrease your total cost of ownership (TCO) for Active Directory by limiting the number of domains you support.

[*] For fault tolerance, you should always deploy new domains with at least two domain controllers. If you have but a single domain controller, its failure would require an immediate restore from backup. This is easily avoided by deploying a second DC.

8.4.3. Step 2: Design and Name the Tree Structure

Now that you have the domains listed, you need to consider what sort of hierarchy to put them in. It is easiest to start with one domain, the one that will become the forest root.

8.4.3.1. Choose the forest root domain

The forest root domain is normally the largest domain left after you split off the smaller ones using the preceding domain design process, but it doesn't have to be. The empty forest root domain approach is also very common: you minimize the amount of data in that domain and put everything in subdomains. The key here is that this domain needs to be centrally managed by an IT group, capable of making solid policy and naming decisions. The forest root domain has special properties. For example, the Schema Admins group exists only in the forest root domain. The administrators of this forest root domain have control over who is added to the Schema Admins group and thus allowed to modify the schema. While the administrators of the forest root domain can add any user from anywhere in the entire forest to the group (due to hierarchical and transitive trusts between all domains), it is the administrators of the forest root domain that call the shots. So this domain is special. Its administrators dictate how the network expands, who can and cannot add domains, and where domains should go. This group has the grand vision for the design and operation of the network.

Whichever domain corresponds to this is the one that should be the forest root domain. If you are having difficulty choosing, pick one of the likely candidates for now. If it becomes obvious later that it was the wrong choice, you can come back and readjust. Once you've chosen, grab a blank piece of paper and draw the forest root domain at the top of the sheet in a triangle. A triangle is the symbol used to represent an Active Directory domain.

8.4.3.2. Design the namespace naming scheme

As each domain has a DNS name to identify it, you need to consider what names you are going to choose. You can use any of the RFC 1123 standard characters:

- A-Z

- a-z
- 09
- - (dash character)

Microsoft's DNS supports a wider range of characters, such as the Unicode character set, but if you need compatibility with other DNS flavors, be very careful allowing these.

There are currently two schools of thought on how to pick the DNS names for your Active Directory network: root zone or subzone. The root zone method says that you name your root Active Directory domain based on the root zone for your organization. For the Mycorp Corporation, this would be *mycorp.com*. The subzone method suggests that you pick a new subdomain from your root zone and make that the base of your Active Directory namespace. For Mycorp, this could be *ad.mycorp.com*. If you choose the root zone method and wish to have a non-Windows DNS, you will need to either turn on dynamic update or manually register a number of records in the DNS, as shown in Chapter 6. If you choose the root zone method and wish to have a Windows DNS at your root, you will need to migrate your existing entries, if you have any, to the new DNS servers. Both methods are fine, but they require configuration or migration at the root. A less-invasive procedure would be to choose a new subzone for your Active Directory network and run your network from that. With this setup, you still have two choices, but they are less disruptive to any existing structure and you won't have to affect the main root zone. Arguably, the easiest solution is to let two servers on your network run Windows DNS server and manage this DNS zone. This allows you to have a root that doesn't allow dynamic updates and a subdomain that does. The alternative would allow a non-Windows DNS to manage the zone.

As an example, Leicester University had a very large existing DNS infrastructure branching down from the root domain that they didn't want to affect with this new Active Directory infrastructure. The main DNS servers, while being dynamic update-capable, did not have dynamic update turned on for specific reasons. So they set up two domain controllers to run the Windows DNS service and gave those name servers a subdomain to host. Then they delegated that subdomain on the main DNS servers and by specifying which servers had authority for the new zone. Then DHCP was modified to point all new client workstations at the two new Windows DNS servers and configured the DNS servers to pass any queries that they could not resolve back to the main campus DNS servers. Clients could update the Windows DNS without affecting the main campus servers. However, external queries were still resolved by passing them to the main campus servers for resolution.

To continue with the planning process, start with the forest root and assign a DNS name to the domain, writing the name inside or beside the triangle on the paper. You should choose the name very carefully for two reasons: first, renaming a domain is impossible in Windows 2000 Active Directory, and while it is possible under Windows Server 2003 Active Directory, the process is very invasive and requires all machines in the domain to be rebooted. Second, you can never remove the forest root domain from Active Directory. You would have to wipe your entire setup and start again.

8.4.3.3. Create additional trees

Having created and named your forest root, you need to consider your other domains. If you have two distinct business units or companies, some analysts may think that they will require noncontiguous names to match the structure. This means that you will need two trees coming from a domain root. Think long and hard on this decision, as multiple domain trees in a forest add complexity and often cause support and application confusion for no real benefit. Some common examples that people will use to indicate a perceived need for multiple trees are different email address suffixes, different UPN suffixes, resource separation, and security separation. However, separate trees aren't actually required to implement any of these requirements.

If you still decide that you need multiple trees, draw all the other tree root domains that you think you will need as separate triangles at the same horizontal level on the paper and assign them valid DNS names. These domains are all tree root domains, but should not be confused with "the" forest root domain. A real-world example is the Microsoft brand name and the MSN brand name. Both *msn.com* and *microsoft.com* could be separate trees in the same forest. They couldn't be in the same tree without giving them a hierarchical link; i.e., *msn.microsoft.com*. However, the only real benefit for having an *msn.com* and *microsoft.com* in the forest instead of an *msn.microsoft.com* is how it all looks on a PowerPoint presentation.

> If we think that Mycorp's finance department needs a separate domain, we will make a subdomain and call it *finance.mycorp.com*. Within Active Directory we could make *finance.mycorp.com* a separate tree in its own right, but since hierarchical and transitive trusts exist throughout a forest, we would gain absolutely nothing by doing this. The only differences come in choosing finance to be a new domain (which we did) or a new forest in itself. Making it a new tree gains absolutely nothing.

8.4.3.4. Create additional forests

So far, we've been considering domains that will exist in the same forest, but you may have business units that will require two entirely separate forests. How do you know if that is the case? If you have business units in an organization that are independent and in fact wish to be isolated from each other, then you must not combine them in a single forest. If you simply give each business unit its own domain, these business units can get the idea that they are autonomous and isolated from each other. However, in Active Directory, this level of isolation can be achieved only through separate forests. This is also the case if you need to comply with regulatory or legal isolation requirements.

The first and most common reason may be political: certain business units may decide that they want to be as autonomous as possible. It may be that, politically, the finance department has to be completely separate, so you end up making a second forest with *finance.mycorp.com* as the second forest's forest root domain. In effect, you are treating this business unit as a separate, autonomous, and noncontiguous part of the tree.

The second reason you may need two forests involves having two businesses that must be separately maintained for regulatory or other legal reasons.

The third reason is one born out of necessity. Remember from Chapter 2 that certain aspects of a namespace are forest wide in scope. If you want to isolate a separate schema, configuration, or GC, your only solution is to create a separate forest.

The fourth reason, which is becoming more common, is the need for a separate forest for Microsoft Exchange. Exchange 2000 and Exchange 2003 are very tightly integrated into Active Directory and do not allow for a good clean separation of duties through delegation. Additionally, Exchange can have serious management issues with multidomain deployments in a single forest. These two reasons can often result in a single domain resource forest being implemented for Exchange with a trusts configured to the appropriate domains in the NOS forest.

If any of these reasons is true, you need to create a second forest root domain and give it a unique DNS name, as you did for the first forest root domain. In effect, you need to separate your designs and do each forest individually. The best thing to do now is to figure out how many forests you need and which domains from your list are going to be the forest root domains. Once you have determined this, you will name these root domains, and then use a separate piece of paper to draw each forest. Maintain separate lists of domains for each forest. You're now doing *x* designs, where *x* is the number of forests you have.

There is one other important point that you need to be aware of. While domains and trees in a forest maintain automatic trust relationships, it is possible to set up manual trust relationships with domains external to a forest. You can therefore set up manual trust relationships between forests. These relationships can be one-way trusts (A trusts B but B does not trust A) or two-way trusts (A trusts B and B trusts A).

If you require a limited trust situation (in the Windows NT/2000 sense), in which you wish to give access to your forest to vendors and partners, you can do this manually. If you have two forests that you wish to link, you have several options: establish an explicit one-way trust or create a transitive forest trust.

The first option allows other domains that are members of another domain tree in a different forest or that do not support Kerberos authentication to have limited access to a domain in the forest. Only resources in the domain will be visible; no other resources in the tree are available for access.

The second option is new to Windows Server 2003 Active Directory. Under Windows 2000, if you wanted all domains in one forest to trust all domains in a second forest, you had to create individual trusts to and from each domain. With the new forest trust, you can simply create a single transitive trust between two forests, and all domains in both forests will trust each other.

You can also allow access to Active Directory via a digital certificate. Effective use of digital certificates allows secure communication between two machines. A digital certificate is used for public-key encryption applications, mostly seen on the Internet where pages need a special certificate installed on the client to allow authentication over Secure Sockets Layer (SSL) . A certificate server, such as the Microsoft Certificate Server that ships with Windows 2000 or Windows Server 2003, can be set up to issue, renew, and revoke digital certificates that allow access to Active Directory. The certificates are used to authenticate connections via specific computers and users. Active Directory has extensions that allow individual user and computer accounts to have digital certificates assigned to them, allowing authentication over this mechanism. While these concepts aren't difficult, they are outside the scope of this book.

8.4.3.5. Arrange subdomain hierarchy

You now have a forest root domain with a valid DNS name. You may have other domains that act as the roots of separate trees in the same forest; you may even have extra forest root domains representing separate forests entirely. Now you need to lay out the domain tree hierarchies. If you have a number of remaining domains listed on your sheet of paper from step 1, these are the subdomains that will form your domain-tree hierarchy.

Start with the first forest. Representing each domain with a triangle on the paper, arrange the domains in a hierarchical fashion beneath one of the domain tree roots in the forest. Name the domain appropriately, according to its position in the hierarchy. Repeat this process for all domains in this forest, then move on to the next forest and repeat.

For example, if we have *mycorp.com* as a tree root, and finance, marketing, and sales all need separate domains, we call them *finance.mycorp.com*, *marketing.mycorp.com*, and *sales.mycorp.com*. If the sales domain needed separate domains for pre-sales and post-sales, we arrange these two domains beneath sales, as *pre.sales.mycorp.com* and *post.sales.mycorp.com*.

8.4.4. Step 3: Design the Workstation and Server-Naming Scheme

You now have one or more forests of domain trees. Each tree is uniquely named in a hierarchical fashion. You can now consider the naming scheme for the servers and workstations .

> While we are considering the naming scheme here, the exact placement of machines in Active Directory is covered in Chapter 10 on designing GPOs. That is because GPOs can impact clients based on machine location.

Each client or server in an Active Directory network must have a computer account somewhere in the forest to let users log on via that client. When a workstation is added to a domain in a forest, the computer account is created in Active Directory, and a trust relationship is set up between the client and the domain so that the client is recognized as a valid member of the domain.

Where a client is placed in the forest determines part of the name. Member servers are usually placed in the domain that hosts most of the users that use the server, and DCs are located by their very nature in the individual domains that they host. Clients can be placed anywhere, but they are usually placed in the domain that the primary users of that client will normally log on to.

Under Windows NT 4.0, if you had a single-master or multimaster domain model in which multiple resource domains had one-way trusts to one or more master user domains that held the accounts, the workstations were normally placed in the resource domains. This enabled the workstations to log on to both the resource domain and the user domain. Putting the clients only in the user domain would have meant that the clients could not be used to access the resources in the resource domains, as no trust existed in that direction.

> Cast this completely out of your mind in Active Directory. Each domain within a single forest has a hierarchical and transitive trust between it and every other domain in that forest, so from that perspective, it no longer makes any difference where the clients are located.

All hosts are named *computer.domain*. For example, a server called *moose* in *mycorp.com* would be called *moose.mycorp.com*; a server called *moose* in the finance domain would be called *moose.finance.mycorp.com*.

> It isn't normally discussed, but the naming of the machines in a domain does not strictly need to have a DNS domain name that matches the Active Directory Domain Name. This is one example of a disjoint namespace, and it is a supported configuration by Microsoft. This is most common in larger Enterprise class organizations that have large distributed DNS configurations. You may find, for example, a server with the name *moose.manton.michigan.us.company.com*, which is a member of the AD Domain *na1.company.com*.

Deploying Active Directory does not force you to change the names of any existing hosts that you have. However, if you are planning to consolidate a number of separate domains, you need to ensure that all hostnames are unique within the domain they exist in or throughout the entire company if WINS is being used. You can easily make use of ADSI (discussed in Part III) to script a query for a list of computers from every one of your domains and then check the lists via a second script for duplicate names.

If you don't already require a consistent naming scheme for your clients and servers, now is the time to create one. Fully Qualified Domain Names must be unique across the entire forest: this is achieved by appending the domain component onto the computer name. That leaves you to worry about the prefix, meaning that computer names have to be unique only domain-wide.

To maintain backwards compatibility , names cannot be longer than 15 characters. This is because Active Directory still has some legacy support for NetBIOS names, and the hostname that you choose will be incorporated as the NetBIOS name on the client. NetBIOS names are limited to 15 characters.

You need to work out a forest-wide naming scheme, determining how you will name the clients within the 15-character limit. We can't help you much here; the choice of your naming scheme is up to you.

Remember that Windows 95 and Windows 98 devices do not require computer accounts in the domain. However, if you do deploy these clients and anticipate upgrading them later to Windows NT Workstation, Windows 2000 Professional, or Windows XP, the names of these clients will become an issue. It would be better to designate a unique name now to facilitate an easier upgrade later.

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8.5. Design of the Internal Domain Structure

Having designed the domain namespace, you can now concentrate on the internals of each domain. The design process itself is the same for each domain, but the order is mostly up to you. The first domain that you should design is the forest root domain. After that, iterate through the tree, designing subdomains within that first tree. Once the tree is finished, go on to the next tree and start at the root as before.

In a tree with three subdomains called Finance, Sales, and Marketing under the root, you could either design the entire tree below Finance, then the entire tree below Sales, and so on, or you could design the three tier-two domains first, then do all the subdomains immediately below these three, and so on.

When designing the internals of a domain, you need to consider both the hierarchical structure of Organizational Units and the users and groups that will sit in those Organizational Units. Let's look at each of those in turn.

> When we refer to a hierarchy, a tree, or the directory tree, we mean the hierarchical Organizational Unit structure within a domain. We are not referring to the hierarchy of domain trees in a forest.

8.5.1. Step 4: Design the Hierarchy of Organizational Units

Earlier, when we discussed how to design domains, we spoke of how to minimize the number of domains you have. The idea is to represent most of your requirements for a hierarchical set of administrative permissions using Organizational Units instead.

Organizational Units are the best way to structure your data because of their flexibility. They can be renamed and easily moved around within and between domains and placed at any point in the hierarchy without affecting their contents. These two facts make them very easy for administrators to manage.

There are four main reasons to structure your data in an effective hierarchy:

To represent your business model to ease management

> Partitioning your data into an Organizational Unit structure that you will instantly recognize makes managing it much more comfortable than with every user and computer in one Organizational Unit.

To delegate administration

Active Directory allows you to set up a hierarchical administration structure that wasn't possible with Windows NT. If you have three branch locations, and the main administrator wants to make one branch completely autonomous with its own administrator but wants to continue to maintain control over the other two branches, it's easy to set up. In a way, most of the limitations that you come up against when structuring Active Directory are limits that you set for yourself: political necessities, organizational models, and so on. Active Directory really won't care how you structure your data.

To replace Windows NT resource domains

If you have a previous Windows NT installation with a master or multimaster domain model, you can replace your resource domains with Organizational Units in a single domain. This allows you to retain all the benefits of having resource domains (i.e., resource administration by local administrators who do not have account administration rights) without forcing you to have multiple domains that you don't really want or need.

To apply policies to subsets of your users and computers

As policies can be applied to each individual Organizational Unit in the hierarchy, you can specify that different computers and users get different policies depending on where you place them in the tree. For example, let's say that you want to place an interactive touch-screen client in the lobby of your headquarters and allow people to interact with whatever applications you specify, such as company reports, maps of the building, and so on. Locking this down in Windows NT (so that the client could not compromise your network in any way) required quite a bit of time and may have required that the client be in a separate domain or even standalone. With Active Directory, if you lock down a certain Organizational Unit hierarchy using policies, you can guarantee that any computer and user accounts that you create or move to that part of the tree will be so severely restricted that hacking the network from the client will be far more difficult.

Let's take Leicester University as an example. The university is a large single site with mostly 10/100 MB links around campus and 2 MB links to some outlying areas a couple of miles away. The domain model was multimaster under Windows NT, but under Active Directory, it moved to a single domain and so it is much simpler than before. Administration is centrally managed, which means that delegation of administration was of little concern during design. We had a departmental organizational model for the Organizational Unit structure holding our accounts. We created a flat structure with more than a hundred Organizational Units directly off the root and almost no lower Organizational Units at all. Each Organizational Unit corresponded to one department, and it held all the users from that department. We also had an Organizational Unit hierarchy for the computer accounts separate from the department Organizational Units. This was due to our requirement for group policies; we'll come back and discuss this in more detail in Chapter 10.

When creating Organizational Units, you need to ask:

- How will the Organizational Units be used?
- Who are the administrators and what sets of administrator permissions should they have?
- What group policies will be applied?

The hierarchy should organize information in a manner pleasing to your administration and allowing you to delegate administration to various parts of the tree.

> You should not nest user or computer accounts in an Organizational Unit structure in such a way that the group policies that apply to the accounts create a slowdown during the logon process. Microsoft recommends nesting no more than 10 Organizational Units deep, but in fact, to a much greater extent, it's the application actions of group policies that you need to consider when designing your OU structure. This prevents slowdown on booting (policies applied to the computer account on boot up) or logon (policies applied to the user account on logon). If your users are in a 10-tier structure but only four policies were applied to the users, you shouldn't have a problem with logons. You can break this rule, but boot-up and/or logon will slow down as a result. By how much is a relative question, and the easiest answer is to test it on your network to get your own feel for the delay if this becomes a problem. We cover this item in much more depth in Chapter 10 when we discuss GPOs. All you need to be aware of here is that this can be a problem.

8.5.1.1. Recreating the business model

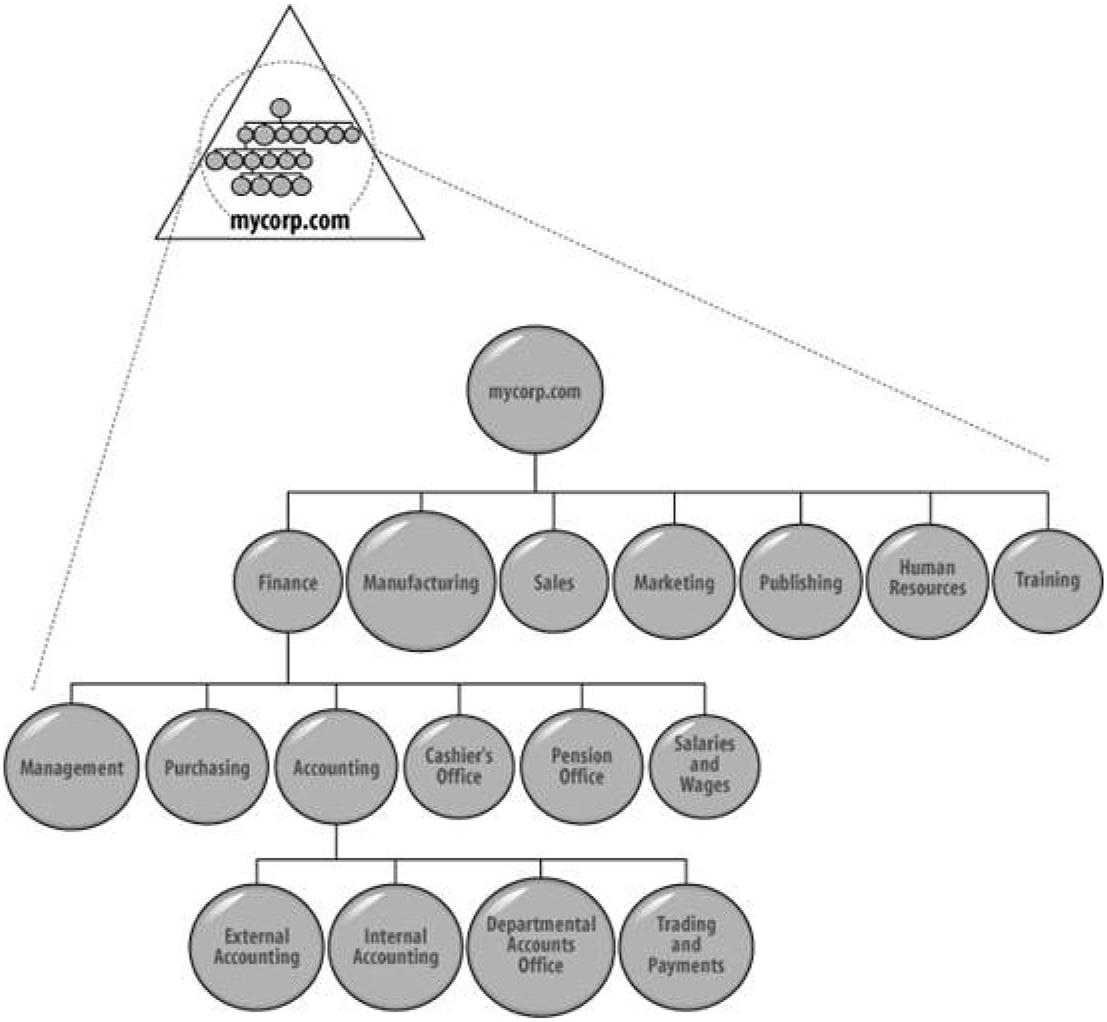
The easiest way to start a design is to consider the business model that you sat down with when creating these designs. You now need to recreate that structure in Active Directory using Organizational Units as the building blocks. Create a complete Organizational Unit structure that exactly mirrors your business model as represented by that domain. In other words, if the domain you are designing is the Finance domain, implement the finance organizational structure within the Finance domain. You don't create the entire organization's business model within each Organizational Unit; you create only the part of the model that would actually apply to that Organizational Unit. Draw this structure out on a piece of paper. Figure 8-3 shows the Organizational Unit structure of *mycorp.com*'s domain. We've expanded only the Finance Organizational Unit here for the example.

Once you have drawn an Organizational Unit structure as a template for your Active Directory hierarchy within the domain, you can begin to tailor it to your specific requirements. The easiest way to tailor the initial Organizational Unit design is to consider the hierarchy that you wish to create for your delegation of administration.

8.5.1.2. Delegating full administration

First, identify any areas of your hierarchy where you need to grant administrators autonomous access over their branch of the tree. These Organizational Units need to have at least two administrators who will look after that Organizational Unit. These administrators will look after the structure below that Organizational Unit, creating whatever Organizational Units, users, groups, shares, and so on that they desire. They will not, however, have administrator access to any other part of the tree.

Figure 8-3. The Mycorp domain's internal Organizational Unit structure



> You need two administrator accounts in case one of the accounts ever gets locked. That way, you can use the second account to unlock the first. Having the second account be the domain administrator is perfectly fine.

You need to note two pieces of information about each of the Organizational Units that you identify:

- Who will be the administrators?
- Which branch of the tree will they administer?

> You must ensure that delegated users take responsibility and can be held accountable. This cannot be stressed too strongly. It is possible for an administrator of a low-level Organizational Unit to corrupt a tree and affect other people. The best way to highlight this is with user accounts. Remember, user accounts are visible forest-wide and so in some sense must be unique forest-wide. In much the same way as with computers, the domain component normally is used here in an attribute of the user object called the `userPrincipalName` (UPN). While the normal username only has to be unique domain-wide, the UPN attribute ensures forest-wide uniqueness. Let's concentrate on the domain-wide part.
>
> If a low-level Organizational Unit administrator creates a user with a username that someone else wants to create in another Organizational Unit, that's tough. Only one account with a given username can exist. We deal with creating a naming scheme for administrators to follow later in step 5.
>
> If you do not have a company policy in this area, you need to create one and document it.

8.5.1.3. Delegating other rights

Having noted the two pieces of information for all Organizational Units that need full administrative access, you next need to identify those Organizational Units that require some users to have a more restricted set of permissions. You may want to set up account administrators that have the ability to create and delete user accounts, as well as setting passwords and account details. You may want accounts that can create and publish printers. We're interested in rights only in general terms at the moment, so just note the following:

- What the access rights are
- Which branch of the tree the access rights will be applied to
- Which users or groups (in general terms) will have these access rights

It is possible to set access rights of any sort down to the individual property level on a specific object if you require. That means you can allow a user named Richard Lang to change the password or telephone number of a user named Vicky Launders (and only that user) if you wish. Obviously the more minute the access, the more complex things can get, especially as permissions are inherited down a tree by default. To make things easier, Microsoft provides a simple Delegation Of Control wizard that allows you to set these access rights in a fairly easy manner. All this information on permissions to Active Directory is covered in much greater depth in Chapter 11. However, all we're concerned with at this stage in the design is delegation of control at the Organizational Unit level. From experience, we can tell you that assigning access rights at the Organizational Unit level is actually a lot simpler to manage than tracking permissions to individual objects and properties.

8.5.2. Step 5: Design the Users and Groups

Before starting this section, we must make clear the distinction between groups and Organizational Units. Organizational Units are containers for objects that allow the objects to be represented in a hierarchical structure within a domain. Placing objects in such a hierarchy allows delegation of administration to those Organizational Units on a selective basis. We've seen all this already. Groups, on the other hand, have only users or computers as members and can be used in assigning permissions or rights to the members collectively. Let's say that we have 50 users contained in an Organizational Unit called FinanceOU, and the users are also members of a group called FinanceGrp. When we want to grant these 50 users read permissions to a share or restricted access to certain parts of a domain's hierarchy, we assign the permissions to the FinanceGrp. The fact that they are in the Organizational Unit makes no difference when you wish to assign permissions to objects containec inside the Organizational Unit. However, if we wish to delegate someone to have permission to manage those 50 accounts, we place the administrative delegation onto the Organizational Unit. Here we'll be talking about how to effectively design user accounts and the groups those users belong to.

8.5.2.1. Naming and placing users

When you are designing users, the only thing you really have to worry about is the username or user identifier that the client logs on with. Each username (the `sAMAccountName` property of a user object) must be unique throughout each domain. Arguably, if you have decided to delegate administration within your organization, you need to create a naming scheme to which each administrator will adhere so that unique usernames are generated for all users throughout your forest. That way, if you ever collapse the existing domains, you never need to rename the users if there are any conflicts. Naming groups is important, too.

Another name that you should give to all Active Directory users is known as the user principal name (the `userPrincipalName` property of the user object). This property looks like an RFC 822 email address; i.e., username@here.there.somewhere.com. In fact, this property is not the email address but is a unique identifier for the user in the entire forest. It has to be unique as it uniquely identifies a user across an entire forest. So while the users AlistairGLN in *mycorp.com* and AlistairGLN in *finance.mycorp.com* are perfectly valid, their UPNs must be different. The normal way to create a UPN is simply to append an @ symbol and the domain onto the end of the username. This ensures uniqueness because the username was unique in the domain, and appending the domain forces a unique forest-wide UPN. This makes AlistairGLN@mycorp.com and AlistairGLN@finance.mycorp.com the UPNs for the two users in the example.

However, while it is conventional to construct the UPNs in this way, you can in fact make the UPN of a user anything you wish as long as it follows the format specified in RFC822. We could, for example, append the @mycorp.com to all our users, eliminating the need to rely on domains at all. If we do that though, we should make sure that our usernames (`sAMAccountName`) are unique not only domain-wide but also forest-wide. In the previous example, we can't have two users with the username AlistairGLN. For such a scheme to work, a central database or allocating authority needs to be set up to uniquely generate and allocate names. Leicester University has maintained a separate database from the early 1980s for this purpose, as have many other universities and companies. If this database or authority can generate unique usernames via a reliable algorithm, you can make use of a much simpler UPN.

Just because we chose @mycorp.com as the suffix does not mean we are limited to a forest or domain name. We could just as easily have chosen @moosebanana.com, which has no relation to the domains or the forest. The UPN simply has to be unique for every user in the forest.

Just as the suffix doesn't have to match the forest or domain name, the username portion doesn't have to match the sAMAccountName. In Windows Server 2003 AD, you can create a user without specifying a sAMAccountName. This will auto-generate a sAMAccountName that looks something like $KJK000-H4GJL6AQOV1I, which really isn't a friendly logon name. However, you could then set the UPN to be joe@mycorp.com and that could be used to logon.

UPNs are very important. Imagine a user sitting down at a client anywhere in a forest and being presented with the logon dialog box. Here he can type in his username (sAMAccountName), password, and domain and be authenticated to the forest. However, it is perfectly valid to authenticate with the UPN. If the user, presented with the same logon dialog box, instead types a UPN in the first field, the domain box becomes grayed out and inaccessible. In other words, a UPN and a password are all that is needed to authenticate to Active Directory. This makes sense since the UPN is unique forest-wide; apart from a password, nothing else should be needed. You now should be able to see that even with a very large and complex set of domains in a forest, you can use a simplified UPN form that does not contain a domain component and then simply instruct users to log on with a UPN and a password. This means that users never need to care about what domain they are in.

Your choice of where you place the user accounts in each domain's hierarchy is really affected only by who is to administer the accounts and what GPOs will be applied on the Organizational Unit the account is in. Other than that, it makes little difference.

8.5.2.2. Naming and placing groups

Groups need unique names, too, so a naming scheme for groups should also be laid out in the design. Where you put groups is less important. In effect, groups can go almost anywhere in the hierarchy. The GPOs that determine your placement of users, for example, do not apply to groups. However, as the groups available to you will differ based on the mode or functional level of your forest, the only way you can do a proper design is to know roughly how long you intend to stay in mixed or interim mode before upgrading. If you have no previous Windows NT infrastructure and do not require any applications that run on NT, you can go native and Windows 2003 forest functional level immediately.

If you are planning to wait a while on mixed/interim mode before upgrading for whatever reason, you need to do two sets of group designs: what the groups will be prior to the upgrade and what you will convert them to after the upgrade. Of course, the two designs may be the same.

Going native in one domain does not have to affect the mode of another domain. There is nothing wrong with *apac.ad.mycorp.com* going native while *ad.mycorp.com* is mixed mode or vice versa. Remember that mixed mode and native mode affect only the use of Windows NT BDCs in a domain, not the use of Windows NT clients or member servers.

8.5.2.3. Creating proper security group designs

If your organization is based on a single site (in the sense of being a "fast interconnected set of subnets," which is detailed in the next chapter), you can use universal security groups entirely. You don't have to, but for the purposes of design, it will make very little difference in the long run which you choose.

Based on the tables in Chapter 2, for large complex organizations with many different sets of permissions to many individual resources, we would suggest using two sets of security groups. One set of security groups has permissions to local resources on a particular server, and the other set of security groups contains the users. You then can add one set of security groups to another to control access. In this manner, you are maintaining a fine-grained control over the access permissions for groups while not having to add users many times over to multiple groups.

In mixed mode, we would use Domain Local Security groups for access to local resources and add users to Domain Global Security groups or even Universal Distribution groups. In native mode, we would do one of three things:

- Continue as before, but now allow Universal Security groups to be members of Domain Local Security groups.
- Convert the Domain Local Security groups to Universal Security groups with the same membership as before, because this is now allowed under native mode.
- Convert the Domain Local Security groups and Domain Global Security groups to Universal Security groups, understanding the impact this will have on the GC and the potential for token explosion when converting Global groups.

> Group use and "what scope is best for what configuration" are topics that spawn endless debate in newsgroups and any time administrators get together to talk about securing resources. In the end, it comes down to what you want and how you want to secure your infrastructure, whether this is through the use of the old NT mechanism called UGLy (Users into Global, Global into Local, Local get permissions) or simply using all groups from a single scope and placing users directly in them. The point is that Microsoft has offered up multiple paths to do the same thing; you are free to choose the path that most appeals to you.

8.5.3. Step 6: Design the Global Catalog

The GC design is dependent partially on the namespace and partially on the replication design. On the namespace side, designing the GC's contents is important to properly respond to searches, and on the replication side, designing the GC to function using a reasonable amount of your bandwidth is important. We'll consider only half the picture in this chapter and do a draft design, coming back and revising the draft design in the next chapter. You have the choice of adding multiple GC servers or of not even hosting the GC at a site at all if you wish.

With Windows Server 2003 Active Directory, the dependencies on the GC are somewhat lessened compared to Windows 2000. With Windows 2000 Active Directory, a GC had to be available for clients to log in.[*] This was necessary because a user's universal group memberships needed to be enumerated to ensure that their token was complete and accurate. Universal group membership is stored in the GC, and since universal group objects can reside anywhere in a forest, the only way for a DC to determine what universal groups a user is a member of is by querying the GC. In Windows Server 2003, you can enable universal group caching and effectively eliminate the need for a GC to be present during login for Universal Group enumeration. However, if a user wants to use their `userPrincipalName` to logon, they will still need to be able to get to a GC.

[*] This requirement can be disabled by implementing a special registry setting on DCs called IgnoreGCFailures. Use it only if you do not use Universal Security Groups.

> Universal group caching can be enabled on a per-site basis via the Active Directory Sites and Services MMC snap-in. The settings to enable universal group caching are available by editing the NTDS Site Settings object of the site you want to enable it for.

8.5.3.1. Including and excluding attributes

Each attribute in the Active Directory schema has a modifiable attribute that is used to indicate whether the attribute is to be contained in the GC . Most objects store at least one property in the GC, even if it is only their common name (`cn`) attribute. Examples of properties that are held in the GC include the `sAMAccountName` for all user objects (so that you can quickly map a userid to a user object) and the access permissions for each object (so that details on objects are not given out in responses if the requester does not have the relevant permissions).

> You can access the GC and look at its contents via an Active Directory viewer, such as ADSI Edit, by using the GC://Programmatic Identifier (ProgID).

Generally, if an attribute that you specifically do not want included is being placed in the GC, you can exclude it. Some attributes are protected from being removed from the Global Catalog, these attributes are needed by the OS for its own purposes and are marked on the attribute's schema definition by bit 1 (0x00000002) on the `systemFlags` attribute. If the attribute is unprotected, you can remove it from the GC either by un-checking the box in the Schema Manager MMC or programmatically via ADSI by setting `isMemberOfPartialAttributeSet` equal to FALSE. If you want an attribute included in the GC, the process is the reverse.

Obviously, the more data that you specify to be stored in the GC, the larger the GC will get. If the attribute that you include is only populated on a handful of objects, the impact will be negligible. Conversely, if you specify an attribute populated on tens of thousands of instances, you will impact the size of the GC.

> You may notice that the member attribute of group is marked in the schema as being part of the Partial Attribute Set (PAS). This is a sneaky little implementation detail that can bite administrators. Since this attribute is marked, you would think that all groups would have their member attributes replicated into all global catalogs. Unfortunately, this is *not* the case. In actuality, due to some internal hard coding in the AD binaries, only Universal Group membership will replicate to all GCs. However, any groups in Domain A will actually have their members show up in a GC query of a Domain A Global Catalog.
>
> This also has an interesting side-effect on the back link attribute of member, which is called memberOf. If you query a user on GCs from different domains and return the memberOf attribute, you could get different results depending on the groups the user is in, in each domain.

This doesn't mean that you should not change anything. You just have to be aware of the potential impact. The time taken for searches is not immediately easy to measure. Every administrator knows that network bandwidth utilization is never the same twice and fluctuates every second with different numbers of users doing different tasks. This will affect your query times.

What you need to consider in this stage of namespace design is which attributes you want to include and which default attributes you want to exclude. This decision is affected by the fact that searches for properties that are contained in the GC are conducted forest-wide, while searches for properties not contained in the GC are conducted only domain-wide.

> Only members of the schema administrators group (Schema Admins) in the forest root domain can modify whether schema attributes are included in or excluded from the GC. This group can have members from any domain, but the group itself is contained in the forest root domain.

Finally, a word of caution: you must be careful when excluding attributes from the PAS. It is fine to exclude attributes that seem to make little difference to the overall picture, but restricting attributes that applications may be depending on can be problematic. Exchange is a great example because it is an extremely popular application that makes extensive use of the GC. If you use Exchange, be very careful when removing attributes from the PAS.

> A script to write out a list of those attributes of a class that are included in the GC alongside a list of those that are excluded is contained in Chapter 24.

8.5.4. Step 7: Design the Application Partition Structure

Another namespace design issue to consider is the application partition structure for your forest. As described in Chapter 3, application partitions, which are new to Windows Server 2003 Active

Directory, are user-defined partitions that have a customized replication scope. Application partitions can be especially helpful in branch office deployment scenarios where you have to deploy a lot of domain controllers. Often you'll have applications that want to store data in Active Directory, but that data is not pertinent or used frequently enough to warrant replicating to all domain controllers, especially in the branch offices. With application partitions, you can configure a new partition to hold application data that replicates data only among your hub domain controllers. The other great thing about application partitions is that you are not restricted by domain boundaries. If you want to replicate data globally and have domain controllers geographically located, you can create an application partition that replicates data between your geographically dispersed domain controllers regardless of which domain they reside in.

Application partitions have an impact on your namespace design because they are named very much like domains. For example, say you wanted to create an application partition in the *mycorp.com* forest; you could name it `dc=apps,dc=mycorp,dc=com`. In fact, application partitions have the same implications on the namespace and to DNS as do regular domains. So in the `dc=apps,dc=mycorp,dc=com` example, the *apps.mycorp.com* DNS domain will be populated with the standard SRV records, just like a domain.

You can also nest application partitions. For example, if you had a specific application you wanted to create a partition for, you could host it directly off the apps partition we just mentioned. We could name it `dc=MyApp,dc=apps,dc=mycorp,dc=com`.

> Don't forget you also have the option to use Active Directory Application Mode (ADAM) instead of Application Partitions in Active Directory. See Chapter 18 for more details on ADAM.

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8.6. Other Design Considerations

In many cases, you may need to revise your namespace designs a number of times. Certainly GPOs will make a difference as to how you structure your users and computer objects, so we do not assume that one pass through a design process will be enough.

Once you have a basic design, there is nothing stopping you from putting that design to one side and working on identifying a perfect design for your Active Directory network, one that you would like to implement in your organization, ignoring all Active Directory-imposed design constraints. You then can work out how difficult it will be to move to that perfect design from the practical one that you worked out using the preceding steps. You can look at the feasibility of the move from one to the other and then rationalize and adjust your final design to take into account the factors you have listed. You can then use this as an iteration tool so that your final design is much closer to the perfection you are aiming for.

Apart from GPOs, which we cover in Chapters 7 and 10, there are other aspects of Active Directory design that we have not and will not be covering. For example, you are quite likely to want printers advertised in Active Directory so that they can be accessed easily using a simple search of Active Directory (which the Add Printer wizard now uses as the default option). You may want shares advertised in Active Directory, so that users can easily locate data partitions on a site nearest to them. The Distributed File System (DFS) that allows you to organize disjointed and distributed shares into a single contiguous hierarchy is a fine example of this. When you reference a share held by the DFS, the DFS uses Active Directory to automatically redirect your request to the closest share replica. There is also the matter of designing your own objects and attributes that you want to include. However, there are two points that you should consider:

- As a general rule, Active Directory should hold only static or relatively static data. At the very least, the lifetime of the data has to be greater than the time to replicate to all DCs throughout the organization. When considering which objects to add, don't consider adding objects with very short life spans. Dynamic datathat is, data with a relatively short lifespanis more suited for storage in an application partition or an ADAM instance.
- Any object that you include will have attributes that are held in the GC. For every type of object that you seek to store in Active Directory, check the schema class entry for that object to find out what attributes will be stored in the GC. Consider whether you need to add or remove items from that list by referring back to the design principles.

PREV NEXT

PREV NEXT

8.7. Design Examples

Having covered the design of the namespace, some real-world example designs are in order. We have created three fictitious companies that will serve as good models for demonstrations of the design process. We will also use these three companies in the following chapters. The companies themselves are not fully detailed here, although there is enough information to enable you to make a reasonable attempt at a namespace design. In the chapters that follow, we will expand the relevant information on each company as required for that part of the design.

We used a number of criteria to create these companies:

- The companies were set up to represent various organizations and structures.
- While each corporation has a large number of users and machines, the design principles will scale down to smaller organizations well.
- In these example corporations, we are not interested in how many servers each company has or where those servers are. These facts come into play in the next chapter on sites. We are interested in users, groups, machines, domains, and the business and administration models that are used.

8.7.1. TwoSiteCorp

TwoSiteCorp is an organization that employs 50,000 people using 50,000 machines. The organization spans two sites connected with a 128 KB dedicated link. The London site has 40,000 clients and 40,000 employees, while the new expansion at the Leicester site has 10,000 clients and 10,000 employees. TwoSiteCorp's business model is based on a structure in which users are members of one of three divisions: U.K. Private Sector, U.K. Public Sector, and Foreign. No division is based entirely at one site. Various other minor divisions exist beneath these as required for the management structure. Administration is handled centrally from the major London site by a team of dedicated systems administrators.

8.7.1.1. Step 1: Set the number of domains

While TwoSiteCorp's 128 KB link between its two physical locations is slow for site purposes, there is no need to split the two sites into two domains. No particular part of the organization has a unique policy requirement, because the administrators decided that they will implement one set of policies for all users. Finally, the sites already have two Windows NT domains installed. However, management has no desire to maintain either, so both will be rationalized into one domain. Thus, TwoSiteCorp will end up with one domain.

8.7.1.2. Step 2: Design and name the tree structure

TwoSiteCorp's single domain will be the forest root domain. The designers decide to name the domain *twositecorp.com* after their DNS domain name. With only one domain, they do not have to worry about any other trees or forests or the domain hierarchy.

8.7.1.3. Step 3: Design the workstation and server-naming scheme

TwoSiteCorp decides that each machine name will be made up of four strings concatenated together. The first string is three characters representing the location of the machine (e.g., LEI or LON). The next string holds two or three letters indicating the type of machine (e.g., DC, SRV, or WKS). Finally, the last string is a six-digit numeric string that starts with 000001 and continues to 999999. The following are example machine names:

- LEIDC000001
- LEIDC000002
- LONWKS000183

This appears to be such a small step, but it can spawn huge wars and cause design meetings to stretch out over long periods of time. Here are a couple of recommendations for things to keep in mind:

- Consider using pieces of information that will not change or will not change often. If you are spinning up, shutting down, or renaming sites all of the time, using a site in the name may not be wise, as the machine names would have to be changed each time the site is renamed or servers are moved. That being said, some really good namespace designs have been based on using the site code for the first part of the machine name.
- Be careful of allowing resource administrators to just choose whatever names they want. This can turn out badly because words not generally associated with professional directories may end up getting used. In addition, you can end up with the same server name in multiple domains because different administrators like the same name. In a very large organization, for example, it would not be surprising to find multiple servers named WEB or WWW in various NT domains that needed to be collapsed into a single Active Directory domain.
- Try to use numbers as much as possible, especially in global organizations. It is much easier to understand numbers spoken in various languages over the phone versus letters.
- *Be consistent!* A bunch of random names pulled out of the blue at the point in time you build the server confuses support techs. If you use a consistent naming system, it will be familiar to the techs and they can put brain energy into other issues. It is probably more comforting to new

support techs to see BBQ00001, FNT00001, and WHQ00001 as server names versus Athena, Vern, Vader, and Nikki, especially if all servers starting with FNT are in some special grouping, such as a site, function, or realm of administrative control.

8.7.1.4. Step 4: Design the hierarchy of Organizational Units

TwoSiteCorp needs three major Organizational Units (U.K. Private Sector, U.K. Public Sector, and Foreign) based on its business model of divisions. The second and succeeding tiers of Organizational Units can then be created according to the lower-level management structure if required. There is no necessity to do so in this scenario, although it would make the structure easier to manage visually. In fact, this domain could be completely flat with all users and machines in one Organizational Unit, but then you aren't gaining much from Active Directory's ability to structure the data in a useful manner for administration. Speaking of administration, since it is handled centrally, there is no need to delegate administration for the three top-tier Organizational Units to any specific group of administrators, although there is room for expansion should that become necessary. Nor does TwoSiteCorp need to delegate any other permissions to the Organizational Unit structure. Now TwoSiteCorp has a fairly simple hierarchy that perfectly maps their domain.

8.7.1.5. Step 5: Design the users and groups

TwoSiteCorp has two Windows NT domains at present using a variety of global groups and local groups. During the migration, the company will have a mixed-mode domain. However, their ultimate aim is to move to native mode very quickly and reap the added benefits of universal groups. The design therefore needs to cover what universal groups the company would like for its resources. The existing global and local groups can be moved to Active Directory during migration, allowing the current setup to work with the new system. Once the switchover to native mode goes ahead, either the groups can be converted to universal groups and rationalized to fit into the new design, or they can be left as they are and new universal groups created according to the design to take the place of the old groups.

8.7.1.6. Step 6: Design the Global Catalog

TwoSite Corp has no specific GC requirements and therefore leaves the system to work out its own defaults. Since there is only one domain, all DCs are configured to be GCs.

8.7.1.7. Step 7: Design the application partition structure

Because TwoSiteCorp has only two sites to replicate, they do not need to create any application partitions.

8.7.1.8. Recap

This is a very simple system that maintains a good level of administration based on the structure of the organization while managing to maintain control over its expansion in the years to come.

8.7.2. RetailCorp

RetailCorp is a global, multibillion-dollar retail organization that has more than 600 stores spread throughout the world under four different store names. There are around 60,000 staff members in the company, with about 25,000 in the central office based in Leicester in the United Kingdom. Each store is connected to the central HQ via 64 KB leased lines. Each store has a number of Windows NT point-of-sale workstations running database software and one or more large database servers in the back room. The database servers replicate the day's transactions down the links each evening to the central HQ.

RetailCorp is very centralized with almost no administrators at the stores themselves. The only really special requirement that the company has is that it would like the administrators to be able to easily hide the operating environment from staff on the tills at each branch. Changes to tills should be possible on an individual branch or global level.

8.7.2.1. Step 1: Identify the number of domains

RetailCorp has no need to isolate replication or do any in-place upgrades. The part about policies is a little tricky: do they need new domains for every branch in case policy changes need to be applied to one branch specifically? The answer is no. The administrators need to be able to apply policies to certain branches or all branches, but these policies have to do with the user interface and thus fall into the area of GPOs rather than separate domains. That effectively leaves them with one domain.

8.7.2.2. Step 2: Design and name the tree structure

RetailCorp, having only one domain, makes that the forest root domain. The namespace has the *retailcorp.com* global name that is already in use.

8.7.2.3. Step 3: Design the workstation and server-naming scheme

RetailCorp uses a central database to register machines, which automatically produces a 15-character name based on a machine's location and purpose (i.e., client, database server, file and print server). Every time a machine is moved or its function changes, the name is updated in the central database, and the machine is renamed.

8.7.2.4. Step 4: Design the hierarchy of Organizational Units

It is decided to make each store an Organizational Unit, so that central administrators can delegate control over individual stores and their objects as required. However, to make things even easier to manage and delegate on a countrywide or regional basis, RetailCorp creates a series of country Organizational Units under the base. Each of these country Organizational Units contains either the shop Organizational Units directly (for countries with only a handful of stores) or a series of regional

Organizational Units that themselves contain the store OUs.

8.7.2.5. Step 5: Design the users and groups

RetailCorp uses a central database to generate its own unique usernames and group names as needed. It has done this for many years, and the database produces a changes file on an hourly basis. A script picks up the changes file and applies it to Active Directory in the same manner that it does with all other systems.

8.7.2.6. Step 6: Design the Global Catalog

RetailCorp has previously had problems with users printing to printers at the wrong site. To make sure that printer details are not replicated past boundaries, all printer attributes are removed from the GC. The rest of the defaults are accepted as standard, and the company intends to keep an eye on the situation to make sure that there are no problems with this in the future.

8.7.2.7. Step 7: Design the application partition structure

Because RetailCorp is using a centralized deployment model and has no special replication requirements, there is no need to create any application partitions.

8.7.2.8. Recap

This example shows how a geographically based company can do its own design. It's not particularly difficult, although this design does not take into account the slow links between the stores and the HQ. That is left until the next chapter, when we revisit RetailCorp from a physical-layer perspective.

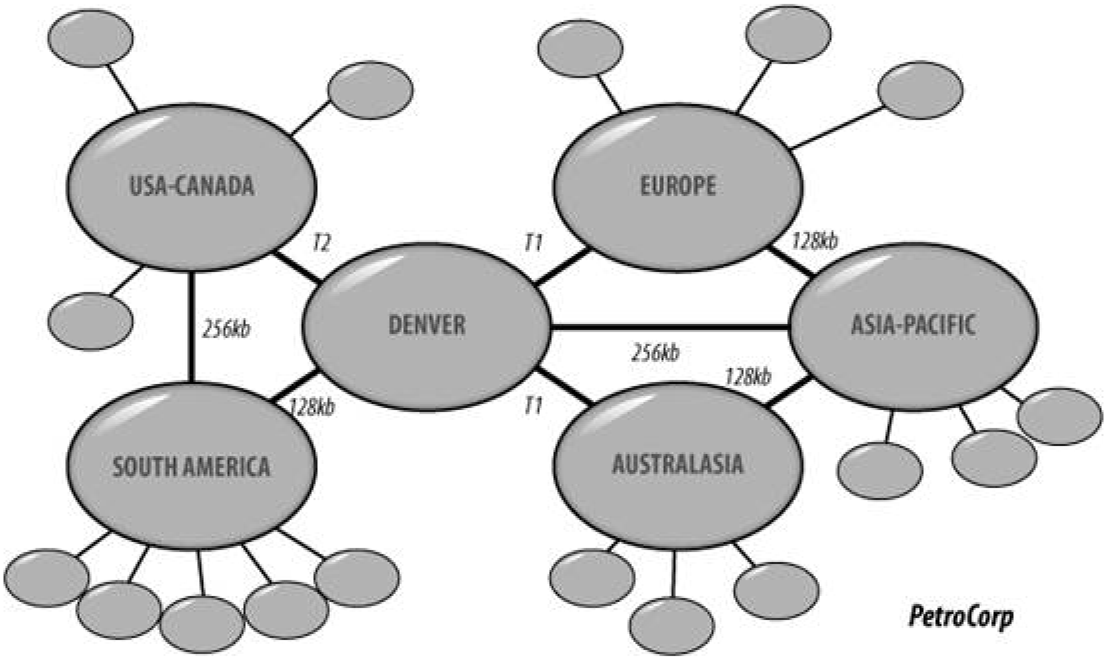
8.7.3. PetroCorp

PetroCorp (refer back to Figure 8-1) is a global multibillion dollar petrochemical organization that has more than 100,000 people and machines at about 100 sites around the world. The business has its global headquarters in Denver. There are five major sites that link to the HQ and to which the smaller 94 smaller branch offices link. The major sites or hubs represent Asia-Pacific, Australasia, USA-Canada, South America, and Europe. The small sites link to the five hubs via 64 KB links; the hubs themselves connect to the HQ via T2, T1, 256 KB, and 128 KB links. Some of the hubs are also interconnected. Management structure is geographic, with each geographical unit running itself as an independent business as part of the global whole. The top level of the management structure is at HQ which sits above the five hubs. Even though Denver could be considered within the USA-Canada area, the organization is not structured that way. In fact, Denver oversees the hubs in terms of selecting the administrators and how the network is to be structured. Corporate policy dictates that branches that have more than 500 people have their own administrator, backup support, and helpdesk staff locally. Branches with fewer than 500 people have to be managed by the administrators of the hub to which they connect (see Figure 8-4).

Other considerations include the following:

- Due to special company policies, public-key encryption and different language settings are used in each of the hubs (and their branches). So Europe and its branches have different settings from those in Australasia and its branches.
- Japan has a database system running on Windows NT 4.0 that must stay in its own domain.
- PetroCorp recently acquired OtherCorp, a Canadian company that has a strong brand name that PetroCorp would like to maintain. OtherCorp is solely based in a new branch in Canada.
- The links between the eight South American branches and the hub are very unreliable.

Figure 8-4. PetroCorp's wide area network



- The branch in France needs to maintain a number of Windows NT BDCs and member servers running legacy applications and services that will not run under Windows 2000. This requirement may exist for a few years.
- The Asia-Pacific 128 KB link to Europe is severely congested at all times.
- Due to various laws and internal information policies, PetroCorp cannot publish information in their United States directory in countries that are subject to American export restrictions (currently including but not necessarily limited to Cuba, the Federal Republic of Yugoslavia (Serbia and Montenegro), Iran, Iraq, Libya, North Korea, and Syria).

8.7.3.1. Step 1: Set the number of domains

There is a wrong way and a right way to look at PetroCorp:

The wrong way

> PetroCorp starts off with five domains representing the hubs because each requires different public-key security settings.[*] As the branch offices are part of the domain at each hub, the hub's settings will apply to the branch offices as well because the settings are domain-wide. So extra domains are not needed, although they are needed for each branch office for Japan and OtherCorp. As France cannot upgrade, whatever domain France is in must remain in mixed mode. Management could make the Europe domain mixed mode, but would like it to be native mode to make use of the features. So a special domain for France makes a total of eight domains.

[*] That they also require different language settings is a red herring: Windows 2000 and Windows Server 2003 can support different language settings on a per-client basis rather than a per-domain basis like Windows NT.

The right way

> PetroCorp starts off with one domain: the one representing Denver, the HQ of PetroCorp. The organization then needs to create a separate domain for each of the five hubs for the public-key security settings. As the branch offices are part of the domain at each hub, the hub's settings will apply to the branch offices as well, due to the settings being domain-wide. Now an extra domain each is needed for Japan and OtherCorp. France cannot upgrade, so whatever domain France is in must remain in mixed mode. Management could make the Europe domain mixed mode, but would like it to be native mode so that they can make use of the Active Directory features. A special domain for France makes a total of nine domains.

Both solutions can seem valid, although you may feel that the first is not as valid as the second. The first solution would result in problems during later parts of the design process. That there are different sites with different link speeds is not really an issue here. The issue revolves around the major HQ that is separate from but which oversees the five hubs in an administrative capacity. In the wrong design, one of these domains must become the forest root domain with the relevant authority that confers. USA-Canada is the natural choice. Then HQ administrators would effectively be running the USA-Canada domain, which conflicts with the initial company notes that each hub and the HQ has its own administrators. Consequently, the second design is better.

> While each domain may have its own administrators, all of them would need to be fully trusted as if they were Enterprise Admins. This reflects the fact that *the domain is not a security boundary* the forest is. If the trust in the administrators does not exist across the domains, this design must suddenly become a multiforest design.

8.7.3.2. Step 2: Design and name the tree structure

PetroCorp chooses the Denver domain as the forest root domain. The forest root domain is to be called *petrocorp.com*.

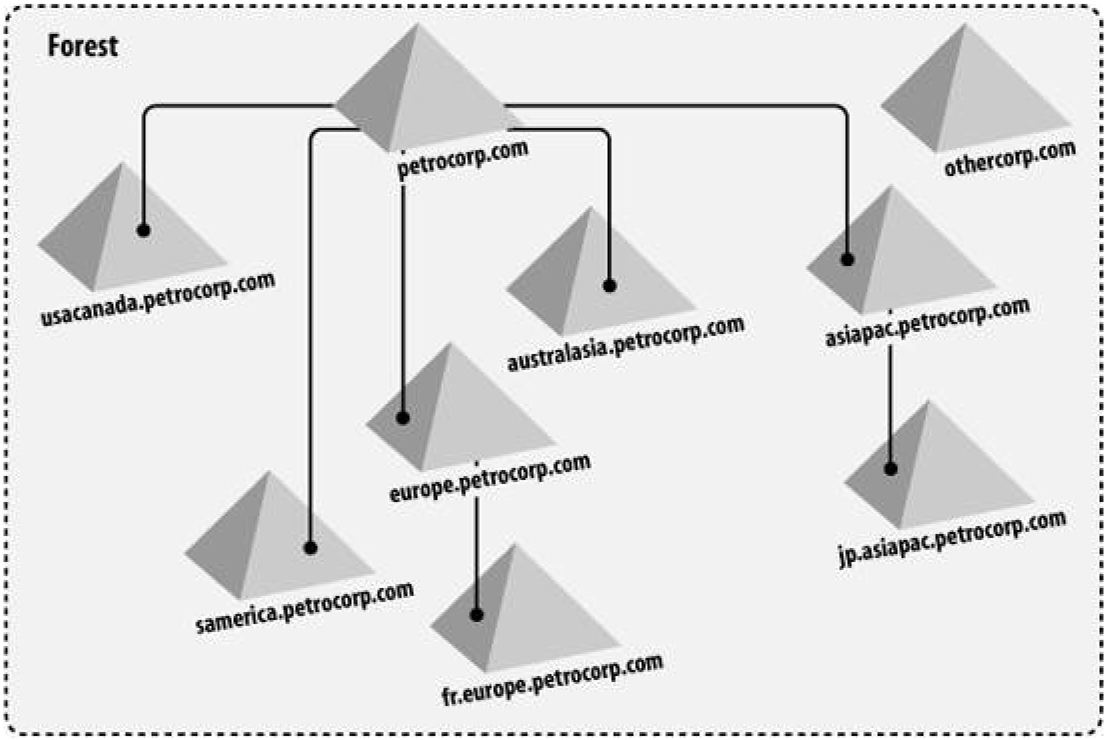
When it comes to choosing a naming scheme for the domains corresponding to the hubs, the administrators choose a simple one. The domains will be called:

- *europe.petrocorp.com*
- *usacanada.petrocorp.com*
- *samerica.petrocorp.com*
- *asiapac.petrocorp.com*
- *australasia.petrocorp.com*

The domain representing OtherCorp will be called *othercorp.com*. They could have merged OtherCorp into PetroCorp's structure and just used multiple DNS names for the web servers and so on. However, the company may be sold for a profit in the future, and management wants to keep it politically separate.

There are obviously now two distinct trees. We'll put them in the same forest so that resources can be shared. The subdomain hierarchy is fairly easy to follow from now on. The domains for France and Japan will follow ISO 3166 country codes and be called *fr.europe.petrocorp.com* and *jp.asiapac.petrocorp.com*. Figure 8-5 shows the forest view of the domain trees.

Figure 8-5. PetroCorp's forest domain tree hierarchies



8.7.3.3. Step 3: Design the workstation and server-naming scheme

PetroCorp has decided that it specifically does not want to use any parts of its naming scheme to duplicate data that can be obtained elsewhere. For example, PetroCorp does not want to use country, city, or building information, as this can be gathered from the exact Active Directory site that the client is in. For example, there's no point in including the data UK, London, Building 3 if the site that the computer resides in is called UK-London-Building3. They also do not want to include indications of the operating system or version, as they will be using Microsoft Systems Management Server (SMS) to inventory each device; the required information can be retrieved directly from SMS's own database. They do, however, want to include the department that the client is installed in.

They also decide to use this name as part of the worldwide asset-registering system under development, so that they can institute a worldwide rolling update program of older devices. Thus, they need to include the year the client was purchased and when the client was introduced to the network.

To do this, they decide to borrow a trick from the FSMO RID Master's book and use a central pool of values at their HQ for the naming of machines. Names of machines will start with a department code of seven or fewer letters, followed by a two-digit year code and a number consisting of six or fewer digits, allocated from the central pool.

When a client is to be installed, the user doing the installation goes to a web page on PetroCorp's intranet and provides his ID and the department and two-digit year for the machine. The web page (which is connected to a database) allocates that user the next central value in the list. In this manner, the central database maintains an exact note of which department a machine is in, what year it was purchased, when it was installed, what its full name is to be, and who installed it.

8.7.3.4. Step 4: Design the hierarchy of Organizational Units

As far as the internal structure of the hub domains goes, each domain is to be broken down into a number of Organizational Units based on its branches. Every branch gets an Organizational Unit created, which will contain its servers, users, and groups.

We don't have enough information to specify the internal structure of the HQ, the Japanese domain, and the OtherCorp domain. However, that doesn't matter, since we do know that local administrators at all three will manage their respective domains. That means we do not have to worry about delegating administration of internal parts of those domains to particular administrators. So effectively we have carte blanche to do what we wish with those designs.

The company notes state that each branch with more than 500 people locally employs its own administrator, backup support, and helpdesk staff. Assuming we have identified the standard set of permissions that each of the three sets of staff require at each branch, we need to delegate administrative responsibility for the three functions to the relevant groups of staff in those branches. Branch staff members now have administrative responsibility for their branch Organizational Unit only, and branches without any staff will be centrally managed.

> Before you start building all of this in Active Directory Users and Computers, pull the *Active Directory Cookbook* by Robbie Allen (O'Reilly) off the bookshelf and put together a script to build the OU structures, three administrative groups, and all permissions. Since the structures will all be very similar, the best mechanism to maintain consistency is to script the process. Administrators don't want to be data entry clerks, so building a structure like this is perfect for a script.

8.7.3.5. Step 5: Design the users and groups

In addition to whatever other groups the organization's designers decide it needs, three groups corresponding to the three delegated jobs need to be created in every branch that is to have autonomous control. These three groups will be used when delegating responsibility.

Any domains intending to stay on Windows NT (i.e., France) can run in mixed mode, with other domains going native as soon as is feasible. Domain Global Security and Domain Local Security will be mainly used, although a scattering of Domain Universal Security groups will be used in the native-mode domains as soon as conversion takes place.

8.7.3.6. Step 6: Design the Global Catalog

Current U.S. laws explicitly state that information in a U.S. directory can be published anywhere except in countries that are subject to American export restrictions. As PetroCorp's Active Directory is a directory that has the United States as its origin, Active Directory cannot be exported to those countries. That throws a monkey wrench into PetroCorp's design, as PetroCorp has offices in several of those countries.

PetroCorp has a number of solutions open to them. They could have Europe or Australia host the PetroCorp domain and make the Denver office a subdomain, with Denver managing both. That's not particularly appropriate here. There are many other variations along those lines as well as a number of solutions that are workable. Here are two examples:

- Create entirely separate domains in separate forests in those countries. These forests, being outside the central forest, will have no Global Catalog exporting issues.
- Create one entirely new forest called something like *export.petrocorp.com*, which is not in any way related to the existing *petrocorp.com* domain, even though the name appears that way. The *export.petrocorp.com* forest could contain servers from all the companies that have export restrictions, holding them together under one manageable structure. This can be hosted (have the forest root domain in another country) and be remotely managed. Manual trusts between forests can now be considered as long as these don't also break the laws.

8.7.3.7. Step 7: Design the application partition structure

PetroCorp has several corporate applications that need to store data in Active Directory. Since everyone in the company uses these applications, placing the data in a single domain would not be sufficient. For this reason, an application partition should be created and replicated to a domain controller in each major geographic location.

8.7.3.8. Recap

This example shows how a global company can create its own design and maintain a large degree of control. It also shows how laws in the real world can wreak havoc with a good design!

> These are only examples; there are multiple ways each of these cases could have been designed. Do not feel that because you saw these designs documented here, they are the way you have to do your designs. It is definitely useful to start with them, but make sure it makes sense for your network.

PREV NEXT

8.8. Designing for the Real World

It's very easy to get bogged down in the early stages of the namespace design without actually progressing much further. The stumbling block seems to be that it feels conceptually wrong to have only one domain, yet administrators can't put their finger on what the problem is. Experienced Windows NT administrators who manage multiple domains seem to find this much more of a problem than those coming from another operating system.

If you follow the guidelines in the initial steps of the namespace design, you quite possibly could end up with one domain to start with. Yet NT administrators tend to feel that they have conceptually lost something very important; with only one domain, somehow this design doesn't "feel right."

This is partly a conceptual problem: a set of domains with individual objects managed by different teams can feel more secure and complete than a set of Organizational Units in a single domain containing individual objects managed by different teams. It's also partly an organizational problem and, possibly, a political problem. Putting in an Active Directory environment is a significant undertaking for an organization and shouldn't be taken lightly. This change is likely to impact everyone across the company, assuming you're deploying across the enterprise. Changes at that level are likely to require ratification by a person or group who may not be directly involved on a day-to-day basis with the team proposing the change. So you have to present a business case that explains the benefits of moving to Active Directory.

8.8.1. Identify the Number of Domains

Following our advice in this chapter and Microsoft's official guidelines from the white papers or Resource Kit will lead most companies to a single domain for their namespace design. It is your network, and you can do what you want. More domains give you better control over replication traffic but may mean more expense in terms of hardware and administrative overhead. If you do decide to have multiple domains but have users in certain locations that need to log on to more than one domain, you need DCs for each domain that the users need in that location. This can be expensive. We'll come back to this again later, but let's start by considering the number of domains you need.

If the algorithm we use to help you determine the number of domains gives you too small a figure in your opinion, here's how you can raise it:

- Have one domain for every single-master and multimaster Windows NT domain that you have. If you are using the Windows NT multimaster domain model, consider the entire set of multimasters as one domain under Active Directory (use Organizational Units for your resource domains).
- Have one domain per geographical region, such as Asia-Pacific, Africa, Europe, and so on.
- Have extra domains whenever putting data into one domain would deny you the control over replication that you would like if you used Organizational Units instead. It's all very well for us to say that Organizational Units are better, but that isn't true in all situations. If you work through

the algorithm and come up with a single domain holding five Organizational Units, but you don't want any of the replication traffic from any of those Organizational Units to go around to certain parts of your network, you need to consider separate domains.

Even Microsoft didn't end up with one domain. They did manage to collapse a lot of Windows NT domains, though, and that's what you should be aiming for if you have multiple Windows NT domains. It isn't unusual for very large organizations to go from hundreds or even thousands of domains to just a few domains.

8.8.2. Design to Help Business Plans and Budget Proposals

There are two parts to this: how you construct a business case itself for such a wide-reaching change and how you can show that you're aiming to save money with this new plan.

Simply stated, your business case should answer two main questions:

- Why should you not stay where you are now?
- Why should you move to Active Directory?

If you can sensibly answer these two questions, you've probably solved half your business case; the other half is cost. Here we're talking about actual money. Will using Active Directory provide you with a tangible business cost reduction? Will it reduce your Total Cost of Ownership (TCO)? It sure will, but only if you design it correctly. Design it the wrong way, and you'll increase costs.

Imagine first that you have a company with two sites, Paris and Leicester, separated by a 64 KB WAN link. Now imagine you have one domain run by Leicester. You do not have to place a DC in Paris if it is acceptable that when a user logs on, the WAN link uses bandwidth for items like these:

- Roaming user profiles
- Access to resources, such as server-based home directories
- GPOs
- Application deployment via Microsoft Installer (MSI) files

If authentication across the link from Paris would represent a reasonable amount of traffic, but you do not want profiles and resources coming across the slow link, you could combat that by putting a member server in Paris that could service those resources. You could even redirect application deployment mount points to the local member server in Paris. However, if GPOs themselves won't go across the link, you need to consider a DC in Paris holding all the local resources. That gives you two sites each with at least one DC, and one domain.

Now let's expand this to imagine that you have a company with 50 WAN locations; they could be shops, banks, suppliers, or whatever. These are the Active Directory sites. Next, imagine that the same company has 10 major business units: Finance, Marketing, Sales, IS, and so on. You really have three choices when designing Active Directory for this environment:

- Assuming everything else is equal, create a single domain with a DC in whichever sites require faster access than they would get across any link. Now make the business units Organizational Units under the single domain.

  Pro

  Everything is in one domain.

  Pro

  You need as many DCs as you have sites with links that you consider too slow. If you wan to count a rough minimum, make it 1 DC per site with more DCs for larger sites; that is a rough minimum of 50 DCs. This is a low-cost solution.

  Pro

  With one forest and one domain, any user can log on quickly anywhere because authentication is always to a local DC.

  Con

  Every part of the domain is replicated to every other part of the domain, so you have no granularity if you don't want objects from one business unit replicating to DCs everywhere.

- Create multiple domains representing the 10 major business units. Place DCs for each business unit in whichever sites require faster access than they would get across any link.

  Pro

  This means more domains than the previous solution, but replication can now be better controlled on a per-business unit basis between sites.

  Con

  Active Directory cannot host multiple domains on a single DC. This can make for an extremely high cost due to the large number of DCs that you may need. If you need to be able to log on to each of the 10 business unit domains from every site, you need 10 DCs per site, which makes 500 DCs. That's a much more costly solution.

  Pro/Con

  With one forest and multiple domains, any user can log on quickly at any site that has a local DC for her domain; otherwise, she would have to span a WAN link to authenticate her logon and send down her data.

- Create multiple domains representing geographical regions that encompass the 50 sites. Make these geographical regions the domains and have each domain hold Organizational Units representing business units that contain only the users from that region.

  Pro

  Even if you end up with 10 geographic regions, the DCs for each region are placed only in the sites belonging to that region. So if there were five sites per region (to make the math simple), each of the five needs only 1 DC. As the namespace model is a geographic model, you need to place a DC for Europe in the Asia-Pacific region only if the Asia-Pacific region ever has visiting users from Europe who need to authenticate faster than they would across the WAN link from Asia-Pacific to Europe. So the number of DCs that you need is going to be smaller.

  Pro

  Domain replication traffic occurs now only within a region and between regions that has DCs hosting the same domain.

  Con

  You end up duplicating the business units in all the domains...or maybe not, if some don't need all business unitsyou get the idea.

  Pro/Con

  With one forest and multiple domains, any user can log on quickly at any site that has a local DC for his domain; otherwise, he would have to span a WAN link to authenticate his logon and send down his data.

We hope this illustrates that while it is easy to map a simple and elegant design on paper, there can be limitations on the feasibility of the design based on replication issues, DC placement, and cost.

8.8.3. Recognizing Nirvana's Problems

Arguably, there are a number of "best" ways to design depending on whom you talk to. We propose an iterative approach with Active Directory, and this is probably going to happen anyway due to the nature of the many competing factors that come into play. On your first pass through this chapter, you'll get a draft design in hand for the namespace. In Chapter 9, you'll get a draft site and replication design. Then you'll come up against the issue that your namespace design may need changing based on the new draft sites and replication design, specifically on the issues of domain replication and server placement that we have just covered. After you've revised the namespace design, you can sit down and look at the GPO design (using Chapters 7 and 10) in a broad sense, as this will have an impact on the Organizational Unit structure that you have previously drafted in your namespace design. And so it goes.

While this is the way to design, you will come up against parts of your organization that do not fit in with the design that you're making. The point is to realize that your job is to identify a very good solution for your organization and then decide how to adapt that solution to the real world that your company lives in. One domain may be ideal but may not be practicable in terms of cost or human resources. You have to go through stages of modifying the design to a compromise solution that you're happy with.

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8.9. Summary

In this chapter, we presented seven steps toward effective namespace design:

1. Decide on the number of domains.
2. Design and name the tree structure.
3. Design the workstation and server-naming scheme.
4. Design the hierarchy of Organizational Units.
5. Design the users and groups.
6. Design the Global Catalog.
7. Design the application partition structure.

Following these seven steps allows you to solve the two main objectives of this chapter:

- Come up with an Active Directory namespace design to represent the structure of your business.
- Minimize the number of domains by making much more use of the more flexible Organizational Units.

Although we've shown you how to start to design your Active Directory, there is still a long way to go. Designing the namespace of domains, trees, and forests and the internal Organizational Unit hierarchy according to the guidelines given here means that you should have a structural template that represents your business model within the preceding restrictions. Hopefully this design makes sense in terms of your organization and will be simpler to manage.

The rest of the design still needs to be completed. You need to look at the low-level network links between sites and how they will affect your replication decisions. You then need to tackle the subject of how to revise the initial namespace design based on Group Policy Objects, security delegation and auditing, schema changes, and so on. Next we'll move on to designing the physical site topology that the DCs use when communicating with one another.

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Chapter 9. Creating a Site Topology

As we mentioned in Chapter 5, there are two aspects to replication:

- How data gets replicated around an existing network of links between DCs
- How the Knowledge Consistency Checker generates and maintains the replication links between servers, both intrasite and intersite

We covered the former in Chapter 5, and we'll cover the latter here, leading to an explanation of how to properly design a representation of your organization's network infrastructure within Active Directory.

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9.1. Intrasite and Intersite Topologies

Two distinct types of replication links exist with Active Directory sites: intrasite (within sites) and intersite (between sites). An Active Directory service known as the Knowledge Consistency Checker (KCC) is responsible for automatically generating the replication links between intrasite DCs. The KCC will create intersite links automatically for you as well, but only when an administrator has specified that two sites should be connected. Every aspect of the KCC and the links that are created is configurable, so you can manipulate what has been automatically created and what will be automatically created via manipulation of the various options. You can even disable the KCC if you wish and manually create all links.

Note that there is a large distinction between the KCC (the process that runs every 15 minutes and creates the replication topology) and the replication process itself. The KCC is not involved in the regular work of replicating the actual data in any way. Intrasite replication along the links created by the KCC uses a notification process to announce that changes have occurred. So each domain controller is responsible for notifying its replication partners of changes. If no changes occur at all within a six-hour period, the replication process is kicked off automatically just to make sure that nothing was missed. Intersite replication, on the other hand, does not use a notification process. Instead, it uses a replication schedule to transfer updates, using compression to reduce the total traffic size.

The KCC and the topologies it generates have been dramatically improved in Windows Server 2003 Active Directory. With Windows 2000 Active Directory, when there were more than 200 sites with domain controllers, it could take the KCC longer than 15 minutes to complete and would also drive up CPU utilization. Since the KCC runs every 15 minutes, it could get backlogged as a result or not finish at all. Typically when faced with this situation, administrators had to disable the KCC and manually create connection objects. With Windows Server 2003, Microsoft has stated that the new limit is closer to 5,000 sites when running a forest at the Windows Server 2003 forest functional level, which is a vast improvement. In fact, the KCC was largely rewritten in Windows Server 2003 and is much more scalable and efficient.

However, we don't think as an Active Directory administrator that you should just accept the topologies it creates without examining them in detail. You should investigate and understand what has been done by the KCC. If you then look over the topology and are happy with it, you have actively rather than passively accepted what has been done. While letting the KCC do its own thing is fine, every organization is different and you may have requirements for the site and link design that it is not aware of and cannot account for automatically.

Other administrators will want to delve into the internals of Active Directory and turn off the KCC entirely, doing everything by hand. This approach is valid as long as you know what you're doing, but we prefer to let the KCC do its work, helping it along with a guiding hand every now and then. We cover all these options in the section "Designing Sites and Links for Replication."

9.1.1. The KCC

DCs within sites have links created between them by the KCC. These links use a random GUID as the unique identifier. These links exist in Active Directory as connection objects and use only the Directory Service Remote Procedure Call (DS-RPC) transport to replicate with one another; no other replication transport mechanism is available. However, when you need to connect two sites, you manually create a site link via the Active Directory Sites and Services MMC snap-in and specify a replication transport to use. When you do this, the Intersite Topology Generator (ISTG) automatically creates connection objects in Active Directory between domain controllers in the two sites. Within each site, an ISTG is designated to generate the intersite topology for that particular site via the KCC process. There are two replication transports to choose from when creating a site link: standard DS-RPC or Inter-Site Mechanism Simple Mail Transport Protocol (ISM-SMTP) . The latter means sending updates via the mail system using certificates and encryption for security; it is limited in that it can only be used for replicating Global Catalog partitions and the Configuration and Schema containers.

There are two reasons that the ISTG cannot automatically create links between two sites. First, the ISTG has no idea which sites you will want to connect. Second, the ISTG does not know which replication transport protocol you will want to use.

The KCC runs locally every 15 minutes on each DC. The default time period can be changed, and it can be started manually on demand if required. If we create two servers called Server A and Server B in a new domain, the KCC will run on each server to create links. Each KCC is tasked with creating a link to define incoming replication only. The KCC on Server A will define an incoming link from Server B, and Server B's KCC will define an incoming link from Server A. The KCC creates only one incoming link per replication partner, so Server A will never have two auto-generated incoming links from Server B, for example.

The KCC does not create one topology for all NCs, or one topology per NC. The Configuration and Schema NCs share one replication topology, so the KCC creates a topology for these two together. The KCC also creates another topology on a per-domain basis. Because the Schema and Configuration are forest-wide in scope, the KCC needs to replicate changes to these items across site links. The KCC needs to maintain a forest-wide topology spanning all domains for these two NCs together. However, unless a domain is set up to span multiple sites, the topology for a particular domain will be made up of only intrasite connections. If the domain does span sites, the KCC needs to create a replication topology across those sites.

9.1.2. Automatic Intrasite Topology Generation by the KCC

For each NC, the KCC builds a bidirectional ring of replication connections between the DCs in a site. However, while upstream and downstream connections are created between partners around a ring, the KCC can also create additional connections across the ring as well. These connections are created on the basis of a single rule, that no DC in the site can be more than three replication hops from any other DC in the same site. It does this to maintain a guaranteed theoretical maximum convergence time within a site for a NC. This convergence time is approximately 15 minutes for Windows 2000 and approximately 1 minute for Windows Server 2003 in Forest Functional Mode.

There were quite a few administrators who weren't happy about the default intrasite convergence time in Windows 2000 without realizing that it is fully configurable. The related registry values are located under the `HKLM\SYSTEM\CurrentControlSet\Services\NTDS\Parameters` registry key. The specific values are:

Replicator notify pause after modify (secs)

> How long to wait before notifying the first change notification partner of an originating write. Windows 2000 default: 300 seconds. Windows Server 2003 default: 15 seconds.

Replicator notify pause between DSAs (secs)

> How long to wait after notifying each additional change notification partner of an originating write. Windows 2000 default: 30 seconds. Windows Server 2003 default: 3 seconds.

These registry modifications also work in Windows Server 2003 AD; however, the timings can be modified by changing the following attributes on the cross-reference objects for the specific NCs:

- `msDSReplicationNotifyFirstDSADelay`
- `msDSReplicationNotifySubsequentDSADelay`

This will impact all domain controllers replicating the NC so it isn't as targeted.

For example, as you add new DCs for a domain to a site, they will just get inserted into the ring. Due to the three-hop rule, when you put in your eighth DC, the KCC must add at least one cross ring connection. Let's take a look at this process in more detail.

9.1.2.1. Two servers

Mycorp starts off with one DC, Server A. When Server B is promoted as the second DC for the domain, the DCPROMO process uses Server A as its source for Active Directory information for the GC, Schema, and Configuration on Server B. During the promotion process, the Configuration Container is replicated from Server A to Server B, and the KCC on Server B creates the relevant incoming connection object representing Server A. Server B then informs Server A that it exists, and Server A correspondingly creates the incoming connection object representing Server B. Replication now occurs for all NCs using the connection objects. While replication occurs separately for each NC, the same connection objects are used for all three at this moment.

9.1.2.2. Three servers

The DCPROMO process is later started on Server C. Server C then uses a DNS lookup and picks one of the existing DCs to use as a promotion partner. For now we'll say that it picks Server B. During the promotion process, the Configuration container is replicated from Server B to Server C, and Server C creates the relevant incoming connection object representing Server B. Server C then informs Server B that it exists, and Server B correspondingly creates the incoming connection object representing Server C. Replication now occurs for all NCs using the connection objects.

At present, you have two-way links between Server A and Server B, as well as between Server B and Server C. We have no links between Server A and Server C, but the KCC must create a ring topology for replication purposes. So as soon as Server B does a full replication to Server C, Server C knows about Server A from the Configuration NC. Server C's KCC then instantly creates an incoming connection object for Server A. Server A now finds out about Server C in one of two ways:

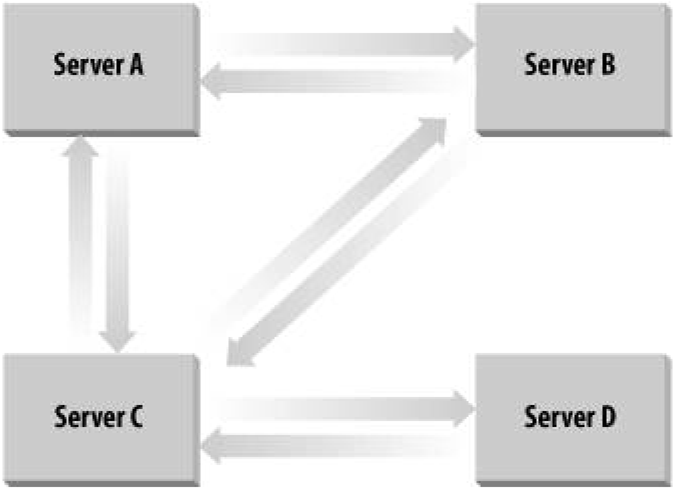
- Server A requests updates from Server B and identifies a new DC.
- Server C requests changes from Server A, and this allows Server A to identify the new DC.

Server A now creates an incoming connection object for Server C. This completes the Server A to Server B to Server C to Server A loop.

9.1.2.3. Four servers

Server D comes along, and the promotion process starts. It picks Server C to connect to. Server D ends up creating the incoming connection object for Server C. Server C also creates the incoming connection object for Server D. You now have the loop from the previous section, plus a two-way link from Server C to Server D. See Figure 9-1 for this topology.

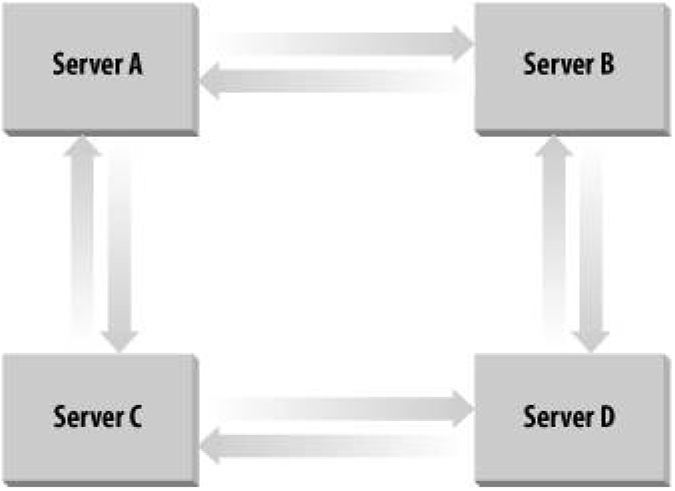
Figure 9-1. Adding a fourth DC to a site



Server D's KCC now uses the newly replicated data from Server C to go through the existing topology. It knows that it has to continue the ring topology, and as it is already linked to Server C, Server D has to create an incoming connection object for one of Server C's partners. It chooses Server B in this case. So Server D's KCC creates an incoming connection object for Server B. Server D then requests changes from Server B. The rest of the process can happen in a number of ways, so we'll just play out one scenario.

Server B now knows about Server D. Server B's KCC kicks into action and realizes that it doesn't need the link to Server C, so it deletes that connection and creates a new one directly to Server D itself. Finally, as replication takes place around the ring along the existing links, Server C notes that it has a now defunct incoming link from Server B and removes it. You now have a simple ring, as depicted in Figure 9-2.

Figure 9-2. Ring of four DCs

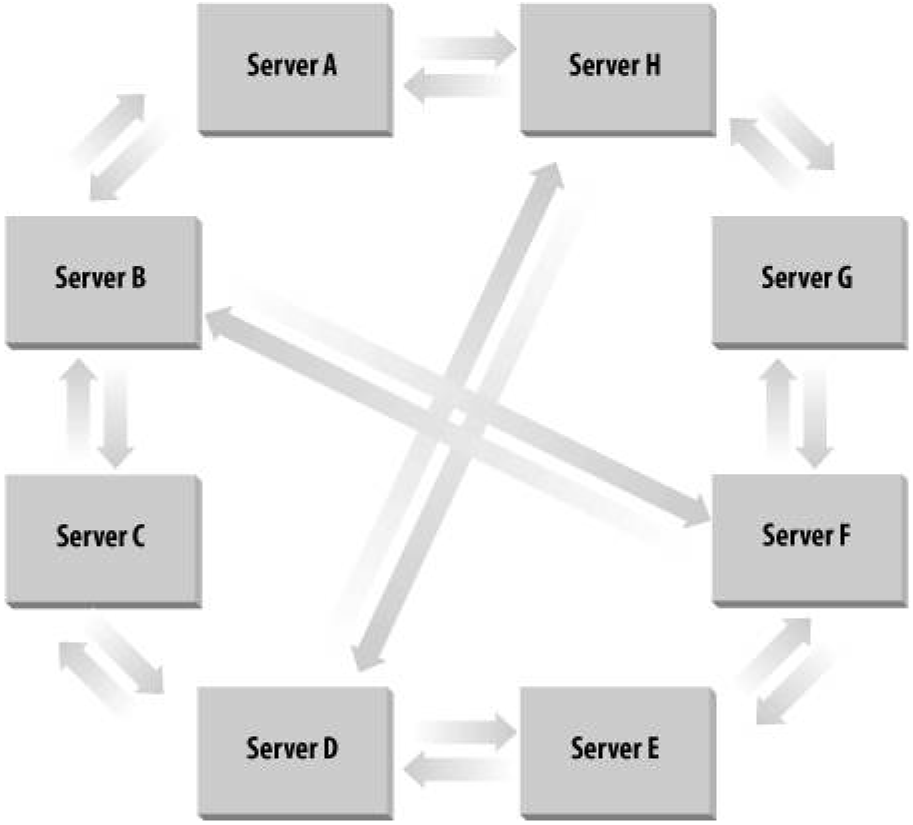


9.1.2.4. Eight servers

Once you hit eight servers connected together, you need more links across the ring if you are to maintain the three-hop rule. If you look at Figure 9-3, you will see this demonstrated. If the cross-ring links did not exist, some servers would be four hops away from one another. The KCC figures out which servers it wishes to link by allowing the last server to enter the ring to make the initial choice. Thus, if Server H is the new server in the ring, it knows that Server D is four hops away and makes a connection to it. When Server D's KCC receives the new data that Server H has linked to it, it reciprocates and creates a link to Server H.

However, this doesn't completely solve the problem. Consider Server B and Server F: they're still four hops away from each other. Now the KCC creates a link between these pairs to maintain the three-hop rule.

Figure 9-3. Eight servers and the extra KCC-generated links



9.1.2.5. Now what?

We've now gone through the mechanism that the KCC uses for intrasite link generation between DCs. However, that's not the whole story. Remember that Active Directory can have multiple domains per site, so what happens if we add *othercorp.com* (a new domain in the same forest) to the same site or even *sales.mycorp.com* (a new child domain)? What happens then? The answer is the same for both, and it is based on NCs:

- The Schema and Configuration replicate across the enterprise, and they share a replication topology. Although they replicate separately, it is along the same links.
- Each domain replicates only domain-wide, so the domain topologies for both domains stay in the same ring formation that they previously had.

Once the two domains integrate, the KCC-generated topologies for *mycorp.com* and the other domain stay the same. However, the KCC-generated Configuration/Schema replication topology that exists separately on both domains will form itself into its own ring, encompassing both domains according to standard KCC rules.

To summarize, when you have multiple domains in a site, each domain has its own KCC-generated topology connecting its DCs, but all the DCs in the site, no matter what domain they come from, link in a separate topology representing Schema/Configuration replication.

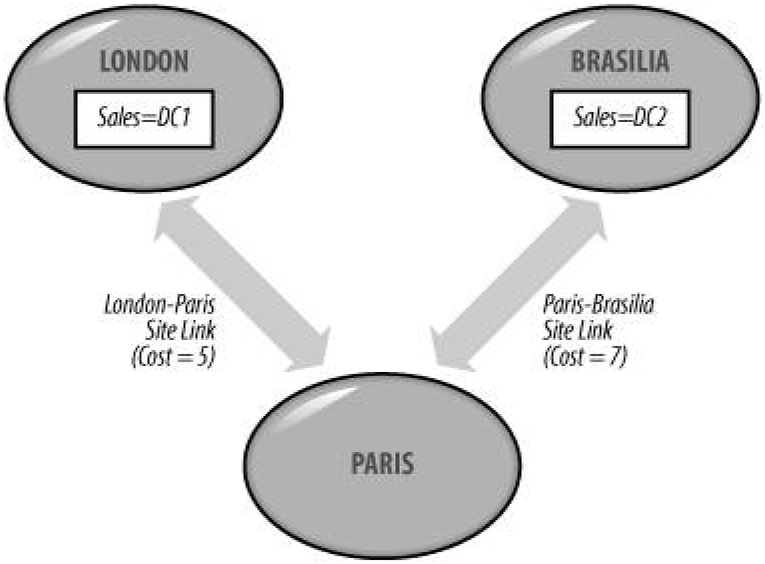
9.1.3. Site Links: The Basic Building Blocks of Intersite Topologies

Having sites is all well and good, but you need to be able to connect them if you are ever going to replicate any data. An intersite connection of this type is known as a *site link*. Site links are created manually by the administrator and are used to indicate that it is possible for two or more sites to replicate with each other. Site links connect more than two sites if the underlying physical network already connects multiple sites together using ATM, Frame Relay, MANs with T1 connections, or similar connections. For example, if a 64 Kbps Frame Relay network exists and is shared by multiple sites, all those sites can share a single site link.

Sites do not have to be physically connected by a network for replication to occur. Replication can occur via multiple links between any two hosts from separate sites. However, for Active Directory to be able to understand that replication should be occurring between these two sites, you have to create a site link between them.

Figure 9-4 shows part of a network that has two site links connecting three sites.

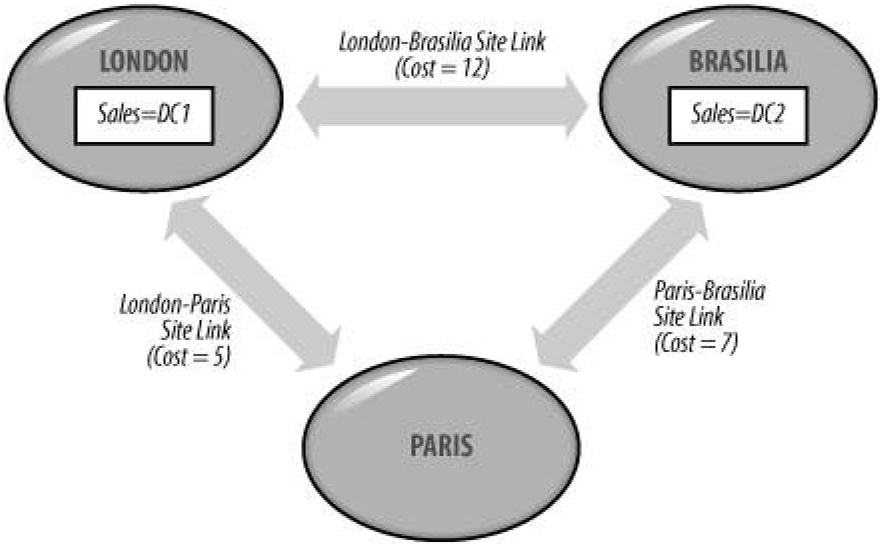
Figure 9-4. Broken Sales domain replication over site links



The site links correspond to the underlying physical network of two dedicated leased-line connections, with one network having a slightly higher cost than the other (not a monetary cost, but a value set by the administrator indicating the speed of the link). The Sales domain has two domain controllers that need to replicate, one in London and one in Brasilia. However, in this figure, replication is broken, as the two DCs cannot directly replicate with each other over a single site link. This may seem confusing as both servers are more than likely able to see each other across the network, but you must nevertheless create a site link between sites that have DCs that need to replicate.

Consider it another way. There are three ways to fix the problem. First, you could add a new Sales DC, say Sales=DC3, to Paris. This allows Sales=DC1 to replicate with Sales=DC3 and Sales=DC3 to replicate with Sales=DC2. Second, you could use a site link bridge, discussed in the next section. Third, you could create a third site link (with the combined cost of the two physical networks that will be used for the replication traffic) that indicates to the two servers that they can replicate with each other. Figure 9-5 shows that new site link in place.

Figure 9-5. Working Sales domain replication over site links



Replication of the Sales domain is now possible between Sales=DC1 and Sales=DC2. Replication traffic will go over the existing physical links, for a total cost of 12 to use those links.

We've mentioned that site links have a cost, but that's not their only property. In fact, site links have four important properties:

Name

An identifying name for the site link.

Cost

An integer weighting for the site link that indicates the speed of the link relative to the other links that exist. Lower costs are faster; higher costs are slower.

Schedule

The times that are available for replication to occur. Replication does not occur on the site link outside of the scheduled times.

Transports

The protocols that are used for replication along this link.

9.1.3.1. Cost

As each link has a cost, it is possible to calculate the total cost of traveling over any one route by adding up all the costs of the individual routes. If multiple routes exist between two disparate sites, the KCC will automatically identify the lowest-cost route and use that for replication.

9.1.3.2. Schedule

The schedule on a link represents the time period that replication is allowed across that link. Servers also maintain times that they are allowed to replicate. Obviously, if two servers and a link do not have times that coincide, no replication will ever be possible.

Between the scheduled start and stop times for replication on a site link, the server is available to open so-called windows for replication to occur. As soon as any server that replicates through that link becomes available for replication, a replication window is opened between the site link and that server. As soon as two servers that need to replicate with each other have two windows that coincide, replication can occur. Once a server becomes unavailable for replication, the window is removed for that server. Once the site link becomes unavailable, all windows close.

> If two servers that need to replicate never have two replication windows that coincide, their connection is deemed to be unavailable.

9.1.3.3. Transport

Site links can currently replicate using two transport mechanisms:

- Directory Service Remote Procedure Call (DS-RPC)
- Inter-Site Mechanism Simple Mail Transport Protocol (ISM-SMTP)

A site link using DS-RPC means that servers wishing to replicate using that site link can make direct synchronous connections using TCP/IP across the link. As the transport protocol is synchronous, the replication across the connection is conducted and negotiated in real time between two partners. This is the normal sort of connection for a real-time link. However, some sites may not be connected all the time. In fact, they may dial up only every half hour to send and receive email or be connected across the Internet, or they may even have a very unreliable link. This sort of link is where ISM-SMTP comes into play.

The SMTP connector, as a site link using the ISM-SMTP transport is called, allows partner DCs to encrypt and email their updates to each other. In this scenario, Active Directory assumes that you already have an underlying SMTP-based connection mechanism between these two sites. If you don't, you'll have to set one up for this to work. If a connection is in place, the SMTP Connector assumes that the existing underlying mail routing structure will sort out how mail is transferred. To that end, a site link using the SMTP Connector ignores the scheduling tab, as it will send and receive updates automatically via the underlying system whenever the email system sends and receives them itself.

SMTP Connector messages are encrypted using digital signatures, so to encrypt the messages, you need to install the optional Certificate Server service and obtain your own digital signature for your organization.

> The SMTP Connector cannot be used for domain NC replication. It can, however, be used to replicate GC, Schema, and configuration information. This means that multi-site domains with slow links will be required to use DS-RPC for domain replication. Of course, this doesn't mean that the physical connection between sites has to be up all the time, only that it must be up when the DCs in each site communicate.

9.1.3.4. When the KCC becomes involved

When you have two sites that you want to connect, you have two options. You can manually create a site link between them, at which point the KCC will automatically connect together one DC from each site. The KCC will automatically select the DCs and create the relevant incoming connection objects for both servers. Alternatively, you can create the incoming connection objects manually in Active Directory using the Sites and Services snap-in. The two DCs that link two sites, no matter how the connection objects are created, are known as bridgehead servers.

The KCC actively uses site link costs to identify which routes it should be using for replication purposes. If a stable series of site links exists in an organization, and a new route is added with a lower cost, the KCC will switch over to use the new link where appropriate and delete the old link. The network of connections that the KCC creates is known as a minimum-cost-spanning tree.

9.1.3.5. Having the KCC compound your mistakes

If you make a mistake with site link costs, you can cause network problems very quickly. For this reason, you need to be aware of what the KCC is doing. If you bring up a new site link with a very high cost, say 50, and you accidentally leave off the zero, the route cost of 5 for the new site link may cause the KCCs on all DCs to suddenly reorganize the links to route through your new slow link. Your link becomes saturated, and your servers replicate much more slowly, if at all, over the slow link.

In fact, the KCC didn't make the mistake, but it has compounded it by following its algorithm. If a real cost-5 link were introduced that represented a real cost saving over many other routes, it is the KCC's job to switch over and use that link. That's why you always need to check your data for the intersite replication topology carefully.

Although it's difficult to guard against occasionally making a mistake like this, no matter how careful an administrator you are, if you understand how the KCC works, you can use this information to debug potential problems much more rapidly.

> This is yet another case that begs for a script solution if you are making site links on a regular basis. This script can have rules built in on what costs can be configured, etc. If you are regularly adding new sites, a common task in large deployments, you should use a script that creates the site and site link based on the rules you need followed. If you don't have the *Active Directory Cookbook* (O'Reilly), this is a good reason to purchase it. It has scripts to help automate things such as subnet and site creation.

9.1.4. Site Link Bridges: The Second Building Blocks of Intersite Topologies

While site links are used to indicate that replication can take place between two sites, site link bridges indicate that replication is possible between two sites that don't have a direct site link. Site link bridges can be created automatically by the KCC, or they can be created manually. When a bridge is created, certain specified site links become members of that bridge and are designated as being interconnected (or bridged) for replication purposes. The bridge knows how these sites are connected, so you could specify, for example, that a particular site link bridge encompasses the London-Paris link and the Paris-Brasilia link. Then servers in Brasilia or London will see that a replication connection is now possible via the site link bridge; the site link bridge will know that for traffic to get from London to Brasilia, it must use the London-Paris and then Paris-Brasilia links in that order. Figure 9-6 demonstrates this in action.

The point here is that a site link bridge knows how the site links in its care are interconnected and thus how to route requests from one site through to another along its network of site links.

For a more complex example, consider the network of site links corresponding to physical networks in Figure 9-7.

If you had to connect all four DCs using only site links, you would have to manually connect London and Vienna to Brasilia using something like Vienna-London and London-Brasilia (although that isn't the only solution) and then connect Brasilia-Kuala Lumpur. However, with a site link bridge, you could bridge every site link except Kuala Lumpur to Georgetown. Bridging all the links except this one tells the servers in those sites that are bridged that they can replicate to any sites that are bridged over the existing site links. So when Vienna wishes to replicate to Kuala Lumpur, the site link bridge knows that the traffic should go from Vienna to Paris to Brasilia to Osaka and finally to Kuala Lumpur.

Figure 9-6. Working Sales domain replication using a site link bridge

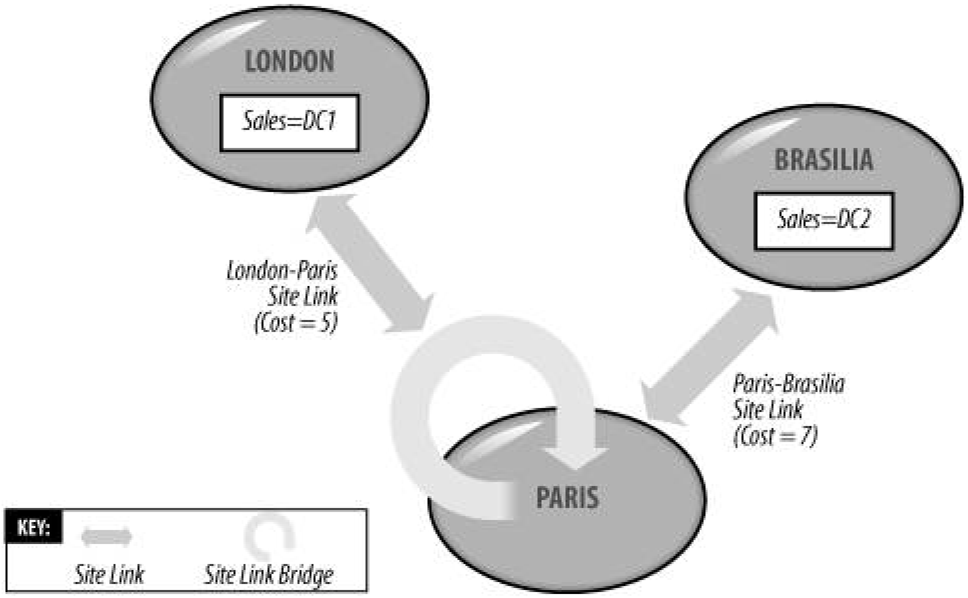
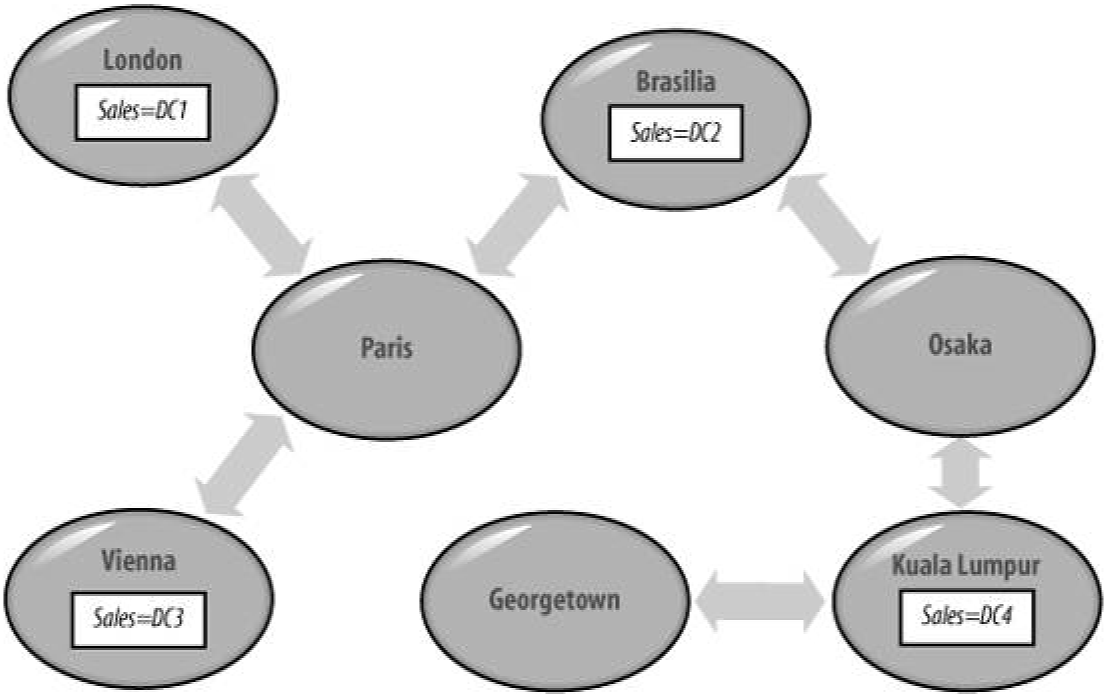


Figure 9-7. A network of site links



Bridging the Kuala Lumpur-Georgetown site link would probably make sense, but in this example there is no need, as no Sales domain servers currently exist in that site.

There are a number of reasons why site link bridges make great sense:

- The ability to bridge multiple site links saves you from creating multiple site links that do not mirror your physical network solely for Active Directory replication purposes.
- If you do not have a fully routed IP network throughout your organization, using a site link bridge enables you to connect non-routed IP networks for replication purposes.
- The KCC determines what route to use across all site links within a bridge, based on the costs of all possible links. Thus, if you have more than one link between sites, bridging all links will make sure the KCC picks the best one when creating a replication connection.
- The KCC can be configured to automatically bridge all site links that use a common transport.
- Site link bridges can be used to force replication to go through certain hub sites. Look at Figure 9-7 again. Imagine you had networks directly between London and Brasilia, London and Vienna, and Vienna and Brasilia, but you did not want to use them for replication traffic under any circumstances. That means you should not create site links between these three sites, since the KCC will detect the link as available for replication purposes and create connection objects across it. Instead, use a site link bridge and force replication traffic between these three sites to be replicated across the existing site links in Figure 9-7 by routing it all through Paris.

Now that you've seen the site links and site link bridges, let's look at how to design your sites and their replication links.

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9.2. Designing Sites and Links for Replication

There is only one really important point, which is the overriding factor when designing a replication strategy for your network: how much traffic and over what period will you be replicating across the network? However, replication isn't the only reason for creating sites. Sites also need to exist to group sets of machines together for ease of locating data, finding the nearest DC to authenticate with, or finding the nearest DFS share mount point.

9.2.1. Step 1: Gather Background Data for Your Network

Before you sit down to design your site and WAN topology, you need to obtain the map of your existing network infrastructure. This map should contain all physical locations where your company has computers, along with every link between those locations. The speed and reliability of each link should be noted.

If you have an existing IP infrastructure, write down all the subnets that correspond to the sites you have noted.

9.2.2. Step 2: Design the Sites

From the network diagram, you need to draw your site structure and name each site, using a one-to-one mapping from the network diagram as your starting point. If you have 50 physical WAN locations, you have 50 sites. If only 30 of these will be used for Active Directory, you may not see a need to include the entire set of sites in Active Directory. If you do include the entire set, however, it is much easier to visualize your entire network and add clients or servers to those locations later.

> When drawing Active Directory networks, sites normally are represented by ovals.

Remember that a site is a well-connected set of subnets ("well-connected" tends to mean about 10 Mbps LAN speed). A site does not have to have a server in it; it can be composed entirely of clients. If you have two buildingsor an entire campusthat is connected over 10/100 Mbps links, your entire location is a single site.

This is not a hard and fast rule. By the normal rules, two locations connected over a 2 Mbps link represent two distinct sites. You can, however, group networks together into single sites if you want to. You have to appreciate that there will be more replication than if you had created two sites and a site link, because DCs in both physical locations will maintain the intrasite replication ring topology. If you had created two sites and a site link, only two bridgehead servers would replicate with each other.

We've also successfully used a single site to represent two networks, one with clients and one with servers, separated by a 2 Mbps link. The clients at the end of the 2 Mbps link successfully authenticated quickly and downloaded profiles from a server at the other end of the other link. If we'd used two sites, we would have had to create a site link between them, but the clients still would have had to authenticate across the link anyway.

To summarize, we would suggest that, by default, you create one site per 10 Mbps or higher location, unless you have an overriding reason not to do so.

9.2.3. Step 3: Design the Domain Controller Locations

Placing of DCs is fairly easy, but the number of DCs to use is a different matter entirely.

9.2.3.1. Where to put DCs

Each workstation in a domain exists in a single site that it knows about. When a user tries to log on to the domain at that workstation, the workstation authenticates to a DC from the local site, which it originally locates via a DNS query. If no DC is available in the local site, the workstation finds a remote site, and by a process of negotiation with a DC in that site, either authenticates with that DC or is redirected to a more local DC.

This consideration governs the placement of DCs. You should place one DC for authentication purposes per domain in all sites that meet any of the following criteria:

- The site has links that are not fast enough for logon purposes to a particular domain.
- The site has links that may be fast enough for logon, but you do not wish to authenticate across them for a particular domain.
- Under Windows 2000, if you made heavy use of universal groups, you needed to place a Global Catalog at a site if you did not want to impact logons due to a network failure. But with Windows Server 2003 Active Directory, you can enable universal group membership caching (with the Sites and Services snap-in) so that this is no longer a requirement.

The first and second points also need to be considered in light of the number of users and workstations at the sites. If a branch office has a 64 Kbps link, would you want users to log on using a centrally located DC at the other end of that link? If you had 10 users in that office, it may be no problem. If you had 20 users, you may not be so sure. If you had 50, it could be impossible, so you should probably put in a DC at that site.

9.2.3.2. How many DCs to have

Deciding how many DCs to create is never easy, as Windows NT administrators well know. The problem is that it depends on the power of the individual server and what else the server is doing at the time as much as it depends on the operating system's ability to authenticate users. If you have a

Windows server that's already serving 500 heavy users and is close to its load limit, could it authenticate 100 additional users quickly enough at the same time? Powerful servers can authenticate hundreds or thousands of users simultaneously, but even these servers will balk if they are already heavily loaded.

Unfortunately, we can't definitively answer this question for you. Microsoft has a tool called adsizer.exe, which is a best guess for AD NOS operations, available at:

http://www.microsoft.com/windows2000/techinfo/planning/activedirectory/adsizer.asp

The accuracy of this tool has been subject to debate, but most find it is a good first cut for planning purposes. There are some things that are tough to accurately assess, such as LDAP-based applications using the DCs. Often you do not know the specifics of how any given application uses the directory, so you end up taking a "wait and see" stance in terms of how many DCs will be needed and hoping that the usage levels aren't so high that users will notice any performance problems.

Some applications, such as Exchange, come with best practice guidelines that tell you how many DCs or GCs are needed for that application alone. For instance, the best practice guideline for Exchange is one matching dedicated GC processor for every four Exchange processors. Even this is simply a best guess to start with, some implementations would work fine with the best practice ratio of 1:4, some may need 1:2 or even 1:1 and others may work fine with 1:8. The only way to decide is to try the best practice and recommended guidelines, and then adjust the actual count to meet your reality as patterns become clear. That way, you should be able to judge for yourself how many DCs you may need for authentication and other purposes.

9.2.3.3. Reasons for putting a server in more than one site

By default, any server that you install or bring into a domain will belong to one site only. However, there can be instances in which you may want to configure a server to cover multiple sites . For example, you might want to make sure that workstations from a number of sites all authenticate using one DC.

Here's an example: imagine five sites (Cairo, Delhi, Bangkok, Sydney, and Rio de Janeiro), each representing a 20-user branch office of a large centralized company. Each site has a 64 Kbps link back to the main office in London. You've decided that each site can authenticate down the slow link to a central server, even though all 20 users will log on at 9:00 each morning, because time zone differences effectively stagger the load. In addition, to make sure that these clients do not authenticate with any other servers , you have to provide them with their own central server that is also a member of all the remote sites. That way, when the clients attempt to log on, they will do so down the slow link, but only to that one server.

While sites are used for replication, in order for clients to find resources, and to cut down on traffic on intersite connections, modifying the site membership can cause performance problems. However, in this case, we understand the consequences, and this looks like a good decision.

> Configuring a server to have multiple site membership is fairly straightforward. You have two options. The first is to simply configure the site link costs such that a DC in one site will automatically cover other sites that do not have domain controllers. The second option is to hardcode the coverage. To do this, edit the registry on the server that will be covering multiple sites and add a `REG_MULTI_SZ` value called `SiteCoverage` to the `HKLM\SYSTEM\CurrentControlSet\ServicesNetlogon\Parameters` subkey. Add the names of the sites to this value. If you're using *RegEdit* or *RegEdt32*, use Shift-Enter to add the data for multiple lines.

9.2.4. Step 4: Plan Intrasite Replication

This is a short step. Your only requirement is to set the schedules that the replication cycles use. As for the connection objects themselves, if you don't specifically need to change the intrasite replication topologies that the KCC sets up, don't. Leave the KCC to do its stuff by itself; it takes care of things pretty well. You could remove the default links and make a long linked list of replication partnersA to B to C to D to Erather than a ring if you wanted to, but you need to have a very good reason to do so.

If you do want to manipulate the existing setup of replication between DCs, you'll have to stop the KCC service generating the intrasite topology for that site.

> You can turn off intrasite or intersite topology generation by the KCC by using the Sites and Services snap-in to look at the properties of the specific NTDS Site Settings object that you are interested in.

9.2.5. Step 5: Decide How You Will Use the KCC to Your Advantage

There are really three ways to use the KCC to your advantage over intersite links:

- Manually create all the connection objects and turn off the KCC for intersite replication. This isn't something we recommend unless you know exactly what you're doing.
- Let the KCC generate your entire topology for you automatically. This is the default and what Microsoft recommends as standard. You still need to create all site links manually, but if you leave site link transitiveness on by default, the KCC will not need you to create extra site links to replicate data via sites that do not have the relevant DCs. Site link bridges are not used in this scenario.

  > You can define multiple site links between two distinct sets of bridgehead servers at separate sites if you wish; i.e., DC1 in Site A connects to DC3 in Site B and DC2 in Site A connects to DC4 in Site B. This will help in case one of the servers at one end of a single site link goes down, as this means that you will lose only one site link and not the intersite connectivity.

- A mixture of the two can be had by forcing the KCC to make decisions based on certain key information that you provide. For example, if you make sure that you leave site links non-transitive, the KCC will be able to replicate only across site links that actually exist. You then can make use of site link bridges to force the KCC to use certain routes for replication.

> If you have many connections that need to be created but don't want to use the KCC, you can use the KCC to start with, allow it to create its default objects, turn it off, and modify the objects to whatever you choose. If you have 500 links, for example, but want to manipulate only one, this is the best way of doing things.

You can leave this step until after you have designed the site links (steps 6, 7, and 8) if you are not sure what to do. The example design for PetroCorp shows later why this is useful.

9.2.6. Step 6: Create Site Links for Low-Cost, Well-Connected Links

Now that you have all the sites down on paper, you need to think about the links. In this step, we identify those sites that are interconnected with what can be considered very fast links or backbones.

Site links should be created along 2 Mbps or faster connections between distinct sites. For each link, you need to choose an appropriate name, cost , and transport. The name should be distinct and immediately conjure up what the link represents. The transport for low-cost links is normally DS-RPC; such a high-capacity network can cope with traffic of this nature. However, if you only want to use email across a link, make the transport ISM-SMTP. If you set up both for some reason, you would normally set a slightly higher cost for the SMTP connectors than you would for standard DS-RPC-based replication.

When choosing costs, the values you choose depend entirely on the different intersite link speeds that you have in your organization. If you have only 64 Kbps and 1 Mbps links between sites, you really need only two values. If you use both transport types, you'll need 4. However, if your sites have many different types of connection, such as 10 Mbps, T3, T2, T1, 256 Kbps, and 64 Kbps, you'll need many more. The values you use should represent in your own mind the difference in cost for using a route. The key to using costs is to realize that everything is relative. After all, if you have two routes to a site and they have costs of 1 and 2, respectively, 2 seems twice as slow as 1. That isn't true; it is just a slower linknot twice as slow. Because the numbers are so close together, there is almost nothing between these values. However, the difference between 10 and 20 is more significant. When determining values, we suggest that as a starting point, use 1 through 10 for low-cost fast links, 11 through 20 for medium-cost links, and 21 and above for higher-cost routes.

Create all the site links along fast-interconnected links between sites.

9.2.7. Step 7: Create Site Links for Medium-Cost Links

Having identified the fastest links and created site links for them, you now need to create any links that are interconnected with a similar transport at medium cost. These are sites such as those connected via MANs with T1 connections, interconnected via frame relay clouds, or entirely connected together. Create these sites now, and remember to use a slightly higher cost value for any SMTP connectors.

9.2.8. Step 8: Create Site Links for High-Cost Links

Finally, you have the WAN connections that are high cost due to their slow speed or unreliability. You now need to create those site links and allocate a name, transport, and cost as before. For unreliable links, consider using an SMTP connector with a certificate to encrypt the data. This will ensure that as soon as a link is available for email, your updates will propagate backward and forward as required; again, remember that this will only work for Global Catalog, Configuration, and Schema NCs. For more reliable links, use the standard DS-RPC connector; later in step 10, you can configure the replication times to be suitable to that link.

9.2.9. Step 9: Create Site Link Bridges

If you chose the third option in step 5 and turned off site link transitiveness, you now need to create site link bridges or more site links to satisfy your desire to force the KCC to create its topology along certain paths.

9.2.10. Step 10: Design the Replication Schedule

Now sit down with your entire map and identify in which time windows you will allow replication along the various links. Low-cost links may allow traffic all day. Medium-cost links may allow traffic from late afternoon until early morning, and high-cost links may allow replication windows only at very specific times. It all depends on you. In my mind, there is certainly a split between the high-, medium-, and low-cost link replication schedules that you create. Remember that you must have a common window for replication across all routes.

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9.3. Examples

Having considered the 10 steps, let's take another brief look at the three examples from the previous chapter and see what they will need in terms of sites.

9.3.1. TwoSiteCorp

TwoSiteCorp has two locations split by a 128 Kbps link. This means creation of two sites separated by a single site link, with DCs for domain authentication in each site. The site link cost is not an issue, as only one route exists between the two sites; whether the link cost is set to 1 or 500, you get the same result. Here the only issue is scheduling the replication, which depends on the existing traffic levels of the link. For a slow link like this one, it is best to schedule replication during the least busy times. If replication has to take place all the time, as changes need to be propagated rapidly, it is time to consider increasing the capacity of the link.

9.3.2. RetailCorp

RetailCorp has a large centralized retail organization with 600 shops connected via 64 Kbps links to a large centralized 10/100 Mbps interconnected headquarters in London. In this situation, you have one site for HQ and 600 sites for the stores. RetailCorp also uses a DC in each store. They then have to create 600 high-cost site links, each with the same cost. RetailCorp decides this is one very good reason to use ADSI (discussed in Part III) and writes a script to automate the creation of the site link objects in the configuration. The only aspect of the site links that is important here is the schedule. Can central HQ cope with all of the servers replicating intersite at the same time? Does the replication have to be staggered? The decision is made that all data has to be replicated during the times that the stores are closed; for stores that do not close, data is replicated during the least busy times. There is no need to worry about site link bridges or site link transitiveness as all links go through the central hub, and no stores need to intercommunicate. The administrators decide to let the KCC pick the bridgehead servers automatically.

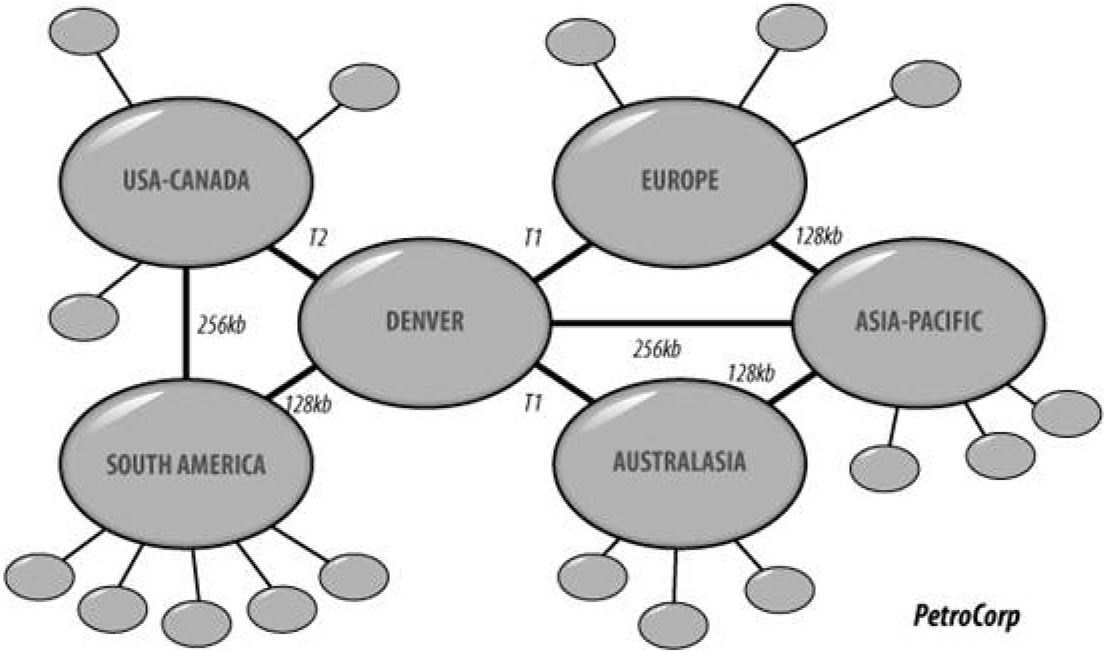
9.3.3. PetroCorp

PetroCorp has 94 outlying branch offices. These branch offices are connected via 64 Kbps links to five central hub sites. These 5 hubs are connected to the central organization's HQ in Denver via T2, T1, 256 Kbps, and 128 Kbps links. Some of the hubs also are interconnected. To make it easier to understand, look at PetroCorp's network again (see Figure 9-8).

Initially, you need to create 100 sites representing HQ, the hubs, and the branch offices. How many servers do you need per site? From the design we made in Chapter 8, we decided on nine domains in the forest. Each of those distinct domains must obviously have a server within it that forms part of the single forest. However, although the description doesn't say so, there is very little cross-pollination of clients from one hub needing to log on to servers from another hub. As this is the case, there is no need to put a server for every domain in every hub. If a user from Denver travels to the asiapac.petrocorp.com domain, the user can still log on to petrocorp.com from the Asia-Pacific hub, albeit much more slowly. PetroCorp sees that what little cross-pollination traffic it has is made up of two types of user:

- Senior petrocorp.com IT and business managers traveling to all hubs.
- Groups of Europe and Australasia users regularly staying at the alternate hub for periods during joint research. This means that europe.petrocorp.com users need to log on in the Australasia hub and australasia.petrocorp.com users need to log on in the Europe hub.

Figure 9-8. PetroCorp's network connections



Although the senior managers' use is infrequent, these key decision makers need to log on as rapidly as possible to access email and their data. Money is found to ultimately place petrocorp.com servers for authentication purposes in each of the five hubs. The second requirement means that servers for each domain need to be added to the alternate hub. Due to this limitation, only enough money is found to support petrocorp.com from outside its own Denver location and the Europe/Australasia hubs hosting each other's domains (see Figure 9-9).

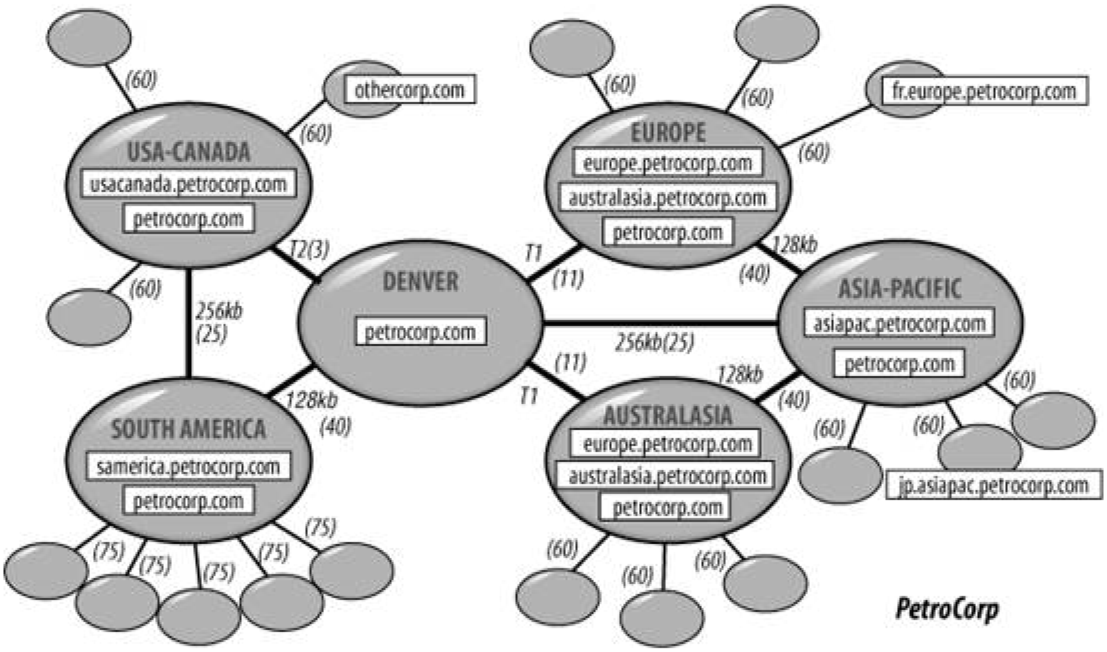
While domains are normally represented by triangles in diagrams, here the rectangular borders around a domain name represent servers that host that domain. Each domain is hosted by multiple servers represented by a single rectangle, although you could run this structure using only one server per rectangle. You can see that petrocorp.com is hosted in Denver, as well as in all other hubs.

Regarding intrasite KCC topology generation: PetroCorp has decided to let the KCC automatically generate intradomain server links. If this causes a problem, local administrators should be able to handle it.

The site links are depicted in Figure 9-9 with parentheses to indicate the costs. They can also be described as follows:

- Create one low-cost (3) DS-RPC site link for the T2 connection.
- Create two medium-cost (11) DS-RPC site links representing the T1 connections.
- Create high-cost DS-RPC site links for the five remaining interhub connections of 256 Kbps (25) and 128 Kbps (40).

Figure 9-9. PetroCorp's sites and servers



What about the branches? All links are stable except the links between the eight South America branches and the hub, which are very unreliable. In this case, you have two choices: you can either let the clients in those eight sites authenticate across the less-than-reliable links, or you can place servers in those branches so that authentication is always possible even when the link is down. PetroCorp opts for the latter and places servers in each of the eight branches.

PetroCorp's administrators then sit back and decide that they are going to create some redundant site links of the same cost, so that if a single bridgehead server is lost in any of the major hubs, replication can still continue. Each hub has enough DCs to cope with this, so they add the redundant links.

Although steps 6, 7, and 8 have been completed, we appear, however, to have skipped steps 4 and 5. Step 5 was left until now on purpose, since the administrators wanted to wait until the site links were designed to see whether site link bridging should be turned off and whether bridging routes might help. Now you can easily see that transitivity is important between the Europe and Australasia hubs. If you don't turn on transitiveness by default, you need to create a site link bridge in Denver that allows the *europe.petrocorp.com* and *australasia.petrocorp.com* domains to replicate across the two T1 links even though they have no direct links.

Now look at the diagram again, and consider that site link bridging is enabled. This means any site can use any connection to any other site based on the lowest cost. So if you leave site link bridging enabled and let the KCC create the intersite connection objects and bridgehead servers, replication traffic between Denver and South America is likely to route through USA-Canada, as the total cost across those two links (28) is lower than the direct link (40). This also is true for Asia-Pacific to either Europe (40) or Australasia (40). All traffic is likely to route through Denver (36) because of that. All that means is that the slow 128 Kbps links will not have their bandwidth used up by replication; instead, the 256 Kbps links will absorb the overflow. In the eastern link, you have potentially added two lots of bidirectional replication traffic across the 256 Kbps link. Whether this is a problem is up to PetroCorp to decide. They have four main choices:

- Turn off transitiveness throughout the network. This forces the KCC to use only directly connected routes to replicate. This forces the use of the 128 Kbps links by default. Now add the site link bridge at Denver as mentioned previously, then add any other site link bridges to enforce using certain routes when the directly connected routes are not to be used for replication.
- Turn off transitiveness throughout the network. This forces the KCC to use only directly connected routes to replicate, which forces the use of the 128 Kbps links by default. Add the site link bridge at Denver as mentioned previously, and add any other site link bridges to enforce use of certain routes when the directly connected routes are not to be used for replication. Finally, turn off the KCC intersite topology generation in key sites where the bridgehead servers need to be handpicked from the available DCs and then create the connection objects manually.
- Leave transitiveness turned on throughout the network, automatically bridge all site links of the same DS-RPC transport, allow the KCC to choose the lowest cost routes, and accept the routes it chooses, controlling it with schedules.
- Leave transitiveness turned on throughout the network, automatically bridge all site links of the same DS-RPC transport, and turn off the KCC intersite topology generation in key sites where the bridgehead servers need to be handpicked from the available DCs, creating the connection objects manually.

Which of these is chosen depends entirely on the traffic use of the links, the requirements on those links, and how much use the administrators wish to make of the KCC. PetroCorp decides that it wants the KCC to make the most of the connections but still wants to retain the greatest control and the potential to force the KCC to use certain routes. To that end, they select the second option.

In the end, the company chooses to bridge South America to Denver via USA-Canada to free up the 128 Kbps link for other traffic. They also choose to bridge Europe to Asia-Pacific via Denver to free up what is currently a congested link. The KCC automatically routes all traffic via Denver, as this bridge cost is lower than the single site link. Finally, the administrators allow the KCC in the Denver site to generate the eight intersite site links (four connections, each with two site links for redundancy) and then turn off intersite generation for that site. They then modify the connection objects created (deleting some and creating others), because they have a number of DCs that they do not want to use for replication purposes within Denver that the KCC picked up and used.

This is a fairly complicated site problem, but one that wasn't difficult to solve. There are many other viable solutions. We could easily have made all the redundant links that we created use the SMTP connector with a higher cost to make sure that they were used only in an emergency. Many options are available to you as well. That's why a design is so important.

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9.4. Additional Resources

Microsoft has produced an outstanding guide for customers setting up a branch office deployment. A branch office deployment is a deployment with a large number of WAN sites that need to be connected. One example of a branch office deployment is a large retail outlet that has a central office and hundreds of retail outlets that are all tied together into the same forest. If you have to deploy this kind of infrastructure, you absolutely need to review the Windows Server 2003 Active Directory Branch Office Guide; you can find it on the Microsoft web site at http://www.microsoft.com/downloads/details.aspx?FamilyId=9353A4F6-A8A8-40BB-9FA7-3A95C9540112.

Bridgehead load balancing is an area that Microsoft greatly improved in Windows Server 2003. Although Windows Server 2003 will better distribute the replication load across multiple domain controllers, the new load-balancing algorithm will only work with new connections that are established so when you add a new domain controller, it will be underutilized for replication connections. Windows 2000, on the other hand, will not spread the load at all, which can create a topology that results in overloaded bridgehead servers in hub sites. Microsoft produced a tool to help with both of these issues. The tool is called the Active Directory Load Balancer (ADLB) and will look at the connection objects for a specified site and evenly spread those connections across all of the DCs in the site that can be used as bridgeheads. ADLB is part of the Windows Server 2003 Resource Kit Tools and is available for download from http://www.microsoft.com/downloads/details.aspx?FamilyID=9d467a69-57ff-4ae7-96ee-b18c4790cffd.

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9.5. Summary

After this chapter, you should have more of an insight into creating the site and replication infrastructure for your own Active Directory network. Having a basic understanding of the replication process (from Chapter 5) and how the KCC operates should allow you to make much more informed judgments on how much control you want to exert over the KCC in your designs. We feel that it is always better to give free reign to the KCC if possible, while maintaining a firm grip over what it has authority to do. While this can seem contradictory, we hope that our explanations on using site link bridges and restricting transitiveness when appropriate show how this is possible in practice.

The next chapter deals with how to update your designs to reflect your requirements for Group Policy Objects in your organization.

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Chapter 10. Designing Organization-Wide Group Policies

This chapter takes an in-depth look at Group Policy Objects (GPOs), focusing on three areas:

- How GPOs work in Active Directory
- How to manage GPOs with the Group Policy Object Editor and Group Policy Management Console
- How to structure your Active Directory effectively using Organizational Units and groups so that you can make the best use of the GPOs required in your organization

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10.1. How GPOs Work

Group policies are very simple to understand, but their uses can be quite complex. Each GPO can consist parts: one that applies to a computer (such as a startup script or a change to the system portion of the r and one that applies to a user (such as a logoff script or a change to the user portion of the registry). Yo GPOs that contain only computer policies, only user policies, or a mixture of the two.

10.1.1. How GPOs Are Stored in Active Directory

GPOs themselves are stored in two places: Group Policy Configuration (GPC) data is stored in Active Dire and certain key Group Policy Template (GPT) data is stored as files and directories in the system volume are split because while there is definitely a need to store GPOs in Active Directory if the system is to asso them with locations in the tree, you do not want to store all the registry changes, logon scripts, and so o Directory itself. To do so could greatly increase the size of your DIT file. To that end, each GPO consists c object holding GPC data, which itself is linked to a companion directory in the system volume that may o have GPTs stored within. The GPT data is essentially a folder structure that stores Administrative Templa policies, security settings, applications available for software installation, and script files. GPT data is stor System Volume folder of DCs in the *Policies* subfolder.

> Third-party developers can extend GPOs by incorporating options that do not reside in th normal GPT location.

The GPO objects themselves are held as instances of the `groupPolicyContainer` class within a single cont Active Directory at this location:

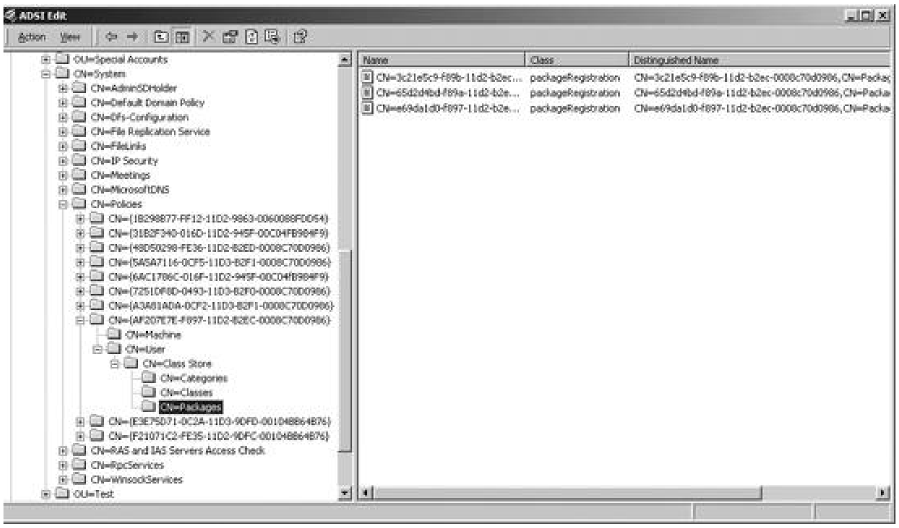
```
CN=Policies,CN=System,dc=mycorp,dc=com
```

Through a process known as linking, the GPOs are associated with the locations in the tree that are to re group policy.[*] In other words, one object can be linked to multiple locations in the tree, which explains GPO can be applied to many Organizational Units, sites, or domains as required.

[*] Any containers that have had group policies linked to them contain a multi-valued attribute called `gPLink` that stores the DNs of the objects.

Let's consider the `groupPolicyContainer` class objects themselves. Take a look at Figure 10-1 ; we are us of the Windows Support Tools utilities, ADSI Edit, to show the view of the Policies container and its childr

Figure 10-1. GPOs in the Policies container



```
OU=Special Accounts
CN=System
  CN=AdminSDHolder
  CN=Default Domain Policy
  CN=Dfs-Configuration
  CN=File Replication Service
  CN=FileLinks
  CN=IP Security
  CN=Meetings
  CN=MicrosoftDNS
  CN=Policies
    CN={1B298877-FF12-11D2-9863-0060088FDD54}
    CN={31B2F340-016D-11D2-945F-00C04FB984F9}
    CN={48D50298-FE36-11D2-B2ED-0008C70D0986}
    CN={5A5A7116-0CF5-11D3-B2F1-0008C70D0986}
    CN={6AC1786C-016F-11D2-945F-00C04fB984F9}
    CN={7251DF8D-0493-11D3-B2F0-0008C70D0986}
    CN={A3A81ADA-0CF2-11D3-B2F1-0008C70D0986}
    CN={AF207E7E-F897-11D2-B2EC-0008C70D0986}
      CN=Machine
      CN=User
        CN=Class Store
          CN=Categories
          CN=Classes
          CN=Packages
    CN={E3E75D71-0C2A-11D3-9DFD-00104B864B76}
    CN={F21071C2-FE35-11D2-9DFC-00104B864B76}
  CN=RAS and IAS Servers Access Check
  CN=RpcServices
  CN=WinsockServices
OU=Test
```

Name	Class	Distinguished Name
CN=3c21e5c9-f89b-11d2-b2ec...	packageRegistration	CN=3c21e5c9-f89b-11d2-b2ec-0008c70d0986,CN=Packag
CN=65d2d4bd-f89a-11d2-b2e...	packageRegistration	CN=65d2d4bd-f89a-11d2-b2ec-0008c70d0986,CN=Packa
CN=e69da1d0-f897-11d2-b2e...	packageRegistration	CN=e69da1d0-f897-11d2-b2ec-0008c70d0986,CN=Packa

Here you can see 10 groupPolicyContainer objects shown with a GUID as the cn field. The displayName a these objects holds the name that administrators of Active Directory would see when using one of the no to view these objects. Each GPO also has a gPCFileSysPath that holds the full path to the corresponding in the system volume.

If you were to look under the Policies container on a default installation, you would find only two children children would correspond to the Default Domain Policy and the Default Domain Controllers Policy , the o created automatically by the system on installation. These GPOs have fixed names across all domains; th Domain Policy is always *{31B2F340-016D-11D2-945F-00C04FB984F9}* , and the Default Domain Controll is always *{6AC1786C-016F-11D2-945F-00C04fB984F9}* .

Looking at Figure 10-1 , you see that the eighth GPO down the list has more children within the User con all the other GPOs. That's because it is a policy to deploy an MSI application to users. In fact, this GPO als entries under the Classes container that we haven't displayed. This particular policy is the one described introduction to Chapter 7 . It applies the Administrator tools MSI file during an administrator-equivalent l install the tools on whatever workstation the administrator happens to log onto. When the policy goes ou scope, it completely uninstalls the tools so that non-administrator users do not have access to them at th computer.

10.1.2. How GPOs Are Used in Active Directory

Any GPO is initially created as a standalone object in Active Directory. Each object can then be linked one times to three different container types: Sites, Domains, and Organizational Units. GPOs for domains and Organizational Units are held in the domain relating to their application, but creating a GPO for a site sto GPO in the forest root domain by default; administrators can change this if they wish.

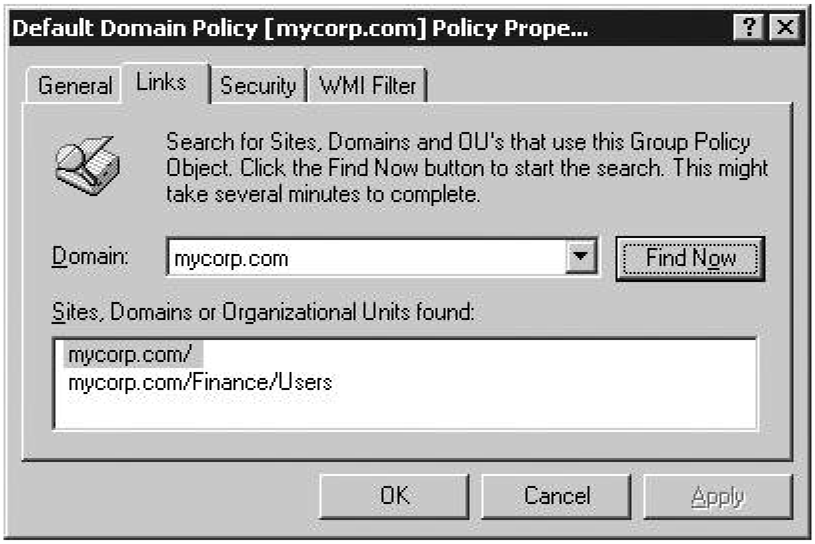
In the normal state of affairs, an administrator would customarily open up the properties of the Site, Dom Organizational Unit, then create a GPO and link it to that container. At this point, it appears that you hav a GPO at that location in the tree rather than what really happened, which was that the system created t as a standalone object in the Policies container and then immediately linked it to that container.

To apply a GPO to a set of users or computers, you simply create a GPO in Active Directory and then link Site, Domain, or Organizational Unit. Then by default, the user portion of the GPO will apply to all users i container and any subcontainers, and the computer portion of the GPO will apply to all computers in the c and any containers beneath it.

Thus, if we were to create a policy and link it to a site or domain, all computers and users of that site or d respectively, would get the policy. If we were to create a policy and link it to an Organizational Unit, all us computers in that Organizational Unit and all the users and computers within Organizational Units beneat Organizational Unit (and so on down the tree) would get the policy.

To identify the links on a GPO, you simply look at the Links tab of the GPO's properties in the Group Polic Editor (GPOE). Figure 10-2 shows the results of a scan for the locations in the domain where the Default Policy GPO has been linked. It seems that Mycorp has chosen to link the Default Domain Policy to a locati down the tree as well, the Users Organizational Unit within the finance Organizational Unit, within the *my* domain.

Figure 10-2. Identifying GPO links


Default Domain Policy [mycorp.com] Policy Prope...

Search for Sites, Domains and OU's that use this Group Policy Object. Click the Find Now button to start the search. This might take several minutes to complete.

Domain: mycorp.com

Sites, Domains or Organizational Units found:

mycorp.com/
mycorp.com/Finance/Users

We want to make three major points here:

- GPOs apply only to sites, domains, and Organizational Units.
- A single GPO can be linked to multiple locations in the tree.
- GPOs by default affect all of the users and computers in a container.

This generates further questions. If multiple policies apply to different locations in a tree, can multiple GP to the same container, and if so, what takes precedence? Why would you want to apply one GPO to differ of the tree? In addition, how can we stop the GPO from applying to the entire set of users and computers container? Let's consider each of these questions to understand policies better.

10.1.3. Prioritizing the Application of Multiple Policies

Let's say that we set a GPO for all users in a site to run a logon script that executes a news system local site. Let's also say that we set a domain GPO to set the My Documents folder location for each user. Fina have two user logon scripts that we need to run in a specific order for specific Organizational Units in tha GPOs are applied in a specific order; this order is commonly called SDOU. Site policies are applied first, th domain policies, and then finally OU policies are applied in the hierarchical order they are applied. If multi are linked to a single site, domain, or Organizational Unit, the administrator can prioritize the order in wh GPOs from that level are applied. So in this scenario, the site news system runs first, then the My Docum settings are applied, and finally the two logon scripts are applied in the order determined by the administ

To account for this, the GPOs for the site that the object resides in are applied first in prioritized order. N sites have any influence over this. Then, the GPOs for the domain that the object resides in are applied ir prioritized order. GPOs applied to parent domains in the domain tree have no influence on objects in dom lower down the tree. Domain trees do not impact GPO application at all. The Organizational Unit structure however, has a significant bearing on what happens with GPOs. GPO links are inherited down the tree. So child Organizational Unit can have its own GPOs linked to it, it also will inherit all of its parent's GPO links Organizational Unit GPOs are applied in order according to the Organizational Unit hierarchy once the site domain GPOs have been applied.

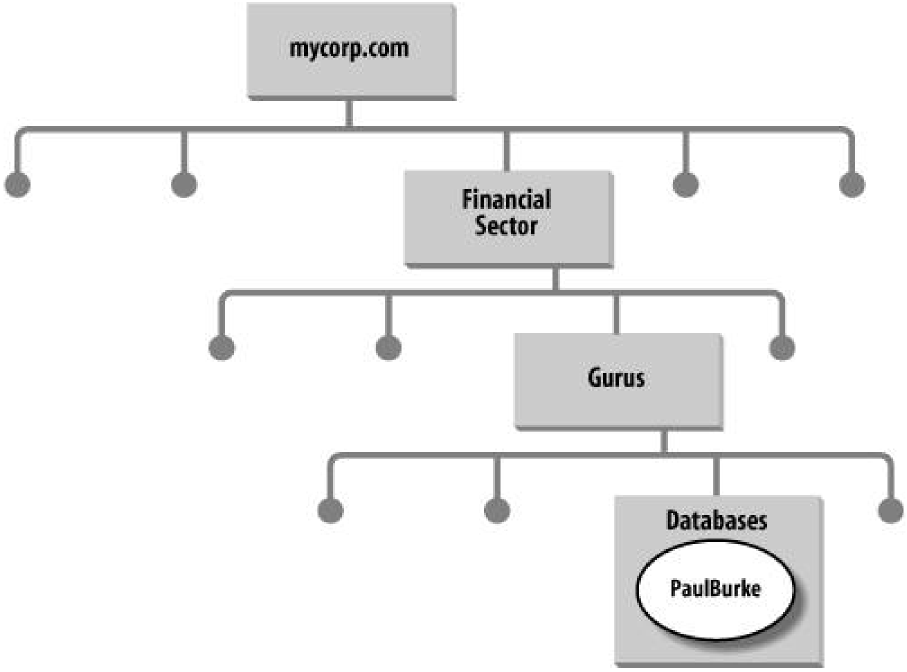
> There are exceptions. You can block inheritance, force an override, and even define ACLs on objects. We'll cover all these topics later in this section.

For example, Paul Burke has the following DN to his account (see Figure 10-3):

```
cn=PaulBurke,ou=Databases,ou=Gurus,ou=Financial Sector,dc=mycorp,dc=com
```

The site GPOs are applied first, and the *mycorp.com* domain GPOs are applied next. Then come the GPOs Financial Sector Organizational Unit, the GPOs on the Gurus Organizational Unit, and the GPOs on the Da Organizational Unit. From this, it's fairly easy to see how Organizational Unit hierarchy design has a signi effect on GPO precedence.

Figure 10-3. Graphical representation of the location of the Paul Burke



Remember that GPOs have a computer part as well as a user part. When a computer boots, any site GPC have computer settings are applied in prioritized order. This is followed by any domain GPOs with comput settings, and so on down the Organizational Unit hierarchy until any GPOs on the Organizational Unit tha computer resides in are applied. During boot up, the user portions of these GPOs are ignored. Later, whe logs on, the same process applies, this time with the user settings. The computer settings are ignored du logon.[*]

[*] This is the default case. There is a setting that you can use to force a different mode of operation. We'll explain this later when we co mode.

> There are several policies that can only be set on the Domain Level Policy. These policies are the ones that affect account settings for the domain users, such as the Kerberos poli Lockout policy, Password Aging, and Complexity policy. No amount of blocking or priority setting will allow you to set different users in a single domain with different account polic settings. You can, however, set the lockout and password aging/complexity settings at th OU level to affect local machine accounts on servers and workstations.

10.1.4. Standard GPO Inheritance Rules in Organizational Units

Any unconfigured settings anywhere in a GPO can be ignored since they are not inherited down the tree; configured settings are inherited. There are three possible scenarios:

- A parent has a value for a setting, and a child does not.
- A parent has a value for a setting, and a child has a non-conflicting value for the same setting.

- A parent has a value for a setting, and a child has a conflicting value for the same setting.

If a GPO has settings configured for a parent Organizational Unit, and the same policy settings are uncon for a child Organizational Unit, the child inherits the parent's GPO settings. That makes sense.

If a GPO has settings configured for a parent Organizational Unit that do not conflict with a GPO on a chil Organizational Unit, the child Organizational Unit inherits the parent GPO settings and applies its own GP well. A good example of this is two logon scripts; these scripts don't conflict, so both are run.

If a GPO has settings configured for a parent Organizational Unit that conflict with the same settings in a GPO configured for a child Organizational Unit, the child Organizational Unit does not inherit that specific setting from the parent Organizational Unit. The setting in the GPO child policy takes priority, although th case in which this is not true. If the parent disables a setting and the child makes a change to that settin child's change is ignored. In other words, the disabling of a setting is always inherited down the hierarch

10.1.5. Blocking Inheritance and Overriding the Block in Organizational Unit

It is possible to force the settings of a GPO to be applied as the final settings for a child.

Blocking inheritance is a fairly simple concept. If you block inheritance to a specific Organizational Unit, G linked to parent Organizational Units up the tree are not applied to objects in this specific Organizational children.

> LGPOs (Local GPOs, discussed shortly) are processed even when Block Policy Inheritance checked.

Refer back to Figure 10-3 . If we decide to block inheritance at the Databases Organizational Unit, Paul B receive only GPOs directly defined on the Databases Organizational Unit. If we decide to block inheritance Gurus Organizational Unit, Paul Burke will receive only GPOs on the Databases Organizational Unit and th inherited from the Gurus Organizational Unit. The Organizational Unit that you block inheritance at stops higher-level GPOs from applying to the branch starting at the blocked Organizational Unit. In fact, we ca inheritance on any of the Organizational Units within the *mycorp.com* domain. For example, blocking inhe on the Financial Sector Organizational Unit makes sense if we want to block site-level GPOs from applyin

This can cause problems if not carefully managed. For example, let's say that you have delegated control Organizational Unit branch to a group of administrators and allowed them access to manipulate GPOs on branch. You may be applying GPOs to Organizational Units farther up the hierarchy that you wish this de branch to receive. However, your branch administrators have the ability to block inheritance of these par Organizational Unit policies of yours. The branch administrators also have the ability to configure a settin conflicts with one you set in a parent GPO; the branch administrator's child setting will take precedence i conflicts.

To prevent this, you can check the Enforce (or No Override) option on an individual GPO. This allows administrators to force GPOs to be inherited by all children of an Organizational Unit. However, it has one effect: it prevents GPO settings in child Organizational Units from overriding conflicting settings in a pare

Let's say that we change a registry setting using a GPO on the Financial Sector Organizational Unit. Unfo another administrator then sets the same registry setting (among many others) to a conflicting value on Organizational Unit and also blocks inheritance at the Databases Organizational Unit. By default, the regi setting will be correctly applied only to the Financial Sector Organizational Unit, as the Gurus Organizatio receives the different setting (child overrides parent on conflicts due to inheritance rules), and the Databa Organizational Unit doesn't inherit either policy. To fix both problems, we could set the original Financial S Organizational Unit policy to No Override. It then prevents the specific setting on the GPO on the Gurus Organizational Unit from modifying it without affecting any of the other GPO settings. Our GPO also is for past the Block Inheritance set up at the Databases Organizational Unit.

> If you perceive a trust issue in who can modify a given policy, it is suggested that you consider setting up an ACL on that policy to restrict the abilities of others to edit that GP(leaving just a core group of administrators with the relevant permissions. This will ensure that the GPO is not changed without the knowledge of the core group. Of course, the cor issue is allowing anyone to have access to make any changes that you do not implicitly trust. Trying to secure bits and pieces from administrators you don't trust is a losing batt If you do not trust someone to be an admin, he shouldn't be one.

10.1.5.1. Summary

- If Block Inheritance has been checked for a child-level GPO, and No Override has not been checked parent GPOs , the child GPO will not inherit any policies from any parent GPOs farther up the hierar
- If No Override has been checked for a parent-level GPO, the child-level GPO will inherit all of the pa configured policies, even if those policies conflict with the child's policies, and even if Block Inheritar been set for the child.

10.1.6. When Policies Apply

We've already said that the computer portion of a GPO applies during boot up and the user portion of a G applies during logon. However, that isn't the only time that a policy can apply. The policies also can be se refresh periodically after a certain time interval. How often this occurs and what conditions are attached t refresh operation are specified under the System\Group Policy key under the Administrative Templates se the computer and user sections of a GPO.

Set the refresh value to 0 to have the policy continually apply every seven seconds. This is very useful for environment but obviously not for a live service.

> For Windows 2000, you also can manually refresh policies on a client using the *SECEDIT.E* tool with the command `SECEDIT /refresh-policy` . Windows XP and Windows Server 200 have a utility called *GPUPDATE* that can accomplish the same thing. If any policies were modified that can only be applied at computer startup or user logon, *GPUPDATE* will ask i you want to do so. Windows XP and Windows Server 2003 also have a tool to display deta on what policies are applied called *GPRESULT* .

Refreshing is very useful for users who do not shut down their computers or log off from the system for d that case, GPOs apply in the normal way, but at very irregular intervals over long periods. Consequently, up policy refresh means that you can manage to apply those settings to such users at whatever interval y decide.

10.1.7. Local Group Policy Objects

Windows 2000 and later machines have their own Local Group Policy Objects, known as LGPOs or Local S Policies . LGPOs are applied prior to any GPOs on the site, but they have restrictions in that they can con security settings, software policies, and scripts. File deployment and application deployment are not avail LGPOs.

> LGPOs are applied before site GPOs . This is normally represented by the string LSDOU.

While GPOs consist of two parts, the Active Directory object and the templates in the system volume (SY LGPOs consist of only the template portion. These templates cannot be stored in the system volume beca concept does not exist on the local machine. Instead, the LGPO templates are stored in *%systemroot%\System32\GroupPolicy* . These ADM files can be added to and extended in much the sar standard GPOs; see http://www.microsoft.com/technet/prodtechnol/windowsserver2003/technologies/management/gp/adm .

LGPOs are very useful in environments in which no DCs exist and Windows NT system policies failed to de their use in enterprise organizations is likely to be quite limited. In some cases, LGPOs will be useful if an administrator requires a machine-specific policy to execute before all others or if a domain client is not to any domain GPOs, but mostly their use is confined to standalone environments.

> LGPOs are processed even when Block Policy Inheritance is checked.

If conflicts occur on a domain client with an LGPO and subsequently applied Active Directory GPOs, the A Directory GPO prevails over the original LGPO.

10.1.8. How Existing Windows NT 4.0 System Policies Affect GPO Processin

Windows NT 4.0 system policies were useful in making sure that a setting was applied with a specific valu somewhere in the registry. These policies dotted the registry with settings throughout its structure and w known as tattooing the registry. Once these settings were applied, to unset them the administrator had t edit the registry or create another policy to force the different settings to the system. By default, ordinar also had the ability to change registry settings in the user portion (HKCU) held in their profile, so they cou unset values that the administrator wished to be firmly set.

To counteract this and bring all the policy settings under one roof, so to speak, Windows 2000 and later w designed so that the GPOs exist as registry keys and values in locations that are restricted to administrat These locations are:

- *HKEY_CURRENT_USER\Software\Policies*

- *HKEY_LOCAL_MACHINE\Software\Policies*
- *HKEY_CURRENT_USER\Software\Microsoft\Windows\CurrentVersion\Policies*
- *HKEY_LOCAL_MACHINE\Software\Microsoft\Windows\CurrentVersion\Policies*

The first two keys are the preferred locations for all new policies. An administrator can specify that a valu
in a user's registry and then reset on a regular basis. Any settings that users have set themselves will be
overwritten by the proper administrator-set values. However, administrators can still import any ADM file
modify keys throughout the registry as they wish. It is up to administrators to make sure that the policy
reapplied regularly or is in a part of the registry to which the user has no access, unless they wish the us
able to change the registry permanently.

10.1.9. When to Use Windows NT System Policies

During an upgrade, Windows NT system policies that reside in the *NETLOGON* share will be transferred tc
controller's *NETLOGON* share (located in the *SYSVOL* structure). However, only Windows NT and Window
down-level clients will use these policies; Active Directory clients will not use them. Active Directory GPOs
affect down-level clients at all.

If you have down-level clients that need policies applied to them, whether these policies already exist or
be created from scratch, you need to fall back on the old system policies that were provided for use on th
systems. You cannot use the Group Policy Object Editor to administer these older policies, so you will nee
the old System Policy Editor (*poledit.exe*) tool that has been reissued with Windows 2000 and later client
manipulate such policies. The POL files generated by the System Policy Editor will still need to be placed i
NETLOGON share as they were under previous versions of Windows NT.

There is one benefit to administrators who have been using system policies to administer down-level clier
some time: while the system policies themselves are not transferable, GPOs can be extended using ADM
the exact format. This means that administrators can migrate their old template files over from system p
GPOs as required.

> If you have any system policy functionality that you wish to apply to your Windows 2000
> later clients, you will have to re-implement your system policies as GPOs because system
> policies are not upgraded when migrating to Active Directory.

We don't intend to cover system policies any more here since there are a number of white papers and ot
documents within Microsoft's Knowledge Base at http://support.microsoft.com that do the job very well.
way to find them is to search for the string "System Policies."

Windows NT System Policies

Windows NT provided a tool called System Policy Editor (*POLEDIT.EXE*) that was installed with the resource kit. This was a very basic graphical tool that allowed you to manage three types of policies: computer, user, and group. By default, the only two policies were Default User and Default Computer.

Do not confuse the Default User policy with the Default User profile; they are not the same thing at all.

If you decided that your entire organization would have only one set of policies for everyone, you would simply modify the Default User and Default Computer policies. Whenever a client booted in your organization, it would retrieve the Default Computer policy and lock itself down (or unlock itself) according to that policy. Whenever a user logged on to that client, the Default User policy would apply and lock or unlock the settings for that account.

The default policies basically allowed you to lock down the desktop settings of the machine based on a series of template files, also known as ADM files. It was always possible to create your own ADM files or to modify the existing ones with settings that corresponded to registry changes you wanted to make. If you created a new file, you just imported it into the tool and could then start applying the policy.

If you did not want just one policy for every computer and user in your organization, you could create policies for individual users, computers, or groups. When a client booted or a user logged on, the system would determine, according to a set of rules, which of the policies would apply to that computer or user. Only one policy was ever applied to a user or computer.

10.1.10. Combating Slowdown Due to GPOs

If you apply too many policies, there will be slowdowns. But there are no good guidelines for how many p apply. We can tell you that in a lab environment, we saw a slowdown when we started applying more tha policies. Unfortunately, that data is of absolutely no use to you. Read on to see why.

10.1.10.1. Limiting the number of GPOs that apply

The problem with trying to test the impact of GPOs on speed of the client during boot up and logon is tha possible only by direct testing. We would not advocate taking our value as a hard and fast rule. Each poli be identified, opened, read to see if it applies, actually applied, and finally closed before moving on to the policy. This process, which is done automatically by the system, will take time. So executing three policie with changes each will be slower than implementing one

How Policies Apply to Clients with Different Operating Systems

If you have a Windows NT 4.0 client in a workgroup or a domain, the only policies that can apply are down-level Windows NT 4.0 policy (POL) file policies.

If you have a standalone Windows 2000, Windows XP, or Windows Server 2003 client or member server, policies are evaluated in the following order:

- Down-level Windows NT 4.0 policy (POL) file
- Local GPO

If you have a Windows 2000 or later client or member server in a mixed-mode or Windows Server 2003 Interim domain, policies are evaluated in the following order:

- Down-level Windows NT 4.0 policy (POL) file
- Local GPO
- Site GPOs in priority order
- Domain GPOs in priority order
- Organizational Unit GPOs in priority order, applied in a hierarchical fashion down the tree ending with the Organizational Unit that the computer or user resides in

As this extends the LSDOU process to include Windows NT 4.0 system policies, this process is commonly written as 4LSDOU.

If you have a Windows 2000 or later client or member server in a Windows 2000 native-mode or Windows Server 2003 domain, policies are evaluated in LSDOU order.

policy with 60 settings. We arrived at the value of 12 by using a series of tests with large and small policie test domain in our lab environment. Without knowing what settings were in the policies, the layout of the the specification and bandwidth capabilities of our clients and servers, and so on, that data is of little use Even if we provided it, there is little chance that it would be similar to your layout, so you'll need to do yc testing to work out what's acceptable. Lab test simulation is really the best way to get a feel for how the that you want to deploy will impact your clients.

Microsoft has its own take on designing your Active Directory for GPOs. They recommend that you shoulc Organizational Unit structures more than 10 deep so that policies do not take too much time during logon. advice is still only half helpful, and we'll come back to it in the design section later.

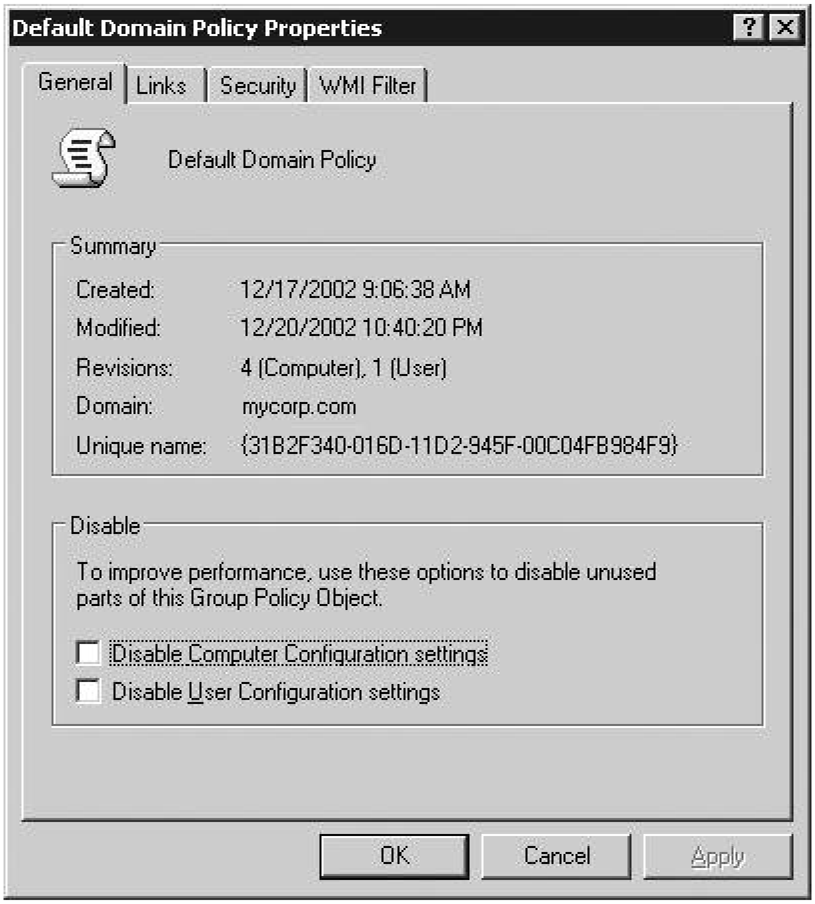
10.1.10.2. Block Inheritance and No Override

If you use either Block Inheritance or No Override/Enforced, you incur extra processing. For this reason, should be cautious in their use.

10.1.10.3. Disabling parts of GPOs

There is another way to speed up policies. Let's say that you have an Organizational Unit that has three p
it: a computer startup script, a computer shutdown script, and a user logon script. Let's also say that you
need for three policies rather than one, perhaps because they are applied elsewhere in the Organizationa
hierarchy as well. When a user in your Organizational Unit logs on, the system will attempt to apply any u
settings from all three GPOs. We know that two of the policies have no relevance whatsoever to a user. W
be a nice touch to have some way to tell the system not to bother processing the user portion for GPOs t
only with computer data and vice versa. In fact, this is a very simple process. Just look at the properties
and check one box or the other in the General tab, as shown in Figure 10-4 .

Figure 10-4. Disabling part of a GPO



Default Domain Policy

Summary

Created: 12/17/2002 9:06:38 AM
Modified: 12/20/2002 10:40:20 PM
Revisions: 4 (Computer), 1 (User)
Domain: mycorp.com
Unique name: {31B2F340-016D-11D2-945F-00C04FB984F9}

Disable

To improve performance, use these options to disable unused parts of this Group Policy Object.

☐ Disable Computer Configuration settings
☐ Disable User Configuration settings

With all the settings in a GPO, browsing both user and computer parts of the tree to see if each part was
whether any changes had been made would normally be a lengthy process. However, Microsoft has thou
this, and as Figure 10-4 shows, the revisions indicate exactly how many changes have been made to the
guides you in whether to disable or enable parts of a GPO.

GPOs with no revisions in a section are skipped; disabling part of the policy stops the need to check the r level and thus can partially speed up the process.

10.1.10.4. Limiting cross-domain linking

It is possible for an administrator of one domain to create a GPO and for it to be applied to an SDOU in ar domain. For example, if the administrator of *othercorp.com* is given access to centralized setup GPOs wit *mycorp.com* , he can link the *mycorp.com* GPOs to SDOUs in the *othercorp.com* domain.

While this is feasible, it is not normally recommended due to network bandwidth considerations, since the in Active Directory and the templates in the system volume need to be read on the remote domain. Norm better to consider duplicating the GPO in the second domain instead of cross-domain linking to it. Howeve links between the domains are as fast and reliable as the links within the second domain that is to receive policy, and if the domain holding the GPO can apply it to the user or computer fast enough to make the administrator happy, there is nothing stopping you from doing this.

10.1.10.5. Limiting GPO application across WAN links

This shouldn't be a problem if you set up your site configuration correctly, but you need to be aware of th implications nonetheless.

Data on GPOs linked to site objects is copied to all DCs in a forest because site information is part of the Configuration container that is replicated to all DCs in all domains in the entire forest. So any GPO linked object is applied to all machines in that site regardless of which domain in the forest they are in.

However, while multiple domains receive the link information, those same domains do not receive the en itself. Instead, the GPO resides in one domain, and clients in the site read the GPO from that domain as r

In the normal course of events, this shouldn't be a problem since a site is supposed to be an area of well connected subnets. A site hosts three domainsDomain A, Domain B, and Domain C; Domain A holds the s itself, and clients of all three domains will access the GPO from Domain A. If you use site GPOs and the si slow WAN links (which it shouldn't do), you will cause GPOs to be accessed across those links.

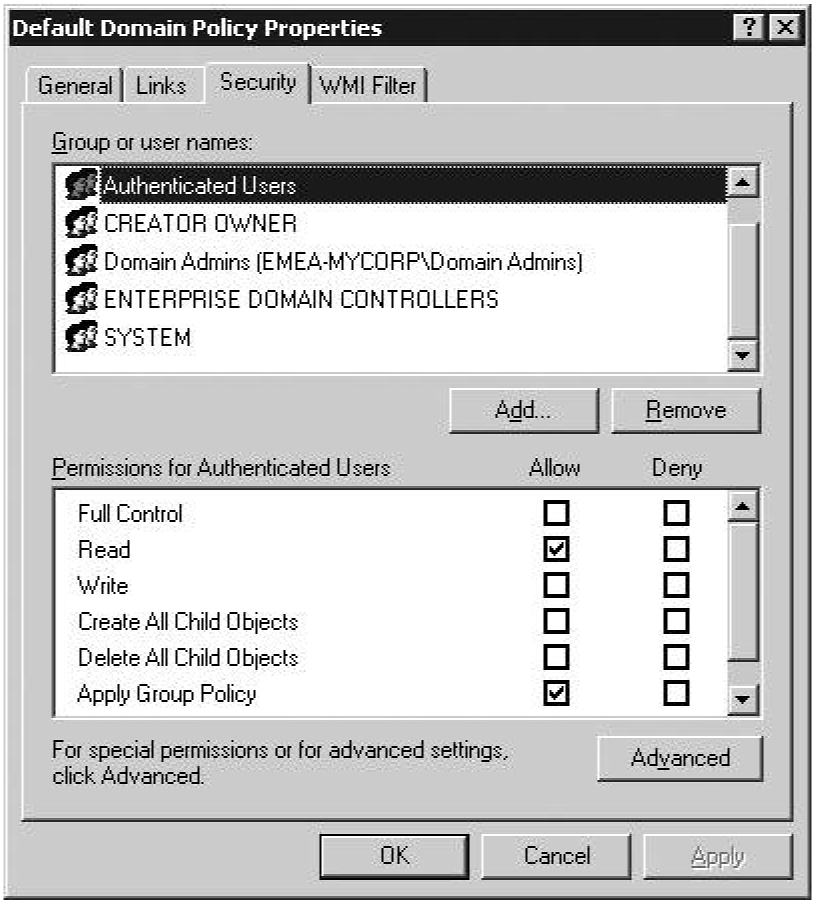
10.1.10.6. Use simple queries in WMI filters

If you have a WMI filter applied to a GPO, a WMI query will be run before the GPO is applied to a user or computer. If the WMI query is very complex, it could significantly impact the time it takes to process the you have multiple GPOs that contain a WMI filter, you need to pay special attention to the impact those q will have.

10.1.11. The Power of Access Control Lists on Group Policy Objects

As each GPO is an object in Active Directory, and all objects have Access Control Lists (ACL) associated w it follows that it must be possible to allow and deny access to a GPO using that ACL. With ACLs , it is poss allow and deny access to GPOs based on security group membership. It is also possible to go to an even grained detail and set access control for an individual computer or user. Figure 10-5 shows us that the sy security group called Authenticated Users will be able to read and apply the Group Policy. If we unchecke Apply Group Policy checkbox, the Authenticated Users group would not receive this policy.

Figure 10-5. Access control entries for a GPO



Group or user names:

- Authenticated Users
- CREATOR OWNER
- Domain Admins (EMEA-MYCORP\Domain Admins)
- ENTERPRISE DOMAIN CONTROLLERS
- SYSTEM

Permissions for Authenticated Users	Allow	Deny
Full Control	□	□
Read	☑	□
Write	□	□
Create All Child Objects	□	□
Delete All Child Objects	□	□
Apply Group Policy	☑	□

For special permissions or for advanced settings, click Advanced.

This is a significant feature of GPOs, and one that you can use heavily to your advantage. Let's take a sin example, in which we create a single GPO to roll out an internal application and link it to the Finance and Organizational Units in one domain. Now all users in the Finance and Marketing Organizational Units will r that application via the GPO on logon. Let's also say that certain users from both Organizational Units are receive this application. All we need to do is create a security group to hold that user subset and set up a Control Entry (ACE) to the Application Deployment GPO and check the Deny Apply Group Policy checkbox every user that we make a member of that new security group will not receive the policy.

> Deny always overrides Allow. Let's say a user or computer is a member of four security groups. If a GPO has an ACL that contains an ACE for the individual user or computer wi Read and Apply rights, an ACE for three of the security groups that have Read and Apply rights, and an ACE for the fourth security group that has Apply rights denied, the GPO wi not be applied.

This has practical applications, too. At Leicester University, they maintain a separate Organizational Unit for the computer objects. On the open-area lab machines, where students from anywhere around the uni can log on, they maintain tight security. Each computer in that lab has a corresponding computer accoun an Organizational Unit that represents that lab. Two GPOs are created and linked to that single Organizat

Unit; one GPO locks down that machine tightly, and the other GPO unlocks it. In other words, they set tw completely conflicting GPOs to act on the same Organizational Unit. Normally that would be plain silly, bu they use two security groups that already exist to give one security group access only to the lockdown GI one security group access only to the unlock GPO. Whenever they create computer accounts in that Orga Unit, they place the computers in the lockdown security group. That means the computers in that securit automatically receive the lockdown policy. If they decide that they need to do work in that lab and wish a particular client, or all clients, unlocked, all they do is make the relevant computers members of the unlo security group and finish off by rebooting them or waiting for a refresh. As long as they never place a cor object in both groups, the client is either locked or unlocked depending on its group memberships.

This is a good demonstration of how you can make use of conflicting GPOs on a single Organizational Uni solely on permission granted by the ACLs to those GPOs, one of the most important aspects of GPOs.

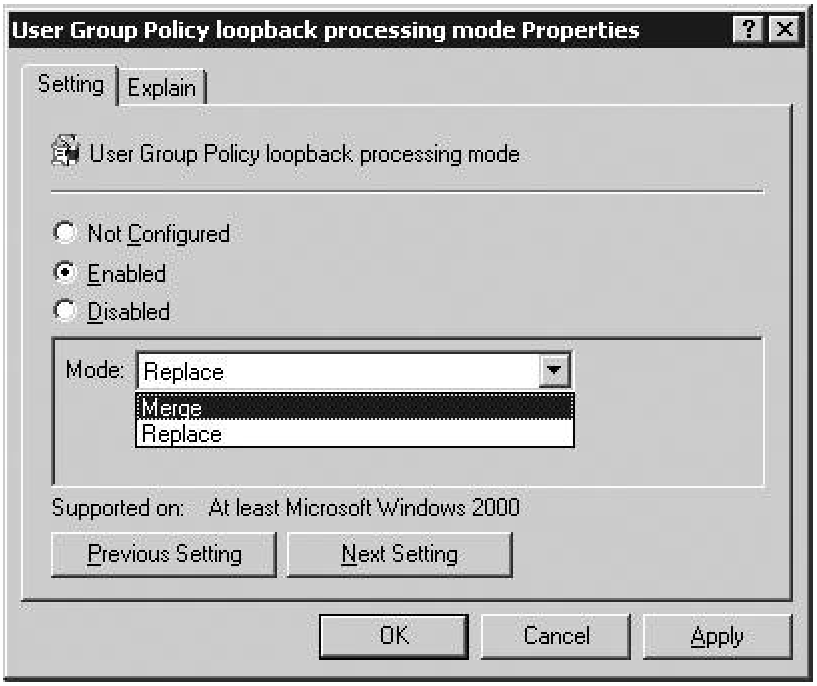
10.1.12. Loopback Merge Mode and Loopback Replace Mode

Loopback mode is a specially configured GPO option that allows you to apply the user portion of a GPO to based on the computer logged in to. For example, imagine we have a suite of public kiosks in the foyer o organization to give outsiders information about the company. Company employees can also use these d they want to check email quickly on their way in or out. Because literally anyone in the building can use t we need a lot of security. We don't want those kiosks to allow company employees to have all the privile permissions that they normally would at their desktop devices; we want them to be able to use only ema we can do is tie a set of user restrictions into the user portion of a GPO that sits on the Organizational Ur holds the computer objects. Then employees are locked down at the kiosks and nowhere else. This effect allows us to restrict what employees can do to their own settings on a per-machine basis.

Many administrators can see the use of this setting in certain environments and for certain situations. Ta of machines in a university where staff accounts are to be locked down like student accounts while the sta members are in the lab, but not when they are at their private machines. As a final example, consider tha Finance Organizational Unit users have a lot of deployed applications specific to Finance. These applicatio work only when accessed from the finance computers and not from anywhere else. So you would put the deployed applications into the computer section of GPOs that apply to the Finance Organizational Unit. Ho you also deployed to finance users (via the user portion of a GPO) applications that were supposed to roa the users everywhere except in sales and marketing, you could use loopback mode to stop the applicatio being advertised specifically in those two Organizational Units.

Loopback mode can be found in the Group Policy settings of the computer portion of any GPO (i.e., Comp Configuration ⟶ Administrative Templates ⟶ System ⟶ Group Policy ⟶ User Group Policy loopbac processing mode). If you open that item, you get the dialog box shown in Figure 10-6 , which allows you between the two modes of loopback operation: merge mode and replace mode.

Figure 10-6. Setting loopback mode



User Group Policy loopback processing mode Properties

User Group Policy loopback processing mode

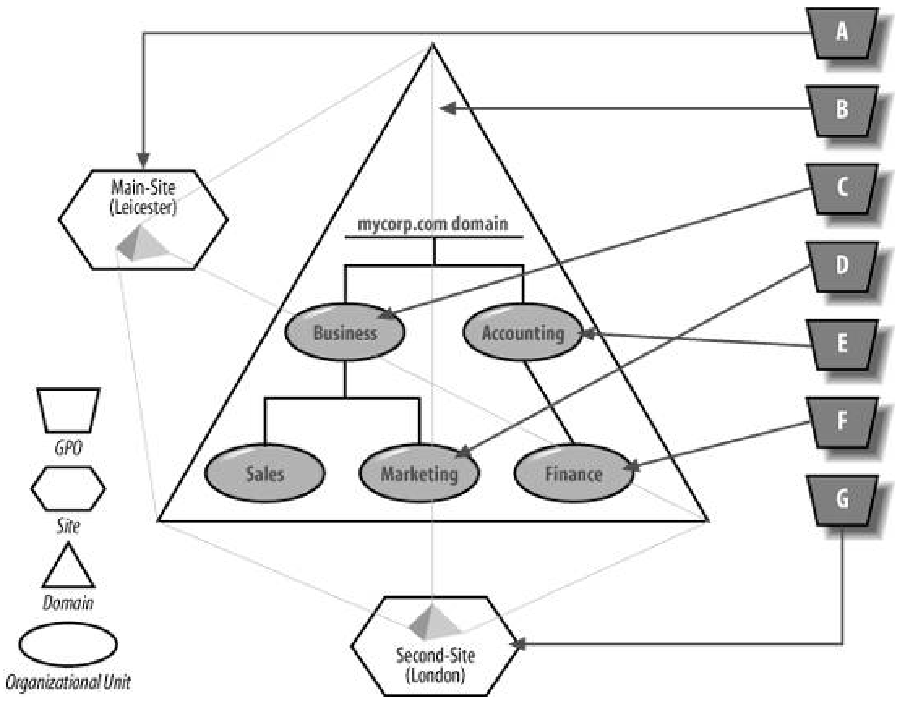
○ Not Configured
● Enabled
○ Disabled

Mode: Replace

Supported on: At least Microsoft Windows 2000

When a user logs on to a machine that uses loopback merge mode, the user policies are applied first as r the user portion of any GPOs that apply to the computer are applied in sequence, overriding any of the p user policies as appropriate. Replace mode, by contrast, ignores the GPOs that would apply to the user a applies only the user portions of the GPOs that apply to the computers. Figure 10-7 illustrates this.

Figure 10-7. Loopback mode processing



In Figure 10-7 , the domain *mycorp.com* spans two sites, Main-Site and Second-Site. Marketing compute Main-Site, and finance computers in Second-Site. Policy A applies to Main-Site only, Policy B applies to th domain, and C, D, E, and F apply to the Organizational Units as indicated. Policy G applies to Second-Site

Table 10-1 summarizes the position. When loopback is not turned on, the only real difference comes from policies (A or G) that are applied. When you turn merge mode on for all the GPOs, it becomes more obvic will happen. In each case, the policy relating to the user is applied first in order, followed by the entire se items that would apply to a user residing in the computer location. Take the example of a finance user lo at a marketing computer in the main site. The Finance user first has the user portion of the site policy tha logging on from applied (A), followed by the user portion of the domain policy (B), the user portion of the Accounting Organizational Unit (E), and the user portion of the Finance Organizational Unit (F). After this portion of the site (A) is applied again, followed by the user portion of the domain policy (B), the user por the Business Organizational Unit (C), and finally the user portion of the Marketing Organizational Unit (D)

Table 10-1. Resultant set of policies for available loopback modes

Loopback mode in use	Organizational Unit in which user resides	Where computer resides	Resultant se policies
No	Marketing	`OU=marketing` (main site)	ABCD
No	Finance	`OU=finance` (second site)	GBEF
No	Marketing	`OU=finance` (second site)	GBCD

Loopback mode in use	Organizational Unit in which user resides	Where computer resides	Resultant se policies
No	Finance	OU=marketing (main site)	ABEF
Merge	Marketing	OU=marketing (main site)	ABCDABCD
Merge	Finance	OU=finance (second site)	GBEFGBEF
Merge	Marketing	OU=finance (second site)	GBCDGBEF
Merge	Finance	OU=marketing (main site)	ABEFABCD
Replace	Marketing	OU=marketing (main site)	ABCD
Replace	Finance	OU=finance (second site)	GBEF
Replace	Marketing	OU=finance (second site)	GBEF
Replace	Finance	OU=marketing (main site)	ABCD

Remember that later policies can override earlier policies, so the user portion of the policies applying to t location of the computer will always override previous policies if there is a conflict. With policy order ABEF can override C, which can override B, which can override A, which can override F, and so on. Also, in all t cases, if any of the computer GPOs do not have any defined settings in the user portion, the policy is ign

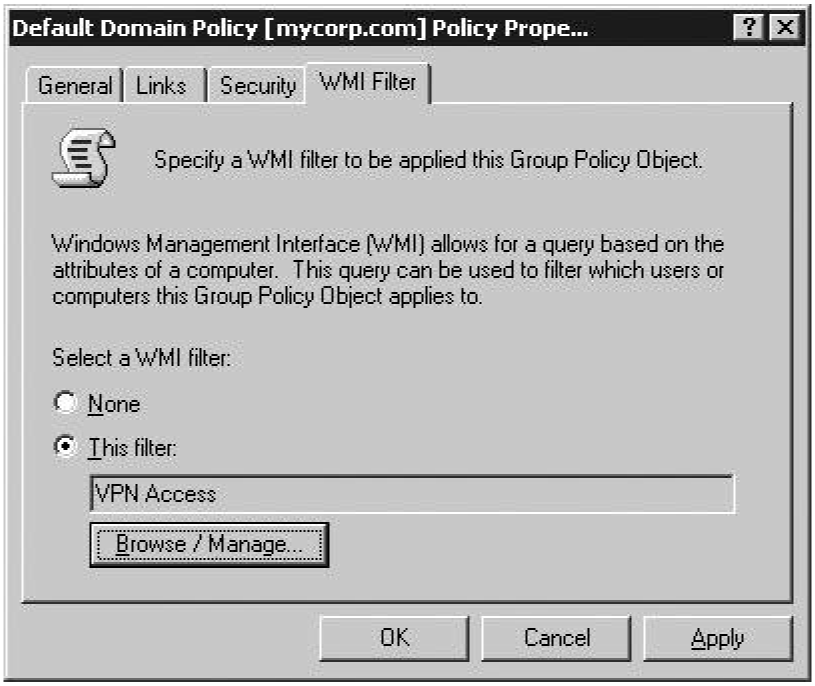
Loopback replace mode is used when the user portion of the GPOs that apply to a computer are to be the ones set. For the finance user logging on to a computer in marketing in the main site, the only policies th applied to that user are ABCD, the user portions of the GPOs that apply to the marketing computer.

> Administrators must be aware that loopback mode can impose a significant amount of extra load on the processing at the client, especially when using loopback in its merge mode.

10.1.13. WMI Filtering in Windows Server 2003

Microsoft has added a powerful new GPO filtering option in Windows Server 2003 Active Directory called W Management Interface (WMI) filtering. With WMI filtering, you can associate a WMI query with a GPO, wh run for each user and computer that the GPO applies to. A WMI filter can utilize any WMI-based informat accessible from the client's machine, including computer hardware and configuration, user profile, and environment settings. This presents a lot of options for targeting GPOs to clients that have certain proper example, let's say you want to apply a certain GPO if a client is accessing your network over VPN. Depen which VPN software the client is running, your WMI query could check for the existence of a process or se even an IP address range. If the query returns true, the GPO will be applied; if it returns false, it will not Figure 10-8 shows the screen in the Group Policy Object Editor that allows you to configure a WMI filter.

Figure 10-8. WMI filter setting



Default Domain Policy [mycorp.com] Policy Prope...

Specify a WMI filter to be applied this Group Policy Object.

Windows Management Interface (WMI) allows for a query based on the attributes of a computer. This query can be used to filter which users or computers this Group Policy Object applies to.

Select a WMI filter:

○ None

● This filter:

VPN Access

> Windows 2000 clients ignore WMI filtering; they will apply a particular GPO regardless of whether they meet the requirements of any filters that have been defined. WMI filtering only be used to limit the scope of GPO processing on Windows XP and later systems.

10.1.14. How GPOs Work Across RAS and Slow Links

GPOs and even user profiles can still work across slow links, and a lot of the configuration is left in the ha administrator. Administrators can specify what speed is used in the definition of a slow link. For compute users, the following policy areas need looking at:

- Computer Configuration → Administrative Templates → System → Group Policy → Group Pol Link Detection
- User Configuration → Administrative Templates → System → Group Policy → Group Policy Sl Detection

In both cases, the default setting is 500 KBps, but administrators can set any KBps connection speed time wish. This speed is used against a slow-link-detection algorithm; if the speed is above the value, the link speed below the value indicates a slow link.

This is the algorithm in pseudocode:

```
Ping server with 0KB of data :
   Receive response#1 as a time in milliseconds (ms)
If response#1 < 10ms Then
   Exit as this is a fast link
Else
   Ping server with 4KB of data :
      Receive response#2 as a time in milliseconds
   Calculate Total-speed as response#2-response#1
End If
Ping server with 0KB of data :
   Receive response#1 as a time in milliseconds
If response#1 < 10ms Then
   Exit as this is a fast link
Else
   Ping server with 4KB of data :
      Receive response#2 as a time in milliseconds
   Calculate Total-speed as Total-speed + (response#2-response#1)
End If
Ping server with 0KB of data :
   Receive response#1 as a time in milliseconds
If response#1 < 10ms Then
   Exit as this is a fast link
Else
   Ping server with 4KB of data :
      Receive response#2 as a time in milliseconds
   Calculate Total-speed as Total-speed + (response#2-response#1)
End If

'Average the total speed of (response#2-response#1)
Difference-in-milliseconds = Total-Speed/3
'If we know 4KB (32,768 bits) was moved in a certain number
'of milliseconds, then we need to calculate the number
'of bits moved per second (not per ms)
Bits-per-second-value = (32768 * 1000/Difference-in-milliseconds)
'Eight bits is a byte, so calculate bytes/second
bps-value = (Bits-per-second-value * 8)
'Calculate kilobytes/second to compare against GPO value
Kbps-value = bps-value / 1024
```

User profiles work in a similar manner. The following setting will check both the performance of the file sy
the speed of the user profile server in both kilobytes per second and kilobytes per milliseconds:[*]

[*] This was included by Microsoft to get past problems where the user profile server was not IP capable; in this case, it checks the file performance instead.

Computer Configuration ⟶ Administrative Templates ⟶ System ⟶ Group Policy ⟶ Slow net connection timeout for user profiles

The following GPOs are applied across slow links:

- When a user dials in from a RAS connection, both computer and user GPOs are applied.
- When a user logs in using the "Logon using dial-up connection" checkbox on the logon screen, user are applied.
- When the computer is a member of the same domain as the RAS server or is in a domain with a tru relationship to the one the RAS server is in, both are applied.

GPOs are not applied:

- When the logon is done using cached credentials, which then include a RAS connection
- To computers that are members of a different domain or workgroup

In all of these cases, security settings (i.e., IP security, EFS recovery, etc.) and Administrative Template are the only ones to be applied by default; folder redirection, disk quotas, scripts, and software installatic are not applied. You can't turn off registry settings you have to apply. You can, however, alter the defaul any of the others, including the security settings, using the relevant sections of those GPOs.

10.1.15. Summary of Policy Options

That's a lot of information on GPOs. Let's summarize what we've covered about the workings of GPOs so

- GPOs exist in a split state. The configuration data for the GPO, known in shorthand form as GPC dat in the AD object itself. The template files and settings that tell the GPO what its capabilities are, knc shorthand form as GPT data, are stored in the SYSVOL.
- Individual GPOs can be linked to multiple sites, domains, and Organizational Units in Active Director required.
- GPOs can contain policies that apply to both computers and users in a container. The default operat GPO on a container is to apply the computer portion of the GPO to every computer in that container boot up and to apply the user portion of the GPO to every user in that container during logon. GPOs be set to refresh periodically.
- Multiple GPOs linked to a particular container in Active Directory will be applied in a strict order accc series of priorities. The default-prioritized order corresponds to the exact order in which the GPOs w to the container. Administrators can adjust the priorities as required.
- While GPOs exist only in a domain environment due to their dependence on Active Directory, indivic domain or workgroup computers can have local GPOs, known as LGPOs, defined for them.
- Windows NT 4.0 system policies can also apply to standalone Windows NT or later clients or to mixe or Windows Server 2003 Interim domain clients.
- GPOs are inherited down the Organizational Unit hierarchy by default. This can be blocked using the

properties of an OU, domain, or site. Administrators can also set a checkbox that allows a policy to all lower settings and bypass any blocks.

- Loopback mode allows the administrator to specify that user settings can be overridden on a per-m basis. Effectively, this means that the user parts of policies that normally apply only to computers a to the users as well as (merge mode) or instead of (replace mode) the existing user policies.
- A new feature in Windows Server 2003 Active Directory called WMI filtering allows you to configure query that can be used as additional criteria to determine whether a GPO should be applied. If the f evaluates to true, the GPO will continue to be processed; if it evaluates to false, the GPO will not be processed. This is a powerful feature because you have the vast amount of WMI data available to d whether GPOs should be applied.
- A number of things can slow down processing on a client, including attempting to process many poli after the other. Use of loopback, especially in merge mode, can significantly impact this. Attemptin GPOs across domains can also lead to slowdowns depending on the network speed between the do Finally, complex queries in WMI filters can also have a negative impact on GPO processing.
- Policies are applied in a strict order known as 4LSDOU. This notation indicates that Windows NT 4.0 policies are applied first, followed by any LGPO policies, followed by site GPOs, domain GPOs, and fi Organizational Unit GPOs hierarchically down the tree. At each point, the policies are applied in prio order if multiple policies exist at a location.
- When policies are to be applied to a client, the system identifies the entire list of policies to be appli actually applying them in order. This is to determine whether any blocking, overriding, or loopback put in place that could alter the order or application of the policies.
- ACLs can be used to limit the application of GPOs to certain individual users or computers or groups or computers. Specifically setting up the ACLs on a GPO to deny or allow access means that you ca the impact of a policy from the normal method of applying the GPO to all users or computers in a c
- If you use the GPOE MMC interface and look at the properties of an individual GPO, four tabs are di the property page. The General tab shows you summary details on the policy and allows you to dis computer or user part of the policy if you require. The Links tab allows you to find all locations in A Directory that have links to that GPO. The Security tab allows you to limit the scope of the GPO on container via ACLs. Finally, the WMI Filter tab allows you to configure a WMI filter to be used for GP processing.
- Finally, both user profiles and policies can be applied across a slow link, but the speed that the syst to determine whether a link is slow is configurable by the administrator within an individual GPO. In while security settings and administrative templates normally are applied by default, the exact setti will apply across a slow link when one is detected are configurable by the administrator as well. The exception is that administrative templates will always be applied; the administrator has no control o

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10.2. Managing Group Policies

The Microsoft tools available to manage GPOs under Windows 2000 were pretty limited, consisting of the Group Policy Object Editor (formerly Group Policy Editor) and built-in support in the Active Directory Users and Computers and Active Directory Sites and Services snap-ins. While these tools could get the job done, they did not provide any support for viewing the Resultant Set of Policy (RSoP), viewing how GPOs had been applied throughout a domain, or backing up or restoring GPOs. Luckily these tools weren't the only option: third-party vendor Full Armor produced Fazam 2000, which has comprehensive group policy management functionality.

Directly after the release of Windows Server 2003, Microsoft released the Group Policy Management Console (GPMC) as a separate web download. The GPMC is a much-needed addition to Microsoft's GPO management tools and provides nearly every GPO management function that an organization might need, including scripting support.

The other new feature available in the Windows Server 2003 Active Directory administrative tools and in GPMC is support for viewing the RSoP for a given domain, site or Organizational Unit based on certain criteria. RSoP allows administrators to determine what settings will be applied to a user and can aid in troubleshooting GPO problems. RSoP will be described in more detail in the section on debugging group policies.

10.2.1. Using the Group Policy Object Editor

When you add a GPOE snap-in to a console, you can only focus on a particular GPO/LGPO. Each GPO/LGPO that you wish to change has to be loaded in as a separate GPOE snap-in to the MMC; unfortunately, you can't tell the GPOE to show you all policies in the tree, but you can use the GPMC for that.

Managing LGPOs is done using the same GPOE tool that you would use to manage GPOs. If you use the GPOE from a workstation or server in a domain, you can focus the snap-in to look at an LGPO on a local client. If you use the GPOE on a standalone server or a workstation, the GPOE will automatically focus on the LGPO for that machine. No matter how the focus is shifted to look at an LGPO, the GPOE will load only the extensions that are appropriate to the templates in use locally on that client. Domain-specific extensions are not loaded for LGPOs.

GPOs and the PDC FSMO Role Owner

When you are editing GPOs, the GPOE connects to and uses the FSMO PDC role owner . This ensures that multiple copies of the GPOE on different machines are all focused on the same DC. This behavior may be overridden in two cases.

If the PDC is unavailable for whatever reason, an error dialog will be displayed, and the administrator may select an alternate DC to use.

Microsoft is also currently considering a GPOE View menu option and/or a policy to allow the GPOE to inherit from the DC that the Active Directory Users and Computers MMC is focused on. This is likely to be most useful when there is a slow link to the PDC.

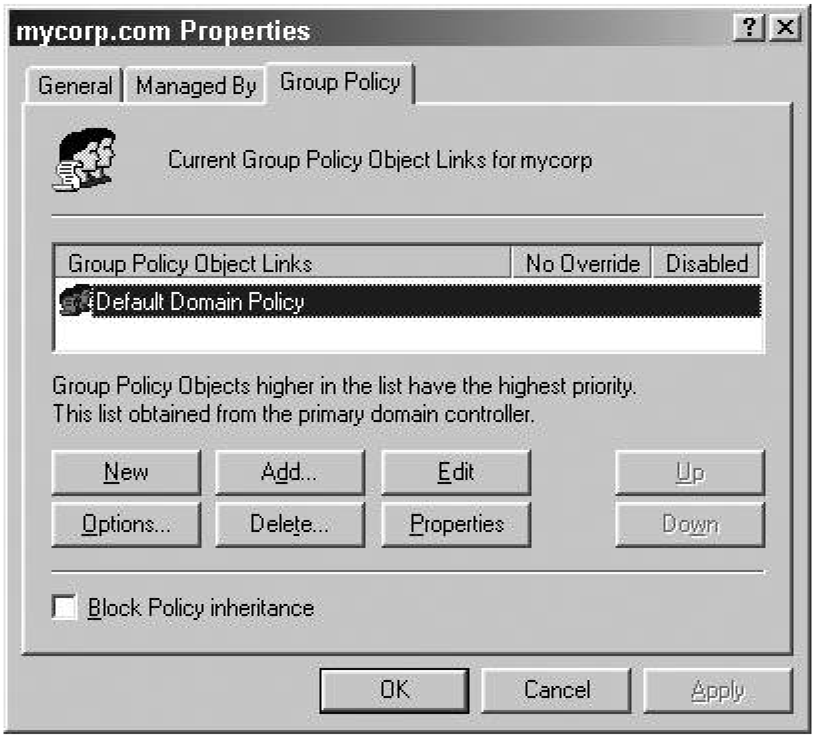
If GPOs are edited on multiple DCs, this could lead to inconsistencies because the last person to write to the GPO wins. For this reason, you should use caution when multiple administrators regularly administer policies.

Starting an MMC and adding the GPOE snap-in is not the normal method of accessing GPOs. In fact, there is a whole extended interface available from the Active Directory Sites and Services snap-in, Active Directory Users and Computers (ADUC) tool, or the group Policy Management Console. If you open up the Sites and Services snap-in, you can right-click any site and from the drop-down list select Properties, finally clicking the Group Policy tab on the resulting property page. If you open the ADUC, right-click any domain or Organizational Unit container and follow the same steps. Ultimately, the Group Policy property page from any of these tools produces a window, such as Figure 10-9, with a number of options. Figure 10-9 shows the policies linked to the root of the *mycorp.com* domain. The following buttons are found on the *Mycorp.com* Properties menu:

New

> This button allows you to create new GPOs and automatically link them to the container for this property page. Since Figure 10-9 is the property page for the domain, any policies that are created and linked in here would be applied to the entire domain.

Figure 10-9. Looking at the domain policies



Current Group Policy Object Links for mycorp

Group Policy Object Links	No Override	Disabled
Default Domain Policy		

Group Policy Objects higher in the list have the highest priority.
This list obtained from the primary domain controller.

□ Block Policy inheritance

Add

This button allows you to link an existing GPO to the container for this property page.

Edit

This button allows you to manipulate the selected policy in the display pane.

Delete

This button allows you to remove a policy. If you do this, a dialog box will appear and ask if you wish to remove just the GPO's link to the container for this property page or to permanently delete the GPO.

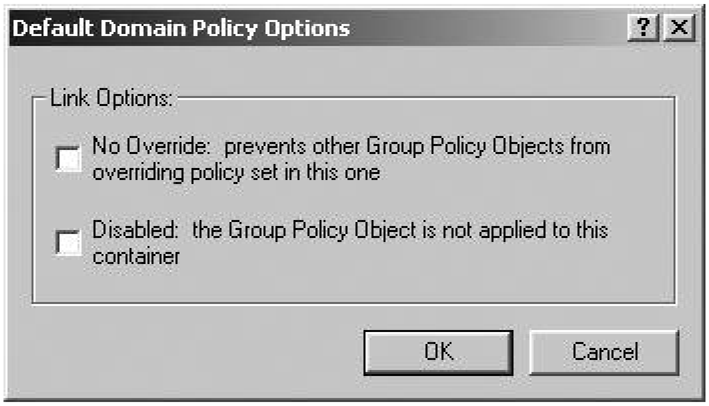
Properties

This button allows you to bring up the properties of the GPO itself; i.e., the General, Links, Security, and WMI Filter tabs in Figures 10-4, 10-2, 10-5, and 10-8, respectively.

Options

This button allows you to set two specific options relating to the application of this GPO by bringing up a dialog box similar to that shown in Figure 10-10.

Figure 10-10. Domain policy options



Default Domain Policy Options

Link Options:

□ No Override: prevents other Group Policy Objects from overriding policy set in this one

□ Disabled: the Group Policy Object is not applied to this container

No Override

This option allows you to force the settings of this GPO to apply no matter what other GPOs later attempt to block inheritance.

Disabled

This option allows you to completely disable the GPO's application to the current container. If you choose this option, any ACLs that you have set on this GPO to explicitly allow or deny application of this policy to individual users, computers, or groups will be ignored. This policy will not be applied under any circumstances.

> Disabling the GPO is not the same as setting an ACE with the Apply Group Policy checkbox cleared for the group Authenticated Users. Denying the ability to apply group policy for a GPO to a group via an ACE is much more restrictive, as the restriction will apply to the GPO across all containers and not just for the one container, which is what the Options button allows you to do.

Block policy inheritance

This checkbox is used to indicate that policies from further up the 4LSDOU inheritance chain are not to be inherited by objects at this point and below. This is used when you want a particular level in the tree to define its own policies without inheriting previously defined ones above it. For example, a block at the site level blocks Windows NT system policies and LGPOs (i.e., 4L) from applying; a block at the domain level blocks 4LS; a block at an Organizational Unit level blocks 4LSD in addition to any other Organizational Unit parents above this level in the tree.

Up/down arrows

These buttons allow you to prioritize multiple GPOs in the display pane. In Figure 10-9, only one GPO is displayed, so these buttons are not displayed.

GPOE GUI Shortcuts

Some useful shortcuts supported by Explorer have been copied over to the GPOE. For example, you can highlight a branch in the GPOE and press * on the numeric keypad to automatically expand the entire tree at that point. You can press + and - on the numeric keypad to expand and collapse individual highlighted branches. You can also use the cursor keys to navigate up and down the list. The Tab key switches back and forth between the scope pane and the results pane.

One last point that is very useful: if you open up the GPOE and double-click on any item, it brings up a floating property page window. There is nothing to stop you from going back to the GPOE and highlighting any other location in the tree, navigating using the cursor keys, and using the keys in the previous paragraph. Each item that you select, however, correspondingly modifies the floating property page. You can see each item's description and options in the floating property page while navigating through the GPOE as before.

If you've installed the GPMC , the Group Policy tab in those snap-ins is not available and you need to use GPMC, which provides a lot more functionality.

10.2.2. Using the Group Policy Management Console (GPMC)

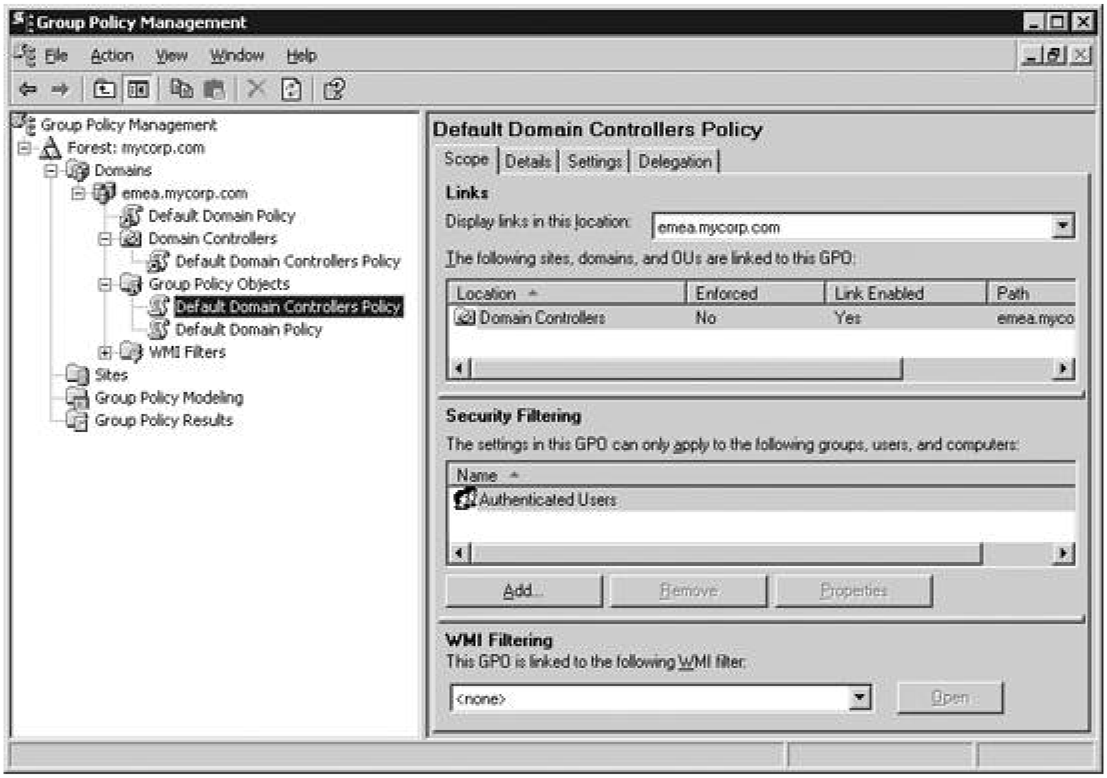
The GPMC is a one-stop shop for all your GPO management needs. You can browse a forest and see where GPOs are applied; you can create and link GPOs; you can import and export, backup and restore, delegate control, and view RSoP reports, all from the GPMC. Not only does the GPMC have a bunch of new functionality not available in any of the previous standard tools, it also integrates the existing toolssuch as the GPOE for editing GPOsso that you do not need to go outside of the GPMC to perform those tasks.

Figure 10-11 shows what the GPMC looks like when viewing a GPO. As you can see in the left pane, you can browse through the domains in a forest down to specific Organizational Units. If you right-click on a domain, you'll get the following options:

- Create and Link a GPO
- Link an Existing GPO
- Block Inheritance
- Search for GPOs

- Create a New Organizational Unit

Figure 10-11. GPO properties in the GPMC



Default Domain Controllers Policy

Links

Display links in this location: emea.mycorp.com

The following sites, domains, and OUs are linked to this GPO:

Location	Enforced	Link Enabled	Path
Domain Controllers	No	Yes	emea.myco

Security Filtering

The settings in this GPO can only apply to the following groups, users, and computers:

Name
Authenticated Users

WMI Filtering

This GPO is linked to the following WMI filter:

<none>

If you right-click on an Organizational Unit, you'll get many of the same options, except for Search.

In Figure 10-11, the Domain Controllers Organizational Unit has been expanded to show that the Default Domain Controllers Policy has been linked to it (i.e., icon with a shortcut/arrow symbol). A virtual Group Policy Objects container is expanded, which shows all of the GPOs that have been created in the domain (currently just the two default GPOs exist). There is also a virtual WMI Filters container that holds any WMI filter objects that have been created. Note that the Group Policy Objects and WMI Filters container are virtual. This was done so that instead of requiring drilling down into the System container to locate GPOs, they would be readily available directly under a domain.

> You can also browse the GPOs that have been linked to a site by right clicking on the Sites container and selecting Show Sites. You have an option of which sites to display.

If we take a look at Figure 10-11 again, we can see that the Default Domain Controllers Policy was selected in the left pane, and several options and settings are displayed in the right pane. The following list is a summary of each tab:

Scope

> Under the Scope tab, you can view the domains, sites, or Organizational Units that have been linked to the GPO and delete them if necessary. You can also view what security groups the GPO applies to, and add and remove groups from the list. Finally, you can set the WMI filter that should be associated with the GPO.

Details

> The Details tab contains information about who created the GPO, the date it was created and last modified, and the current user version and computer version. The only thing that can be set on this page is beside GPO Status, which defines whether the user and/or computer settings are enabled.

Settings

> The Settings tab provides a nice shortcut to view which settings have been configured in a GPO. Unlike the GPOE, in which you have to drill down through each folder to determine which settings have been configured, you can view the Settings tab for a GPO in the GPMC to see only the options that have been set.

Delegation

> The Delegation tab is similar to the Delegation of Control wizard, but it's specifically for GPOs . We'll cover this screen in more detail later in the chapter.

One last feature that is worth mentioning is the Group Policy Modeling and Group Policy Results. Group Policy Modeling is very similar to the RSoP option that is available in the ADUC, which is described at the end of the chapter. Group Policy Results is very similar to the Group Policy Modeling/RSoP, except that it is not a simulation. The results are returned from the client, not simulated on a domain controller. Group Policy Results will only work on a computer running Windows XP or Windows Server 2003.

10.2.3. Scripting Group Policies

Another hurdle to efficiently managing GPOs with the initial release of Active Directory was the lack of scripting support. Not having the ability to automate the creation or maintenance of GPOs meant that administrators had to spend a lot of time manually managing GPOs. Fortunately, the GPMC also provides scripting capabilities. Whenever you install the GPMC, it registers several COM-based objects that can be used to automate most of the tasks you'd need to do with GPOs. The word "most" is used because the GPMC COM objects do not allow you configure any GPO settings; you still have to do that manually. On the other hand, you can copy or import a GPO and its settings, so if you have a template GPO or a GPO you want to create in multiple domains, you can conceivably create it once, then use the COM objects to copy it to other domains.

The following is a list of some of the tasks you can perform via scripts with the GPMC objects. For more information on the objects and interfaces, check out the *GPMC.chm* help file available with the GPMC installation in the Scripts subdirectory.

- Create a GPO with the default settings
- Copy a GPO
- Import GPO settings
- Set GPO permissions
- Delete a GPO
- Search for GPOs
- List GPOs
- Retrieve GPO information
- Back up GPOs
- Restore GPOs
- Generate a RSoP report for GPOs

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10.3. Using GPOs to Help Design the Organizational Unit Structure

In Chapter 8, we described the design of the Active Directory Organizational Unit hierarchy. We also explained that other items have a bearing on that design. You see, there are two key design issues that affect the structure of your Organizational Units: permissions delegation and GPO placement. If you decide that your Active Directory is to be managed centrally rather than in a distributed fashion and that you will employ only a few GPOs that will be implemented mostly domain-wide (rather than many GPOs on many Organizational Units), your Organizational Unit structure can be almost any way that you want it to be. It shouldn't make much difference whether you have 400 branches coming off the root or one container with every item inside it. However, if permissions over specific objects do need to be delegated to specific sets of administrators, it will make more sense to structure your domain Organizational Units in a manner that facilitates that administration. This doesn't have to be the case, but it makes it much easier to use Organizational Units.

For example, if we have 1,000 users and 10 managers who each manage 100 users, we could put the 1,000 users in one Organizational Unit and give the 10 administrators permission to modify only their 100 users. This is a slow and daft way to run systems administration. It would be better to create 10 Organizational Units and put 100 users in each, giving each administrator permission over his particular Organizational Unit. This makes much more sense, as the administrator can be changed very easily, it is easier to report on access, and so on. Sense and reducing management overhead are the overriding keys here. Either solution is feasible; one is just easier to implement and maintain.

Permissions delegation is covered in more detail in Chapter 11.

The same fundamental facts apply to GPOs. If you are going to need to apply multiple policies to multiple sets of users, it makes more sense and will be easier to manage if you set up multiple Organizational Units. However, this isn't always possible, for example, if the Organizational Unit structure that you have as an ideal conflicts with the one that you will need for permissions delegation, which again conflicts with the one you would like for GPO structuring.

10.3.1. Identifying Areas of Policy

We will assume that within your organization, you will be writing a document that describes your plan for the security features you wish to use in your Active Directory environment and exactly how those features will be implemented. Part of this document will relate to other security features of AD such as Kerberos, firewalls, permissions, and so on, but here we're concerned with GPOs.

First you need to identify the general policy goals that you wish to achieve with GPOs. There's no need to go into the exact details of each GPO setting and its value at this moment. Instead, you're looking at items such as "Deploy financial applications" and "Restrict desktop settings." As you identify each general policy area, you need to note whether it is to apply to all computers or users in a site, to all computers or users in a single domain, or to a subsection of the user and computer accounts. If you aren't sure for some items, put the items in more than one category. You end up with items such as "Deploy financial applications to accountants in France" and "Restrict desktop settings in southern Europe."

Once you have the general policy areas constructed, you need to construct an Organizational Unit structure that facilitates implementation of this policy design. At this point, you start placing computers and users in various Organizational Units, deciding if all objects in each container are to receive the policy or whether you will restrict application to the policy via ACLs. There are a number of questions you can ask yourself during this stage. To help with this, a loose set of guidelines follows the example in the next section.

Ultimately the document will need to specify exactly which GPO settings are to be applied, which groups you will set up for ACL permission restrictions, and what the Organizational Unit structure is going to be. It helps to explain justifications for any decisions you make.

To make the guidelines more meaningful, we'll show how you can structure a tree in different ways using a real-world example.

10.3.2. How GPOs Influenced a Real Organizational Unit Design

Leicester University needed an Organizational Unit structure that represented its user and computer population. The system needed to allow users from every department to roam anywhere on campus and log on to the system. User accounts were fairly generic across the system, with the main differences resulting only from membership in certain groups indicating the type of account the user had (staff, undergraduate, and so on). The main distinction came in the two sorts of machines that we maintain on campus: staff devices that exist in a number of staff member's offices, and open devices that exist in areas known as open-area labs, which anyone could use. While staff machines always exist within a department, labs exist in certain locations and buildings throughout the university campus.

Having full Internet and drop-in access, we needed to make sure that these open area client devices were as secure as they could possibly be. This security had to extend to all users who logged on at the machines, whether they were staff or student. However, we also wanted to make sure that staff accounts were not locked down in their own departments. In other words, we wanted the user profiles of the staff users to be much more locked down only in the open-area labs and nowhere else.

In terms of policies, we needed to apply quite a few. While the specifics aren't important here, we needed a number of policies to apply to different areas:

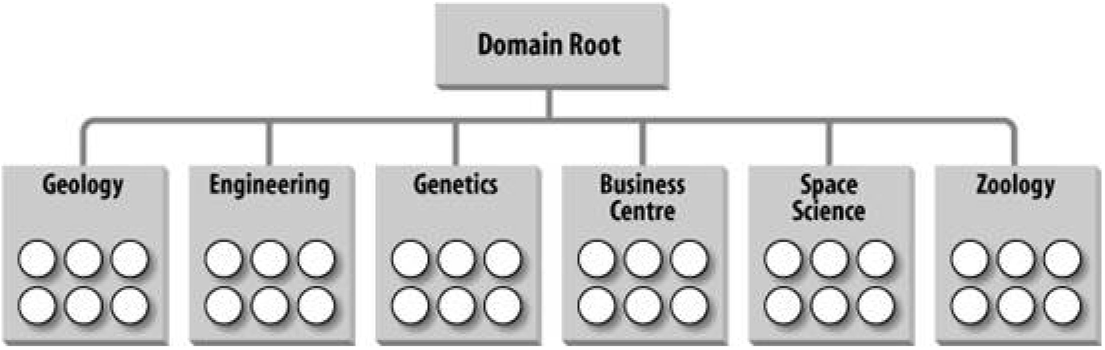
Area	Policies to apply to
A	All computers and users in the domain
B	Users in specific departments
C	All clients (not servers)

Area	Policies to apply to
D	All open-area clients
E	All staff clients
F	Staff clients in specific departments
G	Open-area clients in specific labs

With these requirements, we came up with a design. This was a lengthy process, but we'll try to break it down so that it makes sense. Let's take a look at the users themselves to start with.

Users were always members of a specific department, and this was how the university was structured in terms of its business, so it seemed logical to name the Organizational Units after the university departments. We should add, by the way, that Leicester University needed only one domain, the forest root domain in a single forest, for its organization; the Organizational Unit structure was much more important than the domain structure in this case. The overall Organizational Unit structure came out something like that shown in Figure 10-12. Each department is joined directly to the root of the domain, with the users (represented by the circles) being children of the departmental containers.

Figure 10-12. OU structure to hold user objects

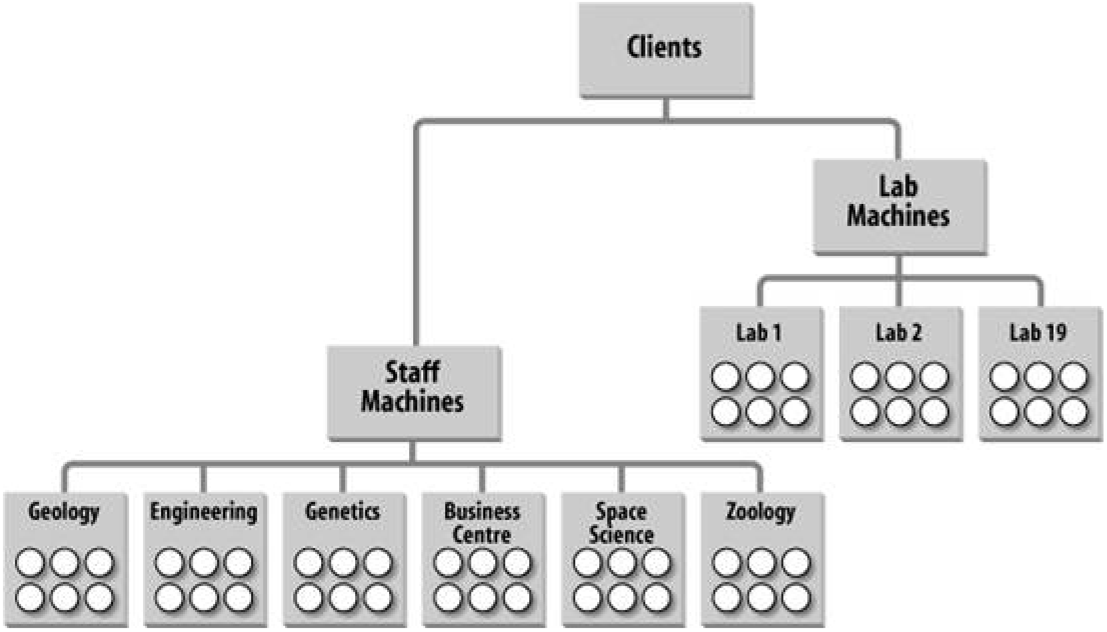


Next, we needed an Organizational Unit structure that represented the distinct divisions of computers that existed throughout the university. There's no necessity to presume that your computers should go in the same Organizational Unit structure as your users, and that's how we approached the concept at Leicester. Initially, based on the policy areas, it seemed sensible to us to create an entirely new client tree that held only the machine accounts. This hierarchy ended up looking like the one in Figure 10-13.

Here you can see the branch solely for the computer accounts, with two children that each hold lab locations or departments themselves. Notice how the staff machine branch of the tree looks remarkably like the user structure diagram from Figure 10-12. We'll come back to that in a minute. For now, let's see if we can successfully apply the policies properly to this hierarchy. Take a look at Figure 10-14; where the policies are shown using the letter notation from the earlier table. This screen looks very cluttered, but it simply depicts each policy area with indications of where the policy area is linked. The trapezoid is Microsoft's symbol for a GPO.

Not every department and lab is listed in this screen. In a similar vein, we've linked the GPOs to only some of the Organizational Units, since that would be the case in reality. After all, if every department or lab were to receive a policy, you might as well link the GPO to the parent.

Figure 10-13. OU structure to hold computer objects



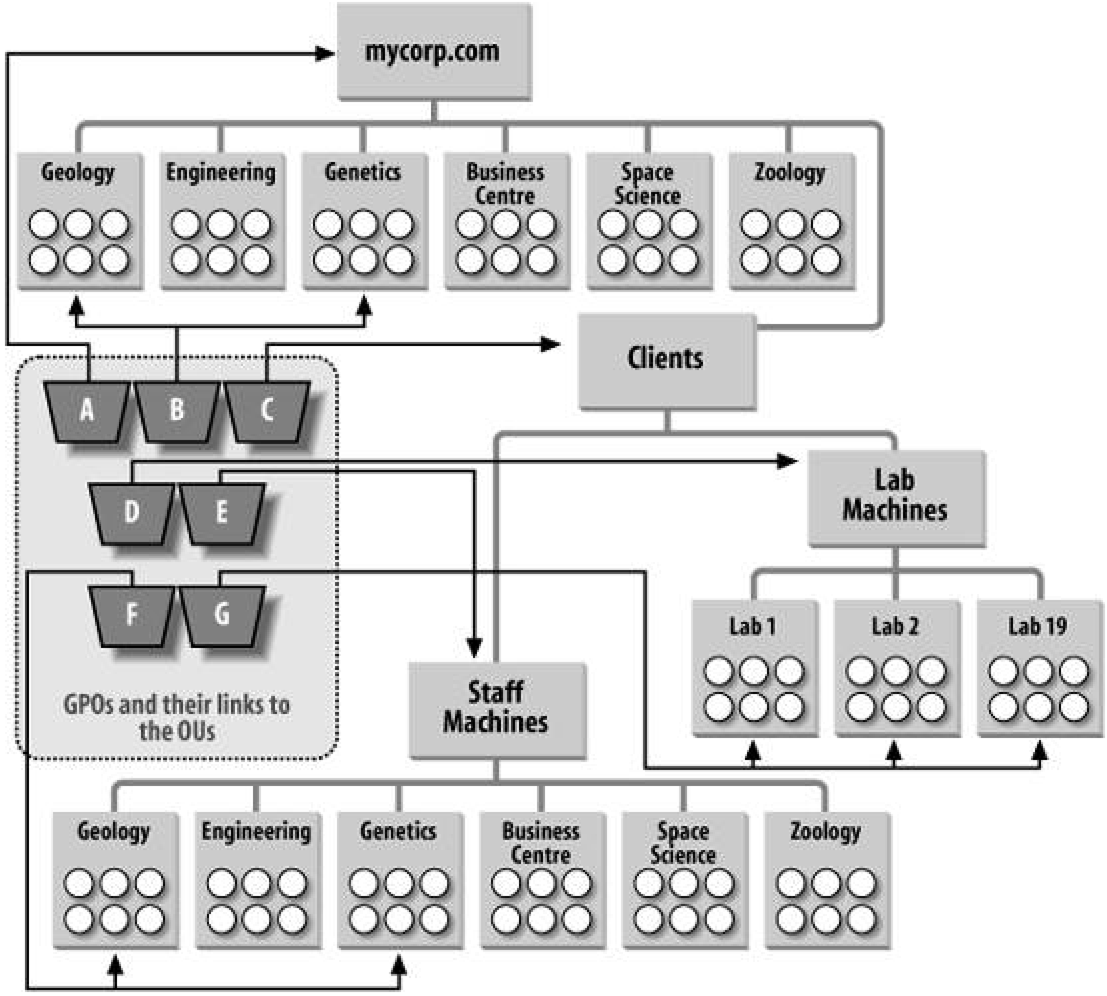
10.3.2.1. The merits of collapsing the Organizational Unit structure

We've created a structure that is understandable and perfectly represents the business that we operate. That's a good achievement from this design. The next step is to consider whether the domain would be easier to manage if we merged the duplicated staff organizational units.

Take a look at Figure 10-15. This is the hierarchy if we do away with all the staff machine Organizational Units and put the staff computers directly into the departmental Organizational Units. Policy areas A and B stay the same. Policy area C has to apply to all clients, so we can't use the Clients Organizational Unit any more. We have two choices: link the policy to the domain and have it apply to all Organizational Units containing computers beneath the root, or link the policy to each Organizational Unit under the root by hand. The latter solution also requires us to link the GPO to any new Organizational Units that we create under the root, if they are to receive the policy.

The former is the easier solution to manage, so let's run with it and link policy area C to the domain root. Unfortunately, this means that the GPO is going to apply to any computer objects in the domain, including Organizational Units that we store servers in, such as the Domain Controllers Organizational Unit that exists under the root of the domain. We don't want this, so the only way forward here is to block policy inheritance at these server Organizational Units. You may see where this is going

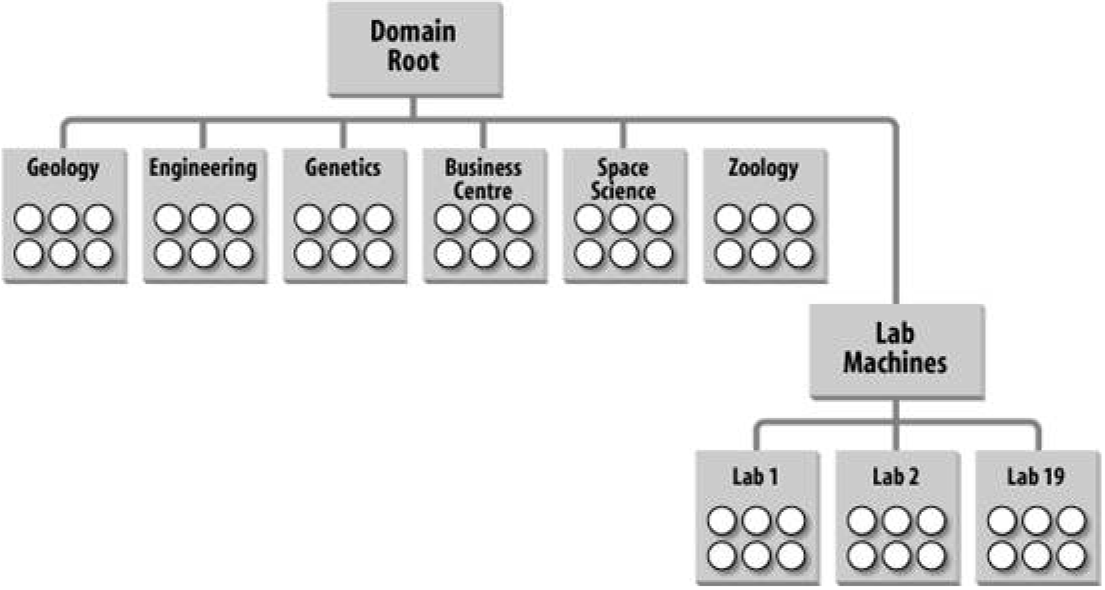
Figure 10-14. GPOs applied to the entire OU structure



now. We've not only blocked policy area C from being inherited by these Organizational Units that contain servers, we've also blocked any other policies that may need to apply as part of policy area A. My only solution to fix this is to use my ability to force an override of policy area A down the tree. So much for a simpler solution; we now have at least one block in place (for the domain controllers Organizational Unit) and policies from area A overriding all blocks down the tree to make sure they get past the blocks we just set up. While this is a solution, it's starting to feel more complex than the one before. Isn't there a better way?

Yes, by making use of security groups. Forget about the blocks and inheritance for now and consider that instead we put all the computers that are not to get policy area C in a security group. We can then deny the Apply Group Policy permission to this particular security group, so that no members of the group ever have that policy applied to them. This is a much easier solution. However, it does mean that the administrators must remember that if a new computer is created and is not to receive the policy, it must be added to the group.

Figure 10-15. Another solution to the OU structure



Policy areas D and G can still apply as they did before. Policy area F applies only to certain Organizational Units, so we just link F to the various departments under the root and carry on as before. However, we have more problems with E. Again, the choices are similar to the previous predicament: we could apply E to the department Organizational Units individually (remembering to do this for each new department we create), we could apply the policy to the domain root and use block inheritance-force override as before, or we could use groups again. The use of groups seems simpler, so let's go with that option. If we create a group for all the staff machines, we can just give the group permission to apply group policy to policy E in addition to removing the default permission for authenticated users to apply group policy. Now all users won't run the policy by default, but members of the staff machines group will.

This is a different solution that now achieves the same goal. The solution that Leicester chose (the first design) required fewer groups and allowed a computer's or user's location in the hierarchy to dictate which policies were applied. The new solution that we've just worked through collapses the tree structure but instead makes more use of groups to indicate which policies are to be applied.

In fact, this tends to be a rule: as you collapse a structure where a number of GPOs apply, you need greater control via groups or the use of block inheritance and overrides.

10.3.2.2. A bridge too far

We could go one stage further and remove the lab machines' Organizational Unit entirely. That would cause the same problems with policy area D that we had with E. The simpler solution is to add all lab machines into a group and allow only members of that group to access the policy.

You can continue on in this manner, removing Organizational Units and creating more groups until you actually end up with all objects in a single Organizational Unit under the domain. At that point, all the GPOs are applied to that Organizational Unit, and you control access to the Organizational Units via groups. Prioritization of the order that the multiple GPOs would be applied might be more of a nightmare in this situation.

We hope you can see that there are a number of options open to you when designing your Organizational Unit structure for GPOs. It doesn't really matter which method you choose, as long as you're happy with it. The Organizational Unit structure that Leicester adopted requires less maintenance, because you don't have to put an object in a group after creation; you just create it in the place in the tree that it is to receive policies from. That's less of an issue with the capabilities of ADSI, since the code to bind to the parent group and add the newly created object to that group is just two extra lines.

We also created some other Organizational Units for specific functions. For example, one Organizational Unit holds all the groups that we ever created. That way, when we want to find a group, we know where it is. We also created a test Organizational Unit so that we could roll out policies and do testing with users and computers within the domain without affecting the existing user setup.

It may appear that Leicester doesn't make much use of groups to control access to GPOs, but that's not the case. Just because they set up the Organizational Unit structure in a way that made sense to them doesn't mean that they shouldn't make good use of groups as well. For example, look back at Figure 10-14. Policy areas D and G actually consist of a number of completely different and opposing GPOs that can affect all lab machines (D) or machines in specific labs (G). One group of settings entirely locks down the workstations in those labs from access to the hard disk and various control panels and places other security measures. Another raft of settings serves to unlock the machines entirely; in other words, this GPO is the complete opposite of the first. Further sets of GPOs allow them to put the lab into a mixture of the two states with some areas locked down and others remaining unlocked. These policies are applied as required to the specific lab Organizational Units, so that if all were to apply at the same time, it would be a complete fiasco. Instead, they use global security groups, one for access to each GPO, and make the computers from that lab members of each group.

To gain access to the policies, they move the computers from one group into another. If a client needs to be unlocked entirely, they move it to the unlocked group and reboot or wait until the policy refreshes. Similarly, if a user from zoology decides that he wants his machine locked down, they can apply the relevant GPOs to the zoology Organizational Unit, then place that machine in the global group that allows access to the GPO.

If they had a situation in which the client was either locked down or not locked down, they could have used just one group and had a lockdown state by default, with membership in the group implying an unlocked state or vice versa.

10.3.2.3. Loopback mode

One important aspect of Leicester's GPO design that hasn't been mentioned until now is loopback mode . Leicester needs to use loopback mode to lock down both staff and students while they are in a lab environment. To do this successfully requires that the computer policies be separate from the user policies. When you add this requirement to the equation, it makes more sense to keep the lab part of the tree separate in some way from the other part of the tree. This ensures that the user sections of the computer policies do not apply to any user accounts except during loopback mode. Both Figure 10-12 and Figure 10-13 have structures that will happily accommodate the requirement.

10.3.3. Guidelines for Designing GPOs

In this section, we provide guidelines that help you toward two critical design goals:

- All policies should be applied quickly, so that users do not feel a significant impact due to policy processing.
- All policies should be as easy as possible to administer and maintain.

With these two concepts in mind, let's take a look at the guidelines:

Design in a way that you feel comfortable with

> As shown in the example in the last section, it can be easier to do large designs by considering the user Organizational Unit and computer Organizational Unit structures separately. If you want to do them together and have a small enough network that you can do so easily, that's fine. If not, try it the way we first did.

Restrict as best you can the number of policies that apply

> In a perfect world, this wouldn't be important. But in the real world, the more policies you have, the more processing the client has to do in addition to its normal logon/boot up, and the longer it takes to complete the process.
>
> If you have multiple policies applying to an object from the same location in a tree, consider collapsing them into a single object, since this will process faster than multiple policies will. If the number of policies you are applying during a logon/boot up is larger than you can effectively get out to the client across the network or, more importantly, larger than you can get the client to process, you need to consider reducing or collapsing the policies. If you need to apply a significantly large set of policies with many settings that extends logon to five minutes, but you feel that is acceptable to achieve this level of policy, that's fine.
>
> When it comes down to it, only you know what you can accept, and you will need to do your own testing in this area to satisfy your constraints. If you have to have a client logged on in less than four seconds, you have to work within that constraint. Microsoft likes to recommend no more than 10 Organizational Units deep to make sure that you don't use too many GPOs. As we know, this isn't very helpful. Having one GPO applying at a site, one at the domain, and one at each of five Organizational Units means only seven GPOs. Applying 10 at each level is 70. So it's not only how deep you nest your Organizational Unit structure that matters, it's how many policies you can apply. The unfortunate part, of course, is that it always comes back to how many settings you are applying in each policy.

The simple answer is that a faster machine with more RAM can apply more policies in less time than a slower PC with less RAM; consequently, for a network of heterogeneous clients, you need to do testing on your own network to see how fast application of policies is and how much bandwidth they take up.

Use security groups to tailor access

While you can set up ACLs to allow or deny application of policy to an individual user or computer, it makes more sense to use groups to do this whenever you can. If you use groups, it lets you keep all policy access in one object, and it can make complex systems much more manageable.

Limit the use of block/force inheritance

You should be very cautious of blocking inheritance at locations in the tree unless you are quite sure that this is the right way to solve your problem. The repercussions from a simple blocking of inheritance can spiral quickly as you encounter areas of policy that need to override the block. Your well-designed system can become quite difficult to maintain if you block and override regularly. This is not to say that you should never use them; just exercise caution in their use.

Collapse the Organizational Unit design

If you wish, you can collapse your Organizational Unit design and make more use of groups (or even block inheritance/force override) to govern access to specific policies. These are both perfectly valid solutions, and you should use whichever you are more comfortable with. Remember the axiom that the more you collapse the Organizational Unit structure while maintaining or increasing the number of GPOs, the greater need for control via groups or block inheritance/force override.

Avoid using cross-domain GPO links

If you link GPOs across domains, the entire set of *SYSVOL* data as well as the object information itself needs to transfer over from the source domain whenever a user or computer needs to access it. So unless you have very fast links between the two domains with enough available bandwidth, you should duplicate the functionality of the GPO in the target domain instead of cross-domain linking unless the domain controllers for each domain are co-located on the same network.

Prioritize GPOs

Remember that it is possible to prioritize applications of multiple GPOs at the site, domain, or Organizational Unit level. This ordering of the application of policies allows you to add useful options to the administrator's toolkit. For example, if you need a group of users to reverse specific settings that are being applied by default as part of a larger set, create a new GPO with ACLs for this group that apply in the priority list to unset all the previous settings. This solution allows you to override a selection of previous settings without creating two GPOs, one with settings for everyone and one for just this group. The former solution allows you to add in settings to the main GPO and still have them apply to everyone, without needing to add them to the second GPO of the latter solution. Prioritizing GPOs can be very useful.

Increase processing speed

The main ways to increase processing speed are to reduce the number of GPOs that you apply, disable the computer or user portion of a GPO if it is not needed, or limit the use of block inheritance, force override, cross-domain linking, and loopback mode. All of these place an extra processing load on the client to some degree. A really bad mistake would be to use combinations of them.

Be cautious with loopback mode

Loopback mode is a very useful tool, but is another technology that you need to approach with caution. As a completely different set of policies (replace mode) or a very large number of policies (merge mode) will be applied to your users, and since there are no Resultant Set of Policy (RSoP) tools in existence as we write this, you need to take great care to ensure that the policy received by a user is the one you expect.

In most cases, loopback merge mode will incur significant extra processing load on the client PC and extra bandwidth on the network. That's not to say it isn't useful, but you have to be very aware of the delays that could occur after its introduction. Loopback replace mode imposes less of a processing load, but it can still be a problem. If you are contemplating loopback mode, ensure adequate stress testing of user impact.

Limit how often GPOs are updated

You should also carefully control the policy refresh interval. You have to ask yourself if you really need to refresh policy every 10 minutes when every 24 hours might be sufficient.

Thoroughly test WMI filters

If you are using WMI filters, be sure to test the queries thoroughly before releasing in production. If you use an inefficient query or one that is very resource-intensive, it could cause significant delays during GPO processing. Creating a simple script or even using the new WMI tool called WMIC can help facilitate the testing.

Restrict blocking of domain GPOs

You should not block domain GPOs to specifically use LGPOs on a domain client without very good reasons. If you do choose to apply LGPOs only to a client, you need to be aware of the management overhead because each client needs to be managed individually. If you have 20 orphaned clients using LGPOs and you need to make a change, you need to make it 20 times, once per client. The whole concept behind GPOs was to aid centralized management and administration of distributed resources, not distributed management of distributed resources. Think carefully before going down this path.

Use test GPOs

> We always recommend creating test GPOs and linking them to a branch of test Organizational Units set up for this purpose. No GPO should ever be applied to users or computers unless it has been fully tested. And with the new tools, such as GPMC or the Resultant Set of Policies (described in more detail shortly), it is much easier to assess the impact GPOs will have on your client base.

Choose monolithic or segmented GPOs

> While we would recommend keeping similar settingsor all settings relating to a particular itemin the same GPO, there is nothing stopping you from having only a few huge GPOs as opposed to a number of smaller GPOs. If you go for the monolithic approach, you process fewer GPOs, which is obviously faster; however, delegation is not as easy due to the fact that the policy contains so many settings. Segmented GPOs allow easier delegation but can impact performance. Mix and match the two to a level that you are comfortable with and that works for your network.

10.3.4. Designing Delegation and Change Control

Now that you've designed a policy-based implementation for your organization, you have to work out how you will maintain firm control over GPOs once you start deploying them. Specifically, you need to consider who will be managing your GPOs and how you will keep control over the wide-ranging changes they can make.

10.3.4.1. The importance of change-control procedures

The best way to keep track of GPOs in your organization is through a series of change-control procedures. These work well whether your GPO administrators are domain administrators or not. We suggest a file such as a Word document with tables, a spreadsheet, or even a database in a central location to hold data on each GPO, the settings that it applies, whether it applies to computers and users or both, the containers in Active Directory that it applies to, and so on. You also should add extra columns/fields to the data for the proposer of the original GPO and those people who ratified the change. If you add those fields/columns, every time a new change is made, it is added by the proposer to the existing data set. Then the proposer or the system automatically contacts the rest of the GPO administrators and asks them to review and ratify the change in the data set. Discussions could continue via email if there were problems preventing ratification or if items needed clarification. Finally, when the GPO data is ratified by all, it can be regression-tested on test systems if that hasn't already been done and then implemented within Active Directory.

Default GPO Permissions

Any user, computer, or group needs both Read and Apply Group Policy to apply a policy. Active Directory ships with certain permissions already in existence for GPOs . These are:

- Authenticated Users group has Read and Apply Group Policy.
- Creator Owner has Full Control without an explicit Apply Group Policy.
- Local System group has Full Control without an explicit Apply Group Policy.
- Domain Admins group has Full Control without an explicit Apply Group Policy.
- Enterprise Admins group has Full Control without an explicit Apply Group Policy.
- Group Policy Creator Owners group has Full Control without an explicit Apply Group Policy.

Administrators in the latter three groups are also authenticated users and so inherit the Read permission from that group. If you don't want administrators to have the user parts of GPOs applied on logon, set the Apply Group Policy setting to Deny for Domain Admins, Enterprise Admins, and possibly Creator Owner as well.

10.3.4.2. Designing the delegation of GPO administration

There are three types of permission that can be considered here:

- The permission to allow sets of users to link policies to a domain or an Organizational Unit branch
- The permission to allow sets of users to create GPOs
- The permission to allow sets of users to change the GPOs themselves

Link delegation can be easily accomplished using the Delegation of Control Wizard [*] that you get by right-clicking an Organizational Unit, domain, or site in Active Directory and choosing Delegate Control. You'll want to use the "Manage Group Policy Links" task. Here you are actually delegating read and write access to the `gPLink`[ ] attribute of containers.

[*] This wizard is discussed more fully in Chapter 11.

[ ] The GPC data part of a GPO is an object in Active Directory. This object, like all others, has attributes..

The other GPO attribute that can be delegated in this way is called `gPOptions`. As discussed earlier and shown in Figure 10-10, this deals with the area of blocking inheritance. If you're interested in how these attributes work, set up a few GPOs in your Active Directory. Then use ADSI Edit from the

Windows Support Tools to examine the attributes of the newly created GPOs in this location:

```
LDAP://CN=Policies,CN=System,dc=windows,dc=mycorp,dc=com
```

Creation of GPOs is limited to those indicated in the sidebar by default. However, you can add users to the Group Policy Creator Owners security group, which allows members to create new GPOs. If a member of Group Policy Creator Owners creates a GPO, that user is set as the Creator Owner[ ] of the GPO and can continue to manage it. The Creator Owner of a GPO can manage the GPO even if the user is removed from all groups that give GPO management privileges.

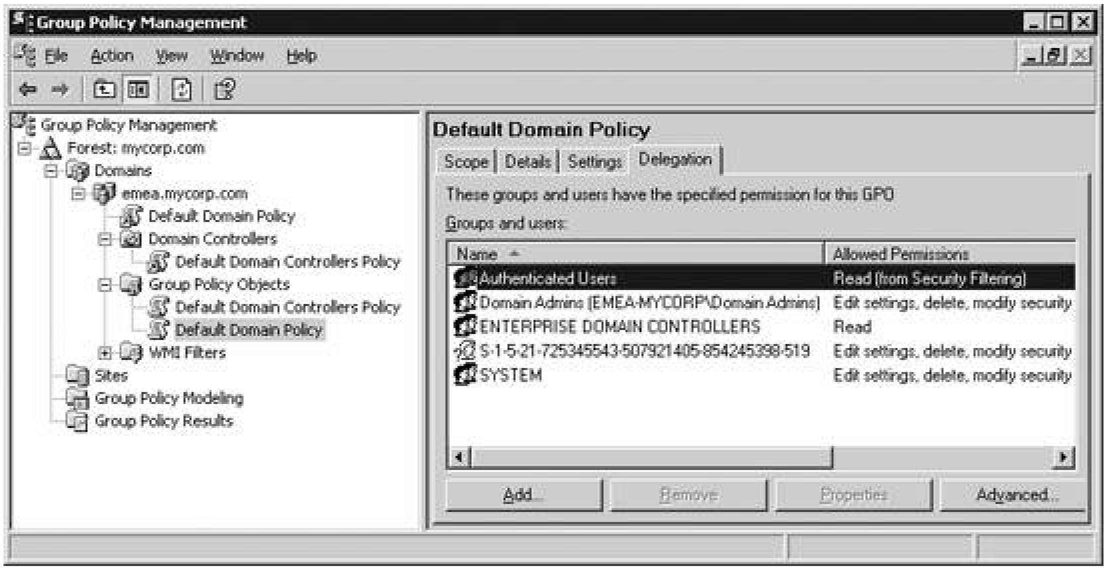
[ ] When administrators create GPOs, the Domain Admins group becomes the Creator Owner.

> GPC data in Active Directory (i.e., the actual Active Directory object itself) will never inherit security permissions from parents up the tree. There is a special block in place that prevents this in Active Directory, so that all GPO ACLs have to be modified from within the Group Policy tools.

You can delegate edit access to new GPOs, as long as the people creating those GPOs are the ones who will be editing them, by placing those users into the Group Policy Creator Owners group. If you also want to delegate edit access to more people or to GPOs that a user is not the Creator Owner of, use the GPMC. Navigate to the Group Policy Object folder under the domain in which the GPO you want to edit is contained. Click on the GPO you want to delegate and select the Delegation tab in the right pane, as shown in Figure 10-16. Click the Add button, which will bring up the object picker, which allows you to select which users or groups you want to have access. Next you'll need to pick the permission you want to grant. You have three options:

- Read
- Edit settings
- Edit settings, delete, modify security

Figure 10-16. GPO delegation in the GPMC



Default Domain Policy

These groups and users have the specified permission for this GPO

Groups and users:

Name	Allowed Permissions
Authenticated Users	Read (from Security Filtering)
Domain Admins (EMEA-MYCORP\Domain Admins)	Edit settings, delete, modify security
ENTERPRISE DOMAIN CONTROLLERS	Read
S-1-5-21-725345543-507921405-854245398-519	Edit settings, delete, modify security
SYSTEM	Edit settings, delete, modify security

Finally, click OK and the delegation will be applied.

> A word of warning before we finish up here; correctly applied, GPOs are fundamental to the wellbeing of your Active Directory. Policies incorrectly applied to the root of the domain could lock down the Administrator account or disallow logons at domain controllers. This is obviously a worst-case scenario, but there are some mistakes that are much more likely to occur: a mistyped registry value that forces users to an invalid proxy server and thus stops Internet Explorer from working, forgetting to clear a checkbox and thus applying a policy down an entire branch of the tree (the default) when it was only to apply to the root of the branch, and so on. These changes have the potential to affect all users or computers throughout the tree, so we would caution you to keep GPO administrators to a very select subset. If you allow nonadministrators the ability to create, change, and delete GPOs, they have to be able to take responsibility for and be accountable for their actions. Users who are already administrator-equivalent will automatically be able to administer GPOs and should already be held accountable.

10.3.4.3. Creating customized GPOEs for administrators

The GPOE comes with a series of permitted snap-ins that normal administrators will get by default. These snap-ins allow administrators to manage all parts of a GPO. However, it is possible to ship customized GPOEs that focus on only one GPO and load only certain permitted snap-ins. This allows you to state that Group 1 can manage one part of a policy and Group 2 another part of the same policy. This is a very useful tool that we encourage you to use when delegating administration, but you must be aware that just giving a restricted tool to certain users will not stop them from being able to manipulate other aspects of a GPO if they open up their own GPOE and point it at the same policy.

To solve this problem, cast your mind back to the section when we was discussing the Administrative Templates (User) section, specifically the Windows Components ⟶ Microsoft Management Console ⟶ Restricted ⟶ Permitted snap-ins ⟶ Group Policy section. The best solution is to use the Restricted ⟶ Permitted snap-ins ⟶ Group Policy section of a GPO in order to allow and deny users or groups access to certain extensions. This covers you completely, since your users or groups can now run up only their own GPOE with the extensions that you have explicitly permitted them to use.

◀ PREV NEXT ▶

PREV NEXT

10.4. Debugging Group Policies

If at any point you need to debug group policies, there are couple of options you can use. The first is new to Windows Server 2003 and is called the Resultant Set of Policy, which some people may be familiar with if you've used tools like Full Armor's Fazam 2000. The Resultant Set of Policy (RSoP) allows you to specify certain user, computer, group, and GPO criteria to determine what will be applied. Another option is to enable some extra logging that can help point out GPO processing problems.

10.4.1. Using the RSoP

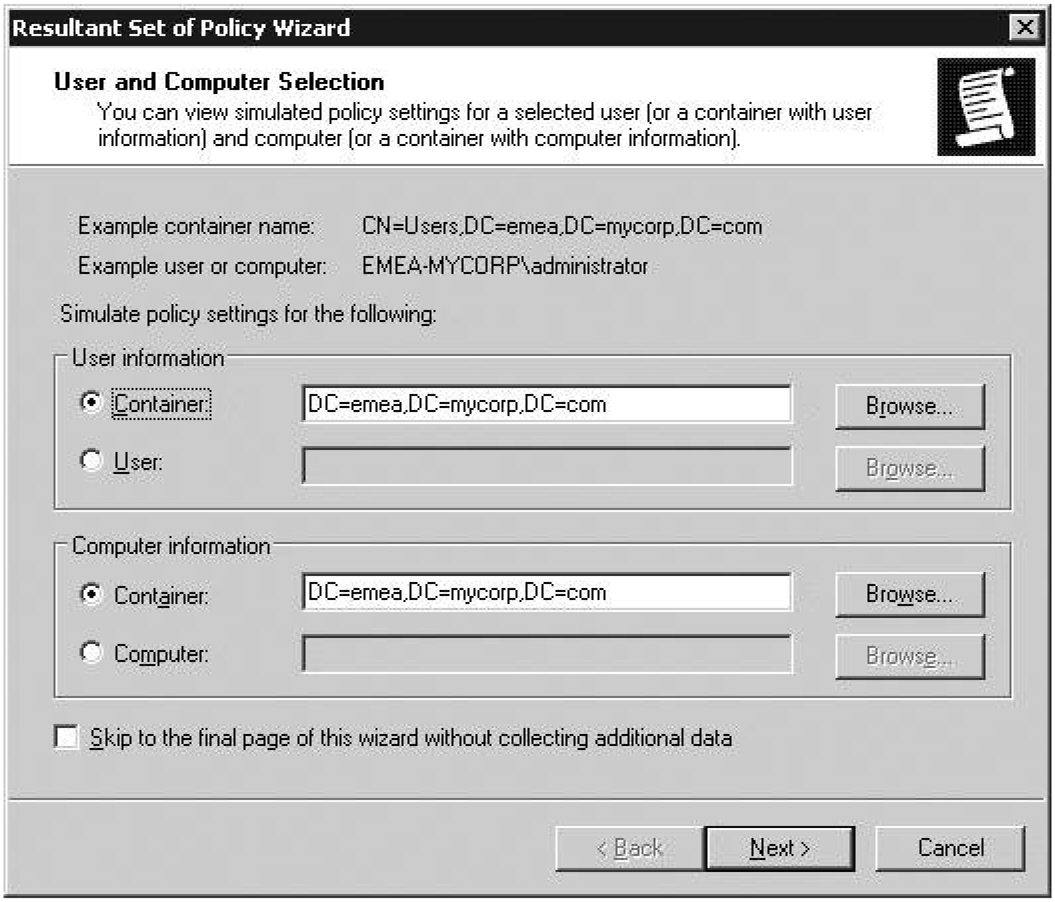
The RSoP is a very powerful tool to help identify what GPO settings will be applied to a user or computer. Before RSoP, administrators were left to do their own estimates as to what GPOs took precedence and what settings were actually applied to users and computers. RSoP removes much of the guesswork with an easy-to-use wizard interface.

To start the RSoP wizard, open Active Directory Users and Computers and browse to the domain or Organizational Unit that contains the users you want to simulate. Right click on the container and select All Tasks → Resultant Set Of Policy (Planning). Figure 10-17 shows the initial screen.

You must first select a specific object DN of a user or computer, an Organizational Unit that contains users or computers, or a domain. After clicking Next, you will come to the Advanced Simulation Options screen where you can select whether to pretend you are over a slow network, whether to use loopback mode, and whether a specific site should be used. Figure 10-18 shows what this screen looks like with the MySite1 site selected.

The next screen, as shown in Figure 10-19, allows you to configure any additional security groups that should be considered while processing GPOs. You will actually see two screens like the one seen in Figure 10-18; the first will allow you to select user security groups and the second will allow you to select any computer security groups.

Figure 10-17. User and Computer Selection options



Resultant Set of Policy Wizard

User and Computer Selection

You can view simulated policy settings for a selected user (or a container with user information) and computer (or a container with computer information).

Example container name: CN=Users,DC=emea,DC=mycorp,DC=com

Example user or computer: EMEA-MYCORP\administrator

Simulate policy settings for the following:

User information

● Container: DC=emea,DC=mycorp,DC=com

○ User:

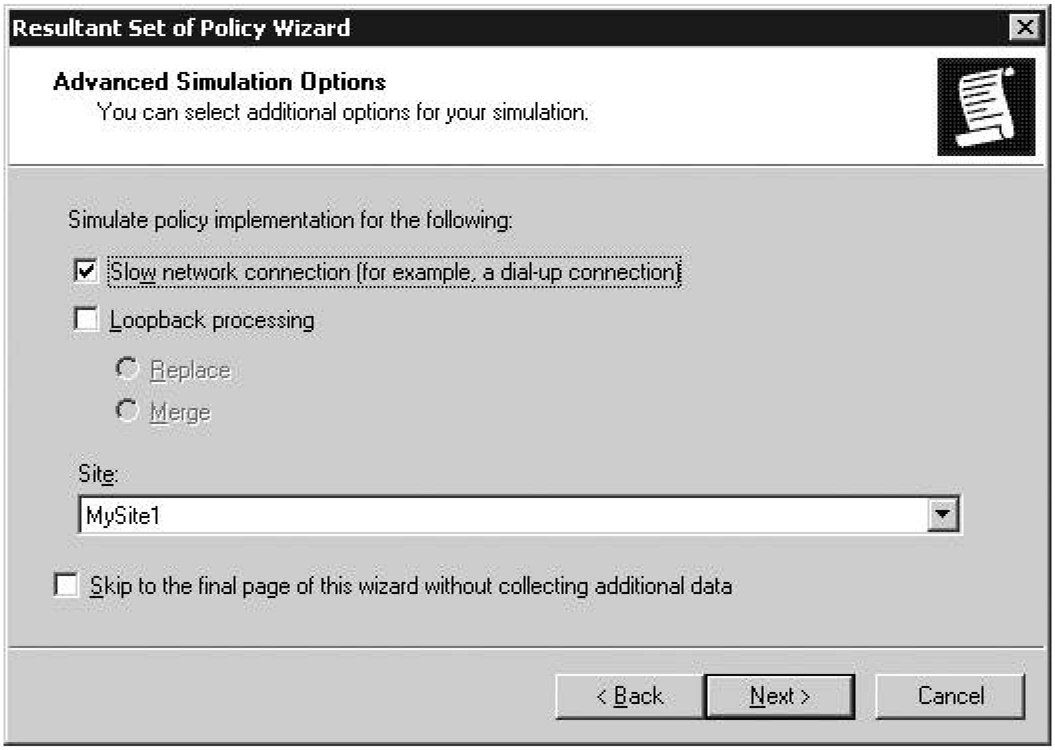
Computer information

● Container: DC=emea,DC=mycorp,DC=com

○ Computer:

□ Skip to the final page of this wizard without collecting additional data

Figure 10-18. Advanced simulation options



Resultant Set of Policy Wizard

Advanced Simulation Options

You can select additional options for your simulation.

Simulate policy implementation for the following:

☑ Slow network connection (for example, a dial-up connection)

□ Loopback processing

○ Replace

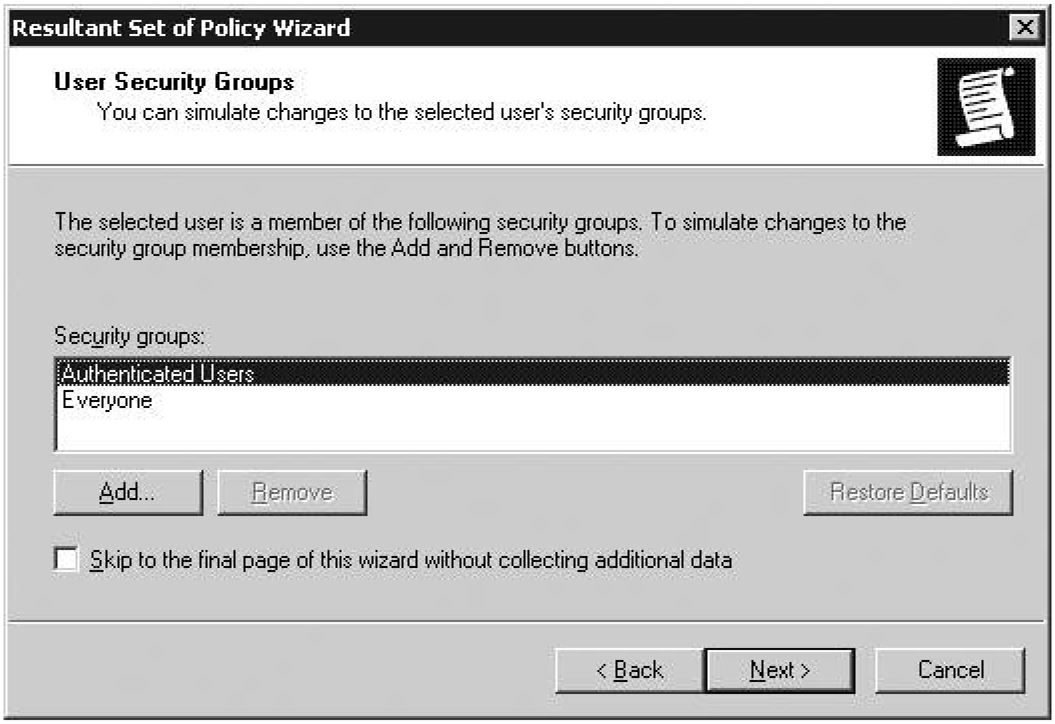
○ Merge

Site:

MySite1

□ Skip to the final page of this wizard without collecting additional data

Figure 10-19. Security group simulation



Resultant Set of Policy Wizard

User Security Groups

You can simulate changes to the selected user's security groups.

The selected user is a member of the following security groups. To simulate changes to the security group membership, use the Add and Remove buttons.

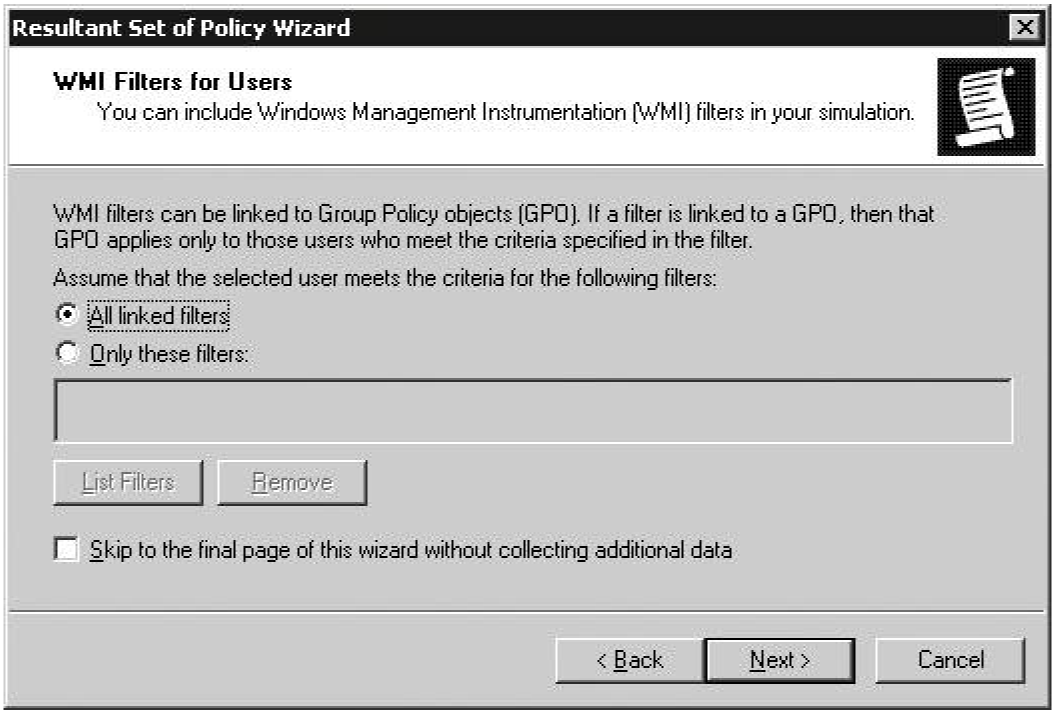
Security groups:

Authenticated Users
Everyone

□ Skip to the final page of this wizard without collecting additional data

In the next screen, you will be able to select one or more WMI filters or use the ones that have been linked to existing GPOs. Just as with the security groups, you can select WMI filters for users and computers independently. The WMI filter screen for users is shown in Figure 10-20.

Figure 10-20. WMI filters simulation



Resultant Set of Policy Wizard

WMI Filters for Users

You can include Windows Management Instrumentation (WMI) filters in your simulation.

WMI filters can be linked to Group Policy objects (GPO). If a filter is linked to a GPO, then that GPO applies only to those users who meet the criteria specified in the filter.

Assume that the selected user meets the criteria for the following filters:

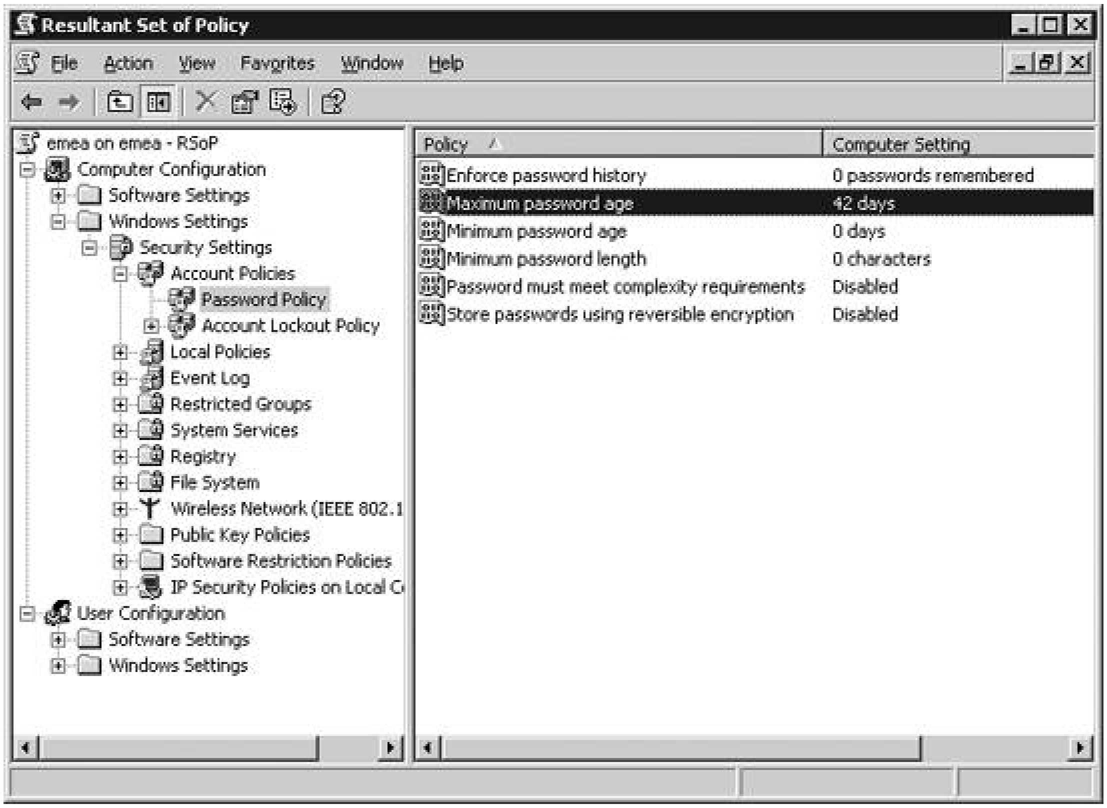
● All linked filters

○ Only these filters:

□ Skip to the final page of this wizard without collecting additional data

After you finish the wizard, a console that looks very similar to the GPOE will be opened that contains the settings that would apply to the user and computer. Figure 10-21 shows that the password policy will be applied based on the simulation criteria we entered.

Figure 10-21. RSoP results



Policy	Computer Setting
Enforce password history	0 passwords remembered
Maximum password age	42 days
Minimum password age	0 days
Minimum password length	0 characters
Password must meet complexity requirements	Disabled
Store passwords using reversible encryption	Disabled

One of the nice features of the RSoP console is that you can save it and refer to it later. You can also change or refresh the query by right-clicking the title and selecting Change Query or Refresh Query.

10.4.2. Enabling Extra Logging

You can turn on verbose logging in the event log for group policy-related events simply by setting a registry key. Once the key exists with the correct value, logging is done automatically. The value, a `REG_DWORD`, is called `RunDiagnosticLoggingGroupPolicy` and needs to be created with a value of 1 in the `HKLM\Software\Microsoft\WindowsNT\CurrentVersion\Diagnostics` key.

The value of 1 sets the logging to verbose mode; setting the value to 0 is the same as having the key absent and is known as normal logging. In other words, the key makes a difference only when set to a value of 1. It's really as simple as that.

> This key is actually one of four currently supported keys that you can use at this location. You also can create the following:
>
> - `RunDiagnosticLoggingIntelli-mirror`
> - `RunDiagnosticLoggingAppDeploy`
> - `RunDiagnosticLogging-Global`
>
> The last turns Application Deployment, Intellimirror, and Group Policy logging on without needing to set all three individually. For more information, check out Microsoft Knowledge Base Article 186454, which can be found at:
>
> http://support.microsoft.com/default.aspx?scid=kb;en-us;186454.

If the verbose logging in the event log is not providing enough information, another option is to enable debug logging for policy and profile processing. To do so, create a value called `UserEnvDebugLevel` as a `REG_DWORD` in the `HKLM\Software\Microsoft\WindowsNT\CurrentVersion\Winlogon` key. Assign `UserEnvDebugLevel` the value 10002 in hexadecimal format. Restart the computer, and from then on, extensive logging information will be recorded on the machine in the file *%SystemRoot%\Debug\UserMode\Userenv.log*. For more information, check out Microsoft Knowledge Base Article 221833, which can be found at:

http://support.microsoft.com/default.aspx?scid=kb;en-us;221833

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10.5. Summary

One of the big selling points of Active Directory has always been group policy and in Windows Server 2003 Active Directory, Microsoft extended the functionality and management of GPOs greatly. In this chapter, we expanded on the information presented in Chapter 7, to cover the details of how group policies are stored in Active Directory, how GPOs are processed by clients, the GPO precedence order, the effect of inheritance, and the role ACLs play.

With Windows Server 2003, Microsoft provided several new tools to help manage and troubleshoot GPOs. Perhaps the most important is the Group Policy Management Console (GPMC), which is a one-stop shop for all your GPO needs. With the GPMC, you can perform virtually any function you need to do from a single interface, as opposed to using three or four as was necessary with the Windows 2000 tools. Another benefit of the GPMC is that it installs several COM objects that allow you to script 90% of your GPO management functions. Another long-awaited feature that is available now is the Resultant Set of Policy (RSoP) that allows for modeling and testing of GPOs. With RSoP, you can configure several different settings including the container to process, any security groups to include, whether to use a specific site, whether to use loopback mode, whether to use a specific WMI filter, and more. The end result is a GPOE view of the settings that would be applied.

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Chapter 11. Active Directory Security: Permissions and Auditing

Permissions can be set in Active Directory in the same way they are set for files. Although you may not care that everyone in the tree can read all your users' phone numbers, you may want to store more sensitive information and restrict that access. Reading is not the only problem, of course. You also have create, modify, and delete privileges to worry about, and the last thing you need is a disgruntled or clever employee finding a way to delete all the users in an Organizational Unit.

None of this should be new to system managers who already deal with Windows NT Access Control Lists and Access Masks, Novell eDirectory Trustee Lists and Inherited Rights Masks, and Unix's access permissions in file masks. In fact, Microsoft has carried the NT terminology from file permissions forward to Active Directory, so if you already know these terms, you're well ahead. If you are not familiar with them, don't worry. Microsoft has a great tradition of calling a shovel a ground-insertion-earth-management device or GIEMD for short. Terminology in permissions can seem confusing at first, so we'll go through it all in detail.

Managing the permissions in Active Directory doesn't have to be a headache. You can design sensible permissions schemes using guidelines on inheritance and complexity that will allow you to have a much easier time as a systems administrator. The GUI that Microsoft provides is fairly good for simple tasks but more cumbersome for complex multiple permissions. In Windows Server 2003, the GUI has been enhanced to provide an "effective permissions" option that lets you determine the effective permissions a user or group has on the container or object. Also, Active Directory permissions are supported by ADSI, which opens up a whole raft of opportunities for you to use scripts to track problems and manipulate access simply and effectively. Finally, the DSACLS utility allows administrators to manage permissions from a command line if you prefer an alternative to the GUI.

Yet permissions are only half the story. If you allow a user to modify details of every user in a specific branch below a certain Organizational Unit, you can monitor the creations, deletions, and changes to objects and properties within that branch using auditing entries. In fact, you can monitor any aspect of modification to Active Directory using auditing . The system keeps track of logging the auditing events, and you can then periodically check them or use a script or third-party tool to alert you quickly to any problems.

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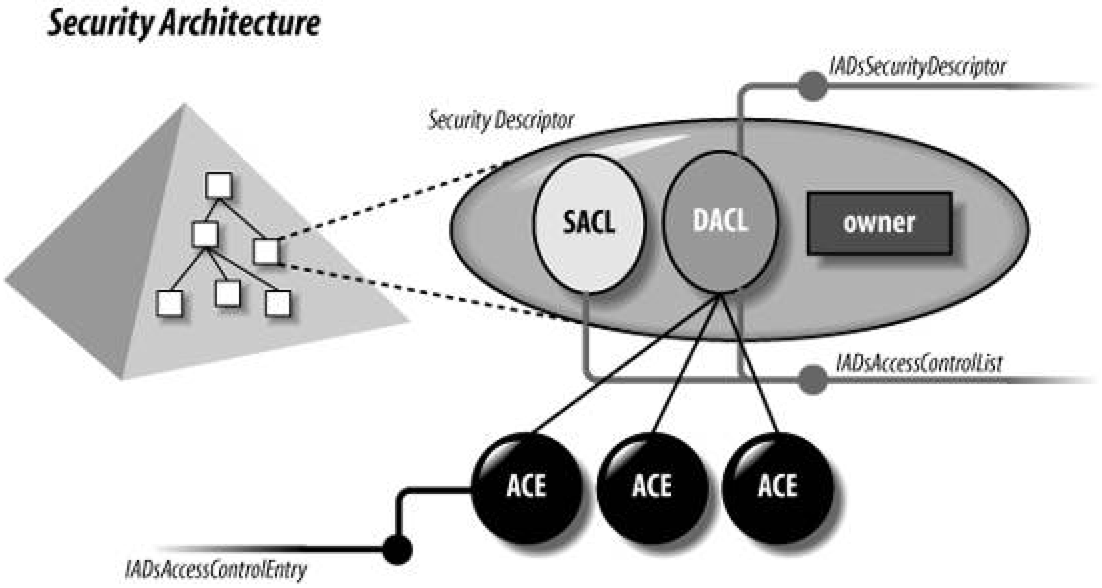
11.1. Permission Basics

Figure 11-1 shows the basics. Each object stores a value called a Security Descriptor, or SD, in the nTSecurityDescriptor attribute. This attribute holds all the information describing the security for that object. Included with the information are a flag indicating whether or not the SD is protected against inheritance, as well as two important collections called Access Control Lists, or ACLs, which hold the relevant permissions .

Figure 11-1. Active Directory security architecture



The first ACL, called the System-Audit ACL or SACL , defines the permission events that will trigger both success and failure audit messages. The second, called the Discretionary ACL or DACL, defines the permissions that users have to the object, its properties, and its children. Each of the two ACLs holds a collection of Access Control Entries, or ACEs , that correspond to individual audit or permission entries.

Audit and permission ACEs can apply to the object as a whole or to the individual properties of the object. This allows an administrator to control all aspects of access and auditing. Audit ACES are discussed further in Chapter 26, but we will briefly document some of the information in the following section so that other permission topics discussed later in this chapter are more readily understood.

11.1.1. Permission ACE

Each permission ACE is made up of several pieces of information:

Trustee

SID of the user or group to which the ACE applies, such as the SID for the group Mycorp\Domain Admins.

ACE Type

Determines whether the ACE is a Grant or a Deny.

Object Type

`schemaIDGUID` for the attribute or object class that the ACE applies to. Alternatively, the `rightsGuid` for the property set, validated write, or extended right that the ACE applies to such as the `member` attribute, `Personal Information` property set, `Change Password` extended right, or `user` objects. For delete or create child objects permissions , the `objectType` should be configured to the `schemaIDGUID` of the object class delegated.

Inherited Object Type

`schemaIDGUID` for the object types that the ACE applies to when an attribute, property set, or validated right is specified or when the ACE is inheritede.g., `user` objects.

Access Mask

A bit flag that describes the type of access, such as Read, Write, List, Create, Delete, Control Access, etc. See Table 26-5 for more detail.

Flags

There are actually two different fields for flags. The flags specify inheritance settings such as ACE is inherited, ACE is allowed to be inherited, ACE is not inheriteable, etc.

Every permission granted in Active Directory is based on these ACE structures as described above. Objects and properties are only revealed to users who have the appropriate permissions on the object. Any attribute that doesn't have an ACE specifically granting the requested access to a trustee is implicitly denied. The security descriptor also allows an administrator to specifically deny access with a deny ACE, but this isn't needed unless you are attempting to override another more generic ACE that is granting access.

This permission mechanism allows different users or groups of users to have completely different and very granular access to an object. For example, all users might be granted read access to the telephone number and email properties, but only a subset will have access to modify the description.

11.1.2. Property Sets, Validated Writes, and Extended Rights

Microsoft introduced several new "tools" that are not present in the NTFS ACLs. These tools are called property sets , validated writes , and extended rights . Instead of inserting the schemaIDGUID into the object type field of an ACE, you would insert the rightsGuid attribute of the property set, validated write, or extended right object. These objects are all stored in the extended-rights subcontainer of the configuration container.

> Property sets, validated writes, and extended rights are all controlAccessRight objects. You can determine what specific type of controlAccessRight they are by looking at the validAccesses attribute of the object with any utility that allows viewing of all attribute values on an object such as *LDP* or *ADSIEDIT*. Property sets have a value of 48, validated writes have a value of 8, and extended rights have a value of 256.

Property sets are collections of attributes that can be referenced in a single permission ACE. The big win here is that you could assign one ACE to a SD and have it grant access to 5, 10, 20, or more attributes. The savings in SD size should be immediately obvious; a single ACE that can substitute for 20 different ACEs is a good data reduction ratio. There are several predefined property sets in a default forest; some of these are Personal Information, Public Information, Web Information, and Account Restrictions. You can also add your own property sets as desired.

While property sets are a great boon to securing the directory in a manner that is simpler than could otherwise have been achieved, the implementation does suffer a major shortcoming. *An attribute can only be part of a single property set*. Unfortunately, many of the base schema attributes are already included in existing property sets; while most[*] of these can be successfully removed from the property sets or moved to other property sets, you can never be sure doing so won't break some application. It is generally much safer to stick to managing property sets comprised of your own custom attributes that you add to the directory.

[*] Property sets cannot be modified in Windows 2000 AD. In Windows Server 2003 AD, you are prevented from modifying the property set memberships of SAM attributes such as sAMAccountName, etc.

Validated writes are writes that go through additional verification. You can not modify these validated writes nor create your own: what comes with AD is what you get. The only validated writes that are currently defined are Validated Write of Service Principal Name, Validated Write of DNS host name, and Add/Remove self as member.

Extended rights are the mechanism used to delegate special operations such as Password Changes or Password Resets. While you can add additional extended rights to the directory, you cannot create extended rights that are enforced by the directory. Any new extended rights that you create will simply be additional permissions that can control an application you write that knows how to use the permissions. Your primary use of these extended rights will generally be to delegate to admins the right to set passwords on user objects with the Reset Password extended right.

11.1.3. Inherited Versus Explicit Permissions

NT4 Administrators everywhere are used to quoting the mantra "Deny overrides everything." Fortunately (or maybe unfortunately, depending on what you are trying to accomplish), Active Directory ACLs are a little more complicated than that. You need to specifically be aware of inherited versus explicit permissions . Explicit permissions are permissions that are directly applied to an object. Inherited permissions are permissions that are applied at some level of the tree above the object and "flow down" to the object and its children. When working with inherited and explicit permissions on an object, *a deny doesn't necessarily override a grant*.

The rules for what access will result from a set of inherited and explicit ACEs are easiest to understand when taken in steps:

1. Deny ACEs override grant ACEs of the same type (inherited versus explicit) and application point in the directory tree.

2. Explicit ACEs override inherited ACEs.

3. Inherited ACEs are hierarchical; e.g., An inherited deny applied to a container will be overridden by an inherited grant applied to containers nested below in the same branch.

Mostly simply, the closest ACEs to the object will dictate the access for the object. If you use an inherited deny to prevent access to some attribute on objects in an OU and the deny isn't effective, look for inherited grant permissions applied further down the branch or for explicit grant permissions applied on the objects themselves.

11.1.4. Default Security Descriptors

Every object defined in the schema has an attribute called `defaultSecurityDescriptor` . This attribute is the Security Descriptor Definition Language (SDDL) format of the object's default SD. It will be applied to any object created without a SD specified during the object creation. These default permissions are rather extensive in Active Directory and are composed entirely of explicit ACEs so that they override any inherited denies (This tends to make denying access to specific attributes a little more challenging than it probably should be.) The DACL defined by the default security descriptor for the user object is listed in Table 11-1.

Table 11-1. DACL for Default Security Descriptor on user objectClass

Trustee	Permission
Domain\Domain Admins	Full Control
Builtin\Account Operators	Full Control
System	Full Control
Self	Read Permissions List Contents

Trustee	Permission
	Read Property List Object Read/Write Personal Information Read/Write Phone and Mail Options Read/Write Web Information Change Password Send As Receive As
Authenticated Users	Read Permissions Read General Information Read Public Information Read Personal Information Read Web Information
Domain\RAS and IAS Servers	Read Account Restrictions Read Logon Information Read Group Membership Read Remote Access Information
Domain\Cert Publishers	Read/Write userCertificate
Builtin\Windows Authorization Access Group	Read tokenGroupsGlobalAndUniversal
Builtin\Terminal Server License Servers	Read/Write terminalServer
Everyone	Change Password

11.1.5. Permission Lockdown

You can see from the information above that in a default Active Directory installation, Authenticated Users have access to quite a bit of information. There is even more information available if you have Pre-Windows 2000 Compatible Access enabled, which allows Authenticated Users to see all properties of groups, users, and inetOrgPerson objects. Open access to this information is a sore spot for many companies who don't want employees to have quite that much information available to them: maybe they want to restrict access to employee phone numbers, or addresses, or other personal information.

Removing the ability to see the information can be difficult to accomplish, especially the items granted through explicit property set ACEs. In addition, any modification you make needs to be thoroughly tested to verify it doesn't break any of your line of business applications. Microsoft Exchange is particularly sensitive to permission lockdowns, and if you take away `Authenticated Users` access to some attributes, you may need to re-grant the permissions back to the Exchange servers. Unfortunately, Microsoft has not been very forthcoming on exactly what permissions Exchange needs for proper operations.

> You cannot permanently lock the directory down from Domain Admins. At any point, anyone from that group can take ownership of any object (if they don't already have it) and rewrite the Security Descriptor to include Domain Admins or any other security principal in the access . There should be very few Domain Admins in your forest, preferably five or less, even for Fortune 10 class companies.

Once you have decided to proceed with the lockdown, your next step is to decide how to accomplish the lockdown. The "how" and the resulting workload and impact depends entirely on the attribute in question and how the access is being granted.

By far, the simplest case is when the access is granted through inheritance . You can either remove the inherited grant if it is just the one attribute or you can add an inherited deny for the attribute or attributes you want protected. An example of an inherited permission you may want to remove is read access to the `employeeID` property. `Authenticated Users` are granted read access to `employeeID` through an ACE applied to the root of the domain that gives access to read all properties of users for the `Pre-Windows 2000 Compatible Access` group. Inserting an inheritable deny read ACE on the root of the domain or other container for `Authenticated Users` will effectively block the inherited grant read access to this attribute. Read access can be re-added further down the tree beneath the deny ACE if desired with either an additional explicit or inherited grant read access ACE.

If the access is granted through an explicit ACE, locking down is considerably more involved and may actually be so difficult it isn't feasible. There are several mechanisms available for locking down explicitly granted access:

- If the access is granted through a property set, modify the membership of the property set involved. This takes effect on a DC as soon as it replicates to the DC.
- Change the default security of the object class definition in the schema to remove the explicit `Authenticated Users` permissions or alternatively add a deny ACE for the specific attribute and then "fix" the ACLs on every instance of the object in existence in the directory. Any new objects will be created with the new security descriptor.
- Strip the explicit grant ACE from every instance of the object in the directory. You will need to keep doing this as new instances of the object are created, or if someone resets the ACL to schema defaults on any of the objects.
- Add an explicit deny ACE on every instance of the object in the directory. Like the previous solution, this requires "fixing" new instances of the objects that are created or reset to schema defaults.
- If all of your domain controllers are at least at Windows Server 2003 Service Pack 1 or better,

you may be able to use the confidentiality bit. This new capability is described in the following section.

> If you use the GUI to set granular permissions, you should double check the actual ACEs written to the ACL with *DSACLS* or a script. The GUI has an annoying habit of trying to figure out what you want instead of just doing what you tell it. The result can be an inefficient ACL with far more ACEs than necessary. This happens most often when adding deny ACEs.

11.1.6. Confidentiality Bit

After five years of customers wrestling with the directory lockdown difficulties outlined above, Microsoft finally tried to fix the problem. The result, more a workaround than a fix, in Windows Server 2003 Service Pack 1 is called confidential attributes. Microsoft has defined a new `searchFlags` bit called the confidentiality bit; this is bit 7, which has the value 128. When the bit is enabled, the attribute is considered to be confidential on any DCs running Windows Server 2003 Service Pack 1. Only users with both Read Property permission AND Control Access permission for the attribute on an object can view the attribute. This would mean anyone with Full Control or All Extended Rights (Control Access for object) or Control Access for the specific attribute. Assuming default permissions, this would mean access would be granted to:

- Builtin\Administrators (inherited FC)
- Builtin\Account Operators (explicit FC)
- NT Authority\System (explicit FC)
- Domain\Domain Admins (explicit FC)
- Domain\Enterprise Admins (inherited CA)

As you can see, this would appear to give us a great new solution to the issues mentioned previously with explicit permissions. You could simply mark any troublesome attributes, as confidential and then normal users can no longer see them. This is a great plan but there is a great big kink in the plan; you can not set the confidentiality bit on category one attributes, which are more generically known as base schema attributes. So, many of the attributes companies are trying to lock down, can't be locked down with this capability.

> Officially, as mentioned previously, you can't lock down category one attributes with the confidentiality bit. Unofficially, there is a back door that is available to accomplish this. However, you are taking things into your own hands if you use it, and if you have a problem, Microsoft will most likely tell you what you have done is unsupported.
>
> Since this capability was released in Windows Server 2003 Service Pack 1, the verification of which attributes can have the bit set only applies to servers running that version of the OS or better. This means that if you make the schema modification of the `searchFlags` attribute on a pre-SP1 machine, nothing will prevent you from modifying any attribute you choose to modify, including category one attributes.
>
> If you choose to do this, it is highly recommended that you avoid the attributes that have bit 1 (value 2) set in `systemFlags`. The attributes with that flag set are very sensitive attributes such as `sAMAccountName`, `nTSecurityDescriptor`, `objectCategory`, `objectClass`, `servicePrinci-palName`, and many others that are core to Active Directory functions. Manipulating their visibility could be quite disastrous to a forest.

In addition to the category one attribute shortcoming, there are some other issues with this new capability. It may seem obvious, but only domain controllers running Windows Server 2003 Service Pack 1 or better will prevent display of confidential attributes to users without Control Access rights. So if you have Windows 2000 domain controllers or Pre-SP1 Windows Server 2003 domain controllers in the domain, any queries sent to those DCs will return the information that is supposed to be confidential. This also applies to any Global Catalogs if the attributes you have made confidential are partial attribute set (PAS) attributes.

Another issue is that Microsoft seems to have forgotten to give a tool with Windows Server 2003 Service Pack 1 to easily grant granular permissions to allow delegation of who can see confidential attributes. The GUI dialogs in Active Directory Users and Computers and *ADSIEDIT* will only allow you to grant Full Control or Control Access of the entire object, which is also known as All Extended Rights. The command-line tool *DSACLS* does nothing to help either. This is a lot of access to grant to allow someone to see one or two attributes. Currently, the only mechanism available to grant granular Control Access permission to a single attribute on an object is to write a script to configure the delegation. Once delegated, the GUI cannot properly display the permission, but *DSACLS* can.

> R2 ADAM and ADAM SP1 have an updated version of *LDP* that has the most flexible GUI-based ACL Editor available in Windows. This tool will allow you to set Control Access for a specific property. You need to be aware, however, that you can set any number of incorrect ACEs with the tool, as it doesn't perform ACE validation that is done with *ADUC*, *DSACLS*, and other ACL Editor tools.

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11.2. Using the GUI to Examine Permissions

To access the permissions for any object, select the Active Directory Users and Computers MMC and right-click on it. Choose Properties from the drop-down menu and select the Security tab of the properties window that is displayed.

> To make the Security tab visible, you need to right-click in the display pane of the Active Directory Users and Computers MMC, choosing View Advanced Features from the pop-up menu. If you reopen the properties window of the object to which you wish to assign permissions, you should see a Security tab.

The window in Figure 11-2 is your first point of contact for permissions. The top area contains a complete list of all groups and users who have permissions to the object whose properties we are looking at. The Permissions section below this list displays which general permissions are allowed and denied for the highlighted user or group. The general permissions listed are only those deemed to be the most likely to be set on a regular basis. Each general permission is only an umbrella term representing a complex set of actual implemented permissions hidden underneath the item. Consequently, the general permission called Read translates to specific permissions like Read All Properties and List Contents, as we will show later. Below the Permissions section are three important parts of this window:

Advanced button

The Advanced button allows you to delve further into the object, so that permissions can be set using a more fine-grained approach.

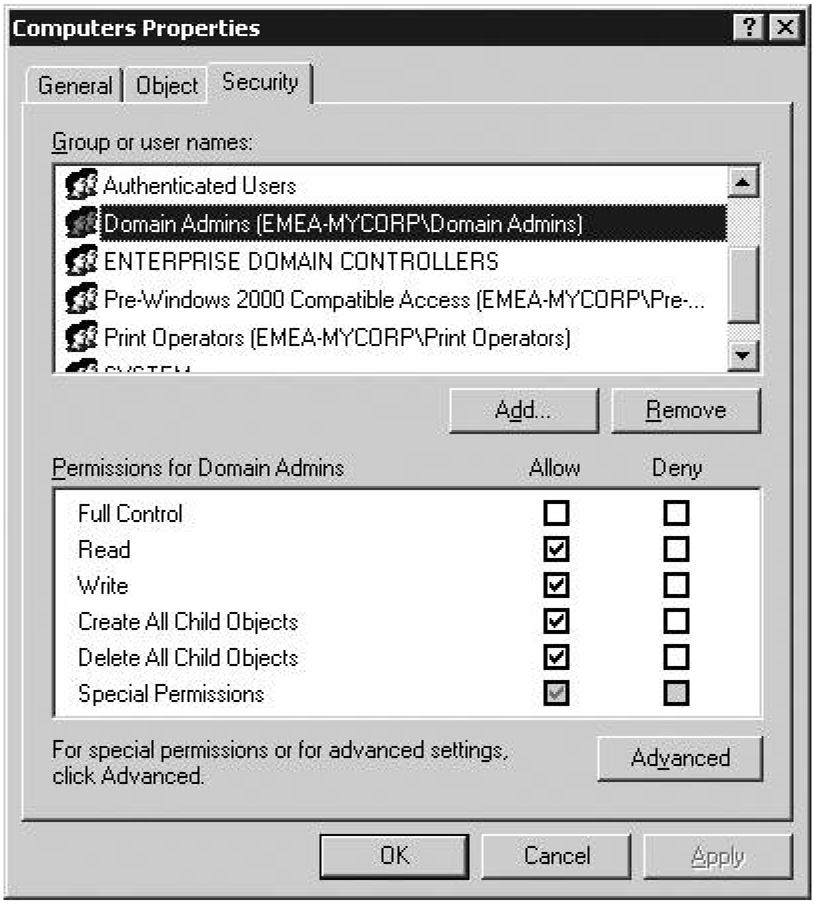
Text display area

The second part of this area of the window is used to display a message, such as that shown in Figure 11-2. The text shows that the permissions for the current object are more complex than can be displayed here. Consequently, we would have to press the Advanced button to see them.

Inheritance checkbox (Windows 2000 only; not shown in Figure 11-2)

The "Allow inheritable permissions from parent to propagate to this object" protects or blocks the object from inheriting Access Control Entries from its parent. When you clear the checkbox on the security properties or Access Control Settings windows mentioned later, the system pops up a Yes/No/Cancel dialog box that asks if you want to convert your inherited entries to normal entries. If you click Cancel, the operation aborts. Clicking No removes all inherited entries and protects the object or branch. Clicking Yes converts the current inherited entries to standard entries and protects the object from any new inherited permissions applied to the parent or higher branch. All normal permission entries for the object are unchanged by whatever choice you make. We will cover this in more detail later in the book. For Windows Server 2003, this checkbox is located on

Figure 11-2. Security properties of an object



Group or user names:

- Authenticated Users
- Domain Admins (EMEA-MYCORP\Domain Admins)
- ENTERPRISE DOMAIN CONTROLLERS
- Pre-Windows 2000 Compatible Access (EMEA-MYCORP\Pre-...
- Print Operators (EMEA-MYCORP\Print Operators)
- SYSTEM

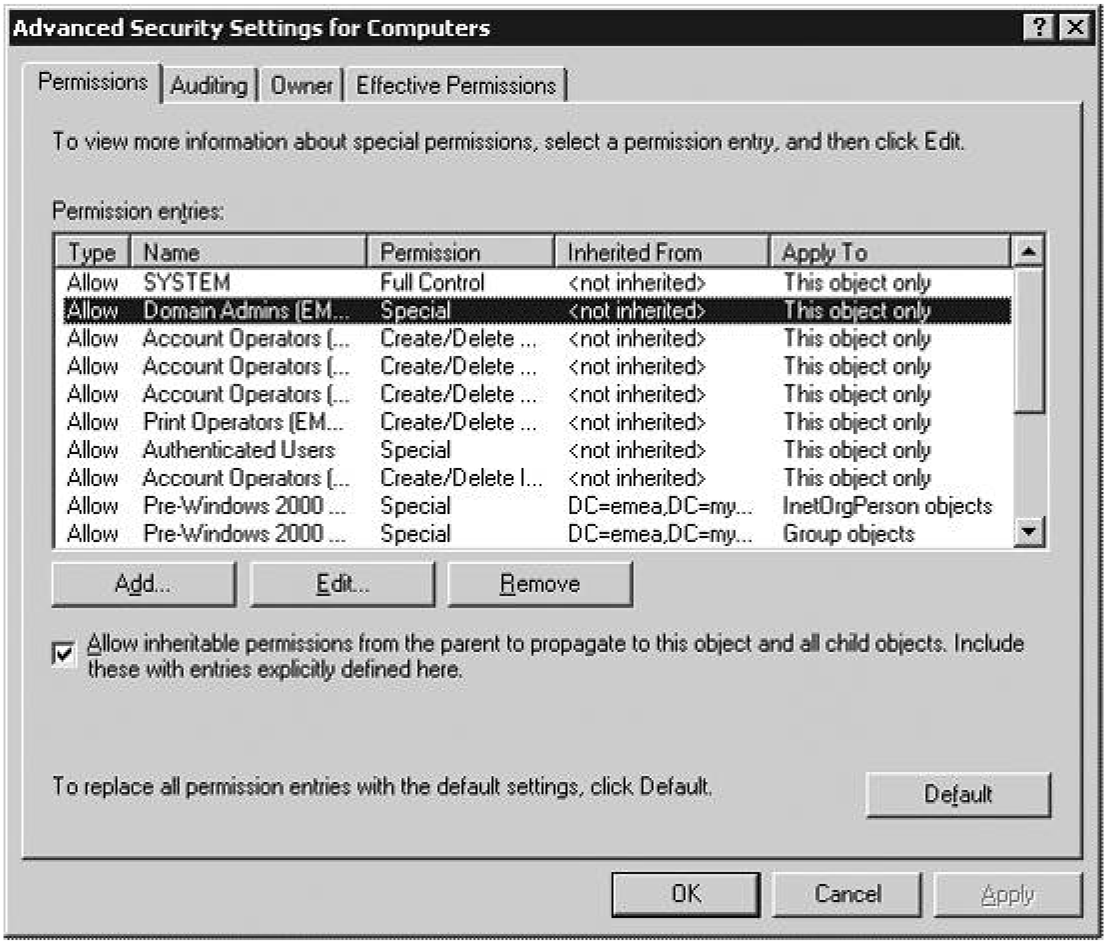
Permissions for Domain Admins	Allow	Deny
Full Control	□	□
Read	☑	□
Write	☑	□
Create All Child Objects	☑	□
Delete All Child Objects	☑	□
Special Permissions	☑	□

For special permissions or for advanced settings, click Advanced.

the Advanced screen. Clicking the Advanced button actually displays the same users and groups again, but in slightly more detail. Figure 11-3 shows this window, known as the Advanced Security Settings for the object.

While the Advanced Security Settings window gives only slightly more information than the previous window, it serves an important purpose: it is a gateway to some of the lowest, most granular, permissions. The Advanced window allows you to view the globally set permissions from Figure 11-2, as well as a brief summary of the advanced permissions that may be set for each object. While the Name and Permission columns effectively duplicate information from Figure 11-2, the Type field shows whether the permissions to the object for this user or group are Allow or Deny. If a group has some allow and some deny permissions, two entries are recorded in this window. The Inherited From field is a new addition in Windows Server 2003 that allows you to see what object, if any, the permission was inherited from. The Apply To column usefully indicates what the permission applies to. This could be to this object only, the object and all sub-objects, or just to an individual property, say telephoneNumber, of a user object.

Figure 11-3. Advanced Security settings for an object



To view more information about special permissions, select a permission entry, and then click Edit.

Permission entries:

Type	Name	Permission	Inherited From	Apply To
Allow	SYSTEM	Full Control	<not inherited>	This object only
Allow	Domain Admins (EM...	Special	<not inherited>	This object only
Allow	Account Operators (...	Create/Delete ...	<not inherited>	This object only
Allow	Account Operators (...	Create/Delete ...	<not inherited>	This object only
Allow	Account Operators (...	Create/Delete ...	<not inherited>	This object only
Allow	Print Operators (EM...	Create/Delete ...	<not inherited>	This object only
Allow	Authenticated Users	Special	<not inherited>	This object only
Allow	Account Operators (...	Create/Delete I...	<not inherited>	This object only
Allow	Pre-Windows 2000 ...	Special	DC=emea,DC=my...	InetOrgPerson objects
Allow	Pre-Windows 2000 ...	Special	DC=emea,DC=my...	Group objects

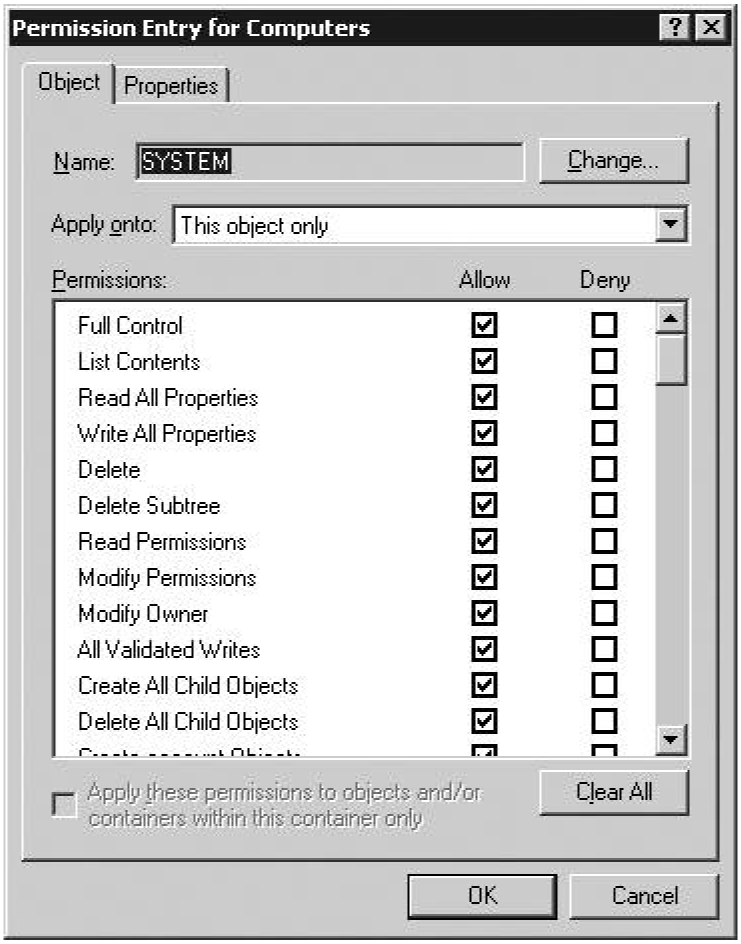
☑ Allow inheritable permissions from the parent to propagate to this object and all child objects. Include these with entries explicitly defined here.

To replace all permission entries with the default settings, click Default.

The permission dialog boxes have quite a lot of information and are usually too small to see the information comfortably. This makes it painful to look at permissions because you are constantly resizing the individual columns or scrolling the dialog back and forth. Unfortunately there is no way to modify these dialog boxes to better fit the information they contain.

You now have two choices to view the atomic permissions . You can click Add, which pops up a window allowing you to add a new user or group to those with permissions set on this object. Alternatively, you can highlight an existing user or group and click the Edit button (or View/Edit on Windows 2000). If you highlight a user or group or add one from the pop-up window, the next screens you see are the PE windows, shown in Figures 11-4 and 11-5.

Figure 11-4. Permission Entry for an object



Permission Entry for Computers

Name: SYSTEM

Apply onto: This object only

Permissions:	Allow	Deny
Full Control	☑	□
List Contents	☑	□
Read All Properties	☑	□
Write All Properties	☑	□
Delete	☑	□
Delete Subtree	☑	□
Read Permissions	☑	□
Modify Permissions	☑	□
Modify Owner	☑	□
All Validated Writes	☑	□
Create All Child Objects	☑	□
Delete All Child Objects	☑	□

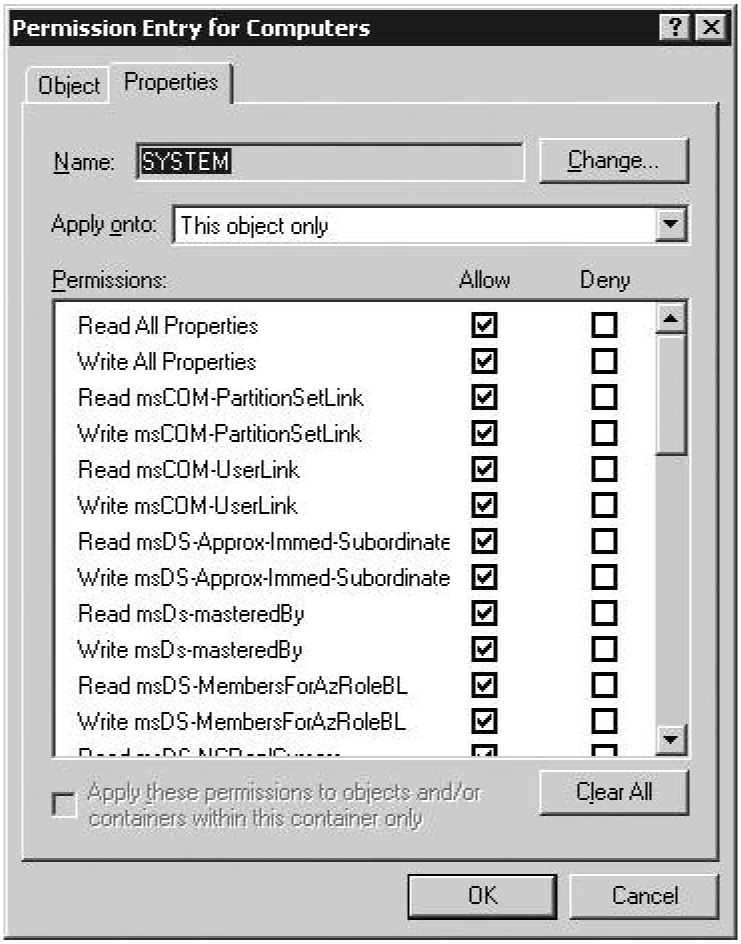
□ Apply these permissions to objects and/or containers within this container only

Until you know exactly what you are doing with permissions, we suggest that you create a few test users and groups to play with permissions settings. The last thing you want to do is make a simple mistake with a built-in group or user and deny yourself access to the tree. If you create two test users and three test groups, put each user in a separate group, and then put both users in the third group, you will have the basis of a test system.

The PE windows are two sides of the same coin, one representing permissions to the object and the other representing permissions to the properties of that object. This is the lowest, most atomic level you can get to with ADUC when setting permissions.

The object name is displayed in the title of the PE window, with the name of the user or group that has permissions prominently displayed in the field at the top. The user or group then has permissions allowed and denied from the column entries. The entries in the window are relative and vary depending on the entry in the drop-down list under the heading of Apply Onto. What is not immediately obvious from this window is how large the drop-down box can actually get. Figure 11-6 shows this nicely. If you look at the scroll bar, you will get an idea of how many items are currently not displayed.

Figure 11-5. Permission Entry for an object's properties



Name: SYSTEM

Apply onto: This object only

Permissions:	Allow	Deny
Read All Properties	☑	□
Write All Properties	☑	□
Read msCOM-PartitionSetLink	☑	□
Write msCOM-PartitionSetLink	☑	□
Read msCOM-UserLink	☑	□
Write msCOM-UserLink	☑	□
Read msDS-Approx-Immed-Subordinate	☑	□
Write msDS-Approx-Immed-Subordinate	☑	□
Read msDs-masteredBy	☑	□
Write msDs-masteredBy	☑	□
Read msDS-MembersForAzRoleBL	☑	□
Write msDS-MembersForAzRoleBL	☑	□

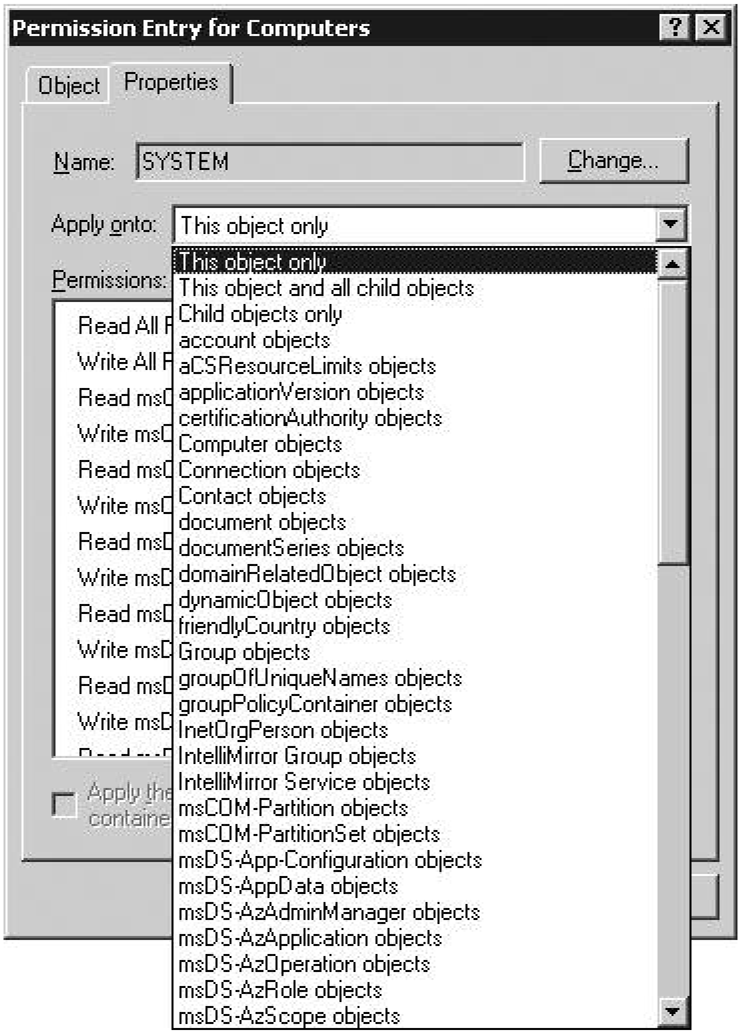
□ Apply these permissions to objects and/or containers within this container only

To set a permission from the PE window, pick where you want to apply the permission and then click the relevant Allow and Deny boxes, selecting OK when done. Since Microsoft has not provided an Apply button, you cannot specify a set of permissions applied onto one area, click Apply, and then repeat the cycle until you are done with this user and group. You have to click OK, which means the window closes, whereupon you then have to click Add again, and so on. This is a tiresome problem if you are implementing multiple changes from a set of prepared designs, but one you have to live with if you choose to use the GUI to set permissions.

11.2.1. Reverting to the Default Permissions

In Figure 11-3, you may have noticed the Default button at the bottom. This is a new feature in Windows Server 2003 that allows you to revert the current permission set to the default security as defined in the schema for the objectclass of the object. If you click Default for an object you have not modified the permissions on, you may notice that the list still changes. If you look closer, you'll see that the inherited permissions were the ones removed. That is because inherited permissions are not defined as part of the default security of an object and will be removed. Even if you then click OK to apply the permissions, as long as the Allow Inheritable Permissions box is checked, the inherited permissions will still apply. Having the ability to apply the default permissions is a useful feature, especially for administrators who are trying to determine what changes have been made from the default installation.

Figure 11-6. Permission Entry window showing the large number of targets to which permissions can be applied



Permission Entry for Computers

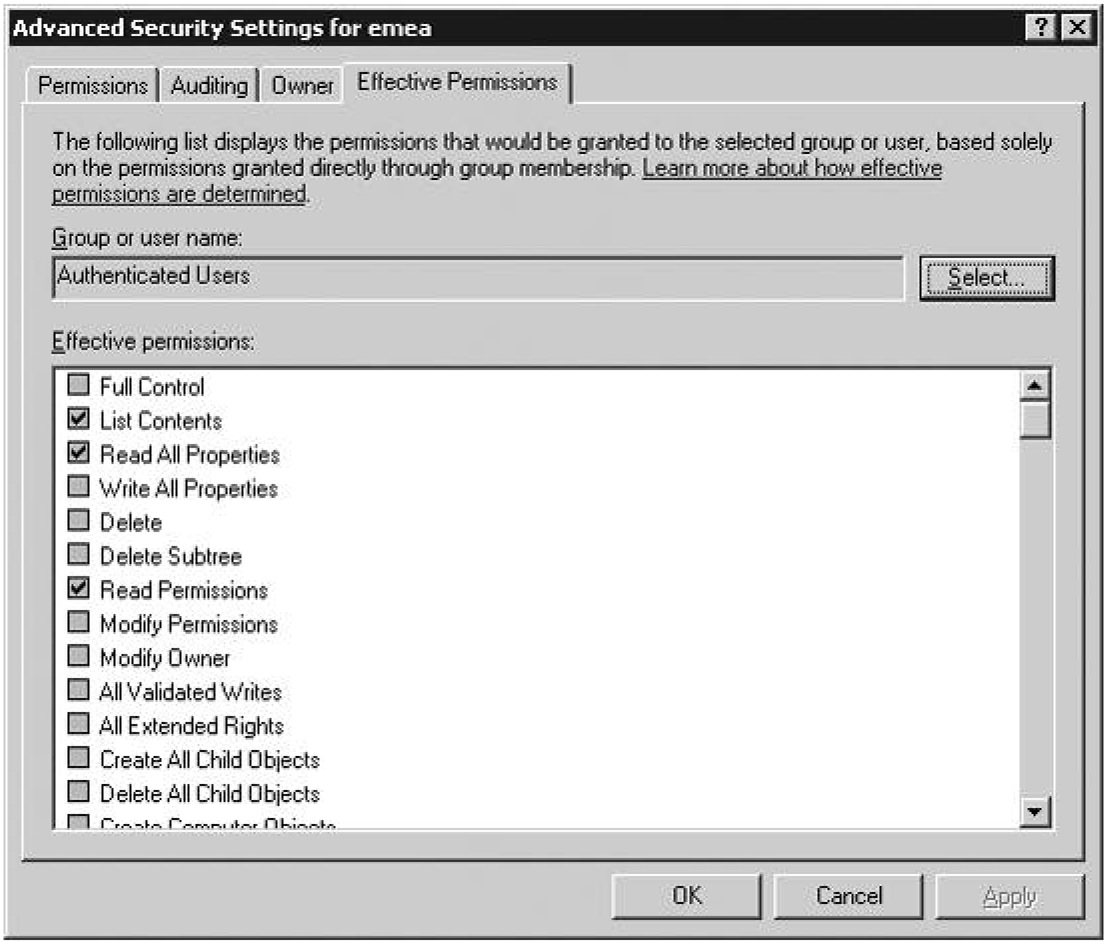
Name: SYSTEM

Apply onto: This object only

11.2.2. Viewing the Effective Permissions for a User or Group

Another new feature in Windows Server 2003 is Effective Permissions, which is available from the Advanced button when viewing the security for an object. The Effective Permissions screen allows you to select a user or group and determine its effective (or actual) permissions to the object, taking into account group membership and permission inheritance. Figure 11-7 shows the results of the effective permissions for Authenticated Users on the EMEA domain object. As you can see, Authenticated Users have List Contents, Read All Properties, and Read Permissions. All objects in the forest will inherit these permissions unless inheritance has been blocked. As you might guess, this is a significant feature that allows for much easier troubleshooting of permission problems. There are some limitations to be aware of, however.

Figure 11-7. Viewing the effective permissions for authenticated users or the EMEA domain object



The following list displays the permissions that would be granted to the selected group or user, based solely on the permissions granted directly through group membership. Learn more about how effective permissions are determined.

Group or user name: Authenticated Users

Effective permissions:

- □ Full Control
- ☑ List Contents
- ☑ Read All Properties
- □ Write All Properties
- □ Delete
- □ Delete Subtree
- ☑ Read Permissions
- □ Modify Permissions
- □ Modify Owner
- □ All Validated Writes
- □ All Extended Rights
- □ Create All Child Objects
- □ Delete All Child Objects
- □ Create Computer Objects

The Effective Permissions tool is only an approximation of the actual permissions a user or group has and does not take into account many of the well-known security principals such as Anonymous Logon and Network. Another potential issue to be mindful of is that the user running the Effective Permissions tool must have the rights to read the group membership of the target user or group. By default, Authenticated Users has this right.

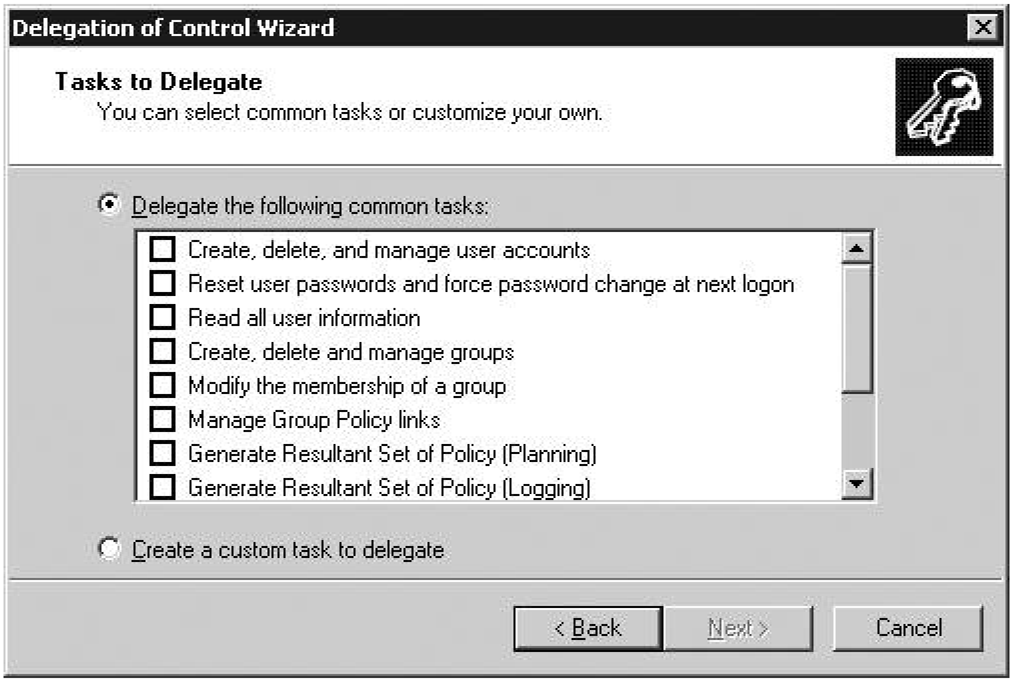
11.2.3. Using the Delegation of Control Wizard

To help with delegating permissions for objects in Active Directory, Windows 2000 and Windows Server 2003 come with a wizard called the Delegation of Control wizard. It is intended to allow administrators to delegate management of certain types of objects to key individuals or groups in the organization. It is activated by right-clicking almost any container in the DIT and selecting the wizard from the pop-up menu. `Builtin` and `LostAndFound` are the two containers for which it does not work by default.

The wizard is useful only when you need to clearly apply general allow permissions to one or more object types below a container. It is not useful if you want to specify deny permissions (which it doesn't support), remove previously delegated control, delegate control over individual objects, or apply special permissions to branches of the tree. The wizard's great strength is its ability to set permissions and apply them to multiple users and groups at the same time. We use the wizard to set these sorts of permissions, although much less regularly than we do the standard GUI, since it is much more limited in what it can do. Scripting with ADSI also provides a solution here which is more adaptive to an administrator's own needs.

The wizard provides several screens for you to navigate through. The first is the welcome screen, which tells you what the wizard does. The second is an object picker for you to select which users or groups to delegate to. The third screen asks what task you wish to delegate control for in that container. Figure 11-8 shows this window.

Figure 11-8. Delegation of Control wizardobject type selection



Tasks to Delegate

You can select common tasks or customize your own.

● Delegate the following common tasks:

- ☐ Create, delete, and manage user accounts
- ☐ Reset user passwords and force password change at next logon
- ☐ Read all user information
- ☐ Create, delete and manage groups
- ☐ Modify the membership of a group
- ☐ Manage Group Policy links
- ☐ Generate Resultant Set of Policy (Planning)
- ☐ Generate Resultant Set of Policy (Logging)

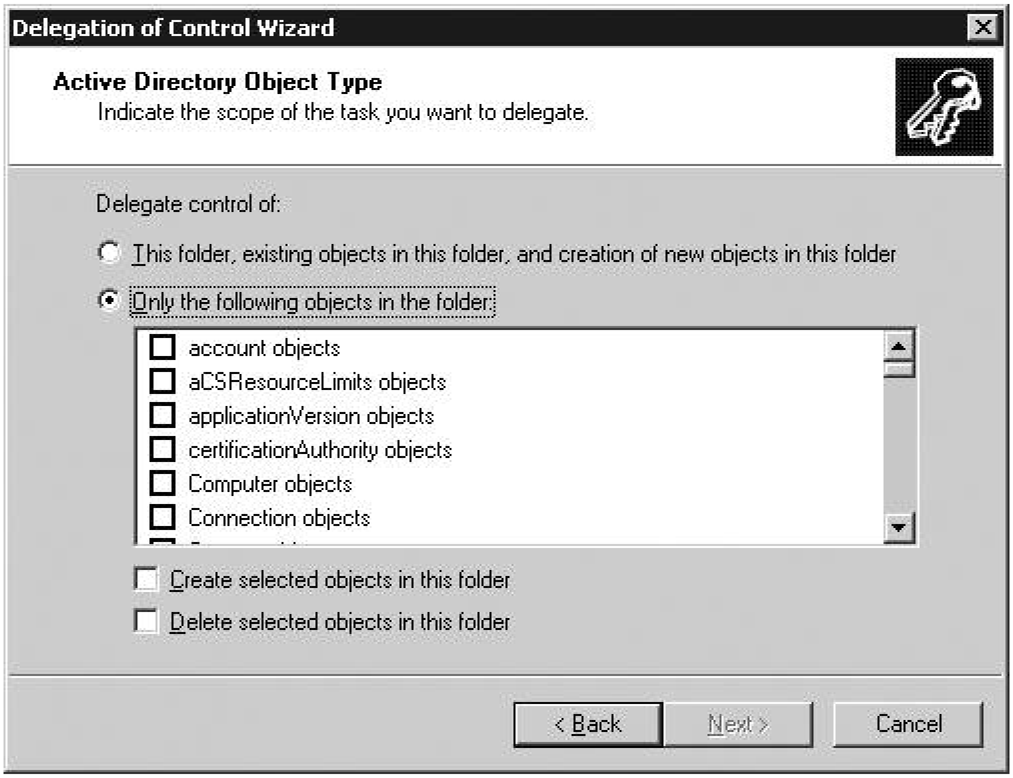
○ Create a custom task to delegate

The default is to delegate control for a specific task, and there are several to choose from. In fact, several new tasks have been added in Windows Server 2003. Since the list scrolled off the screen in Figure 11-8, we'll list them here:

- Create, delete, and manage user accounts
- Reset user passwords and force user change password at next logon
- Read all user information
- Create, delete, and manage groups
- Modify the membership of a group
- Manage Group Policy links
- Generate Resultant Set of Policy (Planning)
- Generate Resultant Set of Policy (Logging)
- Create, delete, and manage inetOrgPerson accounts
- Reset inetOrgPerson passwords and force password change at next logon
- Read all inetOrgPerson information

If you choose the Custom radio button and click Next, an extra page opens, allowing you to specify individual objects. Figure 11-9 shows this.

Figure 11-9. Delegation of Control wizardchoosing objects to delegate



Delegation of Control Wizard

Active Directory Object Type

Indicate the scope of the task you want to delegate.

Delegate control of:

○ This folder, existing objects in this folder, and creation of new objects in this folder

● Only the following objects in the folder:

- □ account objects
- □ aCSResourceLimits objects
- □ applicationVersion objects
- □ certificationAuthority objects
- □ Computer objects
- □ Connection objects

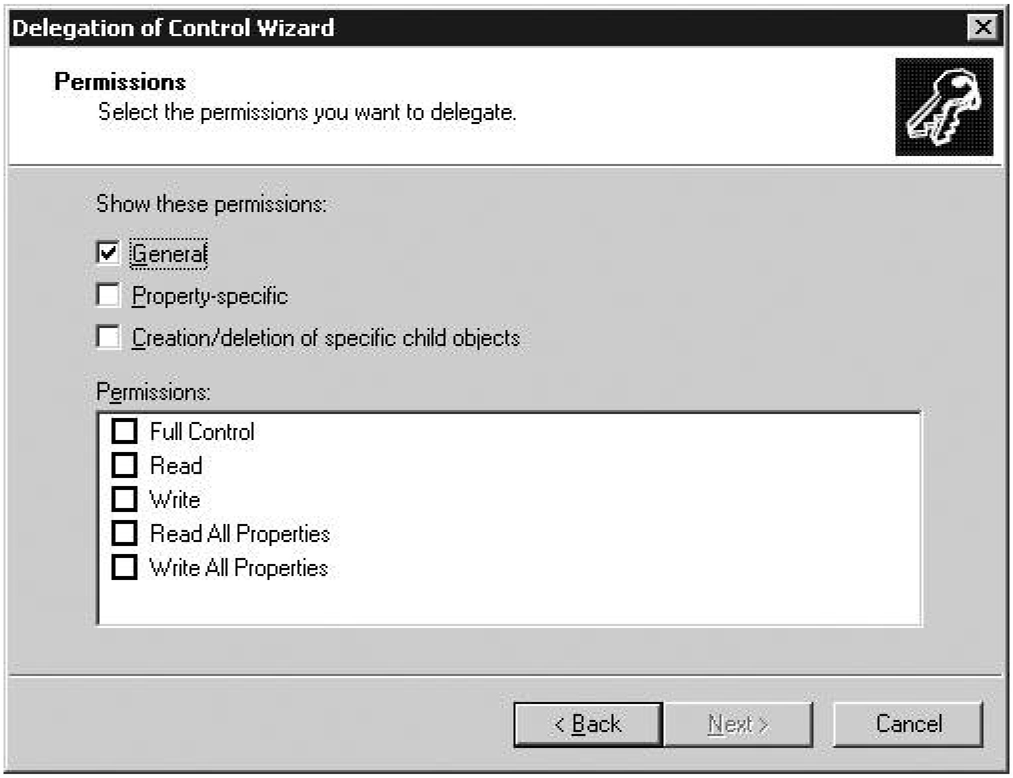
□ Create selected objects in this folder

□ Delete selected objects in this folder

If you want to delegate certain permissions to computer or user objects in a specific container or branch, you can do it from here. The next screen of the wizard allows you to specify what permissions you wish to assign for the selected users/groups. Figure 11-10 shows this screen.

When the window opens initially, only the first checkbox is checked. As you click each of the other boxes, the list of specific permissions that you can delegate becomes very large as it encompasses all of the permissions that you could potentially delegate. Finally, the last screen of the wizard summarizes the previous answers and allows the user to go back, cancel, or finish and grant the permissions.

Figure 11-10. Delegation of Control wizardaccess rights selection



Delegation of Control Wizard

Permissions

Select the permissions you want to delegate.

Show these permissions:

☑ General

□ Property-specific

□ Creation/deletion of specific child objects

Permissions:

□ Full Control

□ Read

□ Write

□ Read All Properties

□ Write All Properties

However, just as the permissions listed in the security properties for an object (Figure 11-2) can change, so can the permissions listed in the access rights box, depending on the object(s) to which permissions are being applied. A good demonstration of this is to open up the security permissions for any user and scroll through the displayed list of permissions. Next, open up the wizard on any container and specify Custom Task (see the screen shown in Figure 11-8) and only user objects (see Figure 11-9). The screen shown in Figure 11-10 should then display the same list that the screen in Figure 11-2 does. This makes sense since they should be the same; available permissions for one user should be the same as the available permissions for all users. It is still nice to see the correlation and appreciate it in the flesh, so to speak.

PREV NEXT

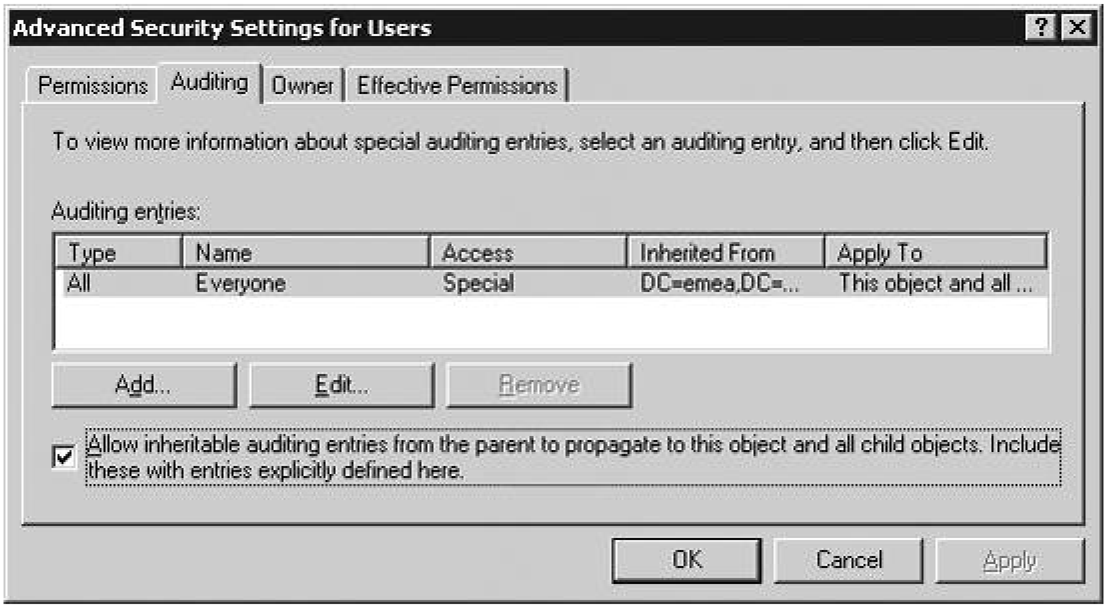
PREV NEXT

11.3. Using the GUI to Examine Auditing

Examining auditing entries is almost identical to viewing permissions entries. If you go back to the screen shown in Figure 11-3 and click on the Auditing tab, a screen similar to that in Figure 11-11 is displayed.

This window shows the list of Auditing Entries (AEs) that have been defined on the object. This object has one AE, and it's not very helpful viewing it from here since the detail is too limited. So just as you would do with permissions, you can click the Edit button (or View/Edit with Windows 2000), drill down, and view the individual AE itself.

Figure 11-11. Advanced Settings window showing auditing entries



Advanced Security Settings for Users

To view more information about special auditing entries, select an auditing entry, and then click Edit.

Auditing entries:

Type	Name	Access	Inherited From	Apply To
All	Everyone	Special	DC=emea,DC=...	This object and all ...

☑ Allow inheritable auditing entries from the parent to propagate to this object and all child objects. Include these with entries explicitly defined here.

Figure 11-12 shows the successful and failed items that are being audited. The items are grayed out because this entry is inherited from further up the tree; i.e., it is not defined directly on this object but instead further up the hierarchy.

Figure 11-13 shows an example AE window for successful and failed auditing of properties. Here you are auditing only property writes.

PREV NEXT

PREV NEXT

11.4. Designing Permission Schemes

Having worked through many designs for different domain structures, we have come up with a series of rules or guidelines you can follow to structure the design process effectively. The idea is that if you design your permissions schemes using these rules, you will be more likely to create a design with global scope and minimum effort.

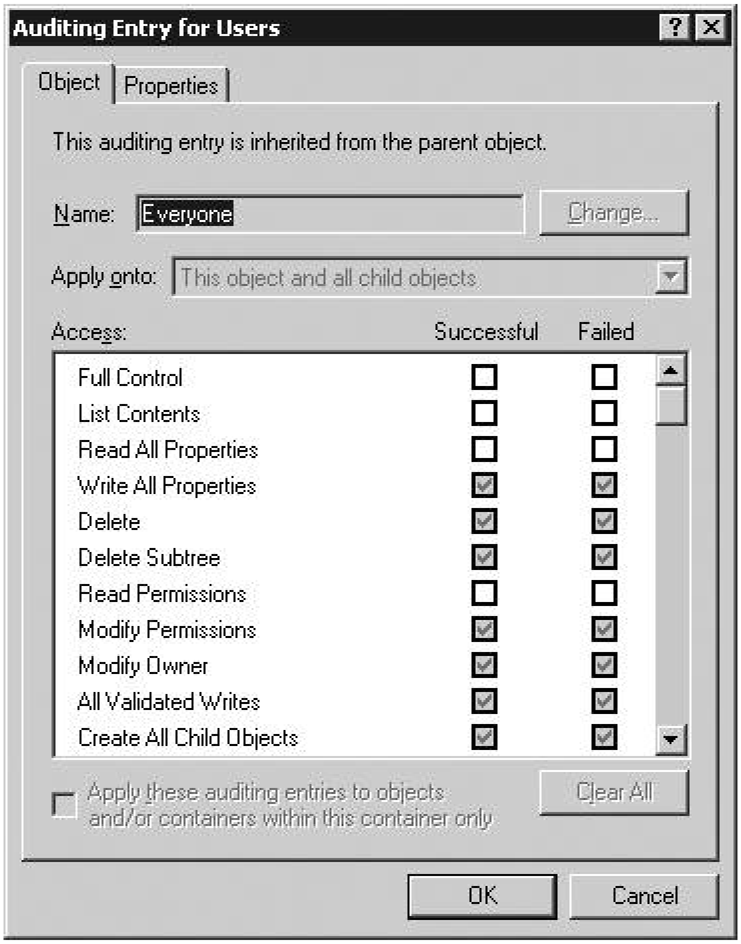
11.4.1. The Five Golden Rules of Permissions Design

This list is not exhaustive. We are sure you will be able to think of others beyond these. If, however, these rules spark your creative juices and help you design more effectively, they will have done their job.

The rules are:

1. Whenever possible, assign object permissions to groups of users rather than individual users.
2. Design group permissions so that you have a minimum of duplication.
3. Manage permissions globally from the ACL window.

Figure 11-12. Auditing entry for an object



Auditing Entry for Users

This auditing entry is inherited from the parent object.

Name: Everyone

Apply onto: This object and all child objects

Access:	Successful	Failed
Full Control	□	□
List Contents	□	□
Read All Properties	□	□
Write All Properties	☑	☑
Delete	☑	☑
Delete Subtree	☑	☑
Read Permissions	□	□
Modify Permissions	☑	☑
Modify Owner	☑	☑
All Validated Writes	☑	☑
Create All Child Objects	☑	☑

□ Apply these auditing entries to objects and/or containers within this container only

4. Allow inheritance: do not protect sections of the tree from inheritance.
5. Keep a log of every unusual change that you have made to the tree, especially when you have protected sections of it from inheritance or applied special rights to certain users.

Let's look at these rules in more detail.

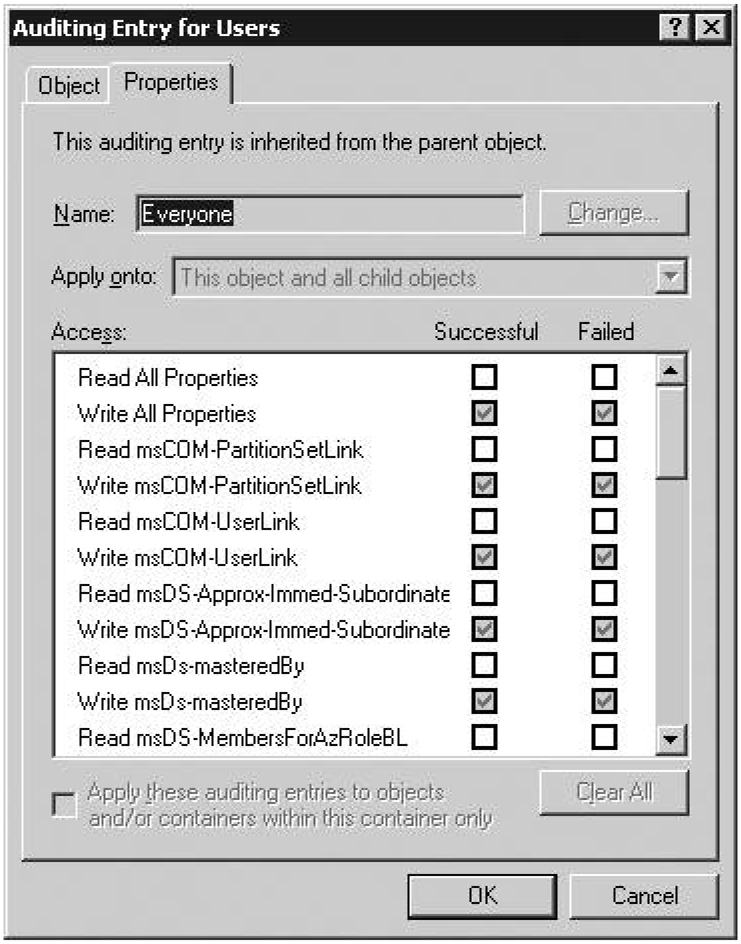
11.4.1.1. Rule 1: Apply permissions to groups whenever possible

By default, you should use groups to manage your user permissions. At its simplest, this rule makes sense whenever you have more than one user for whom you wish to set certain permissions.

Some things need to be made very clear about how groups are different between Windows NT and Active Directory:

- Active Directory supports the concept of two types of group: security and distribution. A distribution group is simply a group that is not Windows Security enabled. A security enabled group is a group that is used in calculating access rights to objects. The SID from security groups a user is a member of will be

Figure 11-13. Auditing entry for an object's properties



This auditing entry is inherited from the parent object.

Name: Everyone

Apply onto: This object and all child objects

Access:	Successful	Failed
Read All Properties	□	□
Write All Properties	☑	☑
Read msCOM-PartitionSetLink	□	□
Write msCOM-PartitionSetLink	☑	☑
Read msCOM-UserLink	□	□
Write msCOM-UserLink	☑	☑
Read msDS-Approx-Immed-Subordinate	□	□
Write msDS-Approx-Immed-Subordinate	☑	☑
Read msDs-masteredBy	□	□
Write msDs-masteredBy	☑	☑
Read msDS-MembersForAzRoleBL	□	□

□ Apply these auditing entries to objects and/or containers within this container only

added to the user's security token when they authenticate. Distribution groups are most often used for mailing lists; however, they can be used for other basic "group" tasks as well, such as IM lists or even security for LDAP-based applications not using Windows Security.

- Windows 2000 mixed-mode and Windows Server 2003 Interim domains natively support Security groups that have two types of scope: Global or Local. These correspond to the Windows NT 4.0 Domain Global and Local groups.
- Windows 2000 native-mode or Windows Server 2003 domains have access to a third scope, universal. Universal security groups can contain other groups and have permissions assigned to them.

More detailed information on the differences between Windows NT groups and Active Directory groups and how Active Directory groups differ in the various modes and functional levels can be found in Chapter 2.

Global Group and Local Group Permissions Under Windows NT 4.0

Under Windows NT 4.0, Microsoft's preferred method of applying file and directory permissions was to create two sets of groups: Local Groups , which had permissions, and Domain Global Groups , which contained users.

The Local Group would exist on the server that had the resource, and the relevant permissions were assigned to that. Local groups were allowed to contain both users and groups. Domain Users were then placed in Domain Global Groups, which themselves were placed in the Local Groups on each server. Domain Global Groups were allowed to contain only users and not other groups. This may sound complicated, but it worked well in practice. A good way of demonstrating this is through an example.

Consider an NT 4.0 domain called Mycorp containing a Global Domain Group called Marketing. This group has four members. Within Mycorp are two servers, called Server1 and Server2, each of which has published a share. Each server also has a Local Group SH_USERS, which contains the Global Group Marketing as a member. Each SH_USERS group has read access to the relevant share on the same server.

You use global groups in this scenario because it is faster to deal with a large number of users as one group than it is to deal with them individually. In a similar vein, it makes sense to keep control over permissions to resources by creating Local Groups, each with a relevant set of permissions. That way, if you ever need to modify the permissions for a particular set of users, you need to modify only the Local Group's permissions.

So if we decide that Keith and Sue should have full permissions to the share on Server1, we could create a Local Group on Server1 with full permissions and add a newly created Global Group, say MKTG_ADMIN, to it with Keith and Sue as members. Future users who need full permissions are added to this Global Group.

Under Windows 2000 mixed-mode and Windows Server 2003 Interim functional level, the paths you can choose are clear. You either follow the method outlined in the "Global Group and Local Group Permissions Under Windows NT 4.0" sidebar, or you choose to assign permissions in some other manner of your own choosing.

When you convert your domain to native mode, you have a more difficult decision: do you choose "Domain users go into universal groups, universal groups go into universal groups, universal groups are assigned resources?" Or do you move to "Domain users go into universal groups, universal groups are assigned resources?" Or do you assign permissions in a manner of your own choosing?

We're not advocating the use of one group or two, as we'll explain in more detail in the next section on how to plan permissions. We are advocating that whichever way you choose to implement group permissions , you should add users to groups and apply permissions to groups, even if the group initially contains only one user. This removes organizational dependence on one particular account. Time after time, we have seen organizations in which individual users with a whole raft of permissions to various objects suddenly leave or change roles. The new administrator then has to go in and unravel differing permissions settings from this account. We have even seen one administrator, who looked in anguish at the tangled mess of a recently departed administrator's account, delete his own account and rename the departed user's account just so that he could get the correct permission set without having to figure out the mess! If the old administrator had been a member of, say, five different groups, each with the relevant permissions, the new administrator could simply have replaced the group memberships of the old account with his new account. This is a much simpler approach, and we are sure that none of the preceding common sense is very new to systems administrators.

11.4.1.2. Rule 2: Design group permissions so that you have minimum duplication

It makes much more sense to create groups with simple permission sets than it does to create multiple groups with overlapping permissions. If you decide that some of your users need, say, create and modify, while others need modify and delete, and a third set needs just modify, it makes much more sense to create three separate groups with create, delete, and modify, than it does to make three groups with the permissions sets described. Let's consider an example. We will call the three groups CRE_MOD, MOD_DEL, and MOD. Let's now say we add 10 users to each group. If the only modifications ever to happen to these groups are occasional membership changes, this solution fits adequately. However, let's say that as with every large organization, the permissions requirements change over time. If Dave Peace, a member of CRE_MOD, now needs delete, what do we do? Do we make a special case of Dave's account and add the delete permission to his account only? Arguably, that is the simple solution, but according to Rule 1, we really should create a group to manage the permission. Do we create a DEL group and add Dave's account or create a CRE_MOD_DEL group and move his membership from CRE_MOD to the new group? Both are valid solutions.

Let's say we go with the former and create a DEL group, adding Dave as a member of that group. Things change again, and Mark Newell joins. Mark needs to be a member of groups giving him both MOD and DEL, so do we add him to MOD_DEL or MOD and DEL? Either way, we now have potential confusion. Whenever we have to check for members who can modify and delete, we have to check three groups, not one.

If we'd taken the second approach and chosen to create CRE_MOD_DEL rather than the DEL group, Mark is added to MOD_DEL when he joins, and things seem to be working fine. Paul Burke now moves from another team and requires create only, so a CRE group is created and his account added to that. Later, three others join the CRE group, but Paul now needs create and delete, so CRE_DEL is created, and he is moved to this group. Now we have six groups: CRE, MOD, CRE_DEL, CRE_MOD, MOD_DEL, and CRE_MOD_DEL. Unfortunately, if we ever have to check who has create and modify permission, we have to check the three groups: CRE, MOD, and CRE_MOD.

The minimum ACEs and groups required solution is to have one group for each permission granted, CRE, MOD, and DEL. Users are added to the groups as needed. If you prefer a more "role"-based approach, you could create role-based groups such as the CRE_MOD and the others and nest it in the CRE and MOD groups that have the actual permissions in the directory.

This example has been heavily contrived. However, we hope it serves to show that duplication will occur whenever you have users requiring separate permissions to an object or property and users requiring combinations of those permissions. It is for this very reason that we suggest creating separate groups for the lowest-common-denominator permissions that you need to set. Keep possible future enhancements and role redefinitions in mind because you don't usually want to be changing permissions in the directory in an ad-hoc manner any time new requirements pop up.

If you have users who always need read, list, and create but require different combinations of delete and modify, it may not make sense to have the three groupsone each for read, list, and create. You could instead create one group with the read, list, and create permissions assigned to it, one group for delete, and one for modify. Then you would use multiple group memberships to assemble the group permissions as you require them. Of course, if later on you now have a requirement to only give read or create, you end up separating out the permissions anyway. Try to think ahead.

The most important point to note is that we are talking about minimizing and simplifying the number of ACEs applied to the directory. If you need only CRE_MOD_DEL to an object, you probably don't want to create three groups. But don't necessarily rule out this approach if you think the requirements are apt to change.

If, after you have created a group with multiple permissions, you find that you now need groups with individual permissions, you can always create the smaller groups and migrate the users. Active Directory is flexible enough to allow you to operate like this, but it can be considerable work to clean up after the fact and must be done in a slow painstaking way to avoid impacting the users.

11.4.1.3. Rule 3: Manage Advanced permissions only when absolutely necessary

(Please note that this says "permissions" and not "auditing." Auditing entries can be accessed only from the Advanced tab, so this rule makes less sense for auditing entries.)

Whenever you right-click an object to view its properties, the Security Properties window that appears has an Advanced button on it. This was shown in Figure 11-1 in the previous section. The Security Properties window itself typically has the following allow and deny options as General Permissions:

- Full control
- Read
- Write
- Create all child objects
- Delete all child objects

In Windows 2000, this screen also allows you to specify whether the object inherits permissions from its parent. In other words, it allows you to protect the object ACL from inheriting ACEs from its parent.

The general permissions are not limited to those five in the previous list, and indeed they change depending on the object you are looking at. For example, the security properties for any user object display additional general permissions, such as Reset Password, Modify Web Information, and Send As. While these general permissions make sense for the user object, they are not all appropriate for other objects. This rule suggests that you manage permissions for objects from the Security Properties window as often as you can. You should choose the Advanced button only when you wish to allow or deny a permission to one aspect of an object rather than the whole object. An example would be manipulating the permission to a user object's telephone number rather than the whole account details.

While there is nothing wrong with managing atomic permissions to objects and properties, permissions are much easier to manage from a higher level. The main permissions that administrators might want to set were put here for this express purpose, so that users and groups can easily manage the tree without having to worry about the large amount of individual properties.

If you choose to get very granular with permissions, you will want to look at using *DSACLS* at the command line for setting the permissions. *DSACLS* does a better job of showing all of the permissions and in some situations is more intelligent about ACEs that are applied than ADUC. Finally, *DSACLS* can be used in scripts for consistent results.

11.4.1.4. Rule 4: Allow inheritance; do not protect sections of the domain tree from inheritance

If you allow or deny permission for a group or user to all objects of a certain type in a container, by default the permissions are applied recursively to all objects of that type in all the child containers down the tree. It is possible to block inheritance, but we recommend leaving inheritance in place (the default) and protecting branches on an individual basis only when there are good justifications for doing so. The reason is simple: if you specify that children do not inherit permissions from their parents, you are adding additional complexity to your Active Directory. There are several examples of inheritance blocking found in every default domain. You can simply look at any administrative ID or alternatively drill down into the system container, then the policies container, and look at any of the `groupPolicyContainer` objects.

The administrative IDs are protected from inheritance due to the possible security issue of moving the user object into a container that would give a non-admin user rights to manipulate the admin ID. These IDs are actually a special case because there is functionality built into Active Directory called `AdminSDHolder` functionality. This is named after the `AdminSDHolder` object, which has the permissions that should be applied to admin user objects. Once an hour,[*] the PDC loops through all admin user objects and makes sure the permissions are set to be the same as what is on the `AdminSDHolder` object. By default, this includes disabling inheritance. This functionality can confuse some administrators and block delegations they purposefully try to configure, so it is often discovered accidentally. Please see Microsoft Knowledge Base Articles Q232199 and Q817433 for more information about `adminSDHolder`.

[*] This is configurable by changing `HKLM\System\CurrentControlSet\Services\NTDS\Parameters\AdminSDProtectFrequency` registry value. The default is 60 minutes; it can be set to any whole value between 1 and 120 minutes.

> Microsoft has changed the definition of the administrator groups protected by this functionality in various hot fixes, services packs, and OS revisions. The original list of protected groups consisted of `Enterprise Admins`, `Schema Admins`, `Domain Admins`, and `Administrators`. After the Q327825 hotfix, Windows 2000 SP4, or Windows Server 2003, several groups were added, including `Account Operators`, `Server Operators`, `Print Operators`, `Backup Operators`, and `Cert Publishers`. In addition to those groups, the `Administrator` and `Krbtgt` user objects are also specifically protected. You have a little control over the groups that are protected with a `dsHeuristics` setting that can be configured; see MS KB817433 for details.

The `groupPolicyContainer` objects are protected for similar security reasons. As discussed in Chapter 10, these objects contain information about security policies applied to the domain. Microsoft rightfully decided to protect these objects from being accidentally impacted by permission delegations higher up in the directory. You will not generally have to manipulate these objects directly, so you could manage Active Directory for years and never notice these objects; the complexity involved with protecting them won't directly impact you.

Ultimately, there is nothing wrong with protecting objects or sections of the tree from inheritance. It is important to remember that every time you do it, you are possibly creating more work and possible confusion for yourself and other administrators. As an administrator, you should keep track of these changes in a log, so that you can easily reference your special cases when required.

11.4.1.5. Rule 5: Keep a log of unusual changes

This may sound like an obvious statement, but it is surprising how many administrators overlook such a simple requirement. Simply put, it is always wise to keep a log of custom changes that you make to a default installation so that you and others have something to refer back to. There will be times when you may not be available and this sort of information is required. The following list shows the relevant fields of a basic Active Directory ACL log :

- Unique name of object or LDAP location of object in tree
- Object class being modified
- Object or property being modified
- User or group to whom permissions are being assigned
- Permissions being assigned
- Notes on reasons why this change is being made

Some additional items outside of ACL changes worth logging are schema default security descriptor changes, property set modifications, attribute index changes, and attribute confidentiality changes.

Let's now look at how you can put these rules into practice in your own designs.

11.4.2. How to Plan Permissions

There are a number of Active Directory Users and Computers permission sets that administrators may need to implement in their organizations. Some examples are:

- A set of centralized teams, each with responsibility for certain areas. Users can be members of more than one area: account modifiers, printer managers, computer account managers, publishing managers, and so on.
- A manager for each individual major Organizational Unit under a domain.
- Again, a manager for each individual major Organizational Unit under a domain, but this time each manager is also able to delegate responsibility for lower Organizational Units.
- An administrator of the top-level domain is given permission to every sub-domain by each sub-domain's administrators.

While we could go through each of the preceding settings and show how to design permissions in each case, every organization is different. For that reason, it seems better to try to show what we consider to be the best method to use when designing Active Directory permissions for all types of organizations.

First, create two documents, one called Allow and the other called Deny. On each document, label two sections, one called Global Tree Permissions and the other Specific Tree Permissions. Place two subheadings under each of the two sections, calling one General Permissions and the other Special Permissions. You should end up with three columns for each general and special heading: "LDAP path," "What to set," and "To whom."

The first six columns relate to permissions that will apply throughout the whole tree; the last six relate to permissions that will apply to specific locations in the tree. The latter is likely to be the much larger of the two. The General columns relate to permissions that can be set without needing to use the Advanced button, such as read access to all objects below an Organizational Unit. The Special columns relate to those permissions that you have to manually bring up a PE window for, such as allowing read access to all telephone numbers of user objects below a particular Organizational Unit. The last three columns relate to the LDAP path to the object that is to have properties set, the permissions that are being set, and the group or user to whom the permissions are being assigned.

The LDAP path under Global Tree Permissions is, strictly speaking, unnecessary, since these columns relate to permissions applied to the domain as a whole. If, however, you have a special need to apply permissions to a large number of Organizational Units directly below the root, you could use this column for this purpose.

Now you should go through your Active Directory design and begin to populate both the Allow and Deny tables. For a first pass, you should concentrate on a thorough design, listing all the permissions that you think you will need. Print out a number of copies of the table. Once you have a list in front of you, you can start amalgamating identical permissions into groups. It is likely that you will need to go through much iteration of these designs until you get a pared-down list that you are happy with. As you go through the design, you will start identifying groups of users to which you need to apply permissions. When designing the groups, you have two choices, as previously discussed under Rule 2. You can either create a single group to which permissions are applied and which contains users, or you can create two groups, one to apply permissions to and one to hold users that is nested in the first group.

The decision on whether to go for single or dual groups is not necessarily an easy one. My preference is to use single groups as often as possible, unless we need extra flexibility or have a lot of permissions to assign to many groups. In order to help you to make a bit more sense of the decision, a few reasons why you would want to consider one or the other are shown in Table 11-2.

Table 11-2. When to consider user groups and permission groups or combined groups

You should consider one group if	You should consider two groups if
You want to keep the number of groups to a minimum.	You want greater flexibility. Having one group for applying permissions and one for users means that you are always able to manage the system with a minimum of fuss.
You have only a small or simple tree, where it would be fairly easy to track down problems.	You have a large or complex tree, in which you need to be able to identify any problems quickly.
You need to assign only a few simple permissions.	You need to assign a large number of permissions.
You have very little change in the membership of groups and very few changes to permissions.	You have regular changes in your group membership or permissions.
You have little cross-membership of groups.	You have major cross-membership of groups, where a user could exist in more than one group with conflicting permissions. (Two groups make it easier to debug problems in a large environment.)
You very rarely need new groups.	You regularly need new groups with subsets of your existing users who have been assigned to some task.
You very rarely have to split user groups so that each user group subset has different permissions than the original group had.	You regularly have to split an existing group into more than one group, because each requires a different set of permissions than the old group used to have.

One last point: if you are creating permission groups and user groups, remember to name them sensibly from the outset. Maybe use something such as res_Finance_UserMod for a resource group granting user modification on the Finance OU and role_Finance_UserAdmin for the user admin role over the Finance OU. It makes it easier when managing and scripting if you can easily identify which type of groups are which.

11.4.3. Bringing Order out of Chaos

We've had people ask what we would recommend to someone arriving at a new company where the previous directory services administrator had left a tree with no proper permissions design or consistency. In this situation, start by analyzing what the organization requires and work from there. You also should analyze what permissions Active Directory currently has assigned, although concentrating solely on this could be detrimental. After all, if the last administrator was not competent or knowledgeable enough to set up a sensible permissions scheme from the start, he may not have accurately implemented the permissions required by the organization.

When analyzing Active Directory, you need to start by identifying the members of the built-in groups on the server, such as Domain Administrators, Backup Operators, and so on. Now do the same for the other groups that are specific to the organization. Once this is done, using the previously described tables, you need to list the permissions on the root of the first domain in the tree you are responsible for. From there you should look at the permissions for the first container or Organizational Unit in that list. Then navigate the branch represented by that container, looking sequentially at the child containers, continually recursing through the tree. Once this first branch of the root is mapped out for the container permissions, you may be getting an idea of what permissions are required. Now go through all the objects in that branch, including printers, users, shares, and so on. This is time-consuming and annoying, but after a while you may start getting an idea of what is going on. All of this is just a sensible approach to going through Active Directory, not a quick-fix solution. You still have to continue throughout the domains you are responsible for to complete the process. It is also often helpful to use a script to iterate through Active Directory and display all of the ACLs for an object. For help on this, consult Chapter 26.

Your first main goal should be to move the individual user permissions to groups with users assigned to them as often as possible, thus making Active Directory simpler to manage and comprehend. These groups should be sensibly named for what they do rather than whom they contain (after all, you are looking to understand Active Directory first). Ideally, you can start consolidating users with identical permissions into the same group.

Your second goal is to remove permissions that users or your newly created groups should not have. This may of course mean that your new groups need to have their members split into two or more separate extra groups. For example, a group that has Read All Properties and Write All Properties to an object may actually need three groups with permissions instead: one to have Read All Properties, one to have Write All Properties, and one to have selected Write rather than complete Write access. This may be evident from your Active Directory analysis, or it may come out of discussions with users or their managers, with whom you should at least confirm the changes before implementing them just to make sure your analysis is correct.

Ultimately, your third goal, having rationalized the array of Active Directory permissions, is to try to limit the inheritance blocking of objects and branches and to try to move as many advanced permissions to general permissions as you can. You might think that it makes more sense to do this earlier, and in some cases, this is true. However, if you complete the first two goals, you will have an Active Directory tree that you understand and that has been brought back into line with sensible rules. It is much easier to attempt to fix problems with inheritance blocking and advanced permissions once you have a manageable and rationalized tree. You may end up going back and changing groups or permissions that you already sorted out in attaining the first two goals, but consider how much more difficult it would be to attempt to do these concurrently. After all, you are trying to make the best of an already annoying task. There is no sense in trying to do everything at once. As you go through the tree checking for inheritance blocking, you should document the blocked objects and branches, as specified in Rule 5, just as if you had set up the blocking from scratch yourself. That way, you can use the tables to analyze and keep track, crossing off those that are of no use as you rationalize the tree.

This whole section can be boiled down to two simple words: simplify and secure. You want to end up with the simplest, least delegated model you can attain while meeting the requirements at hand resulting in the most locked-down directory you can live with.

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11.5. Designing Auditing Schemes

Designing auditing schemes, in contrast to permissions, is a relatively easy process. Imagine the circumstances in which you may need to check what is happening in Active Directory, and then set things up accordingly.

> You must remember that every Active Directory event that is audited causes the system to incur extra processing. Having auditing turned on all the time at the root for every modification by anyone is a great way to get all DCs to really slow down if a lot of Active Directory access occurs on those DCs.
>
> That point bears repeating. Auditing changes to any object in the domain Naming Context (NC) will propagate domain-wide and cause logging to the security event log on every DC that services the Domain NC. Auditing changes to the Configuration NC or Schema NC will cause all DCs in a forest to begin auditing to their security event logs. You must have tools in place to retrieve logs from multiple DCs if you wish to see every security event that occurs. After all, if you have 100 DCs and are logging Configuration NC changes, then because changes can occur on any DC, you need to amalgamate 100 security event logs to gather a complete picture.[*]
>
> [*] Applications for consolidation of event logs are SeNTry by Mission Critical, Event Admin by Aelita, and AppManager by NetIQ. Also, note that Microsoft's WMI technology has excellent event logging, reporting, and notification capabilities if you wish to script such items yourself.

Here are a few examples where designing auditing schemes could come in handy:

- Someone complains that user details are being set to silly values by someone else as a joke.
- You notice that new objects you weren't expecting have been created or deleted in a container.
- The Active Directory hierarchy has changed and you weren't informed.
- You suspect a security problem.

Although the preceding reasons are all great reasons for enabling auditing, they are better reasons for removing native update access rights to the directory and pushing updates through some sort of provisioning system such as Microsoft's Identity Management tool MIIS, Quest's Active Roles Directory Management tool, or even home-grown web-based tools. With these kinds of tools, you can implement good solid features sorely missing from Active Directory, such as the following:

- Centralized logging. All information concerning all requested changes easily deposited in one location with no additional work.
- Business rules. Allows you to force naming standards or specifically allow/disallow values in attributes.
- Triggers. Send notifications to various individuals when certain things are requested, such as notifying the asset management group of a new computer added to Active Directory.
- Custom authorization levels. Could allow you to, for example, specify that a data admin could create no more than five users a day.
- Prevent bad things from happening versus trying to chase the occurrences through auditing. Auditing the directory for things that shouldn't have happened is reactive, securing the directory so those things can't happen in the first place is proactive and considerably less work in the long run.

In all of these scenarios, you will need to set auditing options on a container or a leaf object. These auditing entries do not have to exist all the time, so you could write them up and then code them into a script that you run at the first sign of trouble. That way, the system is immediately updated and ready to monitor the situation. This can happen only if you are prepared.

You need to analyze the scenarios that you envisage cropping up and then translate them into exact sets of auditing entry specifications. After you have written up each scenario and an emergency occurs, you will be able to follow the exact instructions that you previously laid down and set up a proper rapid response, which is what auditing is all about.

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11.6. Real-World Examples

It now seems appropriate to put what we have laid out earlier into practice. We will use a series of tasks that could crop up during your everyday work as an administrator. The solutions we propose probably are not the only solutions to the problems. That is often the case with Active Directory; there are many ways of solving the same problem.

11.6.1. Hiding Specific Personal Details for All Users in an Organizational Unit from a Group

In this example, an Organizational Unit called Hardware Support Staff contains the user accounts of an in-house team of people whose job is to repair and fix broken computers within your organization. Whenever a user has a fault, he rings the central faults hotline to request a support engineer. An engineer is assigned the job, which is added to the end of her existing list of faults to deal with. The user is informed about which engineer will be calling and approximately when she will arrive. As with all jobs of this sort, some take longer than others, and users have discovered how to find the mobile or pager number of the engineer they have been assigned and have taken to calling her to get an arrival time update rather than ringing the central desk. Management has decided that they want to restrict who can ring the pager or mobile, but they do not want to stop giving out the engineer's name as they feel it is part of the friendly service. Consequently, they have asked you to find a way of hiding the pager and mobile numbers in Active Directory from all users who should not have access.

The solution that we will use is to remove the default ability of every user to see the `pager` and `mobile` properties of the Engineer objects by default. The first thing we need to find out is how the permissions are currently granted to the users. We look at the ACL on a user object and we do not see either attribute listed specifically. We do however see an inherited Read Property (RP) access for the entire object granted to the `Pre-Windows 2000 Compatible Access` group. We also see explicit RP access for several Property Sets granted to Authenticated Users.

Next we look at the schema definition for the two attributes and we see that both have the `attributeSecurityGUID` set with `{77B5B886-944A-11D1-AEBD-0000F80367C1}`, which means the attributes are in a property set. We scan through the extended-rights container and determine that the property set these attributes are in is the `Personal Information` property set. We look at the ACL again and see that the `Personal Information` property set is one of the property sets that has RP access granted to Authenticated Users. We know that the domain has `Pre-Windows 2000 Compatible Access` enabled, so users are getting access to the `pager` and `mobile` attributes through two different ACES, both explicit and inherited. If you recall from the earlier Permission Lockdown section, you know that the explicit property set ACE is the more difficult of the two to deal with. We will focus on that one initially.

The first thing we will do is create a sub-OU under Hardware Support Staff called Engineers and move all of the engineer user objects into that OU. We could try to individually lock down the engineer user objects in the parent OU but that is a layer of complexity that isn't needed and should be avoided.

Now that all of the engineers are isolated in their own OU, we need to decide which mechanism previously discussed is appropriate to lock down access to the `pager` and `mobile` attributes. Again, these options are:

1. Remove the pager and mobile attributes from the `Personal Information` property set.
2. Change the `defaultSD` of the user object class to remove `Personal Information` property set.
3. Strip the `Personal Information` ACE from each of the engineer objects and add inherited deny ACES for the `mobile` and `pager` attributes.
4. Add an explicit deny ACE for `mobile` and `pager` attributes on each engineer object.

Options 1 and 2 could be used, but we would have to go back through the rest of the forest and add inherited ACEs granting RP to the `pager` and `mobile` attributes for `Authenticated Users`. All of this extra work would be needed to attain the net effect of a permission change only on the targeted OU. If you think that you will be locking these attributes down for more OUs or maybe all users in the forest, these options would become more palatable.

With option 3, you target only the engineer objects. When you strip the `Personal Information` ACE, not only will access to the `mobile` and `pager` attributes be affected, but also every other attribute in the `Personal Information` property set, which includes over 40 attributes in the default Windows Server 2003 forest.

For all three of these options, if the domain is in Pre-Windows 2000 Compatible mode, users will still have access to all attributes through the inherited ACE granted to the `Pre-Windows 2000 Compatible Access` group. In order to lock down the two targeted attributes, we would also need to add an inherited deny ACE for each attribute on the Engineers OU. This would work great and everyone would be happy until later on, maybe a year or two down the road after you forgot all about this change when you decide, "we don't need to be in Pre-Windows 2000 Compatible mode anymore" and remove the `Authenticated Users` group from the `Pre-Windows 2000 Compatible Access` group. As soon as you do this, the permissions removed for steps 1, 2, and 3 would quite suddenly impact you by disallowing access to all attributes that are in the `Personal Information` property set. Obviously this could be quite a surprise! You could think it was because you still needed to be in Pre-Windows 2000 Compatible mode but it would actually just be a delegation issue.

The last option, option 4, would target just the engineer user objects plus there would be no unintended side effects later with other domain changes. This is probably the best solution in this case, though there is a good amount of initial work plus ongoing maintenance as new engineer users are added. It is best if a script was built strictly for doing this work.

You may wonder, "Wouldn't this be a great place to use the confidential bit capability in Windows Server 2003 Service Pack 1?" Unfortunately no, this isn't a good example because it would impact all users in the forest and, more importantly, both the `mobile` and `pager` attributes are category 1 attributes, so officially you can't modify them to make them confidential.

11.6.2. Allowing Only a Specific Group of Users to Access a New Published Resource

The Finance department created a new share called *Budget_Details* and published it in the tree. The permissions to the share itself allow only the correctly authorized staff to read and view the contents, but everyone by default can see the `volume` object describing the share in the tree. The Finance department does not want the share visible in Active Directory to anyone who is not a member of the Finance group.

Again, the first thing we need to determine how the permissions are currently granted to the users. We look at the ACL on a `volume` object and the only permission granted to normal users is a Generic Read ACE for `Authenticated Users`. Since this is a single object, it probably doesn't make sense to create a whole OU for it, so we will open up the PE window for the `volume` object and remove the `Authenticated Users` group entry. We then add an entry for the Finance group and assign Read and List permissions. A simple solution to a simple problem.

11.6.3. Restricting Everyone but HR from Viewing Social Security Numbers with Confidential Access Capability

Let's say after much discussion, it is decided that social security numbers will be moved from a proprietary database and inserted into Active Directory. There is quite a bit of concern about the visibility of the attribute, as only the HR department and domain admins should be able to see the attributes by default. Luckily, you just installed Windows Server 2003 Service Pack 1 or R2 on all of your domain controllers, so you now have the capability to use the new Confidential Access capability.

You extend the schema with a new social security number attribute and you set the `searchFlags` attribute to 128 to indicate that the attribute should be protected. Now you simply have to create a new group called HR-Confidential and assign a single inheritable ACE at the root of each domain that grants Control Access to the social security number attribute on `user` objects.

Later, if someone decides they want to secure the attribute from Domain Administrators as well, you will need to go through and apply an explicit deny ACE to every single object for that group. However, trying to deny access to data in the directory to Domain Administrators is not actually enforceable. At any point that a Domain Admin would like to get access to the attribute again, she can simply modify the ACL herself. If you absolutely can not allow Domain Administrators access to the data, you need to find someplace else to put the data using third-party encryption or on a machine that isn't in the domain and therefore in some way under the control of the Domain Administrators.

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11.7. Summary

Security is always important, and when access to your organization's network is concerned, it's paramount. We hope this chapter has given you an understanding of how permission to access can be allowed or denied to entire domains or individual properties of a single object. Auditing is also part of security, and having mechanisms already designedso that they can be constantly working or dropped in when requiredis the best way to keep track of such a system.

Assigning permission and auditing entries to an object appears to be a simple subject on the surface. However, once you start delving into the art of setting permissions and auditing entries, it quickly becomes obvious how much there is to consider. Global design is the necessary first step.

Although expanding your tree later by adding extra containers is rarely a problem, in a large tree it makes sense to have some overall guidelines or rules that allow you to impose a sense of structure on the whole process of design and redesign. Ideally, the golden rules and tables that we created should allow you to plan and implement sensible permissions schemes, which was the goal of the chapter.

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Chapter 12. Designing and Implementing Schema Extensions

For Active Directory to hold any object, such as a user, it needs to know what the attributes and characteristics of that object are. In other words, it needs a blueprint for that object. The Active Directory schema is the blueprint for all classes, attributes, and syntaxes that can potentially be stored in Active Directory.

The default schema definition is defined in the *%systemroot%\ntds\schema.ini* file that also contains the initial structure for the *ntds.dit* (Active Directory database). This file contains plain ASCII text and can be viewed using *Notepad* or any text editor.

The following considerations should be kept in mind when you contemplate extending your schema:

- Microsoft designed Active Directory to hold the most common objects and attributes you would require. Because they could never anticipate every class of object or every specific attribute (languages spoken, professional qualifications) that a company would need, Active Directory was designed to be extensible. After all, if these objects and properties are going to be in everyday use, the design shouldn't be taken lightly. Administrators need to be aware of the importance of the schema and how to extend it. Extending the schema is a useful and simple solution to a variety of problems and not being aware of this potential means that you will have a hard time identifying it as a solution to problems you might encounter.

- Designing schema extensions is very important, in part because any new class or attribute that you create in the schema is a permanent addition. While unused objects can be disabled if you no longer require them, they cannot be removed. In Windows 2003 Active Directory, you can redefine schema extensions, but you cannot totally remove them.

- Although it is easy to extend Active Directory, it's surprising how many companies are reluctant to implement schema extensions due to concerns over the impact to Active Directory. One of the biggest impediments in Windows 2000 was that anytime the partial attribute set was extended (i.e., an attribute added to the Global Catalog), a full resync had to be done for all Global Catalog servers. Fortunately, Microsoft resolved this in Windows 2003, and a full resync is no longer performed.

This chapter takes you through the process of extending the schema, from the initial design of the changes through the implementation, and discusses how to avoid the pitfalls that can crop up. We then talk about analyzing the choices available and seeing whether you can obtain the required design result some other way, because schema changes are not to be undertaken lightly. We obviously cover how to implement schema changes from first principles, but before that we identify the steps in designing or modifying a class or attribute. Finally, we cover some pitfalls to be aware of when administering the schema.

We don't spend much time introducing a large number of specific examples. This is mainly because there's no way we can conceive of every sort of class that you will require. Consequently, for examples, we use only one new generic class as well as a few attribute extensions to the default user object. When giving examples of modifying a class, we extend the user object class.

Let's first look at how you would design the changes you may wish to make in an enterprise environment.

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12.1. Nominating Responsible People in Your Organization

If you don't already have a central person or group of people responsible for the OID namespace for your organization, you need to form such a group. This OID Managers group is responsible for obtaining an OID namespace, designing a structure for the namespace that makes sense to your organization, managing that namespace by maintaining a diagram of the structure and a list of the allocated OIDs, and issuing appropriate OIDs for new classes from that structure as required. Whenever a new class of attribute or object is to be created in your organization's forest, the OID Managers provide a unique OID for that new class, which is then logged by the OID Managers with a set of details about the reason for the request and the type of class that it is to be used for. All these details need to be defined by the OID Managers group .

The Schema Managers , by comparison, are responsible for designing and creating proper classes in the schema for a forest. They are responsible for actually making changes to the schema via requests from within the organization, for ensuring that redundant objects doing the same thing are not created, that inheritance is used to best effect, that the appropriate objects are indexed, and that the GC contains the right attributes.

The Schema Managers need to decide on the membership of the Schema Admins universal group that resides in the Forest Root Domain of a particular forest. One possibility is that the Schema Managers may not wish to keep a set of user accounts as members of Schema Admins by default all the time. Instead, they may decide to remove every member of the Schema Admins group so that no unintentional changes can be made to the schema. In this case, the Schema Managers may need to be given permissions to add and remove members of the Schema Admins group to enable any of the Schema Managers to add themselves to the Schema Admins group whenever changes are to be made to the schema. Alternatively, a special change order request process may need to be followed by the Schema Managers to be added to the Schema Admins group when necessary. The change order would be approved by the change control process and the Enterprise Admins would action the change to the group membership.

If you are designing code that will modify some other organization's schema, the documentation accompanying that code should make it explicitly clear exactly which classes and attributes are being created and why. The documentation also should explain that the code needs to be run with the privilege of a member of the Schema Admins group, since some organizations may have an Active Directory in which the Schema Admins group is empty most of the time, as mentioned earlier.

A better solution to programmatically processing schema changes is to supply organizations with the LDIF files for the schema modifications. This allows the organizations to review the actual changes and incorporate them into a batch update process with other schema modifications, which allows for easier testing and production implementation. Some large organizations have extensive schema change control procedures that require LDIF format files describing all changes. Failure to supply the required LDIF file results in the update being rejected.

Note that the membership of OID Managers does not necessarily coincide with that of Schema Managers, although it is a possibility.

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12.2. Thinking of Changing the Schema

Before you start thinking of changing the schema, you need to consider not just the namespace, but also the data your Active Directory will hold. After all, if you know your data, you can decide what changes you want to make and whom those changes might impact.

12.2.1. Designing the Data

No matter how you migrated to Active Directory, at some point you'll need to determine exactly what data you will add or migrate for the objects you create. Will you use the `physicalDeliveryOfficeName` attribute of the user object? What about the `telephonePager` attribute? Do you want to merge the internal staff office location list and telephone database during the migration? What if you really need to know what languages each of your staff speaks or qualifications they hold? What about their shoe size, their shirt size, number of children, and whether they like animals? The point is that some of these already exist in the Active Directory schema and some don't. At some point, you need to design the actual data that you want to include. This is an important decision, since not all data should necessarily be added to Active Directory. While it may be nice to have shoe size in the directory, it may not make much business sense. You need to ask, "Is this data needed on all domain controllers for a given domain or all global catalogs in the forest?" Possibly an application partition, Active Directory Application Mode (ADAM), or even a SQL Server database may be a better store for this information. Keep in mind that every piece of data that gets added to the directory needs to be replicated. This has significant impact on network traffic, storage needs, and the time required to build new domain controllers.

Let's consider MyUnixCorp, a large fictional organization that for many years has run perfectly well on a large mainframe system. The system is unusual in that the login process has been completely replaced in-house with a two-tier password system. A file called *additional-passwd* maintains a list of usernames and their second Unix password in an encrypted format. Your design for the migration for MyUnixCorp's system has to take account of the extra login check. In this scenario, either MyUnixCorp accepts that the new Active Directory Kerberos security mechanism is secure enough for its site, or it has to add entries to the schema for the second password attribute and write a new Active Directory logon interface that incorporates both checks.

This example serves to outline that the data that is to be stored in Active Directory has a bearing on the schema structure and consequently has to be incorporated into the design phase.

12.2.2. To Change or Not to Change

When you identify a deficiency in the schema for your own Active Directory, you have to look hard into whether modifying the schema is the correct way to proceed. Finding that the schema lacks a complete series of objects along with multiple attributes is a far cry from identifying that the person-who-needs-to-refill-the-printer-with-toner attribute of the printer object is missing from the schema.

There's no rule, either, that says that once you wish to create three extra attributes on an existing object, you should modify the schema. It all comes down to choice.

> There is one useful guideline: you should identify all the data you want to hold in Active Directory prior to considering your design. If you consider how to implement each change in Active Directory one at a time, you may simply lose sight of the overall picture.

To help you make that choice, you should ask yourself whether there are any other objects or attributes that you could use to solve your problem.

Let's say you were looking for an attribute of a user object that would hold a staff identification number for your users. You need to ask whether there is an existing attribute of the user object that could hold the staff ID number and that you are not going to use. This saves you from modifying the schema if you don't have to. Take Leicester University as an example: we had a large user base that we were going to register, and we needed to hold a special ID number for our students. In Great Britain, every university student has a so-called University and Colleges Administration System number, more commonly known as the UCAS number: this is a unique alphanumeric string that UCAS assigns independent of a student's particular university affiliation. Students receive their UCAS numbers when they first begin looking into universities. The numbers identify students to their prospective universities, stay with students throughout their undergraduate careers, and are good identifiers for checking the validity of students' details. By default, there is no schema attribute called UCAS-Number, so we had two choices. We could find an appropriately named attribute that we were not going to use and make use of that, or we could modify the schema.

Since we were initially only looking to store this piece of information in addition to the default user information, we were not talking about a huge change in any case. We simply looked to see whether we could use any other schema attributes to contain the data. We soon found the `employeeID` user attribute that we were not ever intending to use, and which seemed to fit the bill, so we decided to use that. While it isn't as appropriately named as an attribute called UCAS-Number would be, it did mean that we didn't have to modify the base schema in this instance.

The important point here is that we chose not to modify the schema, having found a spare attribute that we were satisfied with. We could just as easily have found no appropriate attributes and decided to go through making the schema changes using our own customized attributes.

If you've installed Microsoft Exchange into the forest, there is also a set of attributes available to use for whatever you need. These are known as the extension or custom attributes and have names like extensionAttribute1, extensionAttribute2, and so on. These are not generally used by the operating system[*] and have been left in for you to use as you wish. There are 20 created by default, thus giving you spare attribute capacity built right into Active Directory. So if we wanted to store the number of languages spoken by a user, we could just store that value inside extensionAttribute1 if we chose. You can see how these attributes have been designed by using the Schema Manager.

[*] It is possible that `extensionAttribute10` may be used for `NtdSNoMatch` information. See Microsoft Knowledge Base article 274173.

Making use of extension attributes and making use of unused attributes works well for a small number of cases. However, if there were 20, 30, or more complex attributes each with a specific syntax, or if we needed to store 20 objects with 30 attributes each, we would have more difficulty. When you have data like that, you need to consider the bigger picture.

12.2.3. The Global Picture

So you have a list of all your data and suspect either that the schema will not hold your data or that it will not do so to your satisfaction. You now need to consider the future of your organization's schema and design it accordingly. The following questions should help you decide how to design for each new `classSchema` or `attributeSchema` object:

- Is this `classSchema` or `attributeSchema` object already held in the schema in some form? In other words, does the attribute already exist by default or has someone already created it? If it doesn't exist, you can create it. If it does already exist in some form, can you make use of that existing attribute? If you can, you need to consider doing so. If you can't, you need to consider modifying the existing attribute to cope with your needs or creating a second attribute that essentially holds similar or identical data, which is wasteful. If the existing attribute is of no use, can you create a new one and migrate the values for the existing attribute to the new one and disable the old one? These are the sorts of questions you need to be thinking of.

- Is this a `classSchema` or `attributeSchema` object that is to be used only for a very specific purpose, or could this object potentially be made of use (i.e., created, changed, and modified) by others in the organization? If the object is for only a specific purpose, the person suggesting the change should know what is required. If the object may impact others, care should be taken to ensure it is designed to cope with the requirements of all potential users, for example, that it can later be extended if necessary without affecting the existing object instances at the moment the schema object is updated. For an attribute, for example, you should ask whether the attribute's syntax and maximum/minimum values (for strings or integers) are valid or whether they should be made more applicable to the needs of many. Specifically, if you created a `CASE_INSENSITIVE_STRING` of between 5 and 20 characters now and later you require that attribute to be a `CASE_SENSITIVE_STRING` of between 5 and 20 characters, you may or may not have a problem depending on whether you care that the values for the case-insensitive strings are now case-sensitive. You could obviously write a script that goes through Active Directory and modifies each string appropriately, but what if you had changed the schema attribute to a `CASE_SENSITIVE_STRING` of between 8 and 20 characters? Then you have another problem if there are any strings of between 5 and 7 letters. These attributes would be invalid, since their contents are wrong. We think you can see the sort of problems that can occur.

- Are you modifying an existing object with an attribute? If so, would this attribute be better if it were not applied directly to the object, but instead added to a set of attributes within an auxiliary class `classSchema` object?

- Are you adding an attribute to an existing object that you normally manage through the standard GUI tools such as Active Directory Users and Computers? The new attribute will not automatically show up in the GUI and will require changing the tool being used or extending the tool if it is possible. You must be aware of the impact that your changes may have on existing tools and ones that you design yourself.

Basically, these questions boil down to four much simpler ones:

- Is the change that needs to be made valid and sensible for all potential uses and users of this object?

- Will my change impact any other changes that may need to be made to this and other objects in the future?
- Will my change impact anyone else now or in the future?
- Will my change impact any applications that people inside or outside the company are developing?

> In a similar fashion to getting a valid OID namespace, make sure that the classSchema and attributeSchema objects are created with sensible names. These names should have a unique registered company prefix for easy identification and be capitalized words separated by hyphens. For specific examples, see Chapter 27.

The Schema Managers group needs to sit down with all groups of people who would potentially like to make changes to the schema, brief them on how the schema operates, and attempt to identify the sorts of changes that need to be made by these groups. If a series of meetings is not your style, consider creating a briefing paper, followed by a form to request schema updates, issued to all relevant department heads. If you allow enough time, you will be able to collate responses received and make a good stab at an initial design. You can find attributes that may conflict, ways of making auxiliary classes rather than modifications to individual attributes, and so on. This gives the Schema Managers a good chance to come up with a valid initial design for the schema changes prior to or during a rollout.

An important rule of thumb is to never modify default system attributes. This makes sure that we never conflict with anything considered as default by the operating system, which might eventually cause problems during upgrades or with other applications such as Exchange. Adding extra attributes to objects is fine, but avoid modifying existing ones.

> If we need a longer string for an existing attribute, or if it needs to be of a slightly different type, we just create a new one with a similar name and the class we want.

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12.3. Creating Schema Extensions

There are three ways to modify the schema: through the Schema Manager MMC , using LDIF files, or programmatically using ADSI or LDAP. We will not cover the use of the Schema Manager MMC very heavily here since it is fairly straightforward to use, although we will cover its use in managing the Schema FSMO role. Typically, you should not use the Schema Manager MMC to extend the schema and instead use LDIF files or ADSI. Most vendors provide LDIF files, which contain the schema extensions that you can run at your leisure. We cover extending the schema with ADSI in Chapter 27.

12.3.1. Running the Schema Manager MMC for the First Time

The Schema Manager MMC is not available from the Administrative Tools menu like the other Active Directory snap-ins. To use it, you need to first register the Dynamic Link Library (DLL) file for the MMC snap-in by typing the following command at the command prompt:

```
regsvr32.exe schmmgmt.dll
```

> Windows Server 2003 does not require you to register the schema management plug-in for Active Directory; it is automatically registered. When you install ADAM on a computer, it will automatically register the ADAM schema management plug-in. You must use the ADAM plug-in for ADAM and the Active Directory plug-in for Active Directory; the plug-ins are not interchangeable.

You can then start the Schema Manager console by creating a custom MMC and adding the Active Directory Schema snap-in to it. To create a console, go to the Run menu from the Start button, type `mmc.exe`, and click OK. Then in the empty MMC, choose the Console menu and select Add/Remove Snap-in. From here, you can click the Add button and select Active Directory Schema as the item. If you then click the Add button, followed by Close, and then the OK button, that will give you an MMC hosting the Schema Manager snap-in for you to use and later save as required.

12.3.2. The Schema Cache

Each domain controller maintains a copy of the entire schema in memory. This is known as the schema cache. It is used to provide a very rapid response when requesting a schema object OID from a name.

Allowing the Schema to Be Modified on Windows 2000

Under Windows 2000, there was a safeguard you had to bypass for the Schema FSMO to allow you to modify the schema. First, the user who is to make the changes has to be a member of the Schema Admins group, which exists in the forest root domain. Second, you need to make a change to the registry on the DC that you wish to make the changes on.

The fastest and probably best solution is to use the checkbox from the Schema Master MMC, shown later in the chapter.

Alternatively, on the DC itself, open up the registry using *regedit32.exe* or *regedit.exe* and locate the following key:

```
HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\NTDS\Parameters
```

Now, create a new REG_DWORD value called `Schema Update Allowed` and set the value to 1. That's all you need to do. You now can edit the Schema on that DC.

Another alternative method for making the change is to copy the following three lines to a text file with a REG extension and open it (i.e., execute it) on the DC where you wish to enable schema updates. This will automatically modify the registry for you without the need to open the registry by hand:

```
REGEDIT4
[HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\NTDS\Parameters]
"Schema Update Allowed"=dword:00000001
```

Once you've modified the registry on a particular DC and placed the user account that is to make the changes into the Schema Admins group, any changes you make to the schema on that DC will be accepted. If you wish changes to be accepted on any DC, you need to modify the registry correspondingly on every DC.

The schema cache is actually a set of hash tables of all the `classSchema` and `attributeSchema` objects known to the system, along with specific indices (`attributeID` and `lDAPDisplayName` for `attributeSchema` objects and `governsID`, `lDAPDisplayName`, and `mapiID` for `classSchema` objects) for fast searching.

The objects are loaded into the schema cache when the DC is booted and then five minutes after an update. However, if you need the schema cache to be updated immediately for some reason, say after the creation of a new object or attribute class, you can force an immediate reload of the cache.

As we said, the system holds a copy in memory solely to aid in searches that require quick and regular access to the schema. If the system were to keep both the cache and the actual Active Directory schema in synch, it could be costly in terms of performance; making changes to the schema is an intensive process due to the significant checking and setting of object defaults by the system upon creation of new objects. Consequently, there is a time delay between changes made to the underlying schema and the cached copy. Typically, the schema tends to be updated in bunches. This is likely to be due to applications creating multiple classes for their own purposes during an installation or even normal operation. If classes are still being created after five minutes, the system updates the cache in five-minute increments after the first five-minute update has completed. This continues for as long as schema class updates continue.

During the intervening five-minute period, when the underlying schema has been modified but the cache has yet to be updated, instances of objects or attributes of the new classes cannot be created. If you try to create an object, the system will return an error. This is due to the fact that object creations refer to the cache and not the underlying schema. To get around this problem, you can force an immediate reload of the cache by updating a special operational attribute on the Root DSE. We'll cover this later when we consider how to use the Schema Manager interface to create and delete classes. In a similar vein, if you mark an object as defunct, this will not take effect until the cache is reloaded.

Although you cannot create new instances of new object types that you have created until the schema cache refreshes, you can add new attributes or classes that you have created to other classes that you are creating. For example, if you create a new attribute, you can immediately add it to a new class. Why? Because the attribute or class is added using an OID, and the system thus doesn't need to do any lookups in the schema cache. While all system checks by Active Directory confirming that the data is valid (covered in detail a couple of sections later) will still be performed, the checks are performed on the schema in Active Directory, not in the cache. If this weren't the case, you would have to wait for at least five minutes before any new attributes that you created could be added to new classes, and that would be unacceptable.

12.3.3. The Schema FSMO

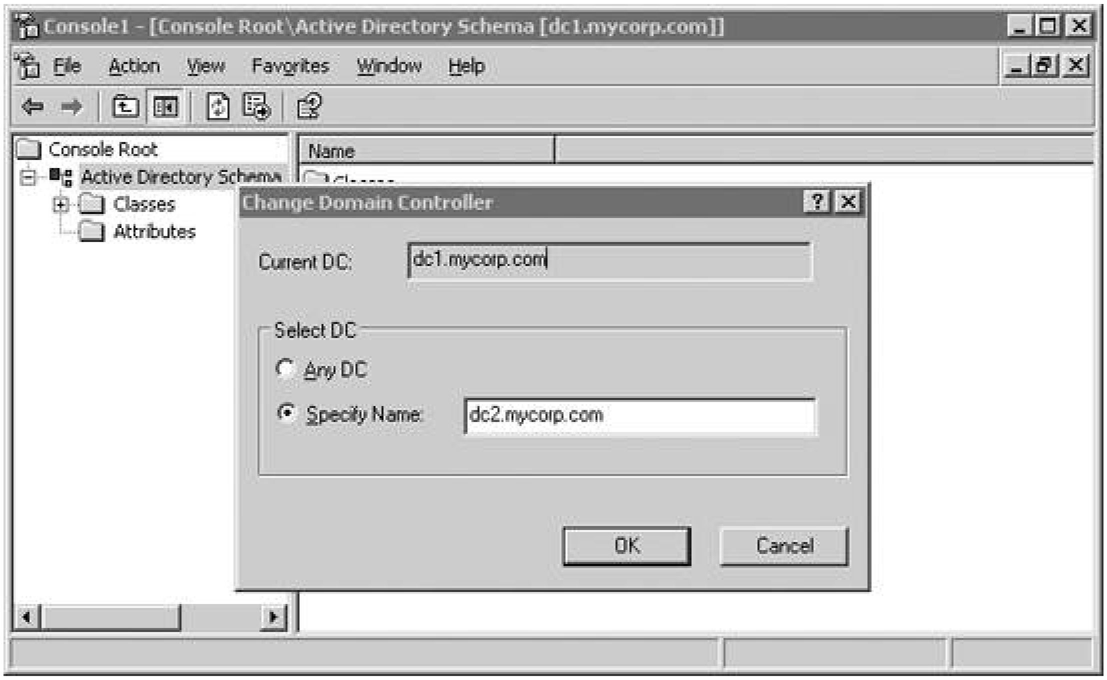
The Schema FSMO is the server where changes to the schema take place so that multiple users or applications cannot modify the schema on two or more different domain controllers at the same time. When Active Directory is installed in an enterprise, the first server in the first domain in the forest (the forest root domain) becomes the nominated Schema FSMO. Later, if changes need to be made to the schema, they can be made at the current master.

Let's take two servers, Server A and Server B. Server A is the current Schema FSMO. When the role is to be transferred, Server A modifies the `fSMORoleOwner` attribute to represent Server B and then passes that attribute to Server B along with any other schema changes that Server B may not yet have seen. Server B then applies any schema changes it hasn't seen, including the `fSMORoleOwner` attribute, and thus becomes the new Schema FSMO. This new role is replicated out when the Schema NC data is next replicated.

You can transfer the role from an existing Schema Master in three ways: via the Schema Manager MMC, via the *NTDSUTIL* tool, or via code that makes use of ADSI or LDAP.

Using the Schema Manager MMC to make the changes is easy. First you need to connect to the server that is to be the new master (*dc2.mycorp.com*), then you need to force the role to change to the server to which you are now connected. To start the process, simply run the MMC and right-click Active Directory Schema in the lefthand scope pane. From the context menu that drops down, select Change Domain Controller. A dialog box similar to Figure 12-1 then appears.

Figure 12-1. Changing the connected server



Current DC: dc1.mycorp.com

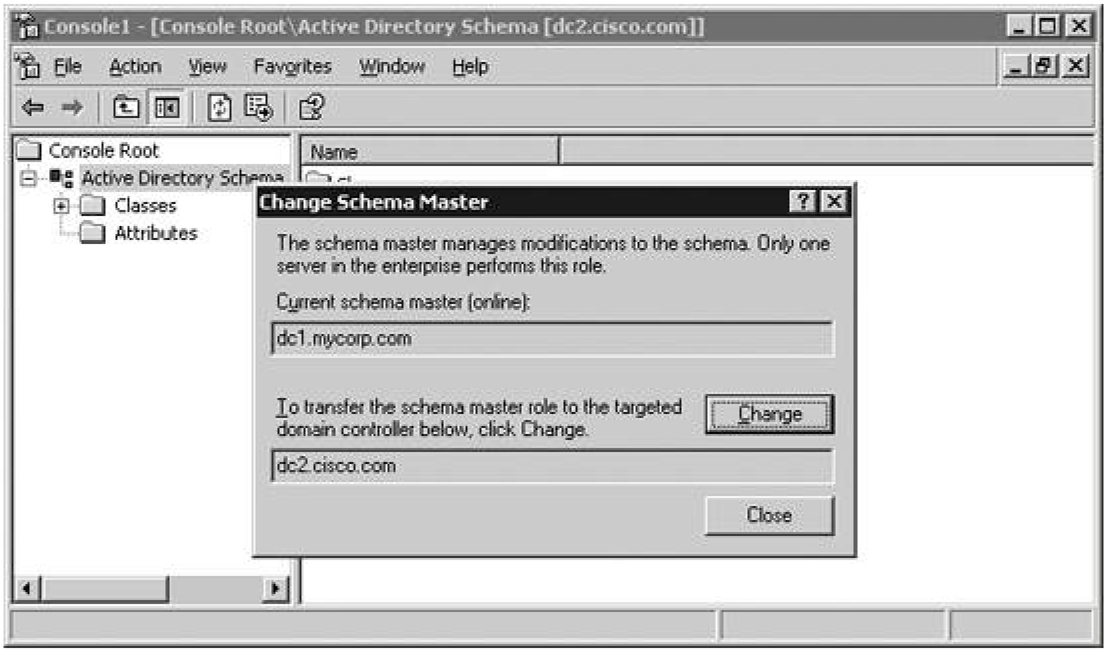
○ Any DC

● Specify Name: dc2.mycorp.com

You can now select a new server to connect to. You should transfer any FSMO roles (not just the Schema Master) to a new server before shutting down a server for an extended period, such as for maintenance. You may wish just to transfer the role to any other server, rather than to a specific one, which is why there is an option to connect to any other server. Once that has been done, right-click on Active Directory Domains Schema in the scope pane and select Operations Master from the context menu. A dialog box will appear, showing the current DC holding the Schema FSMO role, as well as an option to change the role to the currently connected server. Figure 12-2 shows this dialog box.

Click the Change button and change the schema role. There is also an option to modify the registry on the DC you are currently connected to so that schema changes will be allowed on this new Schema FSMO.

Figure 12-2. Changing the Schema FSMO from the MMC



The schema master manages modifications to the schema. Only one server in the enterprise performs this role.

Current schema master (online):

dc1.mycorp.com

To transfer the schema master role to the targeted domain controller below, click Change.

dc2.cisco.com

If a server corruption or crash takes the Schema FSMO out of the enterprise, no server will automatically assume the role. In this situation, you can use similar methods to force the Schema FSMO role on a server. It is possible to force a server to assume the role, but this can cause some confusion in AD if the old server comes back online.

If you are writing ADSI scripts to manipulate the schema, just connect to the Schema FSMO directly and make the changes there, rather than worrying about checking to see if the server you wish to make the changes on is the Schema FSMO. We'll show you how to do that later in the book.

12.3.4. Using LDIF to Extend the Schema

One of the most commonly used ways to extend the schema is with LDIF. The LDAP Data Interchange Format was defined in RFC 2849 (http://www.ietf.org/rfc/rfc2849.txt) and provides a way to represent directory data via a human-readable text file. You can export data from Active Directory in LDIF format, and you can also add, modify, and delete data with LDIF. The LDIFDE program comes installed as part of any Windows 2000 or Windows 2003 Server and can be used to import and export LDIF data. To import the contents of an LDIF file, run the following command:

```
c:> ldifde -v -i -f import.ldf
```

Replace `import.ldf` with the name of the LDIF file you want to import.

LDIF files contain one or more entries, with each entry containing one or more attributes that should be added, replaced, or removed. The format is straightforward but very strict. The following is an

LDIF that would add a group object to the Users container:

```
dn: cn=mygroup,cn=users,dc=mycorp,dc=com
changetype: add
objectclass: group
description: My Group
member: cn=administrator,cn=users,dc=mycorp,dc=com
member: cn=guest,cn=users,dc=mycorp,dc=com
```

The first line must be the DN of the object. The second line is changetype:, which is one of add, modify, modrdn, or delete. When using add as in this case, we must specify all the mandatory attributes for the object. For group objects, we need to specify only objectClass. The cn attribute is not required because it is already specified as part of the DN.

> Windows 2000 Active Directory also requires the sAMAccountName attribute to be specified.

It is easy to create portable schema extensions using LDIF files. Simply create an LDIF file with all the necessary classSchema or attributeSchema object additions or modifications, and administrators using any LDIF-based client can easily import it into Active Directory. The following LDIF shows how to create an attribute and auxiliary class that contains the new attribute:

```
dn: cn=myCorp-ITUserBuilding,cn=schema,cn=configuration,dc=mycorp,dc=com
changetype: add
attributeID: 1.2.3.4.111.1
attributeSyntax: 2.5.5.1
oMSyntax: 127
isSingleValued: TRUE
lDAPDisplayName: myCorp-ITUserBuilding
objectClass: attributeSchema

dn:
changetype: modify
add: schemaUpdateNow
schemaUpdateNow: 1
-

dn: cn=myCorp-ITUser,cn=schema,cn=configuration,dc=mycorp,dc=com
changetype: add
objectclass: classSchema
description: Class for MyCorp Employees
lDAPDisplayName: myCorp-ITUser
governsID: 1.2.3.4.111.2
objectClassCategory: 3
subClassOf: top
```

```
mayContain: myCorp-ITUserBuilding

dn:
changetype: modify
add: schemaUpdateNow
 schemaUpdateNow: 1
-
```

As we mentioned before, all mandatory attributes for attributeSchema and classSchema objects must be specified. The order of the additions is also important. Because we wanted to add the new attribute to the class, we needed to create it first. We also needed to reload the schema cache before attempting to reference the new attribute or a failure would have occurred. When each entry is added or modified, it is only committed to memory, not disk. When we reference the attribute as part of the mayContain for the new class, the attribute must also have been written to the disk. To accomplish that, we perform a modify operation against the Root DSE (i.e., blank DN) and write to the schemaUpdateNow attribute.

The benefits of using LDIF to implement schema extensions are two-fold. First, since LDIF is human-readable with a well-defined syntax, it is easy for those who need to implement the extensions to see what is going to be done. If you use a program that the administrator cannot see the source for, they will not have as much visibility into what changes are made. Along the same lines, LDIF files provide a crude documentation mechanism for schema extensions. Because LDIF files are just text-based files, schema administrators can archive the files on a server and have instant access to exactly what changes were made for certain applications.

12.3.5. Checks the System Makes When You Modify the Schema

When you create a new class or attribute, the system performs some basic checks within Active Directory to see if the data is valid, in addition to any checks you provide. The checks for attributes are shown in Table 12-1, and those for new classes are shown in Table 12-2.

Table 12-1. System checks made when creating new attributes

Attribute	System check performed
lDAPDisplayName	Must be unique in Active Directory.
attributeId	Must be unique in Active Directory.
mapiId	If present, must be unique in Active Directory.
schemaIDGUID	Must be unique in Active Directory.
attributeSyntax	Must correlate with oMSyntax.
oMSyntax	Must correlate with attributeSyntax.

Attribute	System check performed
rangeLower	If rangeUpper is present as well, the following should be true: rangeUpper > rangeLower.
rangeUpper	If RangeLower is present as well, the following should be true: rangeUpper > rangeLower.
linkID	Must be unique in Active Directory. Back link must have corresponding forward link.
searchFlags	Ambiguous Name Resolution (ANR) attributes must be Unicode or Teletex.

Table 12-2. System checks made when creating new classes

Attribute	System check performed
lDAPDisplayName	Must be unique in Active Directory.
governsId	Must be unique in Active Directory.
schemaIDGUID	Must be unique in Active Directory.
subClassOf	Checks to make sure that the X.500 specifications are not contravened, (i.e., that an auxiliary class cannot inherit from a structural class, and an abstract class can only inherit from another abstract class). All classes defined in this attribute must already exist.
rDNAttID	Must have a Unicode string as its syntax.
mayContain	All classes defined in this attribute must already exist.
systemMayContain	All classes defined in this attribute must already exist.
mustContain	All classes defined in this attribute must already exist.
systemMustContain	All classes defined in this attribute must already exist.
auxiliaryClass	All classes defined in this attribute must already exist and must have an objectClassCategory indicating either 88-Class or Auxiliary.
systemAuxiliaryClass	All classes defined in this attribute must already exist and must have an objectClassCategory indicating either 88-Class or Auxiliary.
possSuperiors	All classes defined in this attribute must already exist and must have an objectClassCategory indicating either 88-Class or Auxiliary.
systemPossSuperiors	All classes defined in this attribute must already exist and must have an objectClassCategory indicating either 88-Class or Auxiliary.

12.3.6. Making Classes and Attributes Defunct

Microsoft does not currently allow you to delete objects from the schema. If your forest is running at Windows 2003 functional level, you can redefine classes and attributes. This is a new feature in

Windows 2003, which allows you to correct potential mistakes you may have made or to repurpose classes or attributes you are no longer using.

If you create a class or attribute of some sort and decide that you don't want it any more, you can simply make it defunct. This is achieved by setting the `isDefunct` attribute on the schema object to True. For this to succeed for an attribute, the system makes sure that the attribute is not a mandatory or optional attribute of any non-defunct class. For this to succeed for a class, the system makes sure that the class is not a parent of any other non-defunct class, is not an auxiliary class to any other non-defunct class, and is not a possible superior of any other non-defunct class. If you then decide that you want to use the schema object again, set the value of `isDefunct` to False. The checks that occur when doing this are the same as for creating a new schema object of the appropriate type in the first place.

When a schema object is defunct, attempts to create instances of it fail as if it doesn't exist. The same applies to modifying existing instances, whether an attribute on an object or an object itself, as they will appear not to exist. You can, however, delete instances of defunct classes. Searches for defunct classes will happily succeed, as will searches on non-defunct classes that contain defunct attributes. All attributes, defunct or not, can be read. This is all required to enable the administrator or application author to clean up and remove the now-defunct object instances and all values from now-defunct attributes.

> Even though a schema object is defunct, it still exists in terms of its `distinguishedName`, OID, and `lDAPDisplayName`. You cannot create a second schema object that has these values, but in most cases, you can change them when running Windows 2003 forest functional level. The exception to this is that for attributes used as the RDN attribute for an objectclass, you cannot reuse the OID.

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12.4. Summary

Carefully designing the changes that you make to the Active Directory schema cannot be stressed highly enough for large corporations or application developers. Selecting a team of Schema Managers and OID Managers and creating documentation to accompany and justify changes will smooth that process. Whether you are a small company or a large multinational, creating sensible structures should mean that you rarely make mistakes and almost never have to make objects defunct.

Hopefully we have shown you not only the perils and pitfalls of modifying the schema but also why the schema is necessary and how it underpins the entire Active Directory. While you should be cautious when modifying Active Directory, a sensible administrator should have as little to fear from the Active Directory schema as he does from the Windows Registry.

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Chapter 13. Backup, Recovery, and Maintenance

A very important though often overlooked aspect of maintaining Active Directory is having a solid disaster recovery plan in place. While the reported incidents of corruption of Active Directory have been minimal, it has happened and is something you should be prepared for regardless of how unlikely it is to occur. Restoring accidentally deleted objects is much more likely to happen than complete corruption, and thus you should be equally prepared for this as well. Do you have a plan in place for what to do if a domain controller that has a FSMO role suddenly goes offline, and you are unable to bring it back? All the scenarios we've just described typically happen under times of duress. That is, clients are complaining or an application is no longer working correctly and people aren't happy. It is during times like this that you don't want to have to scramble to find a solution. Having well-documented and tested procedures to handle these issues is critical.

In this chapter, we will look at how to prepare for failures by backing up Active Directory. We will then describe how you can recover all or portions of your Active Directory from backup. We will then cover how to recover from FSMO failures. Finally, we will look at other preventive maintenance operations you can do to ensure the health of Active Directory.

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13.1. Backing Up Active Directory

Backing up Active Directory is a straightforward operation. It can be done using the NT Backup utility provided with the Windows operating system or with a third-party backup package such as Veritas NetBackup . Fortunately, you can back up Active Directory while it is online, so you do not have to worry about taking outages just to perform backups like you do with other systems.

To back up Active Directory, you have to back up the System State of one or more domain controllers within each domain in the forest. If you want to be able to restore any domain controller in the forest, you'll need to back up every domain controller. On a domain controller, the System State contains the following:

Active Directory

This includes the files in the NTDS folder that contains the Active Directory database (*ntds.dit*), the checkpoint file (*edb.chk*), transaction log files (*edb*.log*), and reserved transaction logs (*res1.log* and *res2.log*).

Boot Files

The files necessary for the machine to boot up.

COM+ Class Registration Database

The database for registered COM components.

Registry

The contents of the registry.

SYSVOL

This is the *SYSVOL* share that contains all of the file-based GPO information as well as the *NETLOGON* share, which typically contain user logon and logoff scripts.

Certificate Services

This applies only to DCs that are running Certificate Services.

> Although most backup packages allow you to perform incremental backups, with Active Directory you can only perform full backups of the system state.

The user that performs the backup must be a member of the Backup Operators group or have Domain Admins equivalent privileges.

Due to the way Active Directory handles deleted objects, your backups are only good for a certain period of time. When objects are deleted in Active Directory, initially they are not removed completely. A copy of the object still resides in Active Directory for the duration of the tombstone lifetime. The tombstone lifetime value dictates how long Active Directory keeps deleted objects before completely removing them. The tombstone lifetime is configurable and is defined in the tombStoneLifetime attribute on the following object:

```
cn=Directory Services, cn=WindowsNT, cn=Services, cn=Configuration, <ForestDN>
```

The default value for `tombStoneLifetime` is 60 days prior to Windows Server 2003 Service Pack 1 and 180 days after that for new forests. That means deleted objects are purged from Active Directory several months after they are initially deleted. As far as backups go, you should not restore a backup that is older than the tombstone lifetime because deleted objects will be reintroduced. If for whatever reason you are not able to get successful backups within the `tombstoneLifetime`, consider increasing the value.

Another issue to be mindful of in regard to how long you keep copies of your backup has to do with passwords. Computer accounts change their passwords every 30 days. The Domain Controllers will accept the current password as well as one previous password, so if you restore computer objects from a backup that is older than 60 days, those computers will more than likely have to be reset. Trust relationships can also be affected. Like computer accounts, the current and previous passwords are stored with the trust objects, but unlike computer accounts, trust passwords are changed every seven days. That means if you authoritatively restore trust objects from a backup that is older than 14 days, then you may need to reset the trust.

> Disk imaging is specifically not supported for domain controller backups. This covers all instances of imaging from backup of virtual hardware disks to using disk image software like Ghost to special imaging available in various attached storage products. Active Directory is a distributed system running across multiple domain controllers, which each domain controller maintains state for other domain controllers. Imaging various pieces of the distributed system and recovering them separately can have catastrophic results on the consistency of the directory as a whole. Some of the possible issues are USN rollback, lingering objects, and SID rollback.
>
> The only safe way to use disk imaging is to shut down every domain controller in the forest and then image the disks. When you need to restore, you again shut down every domain controller and roll each domain controller back to the same point in time. Even though this is a safe way to do it, it still isn't supported by Microsoft and should only be used in a test environment.
>
> See MS Knowledge Base article 875495 for more details.

13.1.1. Using the NT Backup Utility

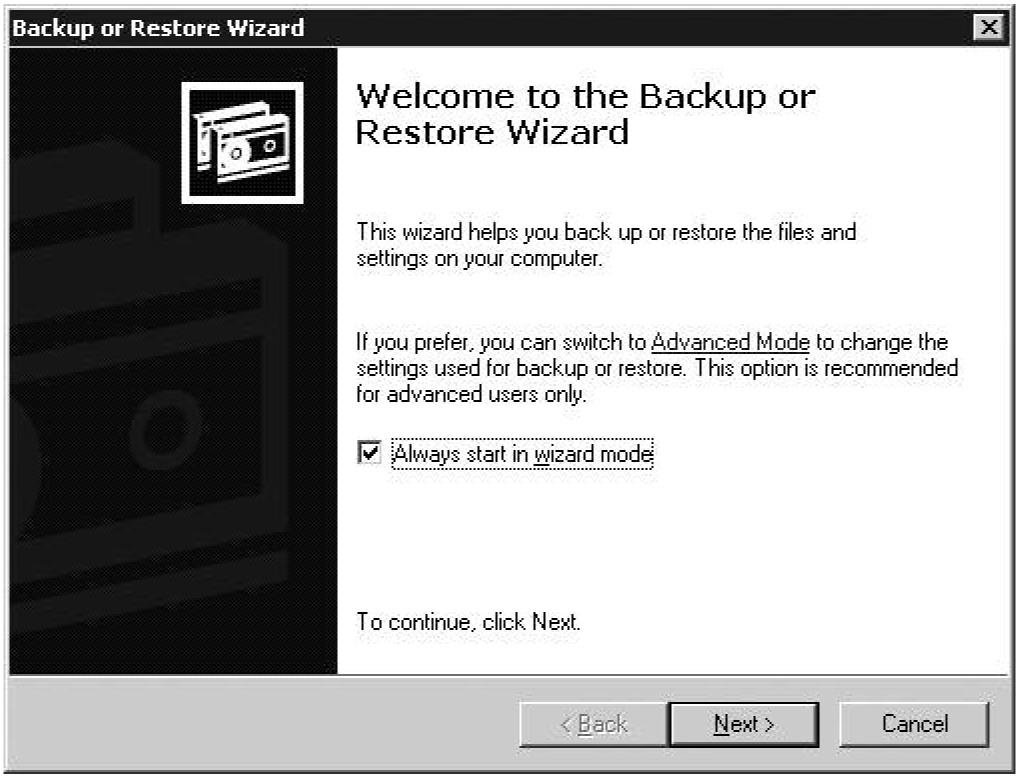
The NT Backup utility is installed on all Windows 2000 and Windows Server 2003 machines. It is available by going to Start → All Programs → Accessories → System Tools → Backup. You can also start it up by going to Start → Run, entering `ntbackup`, and clicking OK. Figure 13-1 shows the first screen of the NT Backup utility under Windows Server 2003.

The NT Backup utility can be used to back up the system and also to perform a restore. We will cover restores in the next section. If you click on the "Advanced Mode" link in the first screen, you'll then see a screen such as that in Figure 13-2.

In this case, we clicked on the Backup tab and then selected the box beside System State. We could also back up any of the other drives if we wanted, but the System State is all that is required when doing a basic restore of Active Directory.

By clicking the "Start Backup" button, we can kick off the backup. In Figure 13-2, we configured the *D:* drive to be the location where the backup file gets stored. This could have been to a remote file server or other backup media if we wanted.

Figure 13-1. NT Backup Wizard



Backup or Restore Wizard

Welcome to the Backup or Restore Wizard

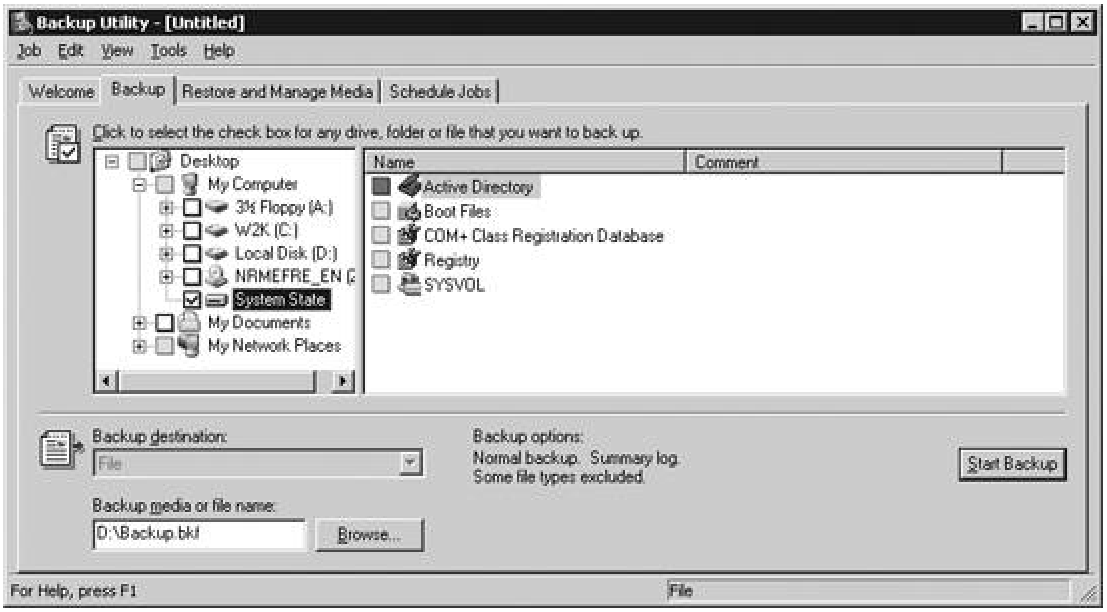
This wizard helps you back up or restore the files and settings on your computer.

If you prefer, you can switch to Advanced Mode to change the settings used for backup or restore. This option is recommended for advanced users only.

☑ Always start in wizard mode

To continue, click Next.

Figure 13-2. Advanced mode NT backup



Backup Utility - [Untitled]

Click to select the check box for any drive, folder or file that you want to back up.

- □ Desktop
  - □ My Computer
    - □ 3½ Floppy (A:)
    - □ W2K (C:)
    - □ Local Disk (D:)
    - □ NRMEFRE_EN (Z
    - ☑ System State
  - □ My Documents
  - □ My Network Places

Name	Comment
■ Active Directory	
□ Boot Files	
□ COM+ Class Registration Database	
□ Registry	
□ SYSVOL	

Backup destination: File

Backup media or file name: D:\Backup.bkf

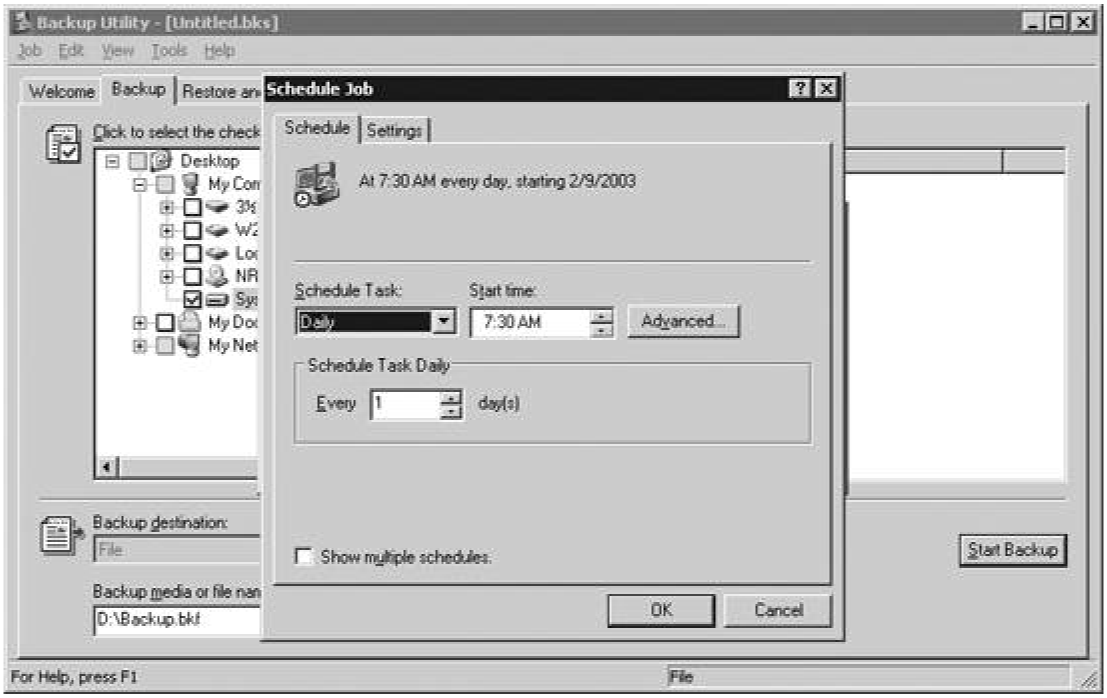
Backup options: Normal backup. Summary log. Some file types excluded.

For Help, press F1 | File

We can also schedule a backup to run at an interval of our choosing by clicking the "Start Backup" button and then the "Schedule" button. After that, we click the "Properties" button and the screen shown in Figure 13-3 pops up.

In this case, we've configured the backup to run once a day at 7:30 A.M. The screen in Figure 13-3 is actually part of Scheduled Tasks, which is the job scheduling system available in Windows 2000 and Windows Server 2003.

Figure 13-3. Scheduling NT backup



At 7:30 AM every day, starting 2/9/2003

Schedule Task: Daily

Start time: 7:30 AM

Schedule Task Daily

Every 1 day(s)

☐ Show multiple schedules.

Backup destination: File

Backup media or file nan: D:\Backup.bkf

File

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13.2. Restoring a Domain Controller

One of the benefits of Active Directory is built-in redundancy. When you lose a single domain controller, the impact can be insignificant. With many services, such as DHCP, the architecture dictates a dependency on a specific server. When that server becomes unavailable, clients are impacted. Over the years, failover or redundancy has been built into most of these services, including DHCP. With Active Directory, the architecture is built around redundancy. Clients are not dependent on a single DC; they can failover to another DC seamlessly if a failure occurs.

When a failure does occur, you should ask yourself several questions to assess the impact:

Is the domain controller the only one for the domain?

> This is the worst-case scenario. The redundancy in Active Directory applies only if you have more than one domain controller in a domain. If there is only one, you have a single point of failure. You could irrevocably lose the domain unless you can get that domain controller back online or restore it from backup.

Does the domain controller have a FSMO role?

> The five FSMO roles outlined in Chapter 2 play an important part in Active Directory. FSMO roles are not redundant, so if a FSMO role owner becomes unavailable, you'll need to seize the FSMO role on another domain controller. Check out the FSMO recovery section later in this chapter for more information.

Is the domain controller a Global Catalog server?

> The Global Catalog is a function that any domain controller can perform if enabled. But if you have only one Global Catalog server in a site and it becomes unavailable, it can impact users' ability to login. As long as clients can access a Global Catalog, even if it isn't in the most optimal location, they will be able to login. If a site without a Global Catalog for some reason loses connectivity with the rest of the network, it would impact users' ability to login. With Windows Server 2003, you can enable universal group caching on a per-site basis to limit this potential issue, but only if the user is not using a `userPrincipalName` for authentication.

Is the domain controller necessary from a capacity perspective?

> If your domain controllers are running near capacity and one fails, it could overwhelm the remaining servers. At this point, clients could start to experience login failures or extreme slowness when authenticating.

Are any other services, such as Exchange, relying on that specific domain controller?

> Exchange is a heavy consumer of Active Directory Services, especially AD Global Catalogs. Failure of a domain controller that Exchange is using can cause considerable issues in the mail environment depending on the versions of the Outlook and Exchange being used. (More recent versions of Exchange and Outlook obviously handle outages better than older versions.) During the outage period, mail delivery could be impacted along with client lookups. Exchange is just one example, but it illustrates that you have to be careful of this when introducing Active Directory-enabled services into your environment.

These questions can help you assess the urgency of restoring the domain controller. If you answered "no" to all of the questions, the domain controller can stay down for a short period without significant impact.

When you've identified that you need to restore a domain controller, there are two options to choose from: restoring from replication or restoring from a backup.

13.2.1. Restore from Replication

One option for restoring a domain controller is to bring up a freshly installed or repaired machine and promote it into Active Directory. You would use this option if you had a single domain controller failure due to hardware and either did not have a recent backup of the machine or you didn't want to go through the process of restoring the DC from a backup. This method allows you to replace the server in AD by promoting a newly installed machine and allowing replication to copy all of the data to the DC. Here are the steps to perform this type of restore:

1. Remove the failed DC from AD. The old remnants of the domain controller must be removed from Active Directory before you promote the freshly installed server. We describe the exact steps to do this shortly.

2. Rebuild OS. Reinstall the operating system and any other applications you support on your domain controllers .

3. Promote server. After you've allowed time for the DC removal process to replicate throughout the forest, you can then promote the new server into AD.

4. Configure any necessary roles. If the failed server had any FSMO roles or was a GC, you can configure the new server to have these roles.

> A best practice is to keep a spare server that already has the OS and any other software installed ready to ship or onsite at all locations. That way, if you have a major failure with one of your domain controllers, you can use the spare server without needing to stress over getting the hardware replaced immediately in the failed machine. Alternatively, just have additional domain controller capacity in the primary sites that failures would be most painful for, especially for Exchange.

The biggest potential drawback with this method is the restore time. Depending on the size of your DIT file and how fast your network connections are between the new DC and the server it will replicate with, the restore time could be several hours or even days. Restore time can be dramatically reduced with a new option in Windows Server 2003, called Restore from Media. It allows you to take files from a system state backup from one domain controller and use them to quickly promote another domain controller. It may possibly be faster to copy these backup files over the network to the remote site or ship the files on some other media to the site versus trying to replicate the entire DIT over the WAN. If this is problematic or too slow for you, you'll want to look at the restore from backup option that we describe next.

13.2.1.1. Manually removing a domain controller from Active Directory

One of the key steps with the restore from replication method is removing the objects that are associated with the domain controller before it gets added to AD again. This is a three-step process. The first step is to remove the associated metadata. That can be accomplished with the *ntdsutil* utility. The following example shows the commands necessary to remove the DC3 domain controller, which is in the RTP site, from the *emea.mycorp.com* domain:

```
C:\>ntdsutil
ntdsutil: metadata cleanup
metadata cleanup: connections
```

Next, we need to connect to an existing domain controller in the domain that contains the domain controller you want to remove. In this case, we connect to DC2:

```
server connections: connect to server dc2
Binding to dc2 ...
Connected to dc2 using credentials of locally logged on user.
server connections: quit
metadata cleanup: select operation target
```

Now we need to select the domain the domain controller is in. In this case, it is *emea.mycorp.com*:

```
select operation target: list domains
Found 2 domain(s)
0 - DC=mycorp,DC=com
1 - DC=emea,DC=mycorp,DC=com
select operation target: select domain 1
No current site
Domain - DC=emea,DC=mycorp,DC=com
No current server
No current Naming Context
```

Next we must select the site the domain controller is in. In this case, it is the RTP site:

```
select operation target: list sites
Found 4 site(s)
 0 - CN=Default-First-Site-Name,CN=Sites,CN=Configuration,DC=mycorp,DC=com
 1 - CN=RTP,CN=Sites,CN=Configuration,DC=mycorp,DC=com
 2 - CN=SJC,CN=Sites,CN=Configuration,DC=mycorp,DC=com
 3 - CN=NYC,CN=Sites,CN=Configuration,DC=mycorp,DC=com
select operation target: select site 1
Site - CN=RTP,CN=Sites,CN=Configuration,DC=mycorp,DC=com
Domain - DC=emea,DC=mycorp,DC=com
No current server
No current Naming Context
```

After listing the servers in the site, we must select the server we want to remove. In this case, it is DC3:

```
select operation target: list servers in site
Found 3 server(s)
 0 - CN=DC1,CN=Servers,CN=RTP,CN=Sites,CN=Configuration,DC=mycorp,DC=com
 1 - CN=DC2,CN=Servers,CN=RTP,CN=Sites,CN=Configuration,DC=mycorp,DC=com
 2 - CN=DC3,CN=Servers,CN=RTP,CN=Sites,CN=Configuration,DC=mycorp,DC=com
select operation target: select server 2
Site - CN=RTP,CN=Sites,CN=Configuration, DC=mycorp,DC=com
Domain - DC=emea,DC=mycorp,DC=com
 Server - CN=DC3,CN=Servers,CN=RTP,CN=Sites,CN=Configuration,DC=mycorp,DC=com
    DSA object - CN=NTDS Settings,CN=DC3,CN=Servers,CN=RTP,CN=Sites,
CN=Configuration,DC=mycorp,DC=com
    Computer object - CN=DC3,OU=Domain Controllers,DC=emea,DC=mycorp,DC=com
No current Naming Context
select operation target: quit
```

This process has been considerably simplified in Windows Server 2003 Service Pack 1; however, you need to know the `distinguishedName` of the Domain Controller's `server` object in the configuration container. It is recommended that you simply follow the preceding directions for removing dead domain controllers, as there is less possibility of a mistake.

The last step removes the metadata for the selected domain controller:

```
metadata cleanup: remove selected server
```

At this point, you should receive confirmation that the DC was removed successfully. If you receive an error that the object could not be found, it might have already been removed if you tried to demote the server with *dcpromo*.

You will then need to manually remove a few more objects from Active Directory, including the computer account and FRS object in the domain-naming context and the server object in the configuration container. See MS Knowledge Base article 216498 for details.

13.2.2. Restore from Backup

Another option to reestablish a failed domain controller is to restore the machine using a backup. This approach does not require you to remove any objects from Active Directory. When you restore a DC from a backup, the latest changes will replicate to make it current. If time is of the essence and the backup file is immediately available, this will be the quicker approach, because only the latest changes since the last backup, instead of the whole directory tree, will be replicated over the network.

Here are the steps to restore from backup:

1. Rebuild OS. Reinstall the operating system and any other applications you support on your domain controllers. Leave the server as a standalone or member server.

2. Restore from backup. Use your backup packagee.g., NT Backupto restore at least the System State onto the machine. In the next section, we will walk through the NT Backup utility to show how this is done.

3. Reboot server and allow replication to complete. If the failed server had any FSMO roles or was a GC, you can configure the new server to have these roles.

It is also possible to restore the backup of a machine onto a machine that has different hardware. Here are some issues to be aware of when doing so:

- The number of drives and drive letters should be the same.

- The disk drive controller and configuration should be the same.

- The attached cards, such as network cards, video adapter, and processors, should be the same. After the restore, you can install the new cards, which should be recognized by Plug and Play.

- The *boot.ini* from the failed machine will be restored, which may not be compatible with the new hardware, so you'll need to make any necessary changes.

- If the HAL is different between machines, you can run into problems. For example, if the failed machine was single processor and the new machine is multiprocessor, you will have a compatibility problem. The only workaround is to copy the *Hal.dll*, which is not included as part of System State, from the old machine and put it on the new machine. The obvious drawback to this is it will make the new multiprocessor machine act like a single processor machine.

Because there are numerous things that can go wrong with restoring to different hardware, we highly suggest you test and document the process thoroughly; refer to MS Knowledge Base article 263532. The last thing you want to do is troubleshoot hardware compatibility issues when you are trying to restore a crucial domain controller.

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13.3. Restoring Active Directory

No one ever wants to be in a position where you have to restore Active Directory, but nevertheless you should prepare for it. Restoring Active Directory comes in a few different flavors, which we'll cover now.

13.3.1. Non-Authoritative Restore

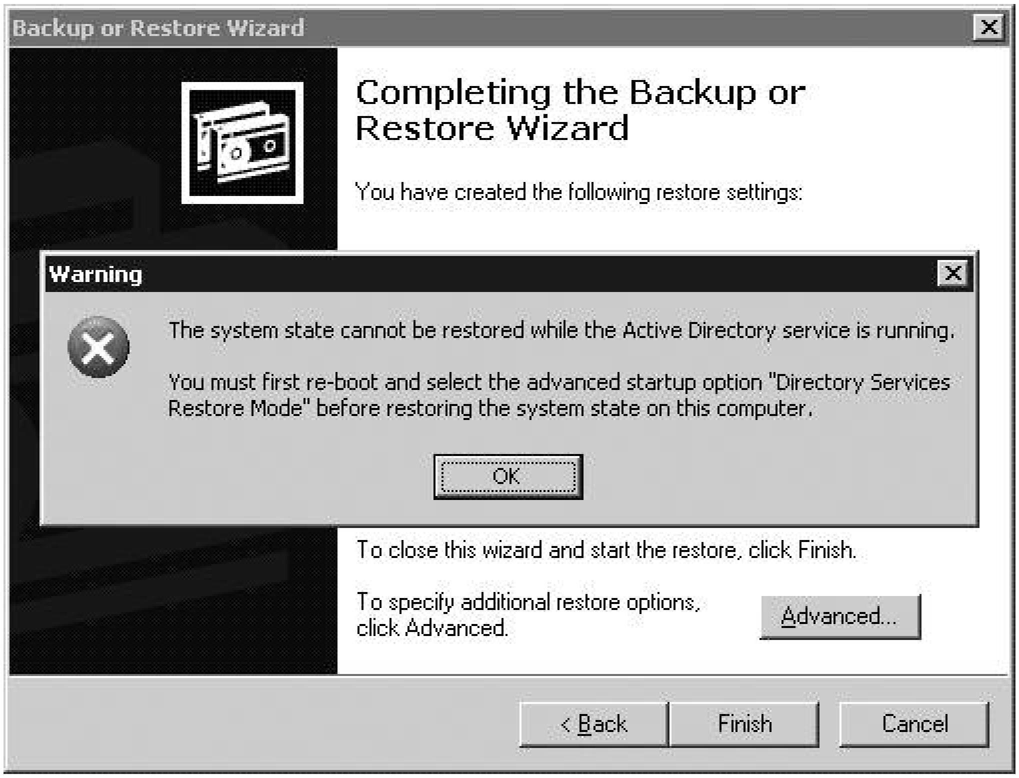
A non-authoritative restore is a restore where you simply bring a domain controller back to a known good state using a backup. You then let replication resync the contents of the latest changes in Active Directory since the backup. The restore from backup method we described earlier to handle DC failures is an example of a non-authoritative restore. The only difference between that scenario and the one we'll describe here is that previously we assumed that the failed server you rebuilt or replaced was not a domain controller yet. There may be some circumstances when you want to perform a similar restore, but the server is already configured as a domain controller. One example might be if some changes were made on a particular domain controller that you wanted to take back. If you were able to disconnect the domain controller from the network in time before it replicated, you could perform a non-authoritative restore to get it back to a known state before the changes were made. This would effectively nullify the changes as long as they didn't replicate to another server.

A non-authoritative restore simply restores Active Directory without marking any of the data as authoritative. This means that any changes that have happened since the backup will replicate to the restored server. Also, any changes that were made on the server that had not replicated will be lost.

To perform a non-authoritative restore of a domain controller, you need to boot the DC into "Directory Services Restore Mode." The reason you have to do this is that when a domain controller is live, it locks the Active Directory database (*ntds.dit*) in exclusive mode. That means that no other processes can modify its contents. To restore over the DIT file, you must boot into DS Restore Mode , which is a version of Safe Mode for domain controllers. If you try to restore a live domain controller, you'll get an error like the one shown in Figure 13-4.

You can get into DS Restore Mode by hitting the F8 key during the initial system startup. After doing so, you'll see the screen shown in Figure 13-5.

Figure 13-4. Restore error on a live domain controller



Backup or Restore Wizard

Completing the Backup or Restore Wizard

You have created the following restore settings:

Warning

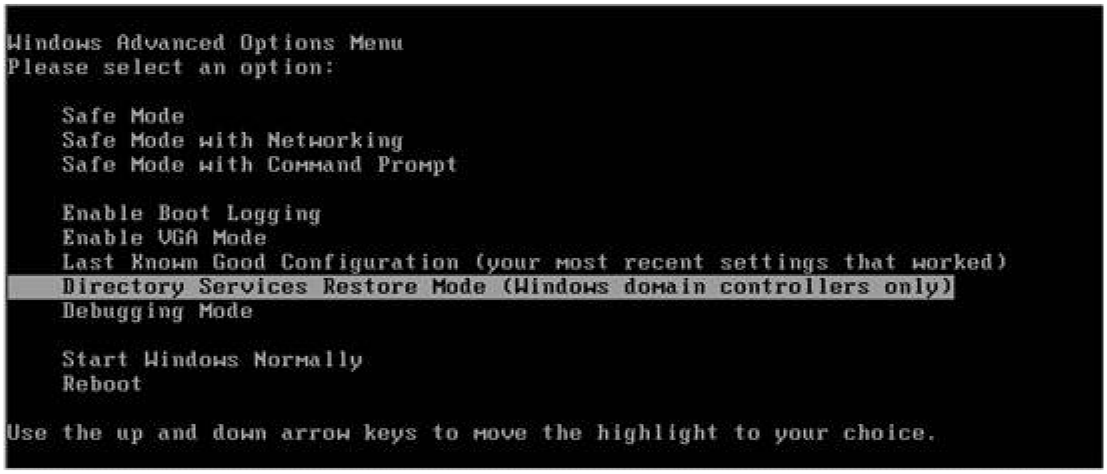
The system state cannot be restored while the Active Directory service is running.

You must first re-boot and select the advanced startup option "Directory Services Restore Mode" before restoring the system state on this computer.

To close this wizard and start the restore, click Finish.

To specify additional restore options, click Advanced.

Figure 13-5. Directory Services Restore Mode



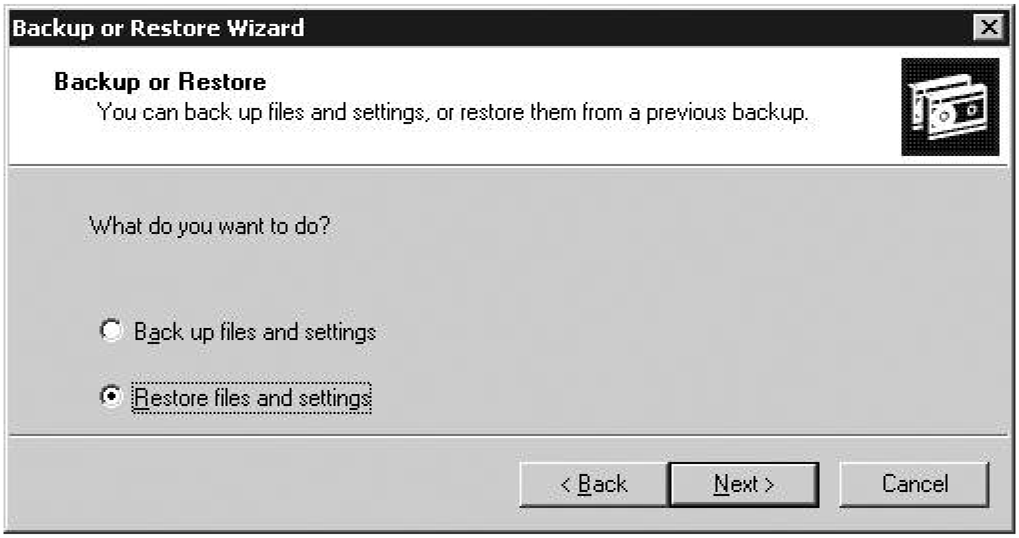
```
Windows Advanced Options Menu
Please select an option:

    Safe Mode
    Safe Mode with Networking
    Safe Mode with Command Prompt

    Enable Boot Logging
    Enable VGA Mode
    Last Known Good Configuration (your most recent settings that worked)
    Directory Services Restore Mode (Windows domain controllers only)
    Debugging Mode

    Start Windows Normally
    Reboot

Use the up and down arrow keys to move the highlight to your choice.
```

Once you receive a logon prompt, you have to login with the DS Restore Administrator account and password. You set the password for this account when you initially *dcpromo* the machine into Active Directory. Since Active Directory is offline in DS Restore Mode, you have to log in with the local Administrator account that is stored in the local SAM and that can only be used in this mode.

After logging into the system, you'll need to bring up the NT Backup utility or other backup software.

We will walk through how to do the restore using NT Backup. After clicking Next at the initial wizard screen, you'll see the screen shown in Figure 13-6.

Figure 13-6. Backup or restore options



Backup or Restore Wizard

Backup or Restore

You can back up files and settings, or restore them from a previous backup.

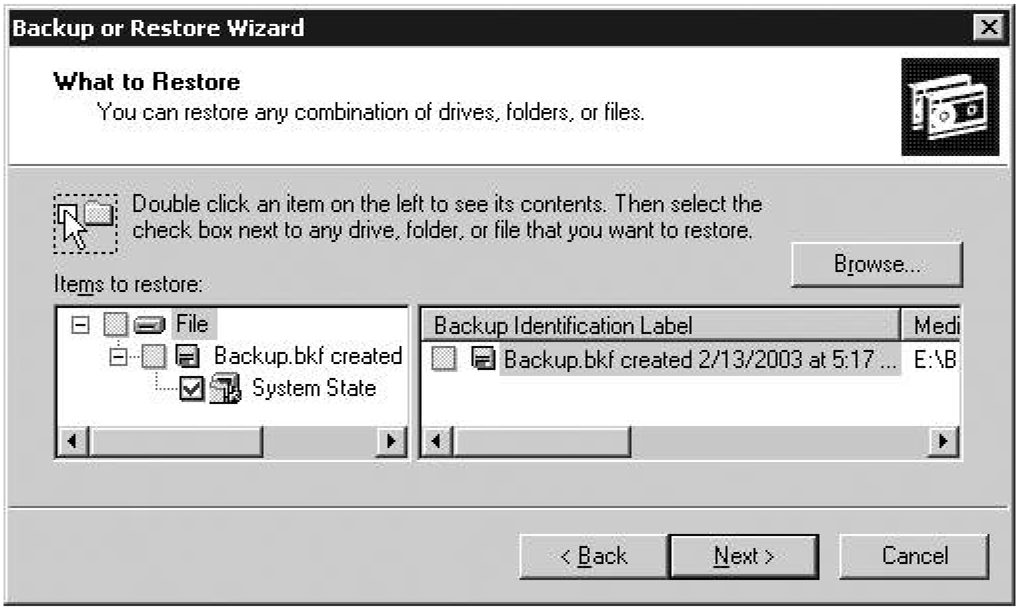
What do you want to do?

○ Back up files and settings

● Restore files and settings

Select Restore Files and Settings and click Next. You'll now be brought to a screen to select what to restore. You should restore at least the System State, but you can also restore the System Drive and other drives if necessary. Figure 13-7 shows the selection screen.

Figure 13-7. Restore selection



Backup or Restore Wizard

What to Restore

You can restore any combination of drives, folders, or files.

Double click an item on the left to see its contents. Then select the check box next to any drive, folder, or file that you want to restore.

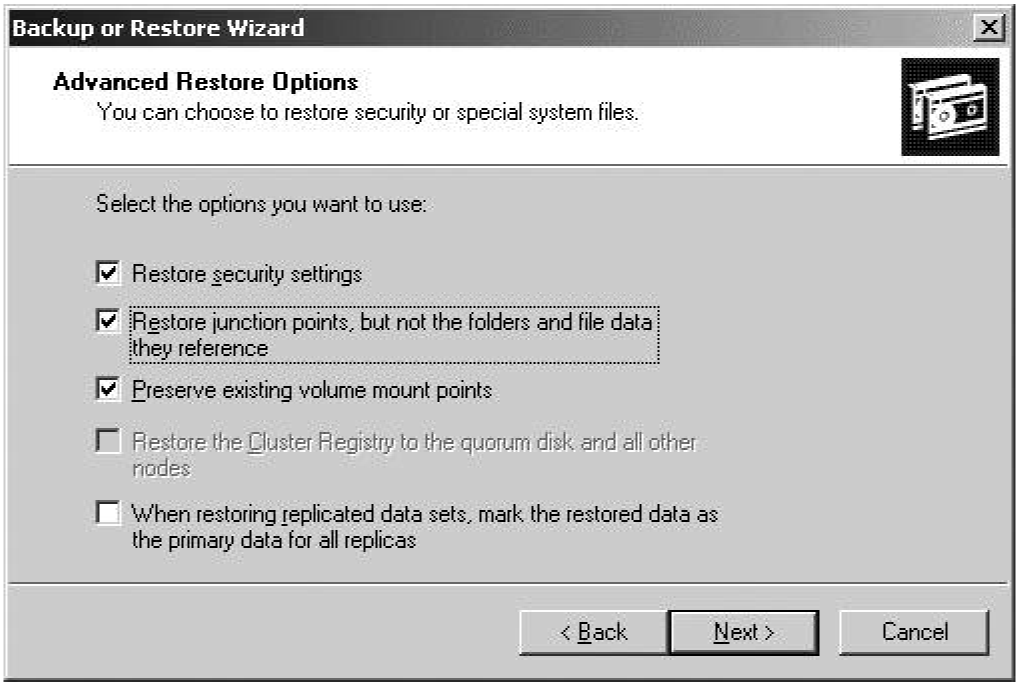
Items to restore:

- □ File
  - □ Backup.bkf created
    - ☑ System State

Backup Identification Label	Medi
□ Backup.bkf created 2/13/2003 at 5:17 ...	E:\B

After you've made your selection and clicked Next, the summary screen will be displayed, showing what will be restored. Before finishing, you need to click the Advanced button and walk through the advanced screens to ensure that junction points will be restored, as shown in Figure 13-8.

Figure 13-8. Restore junction points



Backup or Restore Wizard

Advanced Restore Options

You can choose to restore security or special system files.

Select the options you want to use:

☑ Restore security settings

☑ Restore junction points, but not the folders and file data they reference

☑ Preserve existing volume mount points

□ Restore the Cluster Registry to the quorum disk and all other nodes

□ When restoring replicated data sets, mark the restored data as the primary data for all replicas

Click Finish to kick off the restore. After the restore is complete, you'll need to reboot into normal mode. At this point, the domain controller will replicate the latest changes with its replication partners. Give time for the replication to complete and then monitor the server and check the event logs to make sure it is functioning correctly.

13.3.2. Partial Authoritative Restore

In some situations, you may need to restore data in Active Directory. In the examples we've shown so far of restoring a domain controller and performing a non-authoritative restore, we simply wanted to get the domain controller back up and running. There are certain situations, though, in which you may need to do an authoritative restore. Here are a few examples:

- Accidental deletion of important objects
- Accidental deletion of a subtree
- Corruption of objects or the entire directory
- Reversing certain object additions or modifications

In all of these scenarios, you can do a partial authoritative restore to reverse the changes. If the entire directory gets corrupted, you'll need to do a complete authoritative restore, which we will touch on shortly.

You have two options for doing an authoritative restore. You can either find a domain controller that has the data it is supposed to, perhaps because the changes haven't replicated to it yet, or you can restore the data from a backup. In either case, you need to boot into DS Restore Mode as described in the previous section. Again, this is necessary due to the fact that the Active Directory database is locked when the DC is live, and no modifications can be made. Once you are in DS Restore Mode, you can restore from backup if necessary, as described earlier.

At this point we need to mark the data we want restored as authoritative in our offline Active Directory database. This is done with the *ntdsutil* utility. There are several options to choose from under the `authoritative restore` menu shown here:

```
ntdsutil: authoritative restore
authoritative restore: ?
 ?                             - Show this help information
 Create ldif file(s) from %s   - Creates ldif file(s) using specified
                                 authoritatively restored objects list
                                 to recreate back-links of those objects.
 Help                          - Show this help information
 List NC CRs                   - Lists Partitions and cross-refs.  You need
                                 the cross-ref of a Application Directory
                                 Partition to restore it.
 Quit                          - Return to the prior menu
 Restore database              - Authoritatively restore entire database
 Restore database verinc %d    - ... and override version increase
 Restore object %s             - Authoritatively restore an object
 Restore object %s verinc %d   - ... and override version increase
 Restore subtree %s            - Authoritatively restore a subtree
 Restore subtree %s verinc %d  - ... and override version increase

authoritative restore:
```

When doing a partial restore, you can use either the `restore object %s` subcommand to restore a single object or the `restore subtree %s` subcommand to restore an entire subtree of objects. In the following example, we will restore the jsmith user object:

```
authoritative restore: restore object cn=jsmith,ou=sales,dc=mycorp,dc=com
Opening DIT database... Done.

The current time is 08-10-05 00:15.25.
Most recent database update occured at 08-09-05 21:48.51.
Increasing attribute version numbers by 100000.

Counting records that need updating...
Records found: 0000000001
Done.


Found 1 records to update.

Updating records...
Records remaining: 0000000000
Done.
Successfully updated 1 records.

The following text file with a list of authoritatively restored
objects has been created in the current working director
y:
         ar_20050810-001525_objects.txt

One or more specified objects have back-links in this domain.
The following LDIF files with link restore operations have
 been created in the current working directory:
         ar_20050810-001525_links_ad.loc.ldf

Authoritative Restore completed successfully.
authoritative restore: quit
```

As you can see, *ntdsutil* increases the object's version number by 100,000. This is how it is marked as authoritative in the database. After you reboot into normal mode, the domain controller will check with its replication partners and determine that the jsmith user object has a higher version than its partners have. It will then replicate this out to them. And likewise, all other objects that have been updated on the partner will be replicated to this server.

> If for whatever reason the auto-increment of 100,000 is not enough for the object(s), you can use the alternate subcommand of `restoreobject %s verinc %d` where `%d` is the version increase to increment.

Depending on the version of *ntdsutil*, you could see different results than what are shown above. The utility had some major changes incorporated in Windows Server 2003 Service Pack 1 version that is shown previously. New in this version, you will notice that it has created an LDF file. This file will contain any linked attribute values attached to the object in the same domain; this allows for recovery of group membership and other linked attributes.

13.3.3. Complete Authoritative Restore

Restoring the entire Active Directory database is similar in concept to restoring individual objects or subtrees, except you are restoring all of the objects. This should be done with caution and only under the most extreme situations. We highly recommend that you test this out in a lab environment to ensure you have the process correctly documented and you actually have experience with doing restores.

Again, to run the restore command, you have to be in DS Restore Mode, and you need to have restored the system from backup, as described previously in this chapter. The following is example output from the `restore database` subcommand:

```
authoritative restore: restore database
Opening DIT database... Done.


 The current time is 08-10-05 00:39.46.
 Most recent database update occured at 08-09-05 21:48.51.
 Increasing attribute version numbers by 100000.

Counting records that need updating...
 Records found: 0000001725
Done.


 Found 1725 records to update.

Updating records...
 Records remaining: 0000000000
Done.


 Successfully updated 1725 records.
```

```
The following text file with a list of authoritatively
restored objects has been created in the current working directory:
         ar_20050810-003946_objects.txt

One or more specified objects have back-links in this domain.
The following LDIF files with link restore operations have
 been created in the current working directory:
         ar_20050810-003946_links_ad.loc-Configuration.ldf
         ar_20050810-003946_links_ad.loc.ldf

Authoritative Restore completed successfully.

authoritative restore: quit
```

If you have to perform a complete authoritative restore, the assumption is that something catastrophic happened on a domain controller that caused some form of Active Directory corruption. The safest thing may in fact be to restore one domain controller per domain and rebuild the rest. You would need to manually remove each of the rebuilt domain controllers from Active Directory and then re-promote each. Again, this is only a suggestion, and each situation must be thoroughly thought out before taking such drastic measures. If you have a thorough understanding of the processes and procedures involved and practice them, you will certainly be better prepared to tackle such an eventuality. For the Microsoft whitepaper on Active Directory Forest Recovery best practices, see:

> http://www.microsoft.com/downloads/details.aspx?displaylang=en&FamilyID= 3EDA5A79-C99B-4DF9-823C-933FEBA08CFE

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13.4. FSMO Recovery

The FSMO roles were described in Chapter 2 . These roles are considered special in Active Directory beca they are hosted on a single domain controller within a forest or domain. The architecture of Active Direct is highly redundant, except for FSMO roles. It is for this reason that you need to have a plan on how to handle FSMO failures.

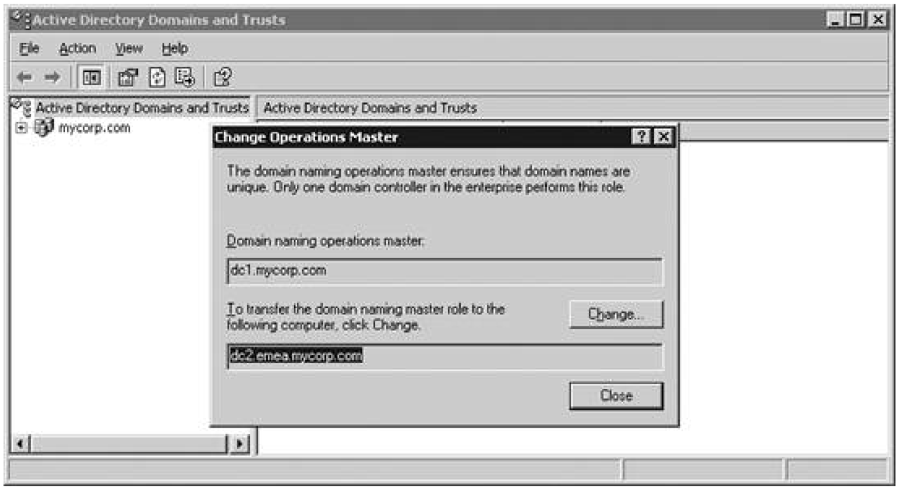
It would be a really nice feature if domain controllers could detect that they are being shut down and gracefully transfer any FSMO roles to other domain controllers. Without having the graceful FSMO role transfer, you have to do manual transfers. Manually transferring a role is pretty straightforward. You brin up the appropriate Active Directory snap-in, bring up the FSMO property page, select a new role owner, a perform the transfer. Here is a list of the FSMO roles and the corresponding snap-in that can be used to transfer it to another domain controller:

- Schema Master: Active Directory Schema
- Domain Naming Master: Active Directory Domains and Trusts
- RID Master: Active Directory Users and Computers
- PDC Emulator: Active Directory Users and Computers
- Infrastructure Master: Active Directory Users and Computers

> You can use the command-line tool *NETDOM* to query all FSMOs for a given domain with a single command:
>
> ```
> netdom query fsmo /domain:domainname
> ```

Figure 13-9 shows the Active Directory Domains and Trusts screen for changing the Domain Naming FSM

Figure 13-9. Changing the Domain Naming FSMO role owner


Active Directory Domains and Trusts
File Action View Help
Active Directory Domains and Trusts
mycorp.com
Active Directory Domains and Trusts
Change Operations Master
Change...
Close

The domain naming operations master ensures that domain names are unique. Only one domain controller in the enterprise performs this role.

Domain naming operations master:

dc1.mycorp.com

To transfer the domain naming master role to the following computer, click Change.

dc2.emea.mycorp.com

When a FSMO role owner goes down and cannot be brought back online, you no longer can transfer the r you instead have to "seize" it. And, unfortunately, you cannot seize FSMO roles using the Active Director snap-ins as you can to transfer them. To seize a FSMO role, you need to use the *ntdsutil* utility that we u earlier to do restores. We will now walk through the *ntdsutil* commands that are used to seize a FSMO rol Note that due to the width of the output, some of the text wraps to the following line.

We first start off by getting into the *ntdsutil* interactive mode and looking at the options for the `roles` command:

```
C:\> ntdsutil
ntdsutil: roles
fsmo maintenance: ?
 ?                              - Show this help information
 Connections                    - Connect to a specific domain controller
 Help                           - Show this help information
 Quit                           - Return to the prior menu
 Seize domain naming master     - Overwrite domain role on connected server
 Seize infrastructure master    - Overwrite infrastructure role on connected server
 Seize PDC                      - Overwrite PDC role on connected server
 Seize RID master               - Overwrite RID role on connected server
 Seize schema master            - Overwrite schema role on connected server
 Select operation target        - Select sites, servers, domains, roles and
                                  naming contexts
 Transfer domain naming master - Make connected server the domain naming master
 Transfer infrastructure master - Make connected server the infrastructure master
 Transfer PDC                   - Make connected server the PDC
 Transfer RID master            - Make connected server the RID master
 Transfer schema master         - Make connected server the schema master
```

We must now connect to the domain controller to which we want to seize the role. In this case, we will connect to DC1.

```
fsmo maintenance: connections
server connections: connect to server dc1
Binding to dc1 ...
Connected to dc1 using credentials of locally logged on user.
server connections: quit
```

At this point, we can transfer and seize any available FSMO role to the DC1 domain controller. In the next example, we will attempt to seize the Schema Master. The current Schema Master is DC2. If we tried to perform a seizure and DC2 was operational, we would effectively do a graceful transfer of the role to DC1 DC2 is not available then, a seizure will take place, as shown in the following output (note that some lines may wrap due to their length):

```
fsmo maintenance: seize schema master
Attempting safe transfer of schema FSMO before seizure.
 ldap_modify_sW error 0x34(52 (Unavailable).
 Ldap extended error message is 000020AF: SvcErr: DSID-03210300, problem 5002
(UNAVAILABLE), data 1753

 Win32 error returned is 0x20af(The requested FSMO operation failed. The currentFS
holder could not be contacted.)
)
Depending on the error code this may indicate a connection,
ldap, or role transfer error.
Transfer of schema FSMO failed, proceeding with seizure ...
Server "dc1" knows about 5 roles
Schema - CN=NTDS
  Settings,CN=DC1,CN=Servers,CN=RTP,CN=Sites,CN=Configuration,DC=mycorp,DC=com
 Domain - CN=NTDS Settings,CN=DC1,CN=Servers,CN=RTP,CN=Configuration, DC=mycorp,DC
 PDC - CN=NTDS Settings,CN=DC1,CN=Servers,CN=RTP,CN=Sites,CN=Configuration,
DC=mycorp,DC=com
 RID - CN=NTDS Settings,CN=DC1,CN=Servers,CN=RTP,CN=Sites,CN=Configuration,
DC=mycorp,DC=com
 Infrastructure - CN=NTDS Settings,CN=DC1,CN=Servers,CN=RTP,CN=Sites,CN=Configurat
DC=mycorp,DC=com
```

Note that a connection is first attempted to the current role owner, and if it cannot be reached, *ntdsutil* d the seizure.

One of the nice features of the quirky *ntdsutil* command is that it can be run in interactive mode as we ju showed, or it can be run from a single command line. To accomplish the same seizure using a single command line, the command would look as follows:

```
C:\> ntdsutil roles conn "co to ser dc1" q "seize schema master" q q
```

Depending on your needs, you could write a batch script pretty easily to prompt for the role you want to seize and the DC to transfer or seize the role to. This could help when it gets down to crunch time, you n to seize the role quickly, and you do not want to thumb through this book trying to find all of the commar

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13.5. DIT Maintenance

On a periodic basis, at least a couple of times a year, you should check the health of the DIT file (*ntds.dit* on your domain controllers. Using the *ntdsutil* utility, you can check the integrity and semantics of the Active Directory database and reclaim white space, which can dramatically reduce the size of the DIT. Also, just as you should rotate the password for the Administrator accounts in the forest, you should also change the DS Restore Mode Administrator password as well. You may even need to do this more frequently depending on whether you have people leave your team that should no longer know the password.

Unfortunately, to accomplish all these tasksexcept changing the DS Restore Mode Administrator passwordyou have to boot the domain controller into DS Restore Mode. That means you will have to hav schedule downtime for the machine. Also, to use DS Restore Mode, you need console access either through being physically at the machine or with out-of-band access, such as with Compaq's Remote Insight Lights Out Board (RILOE) . There is one other option using Terminal Services. You can modify the *boot.ini* file on the domain controller to automatically start up in DS Restore Mode. You can then use a Terminal Services connection to log in to the machine. For more information, check out MS Knowledge Base article 256588 from http://support.microsoft.com .

13.5.1. Checking the Integrity of the DIT

There are several checks you can perform against the DIT file to determine whether it is healthy. The firs we'll show checks the integrity of the DIT file. The integrity check inspects the database at a low level to determine whether there is any binary corruption. It scans the entire file, so depending on the size of you DIT file, it can take a while to complete. We've seen some estimates that state it can check around 2 gigabytes per hour, so allocate your change notification accordingly.

> Before running any integrity checks, be sure you have at least two successful backups of the system.

To start the integrity check, run the *ntdsutil* command from within DS Restore Mode. The `integrity` subcommand can be found within the `files` menu:

```
C:\> ntdsutil
ntdsutil: files
file maintenance: integrity
Opening database [Current].
 Executing Command: C:\WINDOWS\system32\esentutl.exe /g"C:\WINDOWS\NTDS\ntds.dit" /
Initiating INTEGRITY mode...
        Database: C:\WINDOWS\NTDS\ntds.dit
   Temp. Database: TEMPINTEG1752.EDB
Checking database integrity.
                     Scanning Status (% complete)
```

```
          0    10   20   30   40   50   60   70   80   90  100
          |----|----|----|----|----|----|----|----|----|----|
          ..................................................
Integrity check successful.
Operation completed successfully in 11.766 seconds.
Spawned Process Exit code 0x0(0)
If integrity was successful, it is recommended
 you run semantic database analysis to ensure
 semantic database consistency as well.
file maintenance: quit
```

The integrity check looks at the database headers to make sure they are correct and also checks all database tables to make sure they are working correctly. If the database integrity check fails or encounters errors, you must restore the database from backup.

If the integrity check succeeds, you should then run a semantics check. Whereas the integrity check examines the database as a whole, the semantics check will examine the database to determine whether it is healthy as it pertains to Active Directory semantics. Some of the things the semantics check looks at include security descriptors, reference counts, distinguished name tag (DNT) consistency, and deleted objects.

To start a semantics check, run the `go` subcommand from the `semantic databaseanalysis` menu:

```
ntdsutil: semantic database analysis
semantic checker: ?

 ?                              - Show this help information
 Check Quota                    - Integrity-check quota-tracking table
 Get %d                         - Get record info with given DNT
 Go                             - Start Semantic Checker with No Fixup
 Go Fixup                       - Start Semantic Checker with Fixup
 Help                           - Show this help information
 Quit                           - Return to the prior menu
 Rebuild Quota                  - Force asynchronous rebuild of quota-tracking table
 Verbose %s                     - Turn verbose mode on/off

semantic checker: go
Fixup mode is turned off
Opening database [Current].......Done.

Getting record count...3115 records
Getting security descriptor count...82 security descriptors

Writing summary into log file dsdit.dmp.0
SDs scanned:             82
Records scanned:       3115
Processing records..Done.

semantic checker: quit
```

If any errors are reported, you can then run `go fixup` , which will attempt to repair any problems.

If you have to run the `repair` or `go fixup` commands, after you boot back into normal mode, you should perform a backup as soon as possible and be sure to indicate on the backup that a repair was performed If for some reason you need to restore the domain controller at a later point, and if you restore from a backup prior to the repair, you'll need to perform the same commands to fix the database again. Alternatively, if you start experiencing problems immediately after the repair, you want to know where th last backup was before the repair occurred and restore that copy.

13.5.2. Reclaiming Space

If your domain controllers are running low on disk space, or if you have deleted a lot of objects since you promoted your domain controllers, you may want to perform an offline defragmentation of the DIT file. You've probably seen the online defragmentation events that get logged to the Directory Service Event Log . This includes event 700, which states that an online defrag is about to begin, and event 701, which states that the online defrag completed. The online defrag process by default runs twice a day and consolidates free space within the DIT file. The online defrag process does not reclaim any disk space use by the DIT file. To do that, you must perform an offline defragmentation .

An offline defragmentation must be done while the domain controller is in Directory Service Restore Mode You can then use the *ntdsutil* command to compactthat is, defragthe *ntds.dit* file. This process actually creates a copy of the *ntds.dit* file in an alternate location. You can then decide to overwrite the existing DIT file with the new compacted version.

The following shows how to perform an offline defragmentation using *ntdsutil* . After you enter the `files` menu, you'll need to issue the `compact to` *`directorypath`* command. The *`directorypath`* should be the directory the new compacted *ntds.dit* file would be created in. If the directory does not exist, it will be created automatically.

```
ntdsutil: files
file maintenance: compact to c:\windows\ntds\compact
Opening database [Current].
Creating dir: c:\windows\ntds\compact
 Executing Command: C:\WINDOWS\system32\esentutl.exe /d"C:\WINDOWS\NTDS\ntds.dit"
 /t"c:\windows\ntds\compact\ntds.dit" /p /o
Initiating DEFRAGMENTATION mode...
            Database: C:\WINDOWS\NTDS\ntds.dit
      Temp. Database: c:\windows\ntds\compact\ntds.dit
                  Defragmentation Status (% complete)
          0    10   20   30   40   50   60   70   80   90  100
          |----|----|----|----|----|----|----|----|----|----|
          ...................................................
Note:
  It is recommended that you immediately perform a full backup
  of this database. If you restore a backup made before the
  defragmentation, the database will be rolled back to the state
  it was in at the time of that backup.
Operation completed successfully in 20.961 seconds.
```

```
 Spawned Process Exit code 0x0(0)
If compaction was successful you need to:
   copy "c:\windows\ntds\compact\ntds.dit" "C:\WINDOWS\NTDS\ntds.dit"
and delete the old log files:
   del C:\WINDOWS\NTDS\*.log
file maintenance: quit
```

After you've completed the compaction, you can then decide whether you want to overwrite your current *ntds.dit* file.

Performing an offline defrag of a machine affects only that machine. To reclaim space on your other domain controllers, you'll need to follow the same procedures for all other servers.

After you do an offline defrag, you should also make sure a backup is taken soon after. If for some reaso you have to do a restore, and you have not done a backup since you did the offline defrag, the *ntds.dit* fi on the domain controller will go right back to the size it was prior to the defrag.

13.5.3. Changing the DS Restore Mode Admin Password

It is a good practice to periodically change the password for your domain Administrator accounts. This should be done so that the password does not find its way to more people than it should, and so that you don't have former administrators trying to perform tasks they shouldn't if they are no longer in the AD group.

The domain Administrator account should not be the only one you are concerned about. The DS Restore Mode Administrator account is just as important and can be used to do very damaging things, such as directly modifying the contents of the Active Directory database. For this reason, you should also periodically rotate the DS Restore Mode Administrator password.

Unfortunately, with Windows 2000 pre-Sp2, the only way to change the DS Restore Mode Administrator password was by booting into DS Restore Mode. When Windows 2000 Service Pack 2 was released, a ne utility called setpwd was released that allowed an easy way to update the password without entering DS Restore Mode. Windows Server 2003 saw the addition of a command added to the *ntdsutil* utility to allow changing the password even when a domain controller is live. The `reset password on server%s` subcommand can be used from the `set dsrm password` menu, where `%s` is the name of the server to target. Leave `%s` blank if you want to change the password on the local machine. In the following exampl we set the password for the DC1 domain controller:

```
ntdsutil: set dsrm password
 Reset DSRM Administrator Password: reset password on server dc1
Please type password for DS Restore Mode Administrator Account: **********
Please confirm new password: **********
Password has been set successfully.
Reset DSRM Administrator Password: quit
```

You cannot use *ntdsutil* to set the DS Restore Mode administrator password if the target machine is currently in DS Restore Mode.

In a large environment with many hundreds of domain controllers, the methods Microsoft made available for setting the DS Restore Mode password are still sadly lacking. A Microsoft Directory Service MVP and technical reviewer of the third edition of this book, Dean Wells of MSETechnology (http://www.msetechnology.com/), has kindly helped out with this problem. Dean wrapped a batch file around *setpwd* to allow you to easily change all passwords in a forest making a possibly enormous problem into a very simple task. You can get this batch file from http://www.mail-archive.com/activedir@mail.activedir.org/msg31869.html .

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13.6. Summary

In this chapter, we reviewed all the elements necessary to develop a disaster recovery plan. We covered how to back up Active Directory and some of the gotchas related to the tombstone lifetime and password change cycles. We then discussed the various options for restoring Active Directory, including restore by replication, authoritative restores, and nonauthoritative restores. We discussed the FSMO transfer process and what is needed to seize FSMO roles. Finally, we delved into some of the maintenance tasks that can be done with the Active Directory DIT files.

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Chapter 14. Upgrading to Windows Server 2003

The first version of Active Directory with Windows 2000 was surprisingly stable and robust. Microsoft does not have the best track record for initial releases of products, but they must be commended for Windows 2000 Active Directory in terms of its feature richness and reliability. That said, since Active Directory is such a complex and broad technology, there was still much room for improvement. There were some issues with scalability, such as the infamous 5,000-member soft limit with groups or the 300-site soft limit, which may have imposed artificial limitations on how you implemented Active Directory. Both of these issues have been resolved in Windows Server 2003. The default security setup with Windows 2000 Active Directory out-of-the-box was not as secure as it should have been. Signed LDAP traffic and other security enhancements have since been added into service packs, but they are provided by default with Windows Server 2003. Finally, manageability was another area that needed work in Active Directory, and in Windows Server 2003 numerous command-line utilities have been added, along with some significant improvements to the AD Administrative snap-ins.

We have highlighted a few key areas where Active Directory has been improved in Windows Server 2003, and we'll describe more new features in the next section. If you already have a Windows 2000 Active Directory infrastructure deployed, your next big decision will be whether and when to upgrade to Windows Server 2003. Fortunately, the transition to Windows Server 2003 is evolutionary, not revolutionary as with the migration from Windows NT to Active Directory. In fact, Microsoft's goal was to make the move to Windows Server 2003 as seamless as possible, and for the most part they have accomplished this. You can introduce Windows Server 2003 domain controllers at any rate you wish into your existing Active Directory environment; they are fully compatible with Windows 2000 domain controllers.

Before you can introduce Windows Server 2003 domain controllers, you must prepare the forest and domains with the *ADPrep* utility, which primes the forest for new features that will be available once you raise the functional level of the domain or forest. Functional levels are similar in nature to domain modes in Windows 2000 Active Directory. They allow you to configure different levels of functionality that will be available in the domain or forest based on which operating systems are running on the domain controllers.

Before we cover the upgrade process to Windows Server 2003 , we'll first discuss some of the major new features in Windows Server 2003 and some of the functionality differences with Windows 2000. Based on this information, you should be able to prioritize the importance of how quickly you should start migrating.

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14.1. New Features in Windows Server 2003

While the release of Windows Server 2003 is viewed as evolutionary, there are quite a few new features that make the upgrade attractive.

> By "feature," we mean new functionality that is not just a modification of the way it worked in Windows 2000. In this sense, a feature is something you have to use or implement explicitly. Functionality differences with Windows 2000 are covered in the next section.

We suggest you carefully review each of these features and rate them according to the following categories:

- You would use the feature immediately.
- You would use the feature eventually.
- You would never use the feature or it is not important.

Rating each feature will help you determine how much you could benefit from the upgrade. The following is the list of new features, in no particular order:

Application partitions

You can create partitions that can replicate to any domain controller in the forest.

Concurrent LDAP binds

Concurrent LDAP binds do not generate a Kerberos ticket and security token and are therefore much faster than a simple LDAP bind.

Cross-forest trust

This is a transitive trust that allows all the domains in two different forests to trust each other via a single trust defined between two forest root domains. This requires Windows Server 2003 Forest Functional mode.

Domain controller rename

The rename procedure for domain controllers requires a single reboot.

Domain rename

Domains can now be renamed, but not without significant impact to the user base (e.g., all member computers must be rebooted twice). For more information, check out the following whitepaper:

http://www.microsoft.com/windowsserver2003/downloads/domainrename.mspx

This requires Windows Server 2003 Forest Functional mode.

Dynamic auxiliary classes

There is now support for the standards-based implementation of dynamic auxiliary classes. Under Windows 2000, auxiliary classes are considered "static" because they are statically linked to structural classes in the schema. With dynamic auxiliary classes, you can link one when creating an object (or add after the creation) without it being defined in the schema as an auxiliary class for the object's objectClass. This requires Windows Server 2003 Forest Functional mode.

Dynamic objects

Traditionally, objects are stored in Active Directory until they are explicitly deleted. With dynamic objects , you can create objects that have a time to live (TTL) value that dictates when they will be automatically deleted unless refreshed. This requires Windows Server 2003 Forest Functional mode.

Install from media

A much-needed feature allows replica domain controllers to be promoted into a forest using a backup from another domain controller. This can greatly decrease the amount of time it takes to promote domain controllers in large domains.

MMC and CLI enhancements

The Active Directory Users and Computers (ADUC) tool has been enhanced to allow multi-select of objects; other tools such as *repadmin* and *netdom* have new options.

New DS CLI tools

A new set of CLI tools provides greater flexibility with managing Active Directory from a command line. These tools include *dsadd*, *dsmod*, *dsrm*, *dsget*, and *dsquery*.

New GPO settings

Over 100 new GPO settings have been added, providing greater flexibility in managing Active Directory clients.

GPO RSoP

Resultant Set of Policy (RSoP) has been built into ADUC and can be fully utilized with the Group Policy Management Console (GPMC). RSoP allows administrators to determine what settings of GPOs will be applied to end users and computers.

TLS support

With Windows 2000, only SSL was supported to encrypt traffic over the wire. TLS, the latest standards-based approach for encrypting LDAP traffic, is now also supported.

Quotas

In Windows 2000, if users had access to create objects, they could create as many as they wanted, and there was no way to limit it. Quotas allow you to define how many objects a user or group of users can create. Quotas can also dictate how many objects of a certain objectClass can be created.

Query-based groups

Used for role-based authorization, the new Authorization Manager allows you to create flexible groups based on information stored with users (e.g., department). This requires Windows Server 2003 Forest Functional mode.

Redirect users and computers

You can redirect the default location to store new users and computers with the *redirusr* and *redircmp* commands, respectively.

Schema redefine

You can defunct and then redefine attributes and classes in the schema. This requires Windows Server 2003 Forest Functional mode.

Universal Group Caching

You can eliminate the requirement to have a global catalog server present during login for Universal group expansion by enabling Universal Group Caching. This is enabled at the site level and applies to any clients that log on to domain controllers in the site. Global Catalogs are still needed for `userPrincipalName` authentications.

Last logon timestamp attribute

A classic problem in a NOS environment is trying to determine the last time a user or computer logged in. The new `lastLogonTimestamp` attribute is replicated, which means you can use a single query to find all users or computers that have not logged in within a certain period of time. By default, this attribute is updated once every seven days, but can be reduced to as often as once per day. This requires Windows Server 2003 Domain mode.

WMI filtering of GPOs

In addition to the OU, site, domain, and security group criteria that can be used to filter GPOs, you can now use WMI information on a client's machine to determine if a GPO should be applied.

WMI providers for trust and replication monitoring

These new WMI providers provide the ability to query and monitor the health of trusts and replication programmatically.

objectClass Change

You can change `user` objects to `inetOrgPerson` objects and `inetOrgPerson` objects to `user` objects. This requires Windows Server 2003 Forest Functional mode.

If you find that you would immediately use more than four or five features or eventually use four or five of them, the benefit may be great enough to warrant a near-term move to Windows Server 2003. If you don't find that you'll take advantage of many of these new features, take a look at the next section to see if you would benefit from any of the functionality differences with Windows 2000 .

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14.2. Differences with Windows 2000

Even though Active Directory was scalable enough to meet the needs of most organizations, there were some improvements to be made after several years of real-world deployment experience. Many of the functionality differences with Windows 2000 are the direct result of feedback from AD administrators.

As with the new features, we suggest you carefully review each of the differences and rate them according to the following categories:

- It would positively affect my environment to a large degree.
- It would positively affect my environment to a small degree.
- It would negatively affect my environment.

The vast majority of differences are actually improvements that translate into something positive for you, but in some situations, such as with the security-related changes, the impact may cause you additional work initially.

Single instance store

> Unique security descriptors are stored once no matter how many times they are used, as opposed to being stored separately for each instance. This alone can save upwards of 20%-40% of the space in your DIT after upgrading. Note that an offline defragmentation will have to be performed to reclaim the disk space on upgraded domain controllers.

Account Lockout enhancements

> Several bugs have been fixed that erroneously caused user lockouts in Windows 2000.

Improved event log messages

> There are several new event log messages that will aid in troubleshooting replication, DNS, FRS, etc.

Link value replication (LVR)

> Replication in Active Directory is done at the attribute level. That is, when an attribute is modified, the whole attribute is replicated. This was problematic for some attributes, such as the member attribute on group objects, which could only store roughly 5,000 members. LVR replication means that certain attributes, such as member, will only replicate the changes

within the attribute and not the contents of the whole attribute whenever it is updated. This requires Windows Server 2003 Interim mode or Windows Server 2003 Forest Functional mode.

Intrasite replication frequency changed to 15 seconds

The previous default was 5 minutes, which has now been changed to 15 seconds. This requires Windows Server 2003 Forest Functional mode.

No global catalog sync for PAS addition

With Windows Server 2003, whenever an attribute is added to the Partial Attribute Set (PAS), a global catalog sync is no longer performed as it was with Windows 2000. This was especially painful to administrators of large, globally dispersed Windows 2000 domains.

Signed LDAP traffic

Instead of sending LDAP traffic, including usernames and passwords, over the wire in plain text with tools such as ADUC and *ADSIEdit*, the traffic is signed and therefore encrypted.

ISTG and KCC scalability improvements

The algorithms used to generate the intersite connections have been greatly improved to the point where the previous soft limit of 300 to 400 sites has been raised to support roughly 3,000-5,000 sites. This new replication mechanism requires Windows Server 2003 Interim mode or Windows Server 2003 Forest Functional mode.

Faster global catalog removal

With Windows 2000, whenever you disabled the global catalog on a DC, the global catalog removal process could only remove 500 objects every 15 minutes. This has been changed so that the process is much quicker.

Distributed Link Tracking (DLT) service disabled by default

The DLT service can be the source of thousands if not millions of `linkTrackOMTEntry` objects that are nestled within the System container of a domain. By default, the DLT service is disabled on Windows Server 2003 domain controllers.

Changes with Pre-Windows 2000 Compatible Access

To enhance security, the Everyone security principal no longer means all unauthenticated and authenticated users. It instead represents only authenticated users. To grant the equivalent of anonymous access in Windows Server 2003, the Anonymous Logon account should be added to the Pre-Windows 2000 Compatible Access group.

If you find that more than two or three of these would benefit your environment significantly, and fewer than one or two would have a negative affect, that is another good indication that an upgrade to Windows Server 2003 would benefit you enough to start in the near-term. This is by no means a hard-and-fast rule, since some features or differences may be more important than others. For example, if you have over 300 or 400 sites with domain controllers, the improvements in the KCC could potentially help you out significantly. Likewise, if you see the need to add attributes to the partial attribute set in the future, and you have large geographically disperse global catalog servers, then the no global catalog sync behavior could save you some long weekends babysitting replication. You may view other features, such as the MMC enhancements, as benefit, but not to the same degree as the other two just described. You'll have to weigh the priorities of each when you are considering them.

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14.3. Functional Levels Explained

Now that you are sufficiently excited about the new features with Active Directory and improvements since Windows 2000, we will cover how you can actually enable these features in Windows Server 2003 . If you've already deployed Windows 2000 Active Directory, you are most certainly familiar with the domain mode concept. With Windows 2000 Active Directory, you had mixed- and native-mode domains. Domain mode simply dictated what operating systems were allowed to run on the domain controllers and nothing more. New features were enabled with the move to native mode, including universal security groups and enhanced group nesting to name a couple. Think of functional levels like domain modes, but taken a step further.

Windows Server 2003 functional levels are very similar to Windows 2000 domain modes from the standpoint that they dictate what operating systems can run on domain controllers, and they can only be increased or raised and never reversed. One common misunderstanding with domain modes, which hopefully will not be carried over to functional levels, is that they have virtually no impact on clients and what operating systems your clients run. For example, you can have Windows 9x clients in mixed- or native-mode Windows 2000 domains and also in domains that are at the Windows 2000 or Windows Server 2003 domain functional level.

> For information about which operating systems are allowed at the various functional levels, check out Chapter 2.

An important difference with functional levels is that they apply both to domains and at the forest level. The reason for this is that some features of Windows Server 2003 Active Directory require either that all the domain controllers in a domain are running Windows Server 2003 or that all the domain controllers in the entire forest are running Windows Server 2003.

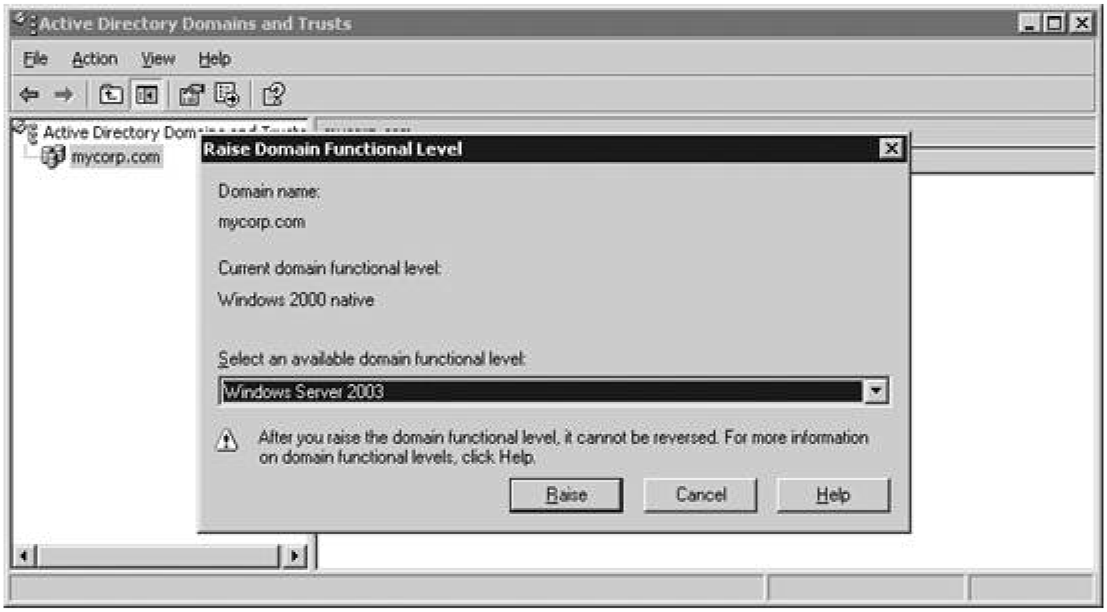
To illustrate why this is necessary, let's look at two examples. First, let's look at the new "Last logon timestamp attribute" feature. With this feature, a new attribute called `lastLogonTimestamp` is populated when a user or computer logs on to a domain, and it is replicated to all the domain controllers in a domain. This attribute provides an easier way to identify whether a user or computer has logged on recently than using the `lastLogon` attribute, which is not replicated and therefore must be queried on every domain controller in the domain. For `lastLogonTimestamp` to be of use, all domain controllers in the domain need to know to update it when they receive a logon request from a user or computer. Domain controllers from other domains only need to worry about the objects within their domain, so for this reason this feature has a domain scope. Windows 2000 domain controllers do not know about `lastLogonTimestamp` and do not update it. Therefore, for that attribute to be truly useful, all domain controllers in the domain must be running Windows Server 2003. All the domain controllers must know that all the other domain controllers are running Windows Server 2003, and they can do this by querying the functional level for the domain. Once they discover the domain is at a certain functional level, they start utilizing features specific to that function level.

Likewise, there are times when all domain controllers in the forest must be running Windows Server 2003 before a certain feature can be used. A good example is with the replication improvements. If some of the ISTGs were using the old site topology algorithms and others were using the new ones, you could have replication chaos. All domain controllers in the forest need to be running Windows Server 2003 before the new algorithms are enabled. Until then, they will revert to the Windows 2000 algorithms.

14.3.1. How to Raise the Functional Level

To raise the functional level of a domain or forest, you can use the Active Directory Domains and Trusts MMC snap-in. To raise the functional level of a domain, open the snap-in, browse to the domain you want to raise, right-click on it in the left pane, and select Raise Domain Functional Level.... You will then see a screen similar to that in Figure 14-1.

Figure 14-1. Raising the domain functional level


Active Directory Domains and Trusts
File
Action
View
Help
Active Directory Dom
mycorp.com
Raise Domain Functional Level
Raise
Cancel
Help

Domain name:
mycorp.com

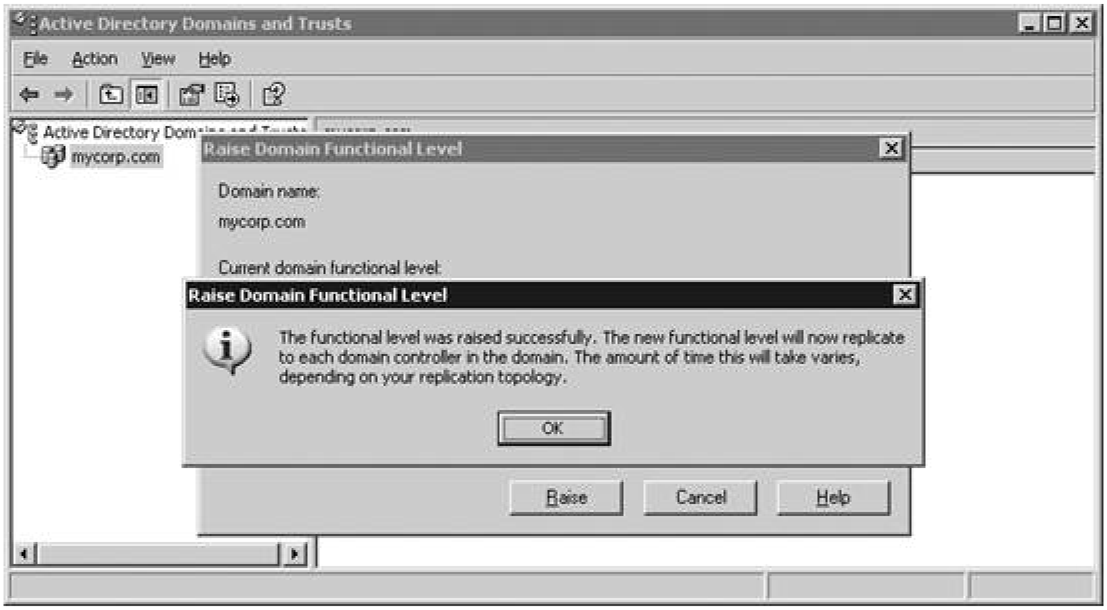
Current domain functional level:
Windows 2000 native

Select an available domain functional level:
Windows Server 2003

After you raise the domain functional level, it cannot be reversed. For more information on domain functional levels, click Help.

Select the new functional level and click the Raise button. You will then get a confirmation that it was successful or an error stating why it couldn't be raised. Figure 14-2 shows the message returned after successfully raising the functional level. Follow the same procedure to raise the functional level of a forest, but right-click on Active Directory Domains and Trusts in the left pane and select Raise Forest Functional Level....

Figure 14-2. The result of raising the domain functional level



Raise Domain Functional Level

Domain name:

mycorp.com

Current domain functional level:

Raise Domain Functional Level

The functional level was raised successfully. The new functional level will now replicate to each domain controller in the domain. The amount of time this will take varies, depending on your replication topology.

OK

You can determine the functional level of a domain or forest two other ways. First, you can look at the `msDS-Behavior-Version` attribute on the Domain Naming Context (e.g., `dc=mycorp,dc=com`) for domains or the Partitions container in the Configuration Naming Context (e.g., `cn=partitions,cn=configuration,dc=mycorp,dc=com`) for the forest. A value of 0 indicates Windows 2000 functional level, 1 indicates Windows Interim functional level, and 2 indicates Windows Server 2003 functional level.

Alternatively, you can view this information by simply looking at the RootDSE for a domain controller. On Windows Server 2003 domain controllers, the RootDSE contains two new attributes that describe the current functional level:

domainFunctionality

This value mirrors the `msDS-Behavior-Version` value on the Domain Naming Context.

forestFunctionality

This value mirrors the `msDS-Behavior-Version` value on the Partitions container.

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14.4. Preparing for ADPrep

Before you can start enabling functional levels, you have to go through the process of upgrading your existing infrastructure to Windows Server 2003. The first step before you can promote your first Windows Server 2003 domain controller is to prepare the forest with the *ADPrep* utility.

If you've installed Exchange 2000 into your Active Directory forest, you are undoubtedly familiar with the Exchange `setup.exe/forestprep` and `/domainprep` switches. These switches are run independently from the Exchange server install to allow Active Directory administrators to take care of the AD-related tasks necessary to support Exchange. The Exchange `/forestprep` command extends the schema and adds some objects in the Configuration Naming Context. The Exchange `/domainprep` command adds objects within the Domain Naming Context of the domain it is being run on and sets some ACLs. The *ADPrep* command follows the same logic and performs similar tasks to prepare for the upgrade to Windows Server 2003.

> Microsoft recommends that you have at least Windows 2000 Service Pack (SP) 2 installed on your domain controllers before running ADPrep. SP 2 fixed a critical internal AD bug, which can manifest itself when extending the schema. There were also some fixes to improve the replication delay that can be seen when indexing attributes. If you plan on supporting a mixed Windows 2000 and Windows Server 2003 environment for an extended period of time, Microsoft recommends that you have at least SP 3 on your Windows 2000 domain controllers.
>
> For more information on the Microsoft recommendations, check out Microsoft Knowledge Base Article 331161 at http://support.microsoft.com.

The *ADPrep* command can be found in the *\i386* directory on the Windows Server 2003 CD. The *ADPrep* command depends on several files in that directory so it cannot simply be copied out and put on a floppy or CD by itself. To run the ForestPrep, you would execute the following:

```
X:\i386\adprep /forestprep
```

where *X*: is a CD drive or mapped drive to a network share containing the Windows Server 2003 SP1 CD. Similarly, to run DomainPrep, you would execute the following:

```
X:\i386\adprep /domainprep
```

You can view detailed output of the *ADPrep* command by looking at the log files in the *%SystemRoot%\system32\debug\adprep\logs* directory. Each time *ADPrep* is executed, a new log file is generated that contains the actions taken during that particular invocation. The log files are named based on the time and date *ADPrep* was run.

Now we will review what ForestPrep and DomainPrep do.

14.4.1. ForestPrep

The *ADPrep*`/forestprep` command extends the schema with quite a few new classes and attributes. These new schema objects are necessary for the new features supported by Windows Server 2003. You can view the schema extensions by looking at the *.ldf* files in the *\i386* directory on the Windows Server 2003 SP1 CD. These files contain LDIF entries for adding and modifying new and existing classes and attributes.

> Microsoft warns against manually extending the schema with the *ADPrep* LDIF files. You should instead let *ADPrep* do it for you.

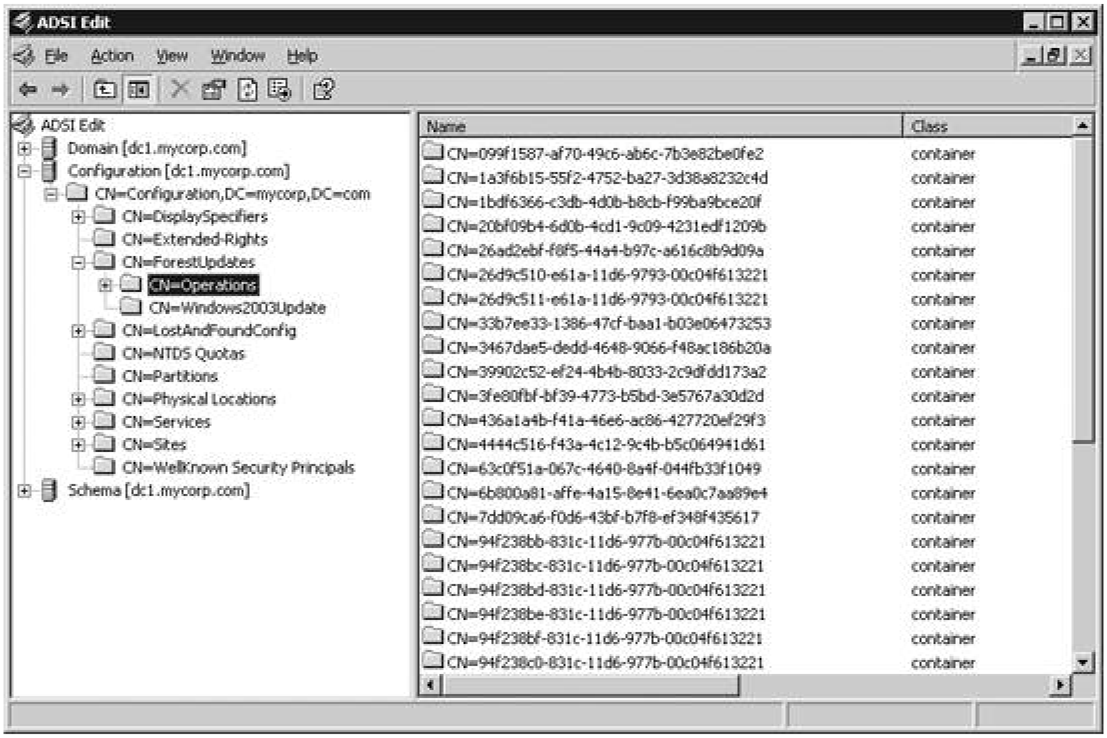
ForestPrep hardens some default security descriptors and modifies some of the ACLs on the containers in the Configuration NC. New `displaySpecifier` objects are added and some existing ones modified to support new features within the Active Directory Administrative snap-ins. A NTDS Quotas container is added at the root of the Configuration container. This is a new container that hosts the quota objects that dictate how many objects a user or group of users can add within a container or OU.

One of the clever aspects of *ADPrep* is that it stores its progress in Active Directory. This is very neat because it can gracefully recover from failures halfway through execution. It also provides a quick way to determine whether all of the necessary operations have completed and whether *ADPrep* was successful. Another benefit of storing the operations in Active Directory is in case you encounter problems and need to call Microsoft Product Support Services (PSS) . You can look at this container and list out all of the operations that have been successful. PSS would then be able to look up which operation is failing.

A ForestUpdates container is created directly under the Configuration container. Within the ForestUpdates container are two other containers, one called Operations and the other called Windows2003Update . The Operations container contains additional containers, each one representing a certain task that *ADPrep* completed. For example, one operation might be to create new `displaySpecifier` objects. The operation container names are GUIDs, and the objects themselves do not contain any information that would be of interest. There should be a total of 36 of these operation containers after ForestPrep completes.

The other object within the ForestUpdates container is called Windows2003Update. This object is created after *ADPrep* finishes. If that object exists, it signifies that *ADPrep* completed ForestPrep successfully. If you are interested to find out when ForestPrep completed in a forest, simply look at the `whenCreated` attribute on the Windows2003Update object . Figure 14-3 shows what these containers look like with the ADSI Edit snap-in from the Windows Support Tools.

Figure 14-3. ADPrep forest update operations



Name	Class
CN=099f1587-af70-49c6-ab6c-7b3e82be0fe2	container
CN=1a3f6b15-55f2-4752-ba27-3d38a8232c4d	container
CN=1bdf6366-c3db-4d0b-b8cb-f99ba9bce20f	container
CN=20bf09b4-6d0b-4cd1-9c09-4231edf1209b	container
CN=26ad2ebf-f8f5-44a4-b97c-a616c8b9d09a	container
CN=26d9c510-e61a-11d6-9793-00c04f613221	container
CN=26d9c511-e61a-11d6-9793-00c04f613221	container
CN=33b7ee33-1386-47cf-baa1-b03e06473253	container
CN=3467dae5-dedd-4648-9066-f48ac186b20a	container
CN=39902c52-ef24-4b4b-8033-2c9dfdd173a2	container
CN=3fe80fbf-bf39-4773-b5bd-3e5767a30d2d	container
CN=436a1a4b-f41a-46e6-ac86-427720ef29f3	container
CN=4444c516-f43a-4c12-9c4b-b5c064941d61	container
CN=63c0f51a-067c-4640-8a4f-044fb33f1049	container
CN=6b800a81-affe-4a15-8e41-6ea0c7aa89e4	container
CN=7dd09ca6-f0d6-43bf-b7f8-ef348f435617	container
CN=94f238bb-831c-11d6-977b-00c04f613221	container
CN=94f238bc-831c-11d6-977b-00c04f613221	container
CN=94f238bd-831c-11d6-977b-00c04f613221	container
CN=94f238be-831c-11d6-977b-00c04f613221	container
CN=94f238bf-831c-11d6-977b-00c04f613221	container
CN=94f238c0-831c-11d6-977b-00c04f613221	container

You only need to execute ForestPrep once. You can run it multiple times, but due to the fact that it keeps track of its progress in Active Directory under the ForestUpdates container, it will only do something if it determines that an operation did not complete previously.

Because the schema is extended and objects are added in several places in the Configuration NC, the user running ForestPrep must be a member of both the Schema Admins and Enterprise Admins groups. In addition, you should run the command directly on the Schema Master for the forest. Importing the schema extensions is fairly resource-intensive, which is why it is necessary to run it from the Schema Master. Also, if you have large domains containing a lot of objects, ForestPrep may take a while to complete. ForestPrep indexes several attributes, which requires a lot of processing while it updates the AD database.

14.4.2. DomainPrep

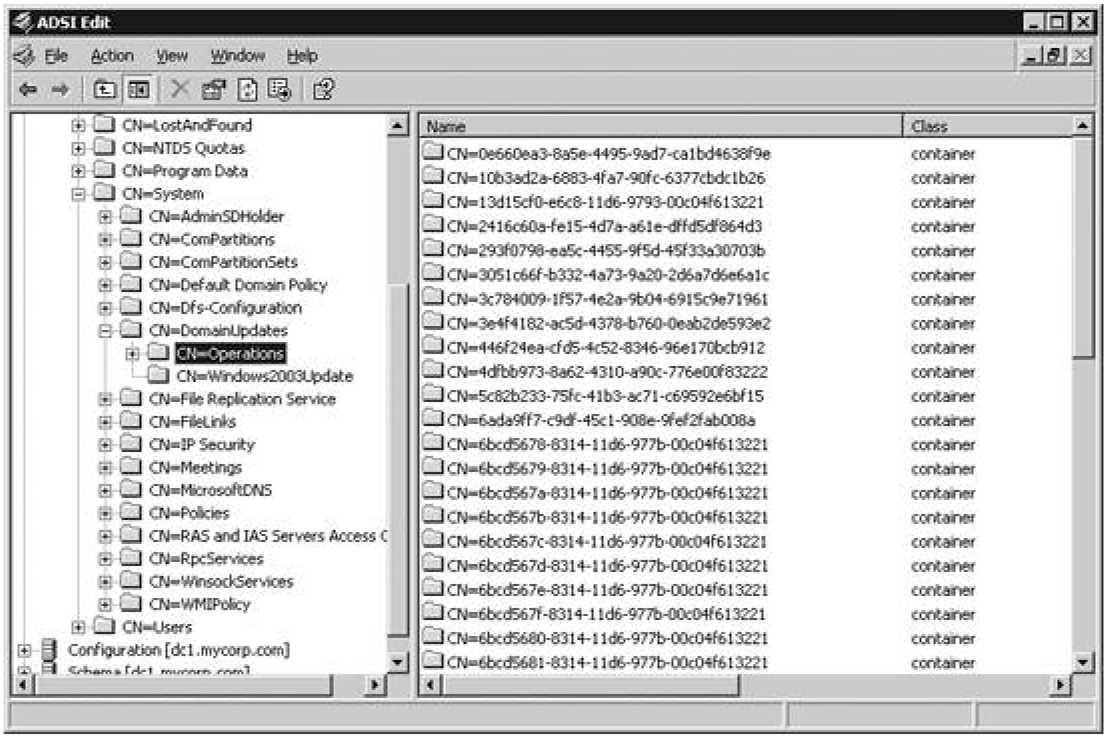
Before you can run *ADPrep*/domainprep, you must be sure that the updates from ForestPrep have replicated to all domain controllers in the forest. DomainPrep must be run on the Infrastructure Master of a domain and under the credentials of someone in the Domain Admins group. If you try to run DomainPrep before ForestPrep has been run or before it has replicated all its changes out, you will get an error message. Again, if you are unsure about the error, check the ADPrep logs in the *%SystemRoot%\system32\debug\adprep\logs* directory for more information.

DomainPrep creates new containers and objects, modifies ACLs on some objects, and changes the meaning of the Everyone security principal.

Unlike the ForestPrep command, which was fairly resource-intensive, DomainPrep completes quickly. The changes in comparison to ForestPrep are relatively minor. Two new top-level containers are created, one called `NTDS Quotas`, just like what ForestPrep added in the Configuration container, and another container called `Program Data`. This is intended to be a starting point for applications to store their data instead of each vendor coming up with their own top-level OU structure.

Just like with ForestPrep, DomainPrep stores the status of its completion in Active Directory. Under the System container, a `DomainUpdates` container is created. Within that container, two other containers are created, called `Operations` and `Windows2003Update`. The same principles apply here as did for ForestPrep. Each of the operations that DomainPrep performs is stored as an individual object within the Operations container. For DomainPrep, there are 52 operations. After all the operations complete, the Windows2003Update object is written, which indicates DomainPrep has completed. Figure 14-4 shows an example of what this container structure looks like using ADSI Edit.

Figure 14-4. ADPrep domain update operations



Name	Class
CN=0e660ea3-8a5e-4495-9ad7-ca1bd4638f9e	container
CN=10b3ad2a-6883-4fa7-90fc-6377cbdc1b26	container
CN=13d15cf0-e6c8-11d6-9793-00c04f613221	container
CN=2416c60a-fe15-4d7a-a61e-dffd5df864d3	container
CN=293f0798-ea5c-4455-9f5d-45f33a30703b	container
CN=3051c66f-b332-4a73-9a20-2d6a7d6e6a1c	container
CN=3c784009-1f57-4e2a-9b04-6915c9e71961	container
CN=3e4f4182-ac5d-4378-b760-0eab2de593e2	container
CN=446f24ea-cfd5-4c52-8346-96e170bcb912	container
CN=4dfbb973-8a62-4310-a90c-776e00f83222	container
CN=5c82b233-75fc-41b3-ac71-c69592e6bf15	container
CN=6ada9ff7-c9df-45c1-908e-9fef2fab008a	container
CN=6bcd5678-8314-11d6-977b-00c04f613221	container
CN=6bcd5679-8314-11d6-977b-00c04f613221	container
CN=6bcd567a-8314-11d6-977b-00c04f613221	container
CN=6bcd567b-8314-11d6-977b-00c04f613221	container
CN=6bcd567c-8314-11d6-977b-00c04f613221	container
CN=6bcd567d-8314-11d6-977b-00c04f613221	container
CN=6bcd567e-8314-11d6-977b-00c04f613221	container
CN=6bcd567f-8314-11d6-977b-00c04f613221	container
CN=6bcd5680-8314-11d6-977b-00c04f613221	container
CN=6bcd5681-8314-11d6-977b-00c04f613221	container

Once you've run both ForestPrep and DomainPrep and allowed time for the changes to replicate to all domain controllers , you can then start upgrading your domain controllers to Windows Server 2003 or installing new Windows Server 2003 domain controllers.

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14.5. Upgrade Process

The upgrade process to Windows Server 2003 should be straightforward for most deployments. No forest restructuring is required, no user profile or workstation changes are necessary assuming you are running the latest service pack and hotfixes, and there should be no need for political turf battles over namespace usage and ownership like there might have been with your initial Active Directory deployment.

We are going to outline five high-level steps that you should follow to upgrade to Windows Server 2003. They include performing an inventory of your domain controllers and clients to determine if there will be any compatibility showstoppers. You are then ready to do a trial run and perform extensive testing to see what impact the upgrade may have on functionality. Next, you have to prepare your forest and domains with *ADPrep*, which we've already discussed in some depth. Finally, you'll upgrade your domain controllers to Windows Server 2003. In the Post-Upgrade Tasks section of this chapter, we will describe what to do after you've upgraded your domain controllers as far as monitoring, raising functional levels, and taking advantage of new features goes.

> Prior to running your *adprep* process, fully read and understand Microsoft Knowledge Base Article 555040. It details all of the known issues with the *adprep* process. Also review 309628, which details the operations *adprep* performs.

14.5.1. Inventory Domain Controllers

A good first step before you start the upgrade process is to do a complete inventory of all the hardware and software that is on your domain controllers. You'll then want to contact your vendors to determine whether they've already done compatibility testing and can verify support for Windows Server 2003. The last thing you want to do is start the upgrade process and find out halfway through that a critical monitoring application or backup software that runs on your domain controllers does not work correctly. Much of this testing can be done in your own labs, but it is always good to check with the vendors and get their seal of approval. After all, if a problem does arise, you'll want to make sure they are supporting the new platform and won't push back on you.

Next you'll want to ensure you have all the necessary hotfixes and service packs installed. A good overview of Microsoft's recommendations is documented in Microsoft Knowledge Base Article 331161. What you need to install depends on how long you plan on having your Windows 2000 domain controllers around. If you plan on a quick upgrade, you'll only need to do the minimal amount of patching required. But if you are going to have a prolonged migration, you should consider applying all the current fixes and service packs.

After you are sure that your hardware and software is fully up to date and will work under Windows Server 2003, you'll then want to do a very thorough check of your current domain controllers and make sure they are running without error. Go through the event logs and resolve any errors and warnings that may be occurring. The *dcdiag* and *netdiag* commands are useful for identifying potentia issues. Also, if you don't already trend CPU and memory statistics, you'll need to start. The reason for collecting all this data is that if problems occur after the upgrade to Windows Server 2003, you'll want to narrow it down to whether it was previously a problem or if it is new, most likely as a result of the upgrade. If you don't collect this data, you are setting yourself up for trouble.

A good compatibility test is to run the /`checkupgradeonly` switch with the Windows Server 2003 installer (*winnt32.exe*):

```
X:\> i386\winnt32.exe /checkupgradeonly
```

This command will go through the steps as if you were upgrading, but it will check only the applications you have installed and the status of the forest. If you have not run *ADPrep* yet, it will return an error about that.

At this point, you'll also want to check the status of your backups. Before you run *ADPrep*, you should have successful backups for at least two domain controllers in every forest and every FSMO role owner. You should also ensure that your disaster recovery procedures are well documented and have been tested.

14.5.2. Inventory Clients

The good news as far as clients go is that there aren't a lot of requirements for them to work in a Windows Server 2003 forest. In fact, there are no changes required for Windows XP and Windows 2000 machines. For NT 4.0 clients, you should have at least Service Pack 3, and Microsoft recommends Service Pack 6a. For Windows 98 and Windows 95 clients, they will need the DS Client installed as described in Microsoft Knowledge Base Article 323466 or to have their OS upgraded to Windows 2000 or later (not a bad idea anyway, if you can get away with it).

Other than that, your clients are fine as is. That said, any wise AD administrator would make sure the clients are thoroughly tested before starting the upgrade. Especially with a new version of Active Directory, there are undoubtedly issues that have yet to be discovered, and you don't want to be the first to find them after you've already upgraded!

14.5.3. Trial Run

Although we can go on all day about how easy the upgrade process is, the proof is in the proverbial pudding. We consider it a mandatory step that before you upgrade your first production domain controller to Windows Server 2003, you go through extensive testing in a "production-like" Active Directory forest. So what do we mean by "production-like?" That depends on how much time and resources you have. Perhaps the best way to simulate your production environment is to actually take a production domain controller from each domain in the forest off the network and put it on a private network. You can then build up the forest on the private network, and all the data that is in production is now in the test environment you just set up. Before we go any further, we want to make it clear that this is the most painstaking option for building a test network, because Active Directory does not self-heal after you put the domain controller on the private network. In fact, you may encounter problems getting the DC to work at all since it cannot initially contact any of the FSMO masters. Microsoft has stated that they'd like to make this process easier and even suggested they may document how to do it, but at the time of publication of this book, nothing of the sort was available. Your other alternative is to populate the test forest with as much of the data from production as possible. If you already have provisioning scripts or a metadirectory that feeds your production Active Directory environment, you may be able to utilize a similar process to populate the test forest.

Once you have a test forest that simulates production up and running, you should add as many clients as possible that represent your users and the various operating systems you support. If you are running Exchange 2000, you should also install it, along with any other directory-enabled applications. Sound tedious? It is necessary to cover your bases no matter how trivial Microsoft says the upgrade will be. The last thing you want to happen is a major blow-up and then having to explain to your CIO that you didn't do very extensive testing because Microsoft said the upgrade was easy.

The key with the trial run is to document everything thoroughly. If you see anomalies, be sure to document them and follow up to determine whether it is going to be a problem. By the time you are done with the trial-run period, you should have an end-to-end document that describes how you are going to upgrade, how long you plan to wait before you raise functional levels, and in what priority you are going to enable new features.

14.5.4. Prepare the Forest and Domains

As we outlined earlier, before you can promote the first Windows Server 2003 domain controller into your forest, you have to run the *ADPrep* command. After you've done the DC and client inventories and determined there are no showstoppers to moving forward, you should run *ADPrep*.

First, you must run *ADPrep*`/forestprep`, and after the changes have replicated throughout the forest, you need to run *ADPrep* /`domainprep` in every domain. Pretty easy, right? There are a couple of gotchas to be aware of with the schema.

14.5.4.1. Exchange 2000

If you've installed Exchange 2000 into the forest before running ADPrep, you have to correct some mistakes that were made in the Exchange 2000 schema extensions. Specifically, both *ADPrep* and Exchange 2000 define `labledURI`, `houseIdentifier`, and `secretary` attributes, but Exchange 2000 does not use the correct LDAP display names (`lDAPDisplayName`) as defined in RFC 2798. If you run *ADPrep* after Exchange 2000 has been installed without fixing these attributes, you can end up with duplicate schema objects with different `lDAPDisplayName` attributes. To solve the problem, you must run the *inetorgpersonfix.ldf* file that is located in *\support\tools\support.cab*. This LDIF file fixes the `lDAPDisplayName` attributes of the three attributes.

First, save the *inetorgpersonfix.ldf* file, then import it using the *ldifde* utility. Here is an example where we will be importing into the *mycorp.com* forest:

```
ldifde.exe /i /f inetOrgPersonFix.ldf /c "DC=X" "DC=mycorp,DC=com"
```

Note that *inetorgpersonfix.ldf* uses DC=X as the forest path, which is why we needed to use the /c switch to replace it with our own forest path.

14.5.4.2. SFU 2.0

If you've installed Microsoft Services For UNIX (SFU) 2.0 in your Windows 2000 forest, you can run across a similar to issue as the one just described with Exchange 2000. The problem again comes back to an incorrectly defined attribute. In this case, it is the uid attribute. Microsoft has developed a hotfix for this issue, which is described in Microsoft Knowledge Base Article 293783.

> This applies only to SFU 2.0. If you are running SFU 3.0, you will not encounter this problem.

14.5.5. Upgrade Domain Controllers

Now comes the easy part. You may be wondering how we could possibly say that doing the upgrade is the easy part. Perhaps we should preface it with this: if you've done all your homework, this will be the easy part. All of the hard work comes from doing the DC and client inventory, checking for compatibility issues, monitoring, checking event logs, getting a representative baseline, performing mock upgrades, etc. By the time you get the point of actually doing the upgrades in production, it should be second nature to you.

You can proceed with the upgrade process as slowly or as quickly as you want. Windows Server 2003 domain controllers are fully compatible with Windows 2000 domain controllers. They can also serve any role in a forest, including acting as a global catalog server, any FSMO master, ISTG, or Bridgehead server.

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14.6. Post-Upgrade Tasks

After you've upgraded one or more of your domain controllers to Windows Server 2003, you need to do some additional tasks to fully complete the migration. First and foremost, you need to monitor the domain controllers every step of the way and especially after they have been upgraded. You are setting yourself up for failure if you are not adequately monitoring Active Directory.

14.6.1. Monitor

The criticality of monitoring cannot be overstated. If you are not monitoring, how can you determine whether something broke during the upgrade? Here are several things you should check after you upgrade your first domain controller in a domain, any FSMO role owner, and after all DCs have been upgraded:

Responds to all services

Query LDAP, Kerberos, GC (if applicable), and DNS (if applicable) and be sure authentication and login requests are being processed. The *dcdiag* command can run many of these tests.

Processor and memory utilization

Trend processor and memory utilization for some period before you do the upgrade so you can compare to the numbers after the upgrade.

DIT growth

The growth of the DIT should not be significant. You may in fact want to do an offline defrag after the upgrade to reclaim any space due to single-instance store of ACLs.

Event logs

This is a no-brainer, but you should always check the event logs to see whether any errors are being logged.

DC resource records registered

Ensure that all of the SRV, CNAME, and A records for the domain controllers are registered. The *dcdiag* command can perform these checks.

Replication is working

Run `repadmin /showreps` and `repadmin /replsum` and watch for anything out of the ordinary.

Group policies are being applied

You may want to add a new setting to an existing GPO or create a new GPO and see if the settings apply on a client that should be receiving it.

NETLOGON and SYSVOL shares exist

This can consist of opening an Explorer window and browsing the available shares on the domain controller.

FRS is replicating correctly

You can test this out by placing a test file in the SYSVOL share on a domain controller and waiting for it to replicate to the other domain controllers.

This is not a comprehensive list of everything you should possibly monitor, but it is a good start. If everything checks out over a period of a week, you can feel pretty comfortable that the upgrade was successful. If nothing else, as long as you keep a close eye on the event logs, you should be able to catch the majority of problems.

14.6.2. Raise Functional Levels

After you feel comfortable that the upgrades have completed successfully, your next step should be to start raising the functional levels. If you've only upgraded the domain controllers in a single domain, you can raise the functional level for only that domain to Windows Server 2003. If you've upgraded all the domain controllers in the forest, you can also proceed to upgrade the forest functional level to Windows Server 2003.

> If you want to err on the side of caution, and you support multiple domains, you may want to raise the functional level of a single domain and repeat the monitoring steps over a week before raising the forest functional level.

After you raise the functional level of a domain or forest, you should add some additional steps to what you monitor to include testing out new features in Windows Server 2003. For example, to test the Windows Server 2003 domain functional level, you should log on to a domain controller and view the `lastLogonTimestamp` attribute of your user object that we discussed earlier in the chapter. This is a new replicated attribute that will contain your logon time. If after a period of time, you don't see that attribute getting populated, you'll need to dig deeper to determine what is going on.

Perhaps the easiest test to determine whether a functional level has been set for a domain or forest is to query the Root DSE and look at the `domainFunctionality` and `forestFunctionality` attributes. A value of 2 indicates the domain or forest is at the Windows Server 2003 functional level.

14.6.3. Tweak Settings

Once the functional levels have been defined, you'll want to tweak any settings that you discovered during your testing that are set differently than what you want or what you have configured previously. Of special interest should be the settings related to security and account lockout. If you need to disable SMB Signing, you can do so via Group Policy in the Domain Controller Policy → Windows Settings → Security Settings → Local Policies → Security Options → Digitally Sign Communications.

A common pain point for Windows 2000 Active Directory administrators was account lockouts. All of the bug fixes that were incorporated into Service Packs 2 and 3 are included in Windows Server 2003 . You may want to revisit your account lockout and password expiration settings. Microsoft's recommendations are included in their Security Template file located at *%SystemRoot%\security\templates\SECUREDC.INF* on a Windows Server 2003 domain controller.

If you had to hardcode any settings on domain controllers in the Registry, you should reevaluate those settings to see whether you still need them. For example, many people increased the intrasite replication frequency from 5 minutes to 15-60 seconds. With Windows Server 2003, the default frequency has changed to 15 seconds.

14.6.4. Start Implementing New Features

After you've upgraded your domain controllers and raised the functional level of a domain or forest, you are ready to start taking advantage of the new features. Some of them, such as the MMC and CLI enhancements, you can start utilizing immediately. With others, such as quotas, you'll want to think out exactly how to implement them and have them properly documented and communicated before you start using them. If you are using AD-integrated DNS zones, you should look at converting to application partitions to store DNS data. This is a fairly easy conversion that can be done with the DNS MMC snap-in. In some cases, you may need to completely rethink your current processes. For example, if you start using the "Install from media" feature, you may change how you build and deploy domain controllers.

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14.7. Summary

In this chapter, we covered the new features in Windows Server 2003 and some of the differences with Windows 2000, most of which were instigated by real-world deployment issues. We then went over how you can enable new features with the use of functional levels and why they are necessary. Next we discussed the *ADPrep* process and how that must be done before the first Windows Server 2003 domain controller can be promoted. Once you have your forest and domains prepared, you can start the upgrade process. We described some of the important issues to be aware of when upgrading, and finally what to do after you've completed the upgrade.

Although this chapter focused mainly on upgrading from an existing Windows 2000 Active Directory infrastructure, in Chapter 16 we discuss some of the key issues with migrating from Windows NT straight to Windows Server 2003 Active Directory.

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Chapter 15. Upgrading to Windows Server 2003 R2

Windows Server 2003 has been available to the public since March 2003. Since its release, Microsoft has also released several feature packs that add additional functionality to the base operating system, and there has also been a substantial update in the form of Service Pack 1. Because the release dates for the next major update of Windows Server have been pushed further and further out, and for a number of other reasons, Microsoft decided to release a new version of Windows Server 2003 called R2. This is the gold version of Windows Server 2003 with Service Pack 1, and includes the previously released to web (RTW) feature packs, as well as some new feature packs that have not previously been released.

Windows Server 2003 Service Pack 1 should not be considered an *optional* update; however, R2 can certainly be considered optional. Service Pack 1 for Windows Server 2003 is comparable to Service Pack 2 for XP in terms of the amount of security changes implemented across the OS. There are also a few additions to the Active Directory Services that this chapter will focus on. If you have already installed Service Pack 1 and do not want or need any of the feature packs on the R2 CD, then you will not need to install R2, though you should still consider running the R2 *ADPrep* to upgrade the schema to the latest Microsoft schema revision.

Before you can introduce Windows Server 2003 R2 domain controllers, you must prepare the forest with the *ADPrep* utility, which is like the *ADPrep* utility needed to upgrade Windows 2000 forests to Windows Server 2003 forests. *ADPrep* primes the forest for new platform interoperability features available in R2. This schema update is one of the reasons that R2 is a "new" server release instead of simply a rollup or Service Pack.

Before diving into the process to upgrade to Windows Server 2003 R2, the discussion will focus on some of the new Active Directory features included in R2, as well as Service Pack 1, and some of the functionality differences with the original Windows Server 2003 release to manufacturing (RTM) edition. Based on this information, you should be able to prioritize the importance of how quickly or even *if* you should start migrating to R2.

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15.1. New Active Directory Features in Windows Server 2003 Service Pack 1

On January 15, 2002, Bill Gates, Chief Software Architect for Microsoft, sent the now-famous Trustworthy Computing email memo to all Microsoft employees disclosing the new Microsoft direction. It outlined a direction toward security and a trusted computing base. As the first major project out of the gate after this milestone event, Windows Server 2003 was a valiant step in the right direction, but the momentum and technical acumen wasn't fully built up by the time of its release.

Microsoft truly started to hit its security stride with the release of Windows XP Service Pack 2 in August 2004. Then in March 2005, Windows Server 2003 Service Pack 1 was RTMed as the comparable service pack for the server OS. As you may well expect, both service packs are packed full of security fixes, new technology, and coding techniques to help counter unknown future security holes. For this reason, these service packs should *not* be considered optional updates.

On top of the security fixes and other non-AD related hotfixes, there are quite a few new Active Directory features and updates that make Service Pack 1 attractive to any Active Directory administrator. We list the specific Active Directory SP1 updates and features in this section. If upgrading from Windows 2000 to Windows Server 2003 SP1, you should also refer to Chapter 14 for benefits gained when upgrading from Windows 2000 to Windows Server 2003.

> By "feature," we mean new functionality that is not just a modification of the way it worked in Windows Server 2003.

We suggest you carefully review each of these features and rate them according to the following categories:

- You would use the feature immediately.
- You would use the feature eventually.
- You would never use the feature or it is not important.

Rating each feature will help you determine how much you could benefit from the upgrade. The following is the list of new features , in no particular order:

Directory service backup reminders

Special messages logged to the Directory Service event log if directory partitions are not backed up in a timely manner.

Virtual Server support

Official support for running domain controllers within Virtual Server 2005. This includes additional protection against directory corruption due to improper backup and restoration procedures.

Confidential attributes

Ability to mark attributes as confidential so they can not be read without additional permissions granted. By default, any attribute marked "confidential" can only be read by administrators; however, this can be delegated.

Drag and drop changes in Active Directory Users and Computers Console

Ability to disable drag and drop functionality in ADUC and display confirmation dialogs when initiating a move operation.

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15.2. Differences with Windows Server 2003

As with the new features, we suggest you carefully review each of the differences and rate them according to the following categories:

- It would positively affect my environment to a large degree.
- It would positively affect my environment to a small degree.
- It would negatively affect my environment.

The vast majority of differences are actually improvements that translate into something positive for you, but in some situations, such as with the security-related changes, the impact may initially cause you additional work.

Additional replication security and fewer replication errors

> Replication metadata is now removed for domain controllers that are removed from the domain. This enhances directory security and eliminates replication error messages related to the deleted domain controllers.

Install from media improvements for installing DNS Servers

> New option to include application directory partitions in the backup media eliminates requirement for network replication of DomainDNSZone and ForestDNSZones application directory partitions before the DNS Server is operational.

Updated tools

> Newer versions of *DcDiag*, *NTDSUtil*, *AdPrep*, and other tools to aid in management, updates, and troubleshooting.

Extended storage of deleted objects

> Tombstone lifetime on new forests increased from 60 to 180 days. Existing forests are not modified.

SID History attribute retained on object deletion

> The SID History attribute has been added to the default list of attributes retained on an object tombstone. When the object is undeleted, the attribute will be restored along with the object.

Operations master health and status reporting

Operations that require a FSMO domain controller that cannot be performed will generate Directory Service event log messages.

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15.3. New Active Directory Features in Windows Server 2003 R2

Windows Server 2003 R2 includes all of the aforementioned Service Pack 1 upgrades, as well as some additional feature packs. There are only a few features in R2 that are specific to Active Directory; these are listed below.

We suggest you carefully review each of these features and rate them according to the following categories:

- You would use the feature immediately.
- You would use the feature eventually.
- You would never use the feature or it is not important.

Rating each feature will help you determine how much you could benefit from the upgrade. The following is the list of new features, in no particular order:

Active Directory Application Mode (AD/AM or ADAM)

> Standalone LDAP service that is Active Directory with the NOS-specific components and requirements stripped out. This feature does not require your domain controllers or your schema to be updated to R2; you can just upgrade the standalone or member server on which you want to run R2 ADAM.

Active Directory Federated Services (ADFS)

> Standards-based technology that enables distributed identification, authentication, and authorization across organizational and platform boundaries. This feature does not require your domain controllers or your schema to be updated to R2; you can just upgrade the standalone or member server on which you want to run ADFS.

Identity Management for UNIX (IMU or IdMU)/Subsystem for UNIX Applications (SUA)

> Manage user accounts and passwords on Windows and Unix via NIS. Automatically synchronize passwords between Windows and Unix.

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15.4. Preparing for ADPrep

Before you can install your first R2 domain controller, you have to go through the process of upgrading your existing schema to Windows Server 2003 R2 with the *ADPrep* utility. If you've upgraded from Windows 2000 to Windows Server 2003 AD, you are undoubtedly familiar with the *adprep.exe*`/forestprep` switch; if not, please review Chapter 14. This switch is run independently from the domain controller promotion to allow Active Directory administrators to take care of the AD-related tasks necessary to support Windows Server 2003 R2 Active Directory. The R2 ForestPrep process extends the schema to include the objects and attributes necessary for the R2 Feature Packs, primarily the Unix interoperability functions.

Unlike the Windows 2000 to Windows Server 2003 upgrade, you do not have to run *adprep.exe*`/domainprep` for the Windows Server 2003 to Windows Server 2003 R2 Upgrade, as there are no domain-level changes that need to be implemented.

If upgrading from Windows 2000 to Windows Server 2003 R2, however, you do need to run *adprep.exe*`/domainprep`. See Chapter 14 for details; the process is the same as it is under the gold version of Windows Server 2003.

> Windows Server 2003 Service Pack 1 is required to load R2.

The *ADPrep* command can be found in the *\CMPNENTS\R2\ADPREP* directory on Windows Server 2003 R2 disc 2. The *ADPrep* command depends on several files that reside in that directory, so it cannot simply be copied out and put on a floppy or CD by itself. To run the ForestPrep, you would execute the following:

```
X:\CMPNENTS\R2\ADPREP\adprep /forestprep
```

where *X:* is a CD drive or mapped drive to a network share containing the Windows Server 2003 R2 CD.

You can view detailed output of the *ADPrep* command by looking at the log files in the *%SystemRoot%\system32\debug\adprep\logs* directory. Each time *ADPrep* is executed, a new folder with the current date is generated that contains files with information concerning the actions taken during that particular invocation of *ADPrep*. The folders are named based on the time and date *ADPrep* was run.

15.4.1. ForestPrep

The *ADPrep*`/forestprep` command extends the schema with quite a few new classes and attributes. These new schema objects are necessary for the new features supported by Windows Server 2003 R2. You can view the schema extensions by looking at the *.ldf* files in the *\CMPNENTS\R2\ADPREP* directory on the Windows Server 2003 R2 CD. These files contain LDIF entries for adding and modifying new and existing classes and attributes.

> Microsoft warns against manually extending the schema with the *ADPrep* LDIF files. You should instead let *ADPrep* do it for you.

You only need to execute ForestPrep once when upgrading from Windows Server 2003 to R2. You can run it multiple times, but due to the fact that it updates only the schema, it will only apply schema changes that did not complete previously.

Because the schema is being upgraded, the user running ForestPrep must be a member of the Schema Admins group. In addition, you should run the command directly on the Schema Master for the forest.

> When running the R2 ForestPrep against a Windows 2000 forest, you *must* be at Windows 2000 SP2 or later with hot fix 265089 installed on all domain controllers. Failure to adhere to this requirement could cause domain controller corruption. For more information, see Microsoft KB Q331161.

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15.5. Service Pack 1 Upgrade Process

The upgrade process to Windows Server 2003 Service Pack 1 is similar to any service pack upgradetest, test, test, test, and test some more before introducing changes to production. You need to test all aspects of your business requirements and management tools against a domain with domain controllers that have been upgraded. This upgrade will not require you to make any Active Directory changes. However, there are non-Active Directory-related changes, specifically security changes, in SP1 that could impact your line of business applications and management capabilities.

> One non-AD related change in Windows Server 2003 Service Pack 1 that has caused a significant number of issues in managing domains and servers is a change to the Discretionary Access Control List (DACL) of the Service Control (SC) Manager. This change locks down the ability to remotely enumerate installed services to administrators. Previously, an administrator could delegate to a non-administrator the ability to stop and start services. This delegation will break under SP1 if the tool used to manage the services enumerates the services on the remote server. You must either re-open the DACL access on the SC Manager using the Support Tool *SC.EXE* or use a tool that doesn't enumerate the services prior to managing the delegated service.

The Service Pack 1 installation files can be downloaded directly from the Microsoft Website; see Microsoft Knowledge Base Article 889101 for the Service Pack release notes and the download location.

Once you have determined through testing that loading Service Pack 1 on your domain controllers will create no obvious dangers to your business or your ability to manage your environment, you should back up any systems to be upgraded. Make sure that the backup includes the system state to capture Active Directory and SYSVOL information, and then deploy the Service Pack into production. Don't forget to verify that your Line of Business apps, monitoring, and management software are all working properly after the upgrade.

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15.6. R2 Upgrade Process

The R2 upgrade process is quite simple, and because there is no change in the function of the operating system, there is no real concern of possible issues with the exception of the schema update processed in the ForestPrep. Even if there are issues during the schema update, they are not usually terribly difficult to overcome, especially with the schema defunct capability in Windows Server 2003 Active Directory. The ForestPrep only has to be run once, so after that is completed, the rest of the R2 rollout should be quite smooth.

> During the beta of R2, there were cases reporting failures during the ForestPrep process due to preexisting schema attributes colliding with the new attributes in various ways. All of these cases were corrected by defuncting and/or redefining the old attributes causing the collisions.

15.6.1. Prepare the Forest

As we outlined earlier, before you can promote the first Windows Server 2003 R2 domain controller into your forest, you have to run the ForestPrep procedure. Log into the Schema FSMO role holder and run `ADPrep/forestprep`. When the process has successfully completed, you will be greeted with a heartening success message:

```
The command has completed successfully.
ADPrep successfully updated the forest-wide information.
```

If you run into errors, messages will be provided that should give an indication of the problem. Assuming your prerequisites are in order, any errors will be concerning pre-existing schema definitions. If you have been particular about your schema updates, it is unlikely you will encounter issues.

15.6.2. Upgrade Domain Controllers

Now comes the easy part, really. The installation of R2 will copy a few files to the server and add some menu items to the Add/Remove Windows Components of the Add or Remove Programs dialog. These additional menu picks will allow you to later install the various feature packs as needed. The Active Directory-specific feature packs, including ADAM, ADFS, and IMU, are available under the Active Directory Services pack.

That's it, all done, nothing else to do for the upgrade. The hard part was the SP1 upgrade and

ForestPrep procedure mentioned previously.

> Creating a new R2 forest is as simple as building a new Windows 2000 or Windows Server 2003 gold forest. Configure DNS for the forest root domain enabling dynamic updates, and then DCPROMO an R2 server (standalone or domain member) to domain controller status. There are no ForestPrep or other upgrade processes necessary.

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15.7. Summary

In this chapter, we covered the new Active Directory features in Windows Server 2003 SP1 and Windows Server 2003 R2. Further, we mentioned that while Windows Server 2003 Service Pack 1 is an important, if not critical, upgrade, R2 is optional and should only be done if you need one or more of the feature packs included in the release. Next, we discussed the processes involved with upgrading from a Windows Server 2003 Active Directory and domain controllers to Windows Server SP1 and then R2. Finally, we discussed the ForestPrep process and how that must be completed prior to introduction of the first R2 domain controller.

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Chapter 16. Migrating from Windows NT

Knowing how to design Active Directory is very useful, but it's not the end of the story. You may already have an existing NetWare or Windows NT infrastructure and want to consider migrating to Active Directory. Alternatively, you may have existing directories and networks that you would like Active Directory to complement rather than replace. One of the most important features of Active Directory is its ability to integrate with other directory services.

In this chapter, we will cover some of the issues to consider when migrating from a Windows NT environment to Active Directory. Migrating to Active Directory from an existing NOS infrastructure is analogous to jumping from one moving car to another. This is due to the fact that organizations rarely get the opportunity to take extended downtime from both the client and server perspective to move everyone to Active Directory. In fact, limiting downtime for users is typically one of the top priorities, so having a well-thought-out migration and fallback plan is critical to reduce the impact to your user base.

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16.1. The Principles of Upgrading Windows NT Domains

There are many reasons that you will want to upgrade your Windows NT domains to Active Directory, not least of which is to make use of Active Directory and other features. It's possible to have significantly fewer domains in Active Directory because each domain can now store millions of objects. While fewer domains means less administration, the added benefit of using organizational units to segregate objects makes the Active Directory represent a business more accurately, both geographically and organizationally, and is a significant step forward. Couple this with the ability to set ACLs on objects and their properties in Active Directory, and you get much more fine-grained control for administrative delegation than before. You also can start phasing out old services such as extraneous Windows NT Backup Domain Controller (BDC) servers, since the clients now make more efficient use of DCs via TCP/IP and DNS. With all these improvements, the goals of upgrading a domain are easy to state:

- Reduce the number of domains in use because it is easier to administer fewer domains.
- Gain an extensible schema that allows locally defined corporate information to be stored in the directory.
- Create a hierarchical namespace that as closely as possible mirrors the organizational structure of the business.
- Gain much more fine-grained control over delegation of administration without needing to resort to the use of multiple domains.
- Reduce network bandwidth use by DCs through both multimaster replication and a significantly more efficient set of replication algorithms.
- Reduce the number of PDCs/BDCs to a smaller number of DCs through a more efficient use of DCs by clients.

> To get the maximum benefit from the new technologies, you really need to upgrade both clients and servers.

16.1.1. Preparing for a Domain Upgrade

There are three important steps in preparing for a domain upgrade:

1. Test the upgrade on an isolated network segment set aside for testing.
2. Do a full backup of the SAM and all core data prior to the actual upgrade.

3. Set up a fallback position in case of problems.

We cannot stress strongly enough how enlightening doing initial testing on a separate network segment can be. It can show a wide variety of upgrade problems, show you areas that you never considered, and in cases in which you have considered everything, give you the confidence that your trial run did exactly what you expected. In the world of today's complex systems, some organizations still try to roll out operating system upgrades and patches without full testing and fail miserably. The first part of your plan should be for a test of your upgrade plans.

When you do the domain upgrade itself, it goes without saying that you should have full backups of the Windows NT SAM and the data on the servers. You would think this is obvious, but again we have seen a number of organizations attempt this without doing backups first.

The best fallback position is to have an ace up your sleeve, and in Windows NT upgrade terms, that means you need a copy of the SAM somewhere safe. While backup tapes are good for this, there are better solutions for rapid recovery of a domain. These recipes for success require keeping a PDC or a BDC of your domain safely somewhere. In this context, by "safely" we mean off the main network. Your first option is to take the PDC off the network. This effectively stores it safely in case anything serious goes wrong. Next, as your domain now has no PDC, you need to promote a BDC to be the PDC for the domain. Once that has been done successfully, and you've manipulated any other services that statically pointed at the old PDC, you can upgrade that new PDC with the knowledge that your old PDC is safe in case of problems. The second option is to make sure that an existing BDC is fully replicated, then take it offline and store it. Both solutions give you a fallback PDC in case of problems.

16.1.2. Forests and the Forest Root Domain

Remember that the first domain in a forest is a significant domain and cannot be deleted. That means you cannot create a test domain tree called *testdom.root.com* , add a completely different noncontiguous tree called *mycorp.com* to the same forest, and subsequently remove *testdom.root.com* . You have to make sure that the first domain that you ever upgrade is the major or root domain for the company. In Windows NT domain model terms, that means upgrading the master domains prior to the resource domains. The resource domains may end up being Organizational Units instead anyway now, unless political, cultural, or bandwidth reasons force you to want to keep them as domains.

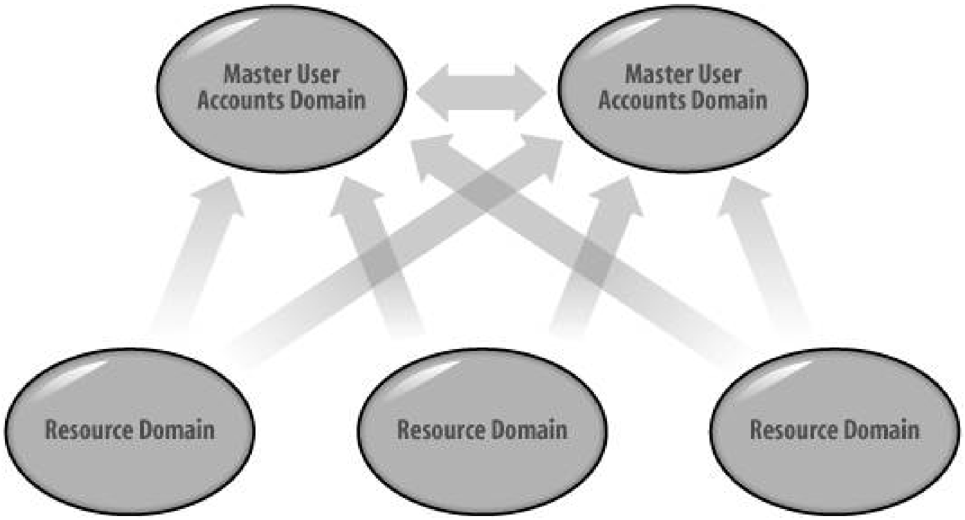
16.1.3. Windows NT Domain Upgrades

Single Windows NT domains and complete trust domains can be upgraded with few problems. With a single domain, you have just one to convert, and with complete trust domains, every domain that you convert will still maintain a complete trust with all the others. However, when you upgrade master domains or multimaster domains, there are account and resource domains that need to be considered. No matter how many master domains you have, the upgrade of these domains has to be done in a certain manner to preserve the trust relationships and functionality of the organization as a whole. We'll now explain the three broad ways to upgrade your master domain structure.

Let's assume that you have one or more single-master or multimaster domains that you want to convert. Your first task will be to create the forest root domain. This domain will act as your placeholder and allow you to join the rest of the domains to it. The forest root domain can be an entirely new domain that you set up, or you can make the first domain that you migrate the forest root domain.

Take a look at Figure 16-1 , which shows a Windows NT multimaster domain. Each domain that holds resources trusts the domains that hold user accounts, allowing the users to log on to any of the resource domains and use the respective resources.

Figure 16-1. Windows NT multimaster domain prior to migration



There are three main ways to upgrade this domain. None of them is necessarily any better than the other, as each design would be based on choices that you made in your namespace design notes from Chapter 8 .

16.1.3.1. Solution 1: Migration to a new forest root domain

First, the domains could all be joined as one tree under an entirely new root. Each master domain would represent a branch under the root with each resource domain joined to one of the masters. This is shown in Figure 16-2 .

> Although it is conventional to think of the resource domains under the master domains, there is nothing to stop you from joining resource domains under resource domains if you like; it will make no difference for access to the resource domain's data.

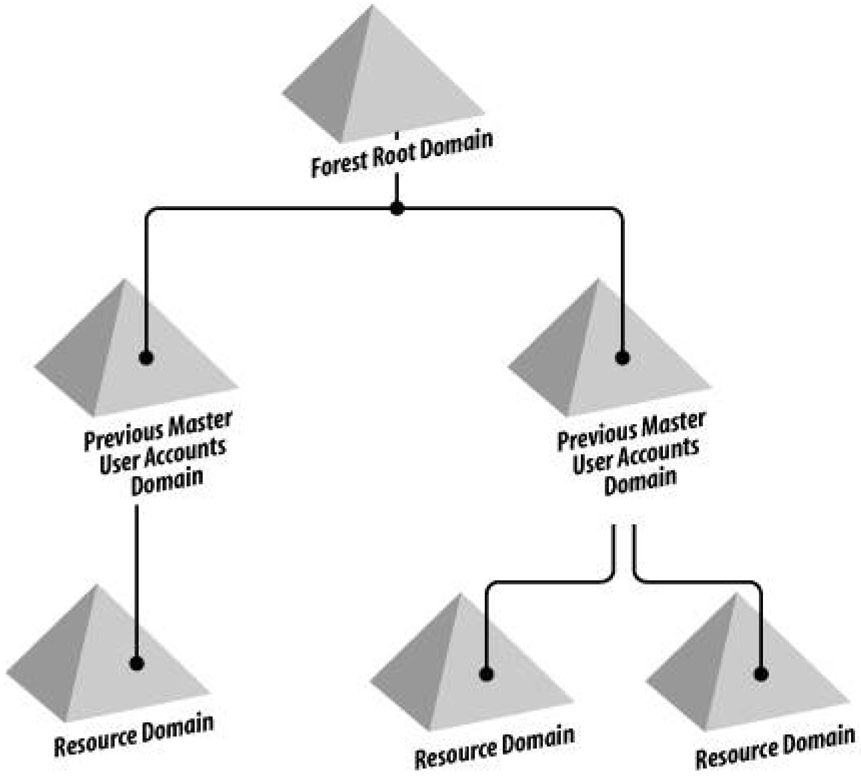
16.1.3.2. Solution 2: Migration with one domain as the domain-tree root

The second option is to aim toward making one of the master domains the root of the new tree. All resource domains could then join to the root, one of the other master domains, or one of the resource domains. Figure 16-3 shows this in more detail. Two resource domains have been joined to one of the master domains, but the third resource domain can still go to one of three parents, as indicated by the dashed lines.

16.1.3.3. Solution 3: Migration to separate domain trees in a forest

Finally, you could make each domain a separate tree. Although the first master domain that you migrate will be the forest root domain, the rest of the master domains will simply be tree roots in their own right.

Figure 16-2. Migration to a new forest root domain


Forest Root Domain
Previous Master User Accounts Domain
Previous Master User Accounts Domain
Resource Domain
Resource Domain
Resource Domain

16.1.4. A Solution-Independent Migration Process

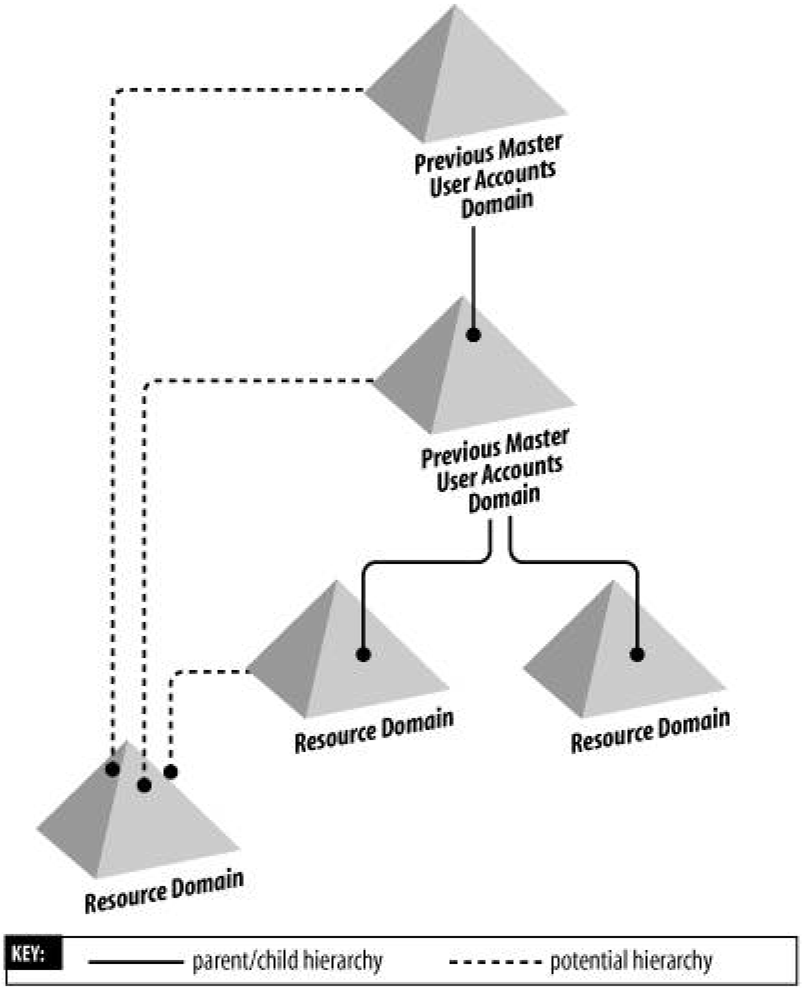
Let's now consider the process for migrating these domains. We must migrate the master account domains first, since they are the ones that the resource domains depend on. To start the process, convert any one of the master account domains over to Active Directory by upgrading the PDC of that master domain. If any of the trust relationships have been broken between this domain and the other master and resource domains during migration, reestablish them. Once the PDC is upgraded, proceed to upgrade the other BDCs of that domain (or you can leave the domain running with Windows NT BDCs; it doesn't really matter to the rest of the migration).

The next step is to migrate the other master domains. You continue in the same manner as you did with the first domain until all master domains have been converted. Once each domain is converted, you need to reestablish only trust relationships with the existing Windows NT domains; the Active Directory domains in the forest will each have hierarchical and transitive trusts automatically anyway. So now you end up with a series of Active Directory master domains in a tree/forest and a series of

Windows NT resource domains with manual trusts in place.

Once all the master domains are converted, you can start consolidating them (as discussed in the next section), or you can immediately convert the resource domains. Either way, once all domains are converted, you are likely to start a consolidation process to reduce the number of domains that you have in existence. Part of that consolidation will be to convert existing resource domains to Organizational Units. This is because resource domains by their very nature tend to fit in well as Organizational Units.[*] For that to happen, these future Organizational Units will need to be children of one of the migrated master or resource domains. It doesn't matter which master or resource domain acts as the parent, since there are consolidation tools available that allow you to move entire branches of the tree between domains. The process is simple: you take each resource domain in turn and convert it to a child domain of one of the existing Active Directory master or resource domains. Once they are all converted, you can really begin consolidation.

Figure 16-3. Migration with one domain as tree root



[*] Resource domains were created because of Windows NT's inability to allow delegation of authority within a domain. Now Organizational Units provide that functionality, so separate resource domains are no longer required. Thus, old resource domains can become Organizational Units under Active Directory domains and still maintain much of their previous functionality.

16.1.5. Consolidating Domains After the Move

Upgrading your domains is not the end of the story. Many administrators implemented multiple Windows NT domains to cope with the size constraints inherent in Windows NT domains. With Active Directory, those constraints are lifted, and each domain in a forest can easily share resources with any other domain. This allows administrators to begin removing from the directory information that has become unnecessary in an Active Directory environment.

16.1.5.1. Windows 2003 Interim and Windows 2003 functional levels and groups

When your final Windows NT 4.0 BDC for a domain has been taken out of service or upgraded, you are ready to convert the domain to the Windows 2003 functional level. After the conversion, you have some decisions to make about the groups you have in this domain. You can leave all groups as they are or start converting some or all groups to universal groups. With multiple domains in a single forest, you can consolidate groups from more than one domain together into one universal group. This allows you to combine resources and accounts from many domains into single groups.

There are two methods for bringing these groups online:

- Setting up parallel groups
- Moving existing groups

In a parallel group setup, the idea is that the administrator sets up groups that hold the same members as existing groups. In this way, users become members of both groups at the same time, and the old group and a user's membership can be removed in a calculated manner over time. The arguably easier solution is to move existing groups.

16.1.5.2. Computers

When it comes to considering computer accounts, things are relatively straightforward. Under Windows NT, a computer could exist in only one domain at a time, since that computer and domain required a trust relationship to be established to allow domain users to log on to the domain at that client. You could set up bidirectional trust relationships manually between domains, allowing a client in Domain A to authenticate Domain B users to Domain B, but this was not common. With Active Directory, all domains in a forest implicitly trust one another automatically. As long as the computer has a trust relationship with one domain, users from any other domain can log on to their domain via the client by default. The following is a rough list of items to consider:

- Moving computer accounts between domains to gain better control over delegation
- Joining computers to the domain
- Creating computer groups

- Defining system policies

In all of these, it is important to understand that the source domain does not have to be at the Windows 2003 functional level to move computers to a new domain. In addition, administrators can use the *NETDOM* utility in the Windows Support Tools to add and remove domain computer objects/accounts; join a client to a domain; move a client between domains; verify, reset, and manage the trust relationship between domains; and so on.

While you may have had computer accounts in a series of domains before, you now can move these accounts anywhere you want in the forest to aid your delegation of control. Group Policy Object processing also has a significant impact on where your computer accounts should reside. However, you now can work out what sort of Organizational Unit hierarchy you would ideally wish for your computer accounts and attempt to bring this about. Moving computers between domains is as simple as the following *NETDOM* command.

Here we want to move a workstation or member server, called *mycomputerorserver* , from the domain *sales.mycorp.com* to the location `ou=computers,ou=finance,dc=mycorp,dc=com` . We specifically want to use the *myDC* domain controller and the MYCORP\JOINTODOMAIN account to do the move. Connection to the client will be done with the SALES\Administrator account, which uses an asterisk (*) in the password field to indicate to prompt for the password. We could just as easily have used an account on the client itself. We also include a 60-second grace period before the client is automatically rebooted:

```
NETDOM MOVE mycomputerorserver /DOMAIN:mycorp.com /OU:Finance/Computers
  /UserD:jointodomain /PasswordD:thepassword
  /Server:myDC
  /UserO:SALES\Administrator /PasswordO:*
  /REBOOT:60
```

This is actually the long-winded version, split up onto multiple lines for visibility; here's the short form:

```
NETDOM MOVE /D:mycorp.com /OU:Finance/Computers /UD:jointodomain
   /PD:thepassword /S:myDC /UO:SALES\Administrator /PO:* /REB:60
```

Note that moving a Windows NT computer doesn't delete the original account, and moving a Windows 2000 computer just disables it in the source domain.

You also need to consider who will be able to add workstations to the domain. You can set up an account with join-domain privileges only; i.e., an account with the ability to make and break trust relationships for clients. We've used this approach with a lot of success, and it means that an administrator-equivalent user is no longer required for joining clients to a domain. Let's take the previous example, but this time we want to both create an account and join a new computer to the domain with that account. This is the code to do that using *NETDOM* :

```
NETDOM JOIN mycomputerorserver /D:mycorp.com /OU:Finance/Computers
   /UD:jointodomain /PD:thepassword /S:myDC /UO:SALES\Administrator /PO:* /REB:60
```

In all these *NETDOM* examples, we're using a specially constructed account that only has privileges to add computer objects to this specific Organizational Unit. At Leicester, we precreated all the computer accounts, and the jointodomain account was used only to establish trusts between existing accounts; it had no privilege to create accounts in any way.

You also need to be aware that workstation accounts under Windows NT could not go into groups. Under Active Directory, that has all changed, and you can now add computers to groups. So when moving computers between domains for whatever purposes, you now can use hierarchical Organizational Unit structures to delegate administrative/join-domain control, as well as using groups to facilitate Group Policy Object (GPO) upgrades from system policies .

System policies themselves are not upgradeable. However, as explained in Chapters 7 and 10 , you can use system policies with Active Directory clients and bring GPOs online slowly. In other words, you can keep your system policies going and then incrementally introduce the same functionality into GPOs. Since each part of each system policy is included in the GPO, you can remove that functionality from the system policy while still maintaining the policies application. Ultimately, you will end up replacing all the functionality incrementally, and the system policies will have no more policies left, so they can be deleted.

16.1.5.3. Users

When consolidating domains, at some point you will need to move users around to better represent the organization's structure, to gain better control over delegation of administration, or for group policy reasons. Whichever of these it is, there are useful tools to help you move users between domains.

To be able to transfer users between domains, you need to have gone to Windows 2000 functional level, which requires you to have upgraded or decommissioned all of your Windows NT BDCs. This allows a seamless transfer of the user object, including the password.

MOVETREE allows you to move containers from one part of a tree in one domain to a tree in a completely different domain. For example, suppose we wish to move the branch of the tree under an Organizational Unit called Managers from the *sales.mycorp.com* domain to the Organizational Unit called Sales-Managers on the *mycorp.com* domain. The command we would use to start the move is something like the following, preceded by a full check:

```
MOVETREE /start /s sales.mycorp.com /d mycorp.com
  /sdn OU=Managers,DC=sales,DC=mycorp,DC=com
  /ddn OU=Sales-Managers,DC=mycorp,DC=com
  /u SALES\Administrator /p thepassword
```

The *SIDWALK* utility is designed to support a three-stage approach to modifying ACLs . Each stage of changing ACLs can take a while to complete and verify, sometimes a day or more. It thus requires some amount of system resources and administrator time. The stages are as follows:

Planning

The administrator needs to determine what users have been granted access to resources (file shares, print shares, NTFS files, registry keys, and local group membership) on a particular computer.

Account mapping

Based on who has access to what resources on the system, the administrator can chose to delete old, unused security identities or replace them with corresponding new identities, such as new security groups.

Converting ACLs

Using the information from the planning and mapping phases, the third stage is the conversion of security identities found anywhere on a system to corresponding new identities.

16.1.5.4. Member servers and removing domains

After you've migrated, you may want to get rid of some old domains entirely, move member servers between domains, consolidate multiple servers together, or possibly even convert a member server to become a DC. Whatever you're considering, moving member servers and their data while maintaining group memberships and ACLs to resources can be done.

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16.2. Summary

This chapter focused on the principles behind the migration of existing Windows NT domains to Active Directory. Microsoft has taken the time to properly think through a very scalable and stable directory service in its Active Directory implementation. It has, in its own words, "bet the barn on Active Directory."

The next chapter takes a look at the potential for integrating Microsoft Exchange into Active Directory.

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Chapter 17. Integrating Microsoft Exchange

Exchange[*] has been the driving reason behind many companies' move to Active Directory. Starting with Exchange 2000, Exchange requires an Active Directory infrastructure, and the dependencies it places on AD are not small. In fact, the Exchange schema extensions roughly double the size of the default Active Directory schema. There are also restrictions on the location of your domain controllers relative to the Exchange servers. For these reasons and the critical nature of email, calendar, and collaboration services, all of which Exchange can provide, it is clear that Exchange can be one of the most significant application you integrate into Active Directory.

In this chapter, we will briefly touch on some of the important issues regarding the integration of Exchange with Active Directory. We'll cover how to prepare the forest for Exchange and describe some of the changes this causes. Finally, we will review the Active Directory Connector (ADC), which aids in the transition from Exchange 5.5 to newer versions of Exchange.

[*] The word "Exchange" signifies Exchange 2000 or Exchange 2003 unless specified.

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17.1. A Quick Word About Exchange/AD Interaction

Here are a few key points to note about Active Directory, Exchange Server 5.5, Exchange Server 2000, and Exchange Server 2003:

- Exchange 2000 can run only on Windows 2000.
- Exchange Server 2003 can run on Windows 2000 and Windows Server 2003.
- Exchange 5.5 can run in a Windows Server 2003 or Windows 2000 Active Directory forest.
- Exchange 2000 can run in a Windows Server 2003 or Windows 2000 Active Directory forest.[ ]

[ ] Windows Server 2003 Active Directory must not be in Forest Functional Mode.

- Exchange Server 2003 can run in a Windows Server 2003 or Windows 2000 Active Directory forest.
- Exchange 5.5 can interoperate with Exchange Server 2003 and Windows Server 2003 just as it could with Exchange 2000 and Windows 2000.
- The Outlook 2003 mail client allows cross-forest authentication with Windows Server 2003 forests.

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17.2. Preparing Active Directory for Exchange

Before you can install the first Exchange server in Active Directory, you have to prepare your forest. The Exchange setup program provides two options called `/forestprep` and `/domainprep` , which perform vario tasks such as extending the schema, creating groups, creating containers for Exchange, and setting permissions on those containers. Due to the extent of changes caused by running these commands and t elevated privileges required to do so, it is imperative that AD administrators have a thorough understand of what they do.

17.2.1. Forestprep

The Forestprep option of the Exchange setup extends the schema and makes some changes to the Configuration container. Forestprep must be run before Domainprep can be executed, and both need to b run before you can install your first Exchange server. The user that runs Forestprep must be a member o both the Enterprise Admins and Schema Admins groups. Here is a list of some of the tasks Forestprep ta care of:

- Extends the schema with schema additions and modifications. Forestprep effectively doubles the nu of classes and attributes in the default Active Directory schema. Several attributes are also added t Global Catalog, which will cause a GC resync with Windows 2000 Active Directory domain controllers
- Creates the Exchange organization with the following distinguished name:

```
cn=<ExchangeOrgName>,cn=Microsoft Exchange,cn=Services,cn=Configuration,<Forest
```

- This container is where Exchange stores application configuration data in Active Directory, including address lists, administrative groups, recipient policies, and other global settings.
- Grants full control rights to the designated user or group over the Exchange organization. The rights granted are equivalent to the Exchange Full Administrator rights when using the Exchange Delegati Control wizard.

Due to the massive number of schema extensions, you should consider running Forestprep on the Schem FSMO role owner. This can speed up the time it takes to complete Forestprep. Before moving forward to Domainprep, you must ensure that the schema extensions and objects injected by Forestprep have replic across the forest.

17.2.2. Domainprep

After you've successfully run Forestprep, you need to run Domainprep in any domain in which you plan to install an Exchange server or have mail-enabled users. The user that runs Domainprep must be a membe the Domain Admins group for the target domain. Some of the tasks performed during Domainprep includ following:

- Creates a container for the System mailboxes under `cn=Microsoft Exchange System Objects`,*<DomainDN>* .
- Creates the Exchange Domain Servers global group; all Exchange servers in the domain will be members of this group. This group *cannot* be moved from the Users container.
- Creates the Exchange Enterprise Servers domain local group. The Recipient Update Service eventua adds all the Exchange Domain Servers groups from each domain to this group. This group *cannot* b moved from the Users container.
- The Exchange admin account or group specified during Forestprep is granted administrative control the Exchange Domain Servers and Exchange Enterprise Servers groups.
- Grants the "Manage audit and security log" privilege to the Exchange Enterprise Servers group on tl Domain Controller Security Policy.

Note that after Domainprep completes, the Exchange administrators will only have the rights to add Exch servers to the domain. They will not have the privileges to create mailboxes for users. To do that, you wil need to grant them additional permissions over the user objects.

17.2.3. Running Forestprep and Domainprep

To run Forestprep or Domainprep, insert an Exchange Server CD into a computer where you are logged i with the appropriate credentials as described earlier. To run Forestprep, run the following command (repl `E`*:* with your CD drive letter):

```
> E:\setup\i386\setup /forestprep
```

To complete the Forestprep wizard, you will need to know the name of the Exchange organization you wa create and the user or group account that should be given Exchange Full Administrator rights. If you are joining an existing Exchange 5.5 organization, you'll need to know the name of that organization and the Exchange 5.5 service account and password.

After Forestprep completes, you should wait until the schema extensions have replicated across your fore Domainprep will fail to complete if the targeted server has not received the Forestprep changes. If you ar still running Windows 2000, the replication delay may be significant due to the Global Catalog sync that is caused by Forestprep adding to the partial attribute set. You may even want to run Domainprep several (after Forestprep to ensure that everything has replicated. Because of replication improvements and the f that a Global Catalog sync is no longer required in Windows Server 2003 Active Directory, you can expect shorter replication period if you've upgraded your forest to the Windows Server 2003 forest functional lev

To run Domainprep, run the following command (replace `E:` with your CD drive letter):

```
> E:\setup\i386\setup /domainprep
```

After Domainprep has run and replicated throughout the domain, your Exchange administrators should th be able to install Exchange servers. One other caveat to be aware of when installing Exchange servers is the subnet the Exchange servers are on must be defined in the Active Directory site topology or else the setup process will fail.

17.2.4. Active Directory Site Design and Domain Controller Placement

If you did not plan for Exchange in your initial Active Directory design, consider a whiteboard discussion t review your entire design with Exchange in mind. It is possible and even likely there are aspects of your design that are not optimal for Exchange and will cause issues unless redesigned. Exchange is not very tolerant of Active Directory issues; it is much less tolerant than, for instance, the client logon process. Yo could have a directory that is working great for NOS functions that just doesn't operate well enough for Exchange and causes issue after issue in the mail system. Additionally, Exchange can have significant im on your forest and cause issues for other applications or the NOS functions. As an Active Directory Administrator, you need to understand Exchange's requirements and best practices and how it uses, or in some cases abuses, Active Directory. If you simply try to install Exchange into the forest as-is, you could in for a rough time with lots of troubleshooting and heartache.

A common practice in Exchange 5.5 environments was to load Exchange 5.5 onto domain controllers to s up authentication. This is not recommended with Exchange 2000 and Exchange 2003 since the directory h been separated from the application. Normally if Exchange is experiencing slow or failed responses from a domain controller, it will start using another domain controller. When Exchange is loaded on a domain controller, this failover capability is disabled.

When you implement Exchange, keeping the Active Directory site topology up to date becomes even mor important. The Exchange installation process will abort if the server does not have a subnet defined in Ac Directory that map to a site in the topology. Each Exchange server uses the site topology to build a list o domain controllers to use for server queries and to assign to clients for their queries.

Perhaps the most significant impact of Exchange on Active Directory is the dependencies it creates in reg to domain controller location. The general best practice recommendation is to have domain controllers on same subnet as your Exchange servers. This isn't feasible in all situations; however, as long as the doma controllers are relatively close from a network perspective, you should be OK. The latency between the Exchange servers and domain controllers should be less than 100 ms.

A common practice in larger organizations is to place Exchange Servers and domain controllers dedicatec Exchange in a single Active Directory site together. This helps protect Exchange from NOS functions and applications and helps protect other applications and NOS functions from Exchange. It also helps you kee focused on which DCs are being used for Exchange and therefore need a little extra attention.

Finally, there is a service on Exchange called the Recipient Update Service (RUS). This is the service that actually mailbox- and mail-enables users when you specify that a user should get a mailbox or be mail-enabled. It is extremely important that any RUS instances have minimum latency between the domain controllers being used. Preferably, all domain controllers targeted by the RUS instances should be in the s site. This is critical because the RUS is responsible for finding unique values for many of the mail attribute and if there is a lot of latency between the RUS instances, the possibility of duplicate values is greatly increased. Duplicate values for the Exchange attributes can cause no end of issues and can be quite diffic to troubleshoot.

17.2.5. Other Considerations

Microsoft went the route of splitting up the install process for Exchange, but you have the option of doing at the same time. If the user account you used to install Exchange for the first time is a member of the Enterprise Admins and Schema Admins group, the setup process perform both the Forestprep and Domainprep functions. While it is generally a good practice to split up the install, you do have the option doing it all at once.

The GC to Exchange server ratio guideline put forth by Microsoft Best Practices is based on a number of processors in the Exchange servers. Assuming comparable processors, you should have at least one GC processor for every four Exchange processors. So if you have a 4x3Ghz Exchange Server, you should ha least one single processor 3Ghz Global Catalog. Bear in mind that this is a guideline; you could very well fi that your own Exchange users are much harder on Exchange and could require two GC processors for ev four Exchange processors or maybe even a one to one ratio of GC-to-Exchange server processors. Unfortunately, there are no guaranteed signs to tell you when you need more capacity. Generally, when DSACCESS performance counters start reporting slow LDAP lookups, it is a sign that you may need more domain controller capacity. However, it could also signify network issues or that your distribution lists hav too many individual users in them and you need to start placing fewer users in groups and nesting the gr together, or any number of other things.

Deploying Exchange in a multi-domain forest almost guarantees that you will need to use Universal Grou for Exchange permissioning and distribution lists. Exchange is more dependent on global catalogs than or domain controllers, which means that resolution of a DL could occur on any GC in the forest and if the DL a universal group, there is a good chance the group will not be able to be expanded to its full membershi There are mechanisms that can be employed to counteract this; however, it adds additional overhead an possible break points. If you intend to use Exchange Distribution Lists or secure Exchange with groups, u Universal groups to do so.

In a single forest implementation, creating a "split permissions model" to separate Active Directory Administrators and Exchange Administrators in a single forest implementation is extremely difficult to attempt, and if you are completely honest, actually impossible. If having this separation is mandatory du security concerns or legal ramifications, then you absolutely must look into a dedicated Exchange Resour Forest model. In that model, Exchange is not installed in the NOS forest; instead, it has its own single do resource forest that is entirely managed by the Exchange Administrators. This resource forest will trust th NOS forest (or individual domains) and is run very much like Exchange 5.5 was run in large organizations There is additional work required when provisioning and de-provisioning users, but this model offers a tru security boundary and actually can solve other painful multi-domain issues that are otherwise present in Exchange.

Even if you don't want to produce a split permission model, you will need to be careful with the permissio granted to data administrators such as those managing users or anyone with the ability to create users. someone has full control access to a user object, they can manipulate the mailbox settings for the user o even mailbox-enable users that the Exchange administrators never intended to have mailboxes. Normally need at least Exchange View-level permissions to use ADUC to manage mail attributes; that also goes for scripts using CDOEXM. The truth is that you don't need that level of access; as long as you know the valu to write to certain attributes, you can use standard LDAP modifications on user objects to mailbox enable them and configure their mailbox on any Exchange server in the ORG. You can also modify quotas and send/receive limits at will. Finally, and probably the scariest from a security standpoint, you can send em as any users you have full control over and can probably also view their mailbox without knowing or rese their password.

Microsoft has produced some documentation on configuring permissions in Active Directory for Exchange. It attempts to offer a split permission model, and while it is a valiant attempt, it doesn't completely do the job, but it may be sufficient for some. You can find the documentation on the Microsoft Exchange Server TechCenter web site:

http://www.microsoft.com/technet/prodtechnol/exchange/2003/library/ex2k3ad.mspx .

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17.3. Exchange 5.5 and the Active Directory Connector

A lot of companies that are migrating to Exchange 2000 or Exchange 2003 had Exchange 5.5 deployed previously. To help with the transition process, Microsoft created the Active Directory Connector (ADC), which allows you to migrate at your own pace while maintaining both environments.

> The ADC is a *migration* utility. It was written for migrations where you want to quickly get off of Exchange 5.5 and onto Exchange 2000 or 2003. The recommendation from Microsoft is to take your time, but don't take *too* much time. The utility is a very simple metadirectory tool and is not intended for long-term synchronization or very complex syncing tasks. If your goal isn't a quick and direct migration but instead possibly a long-term coexistence of the two environments or alternatively if you have an extremely complicated environment, you may want to consider a more robust metadirectory tool such as Microsoft Identity Integration Server (MIIS).

The ADC is comprised of a service that does the work and an MMC console to manage the service. While the console can be installed on any client or server, the ADC service has to be installed on a server for it to work. If you have separate AD and Exchange administrators, it is generally managed by the Exchange administrators.

> To support connection to the ADC, you will need Microsoft Exchange 5.5 Service Pack 1 or above.

When you install the ADC for the first time in a forest, it extends the schema if you have not already installed the Exchange schema extensions. The extensions are the same as those processed for the Forest Prep and include new Exchange objects and attributes, as well as modifying existing Active Directory objects to include new Exchange-relevant attributes. The Exchange Schema is also modified if you intend to replicate Active Directory data to Exchange.

Once the Active Directory schema is extended, Active Directory then can hold mail attributes for groups, users, and contacts just as the Exchange directory can. This means that the ADC now can replicate data bi-directionally, knowing that either end can store the same data. This allows you to run the ADC in one of three ways:

From Active Directory to Exchange

Every new creation of a user, distribution group, security group, or contact object that is mail-enabled in a designated Organizational Unit will be copied over to a designated Recipients container on Exchange. Every change to the attributes of an existing mail-enabled object will also be passed. Deletions also can be synchronized.

From Exchange to Active Directory

Every new creation of a user, mailing list, or custom recipient object in Exchange automatically creates a corresponding user account in a specified Organizational Unit in Active Directory. Attribute changes also get passed, as do deletions.

Bidirectional replication

Changes at either end get replicated over to the other system.

If you choose to manage one-way replication, you must realize that you can update the details only for those objects on the one-way source directory from that time on. If you were to update the target directory, the changes you made could potentially be erased during the next update as the system realizes that the target is no longer in synchronization with the source. To fully appreciate this and see why bidirectional replication does not necessarily help you here, see the section "Why Bidirectional Replication May Not Solve Your Problems ."

There are other implications that need to be understood for these scenarios. When passing information from Active Directory to Exchange, for example, you must designate a set of specific Organizational Units that will contain the objects to be replicated. Any Organizational Units that you do not list will never have objects replicated, even if they are mail-enabled objects.

Once the ADC is installed, the Active Directory Users and Computers MMC has three extra property pages available to it. Two of these pages are visible only if you choose the Advanced option from the View menu. One word of warning: to see the extra pages in the Active Directory Users and Computers MMC on any server or workstation, you must have the ADC MMC installed onto that client first. Installing the MMC part of the ADC onto a client configures the Active Directory User and Computers MMC with the extra snap-in options for these pages.

We'll now take a look at how to configure the ADC for your use and follow on with how to mail-enable a user using the GUI and ADSI.

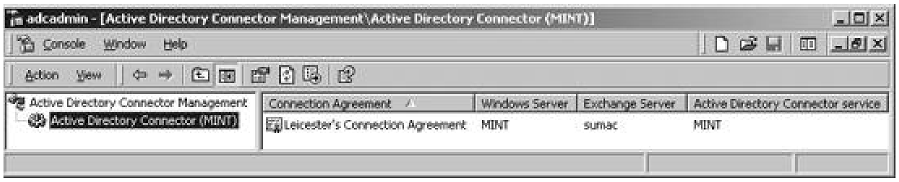
17.3.1. Configuring the ADC

Once you've installed the ADC, you need to designate a DC to hold what's known as a connection agreement. This agreement is an Active Directory `msExchConnectionAgreement` object that will hold all the information relating to the replication of the data you require. Specifically, when you set up an agreement, it adds an item to a part of the Configuration Naming Context with a path similar to this:

```
cn=My Connection Agreement, cn=Active Directory Connections, cn=Microsoft Exchange,
cn=Services, cn=Configuration, dc=windows, dc=mycorp, dc=com.
```

The agreement stores all the data as attributes of the agreement object itself. Attributes hold information such as which direction replication will take place, when it will take place, what parts of Active Directory or Exchange actually hold the objects that you wish to replicate, and so on. For example, the attribute that holds Active Directory Organizational Units to replicate to Exchange is known as the msExchServer1ExportContainers attribute. Figure 17-1 shows a sample connection agreement running on a DC called *Mint* and connecting to an Exchange server called *Sumac* .

Figure 17-1. A connection agreement


adcadmin - [Active Directory Connector Management\Active Directory Connector (MINT)]
Console
Window
Help
Action
View

Active Directory Connector Management
Active Directory Connector (MINT)

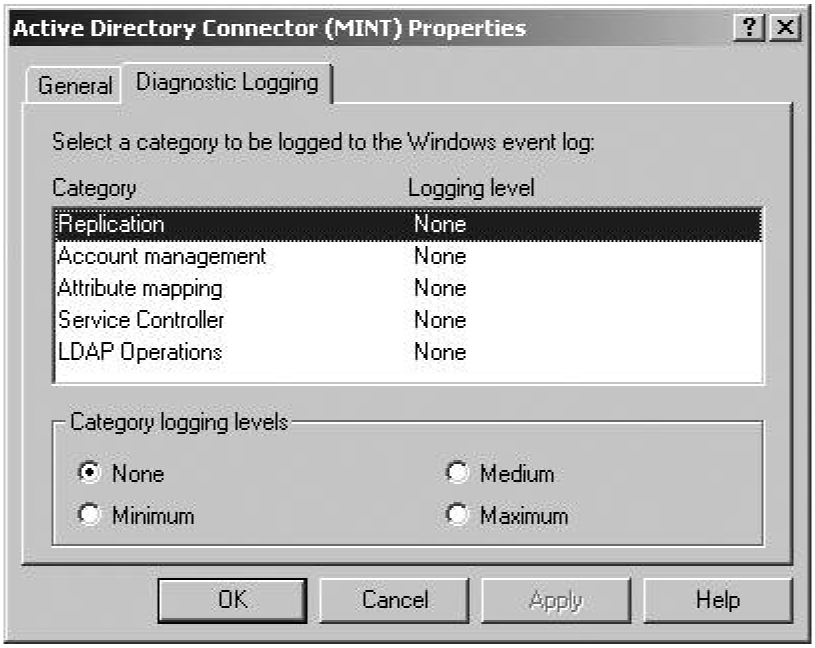
Connection Agreement	Windows Server	Exchange Server	Active Directory Connector service
Leicester's Connection Agreement	MINT	sumac	MINT

If you right-click the agreement in the display pane, you can replicate the agreement immediately. You also can create new agreements from here as well.

If you have more than one Exchange site or multiple Windows 2000 domains that you wish to replicate to or from, you need more than one connection agreement. Similarly, if you have only one Exchange server, but you need to replicate differently for various parts of the service (e.g., the Finance Organizational Unit replicates once nightly to an Exchange container, the Sales Organizational Unit replicates hourly to an Exchange container, but the Marketing Exchange container replicates every 15 minutes back to Active Directory), you will need more than one agreement (in this case, three).

When you set a connector up and try to replicate objects and attributes back and forth, it's not surprising that there might be a few problems at first while you begin to understand how things work. To help with this, you can open up the properties of any connection agreement and specify a set of logging levels for various aspects of the agreement. Figure 17-2 shows these.

Figure 17-2. Diagnostic logging for the connector



Select a category to be logged to the Windows event log:

Category	Logging level
Replication	None
Account management	None
Attribute mapping	None
Service Controller	None
LDAP Operations	None

Category logging levels

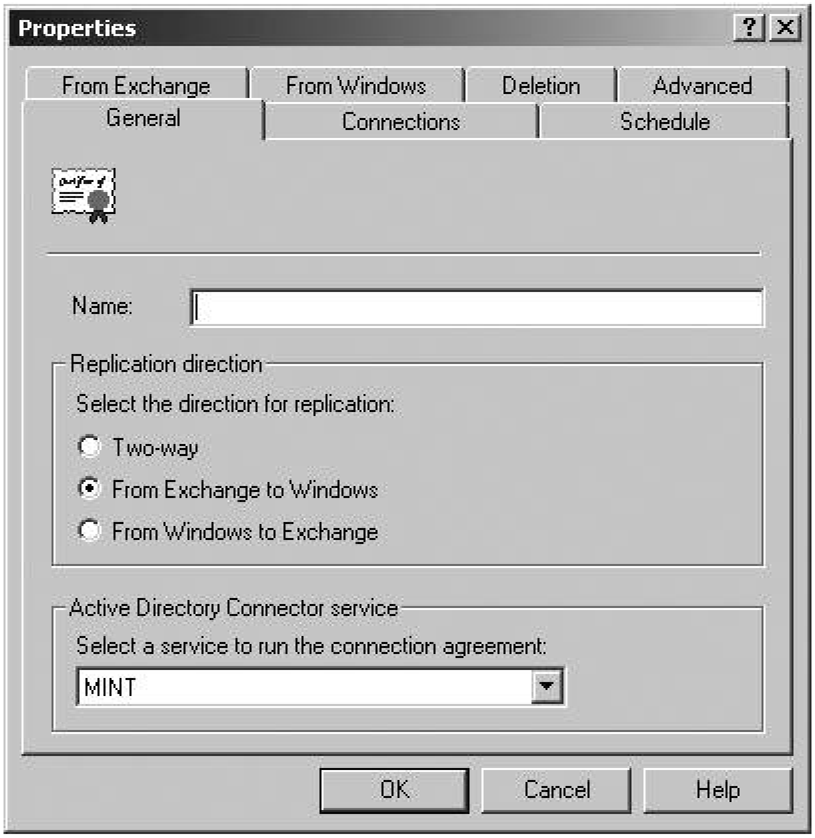
● None ○ Medium
○ Minimum ○ Maximum

When you select a logging level, events are logged to the event log. The highest level produces copious amounts of information and thus is very useful when debugging. When we go to create a new connection agreement from the ADC MMC, seven property pages are available. We've had a lot of personal experience with these pages, so we'll try to help you understand them better. The first page that appears is shown in Figure 17-3 .

The agreement needs a name, which is what the screen is prompting for. The agreement is currently unidirectional from Exchange to Active Directory, and the ADC service is running on the DC called *Mint* at present. Depending on the replication direction that you choose, the From Windows and From Exchange tabs will be modified. Having typed in the name, we then need to tell the ADC what server is hosting the Exchange services and what server is hosting the ADC service. We do that from Figure 17-4 , which is the Connections property page.

Here *Mint* , a DC in the domain CFS, is using Windows Challenge/Response authentication and connecting to the Exchange server *Sumac* , also in the CFS domain, as the Administrator user from the CFS domain. Any account or pair of accounts can be used for the connections; in this example, we've chosen to use a single account, the default administrator account for the test domain. The only requirement is that the account used for the Exchange connection has full privileges in Exchange 5.5 and the account used for the Windows connection has full privilege in Active Directory to be able to update the required databases and view all objects (including deleted objects in active directory).

Figure 17-3. Properties of a new connection agreement



Name:

Replication direction

Select the direction for replication:

○ Two-way

● From Exchange to Windows

○ From Windows to Exchange

Active Directory Connector service

Select a service to run the connection agreement:

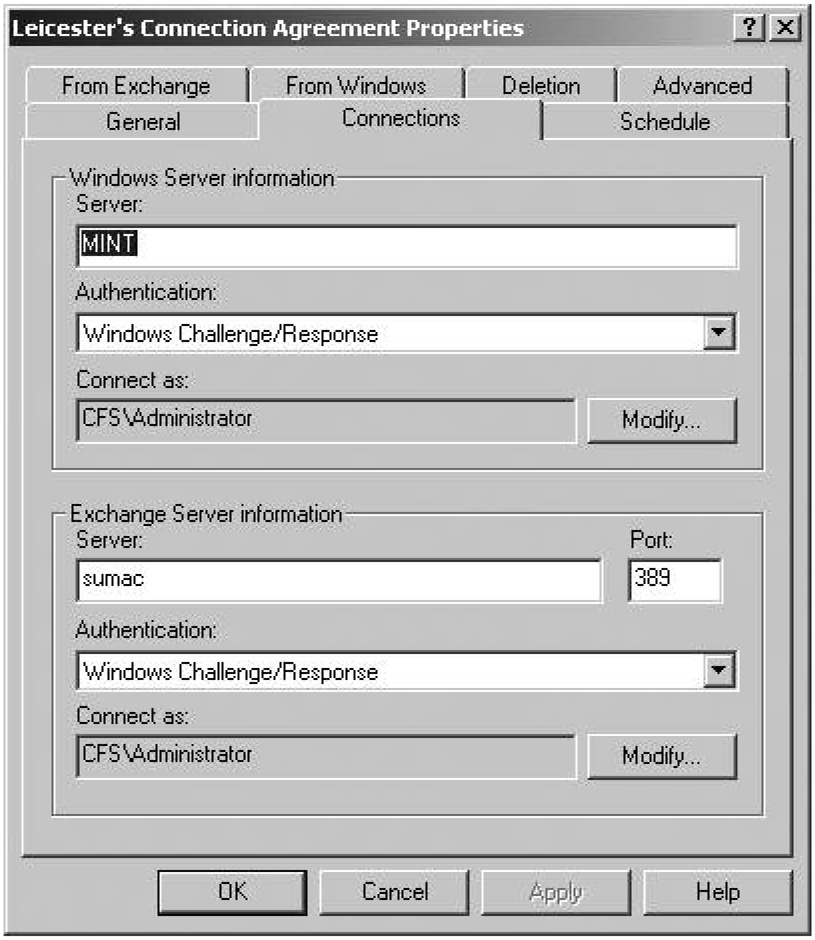
MINT

Once this page is completed, we need to consider when we want the agreement to run. We do this from the Schedule property page shown in Figure 17-5 .

Figure 17-5 appears to indicate that we can specify the replication interval in 15-minute or hourly cycles. In fact, this isn't the case. While this screen allows you to see a weekly replication cycle in 15-minute or hourly slots, replication will occur once during every 15-minute slot. Figure 17-5 shows a replication schedule from 8 A.M. to 10 P.M. This means that replication will occur every 15 minutes between 8 A.M. and 10 P.M.; i.e., 56 times. If we want the replication to occur once an hour, the only recourse is to switch to a 15-minute view and highlight the 15-minute time period when we want replication to take place. For example, we could switch to the 15 minute view and choose 08:45-09:00, 09:45-10:00, 10:45-11:00, and so on, making sure that no other 15-minute slots were enabled.

While we have chosen to replicate at the selected times on this screen, there are two other options available. The first is never to replicate the agreement. If you ever need to stop replicating this agreement, this is where you come to disable replication. The option called Always forces the agreement to constantly replicate with almost no breathing space. Almost as soon as the agreement has finished replicating, it starts the replication cycle again. It is unlikely to be replicating a significant amount of data each time the agreement replicates, as there will have been so little time since the previous cycle. However, one or both databases will still be scanned to see whether

Figure 17-4. Connections property page



Windows Server information

Server: MINT

Authentication: Windows Challenge/Response

Connect as: CFS\Administrator

Exchange Server information

Server: sumac

Port: 389

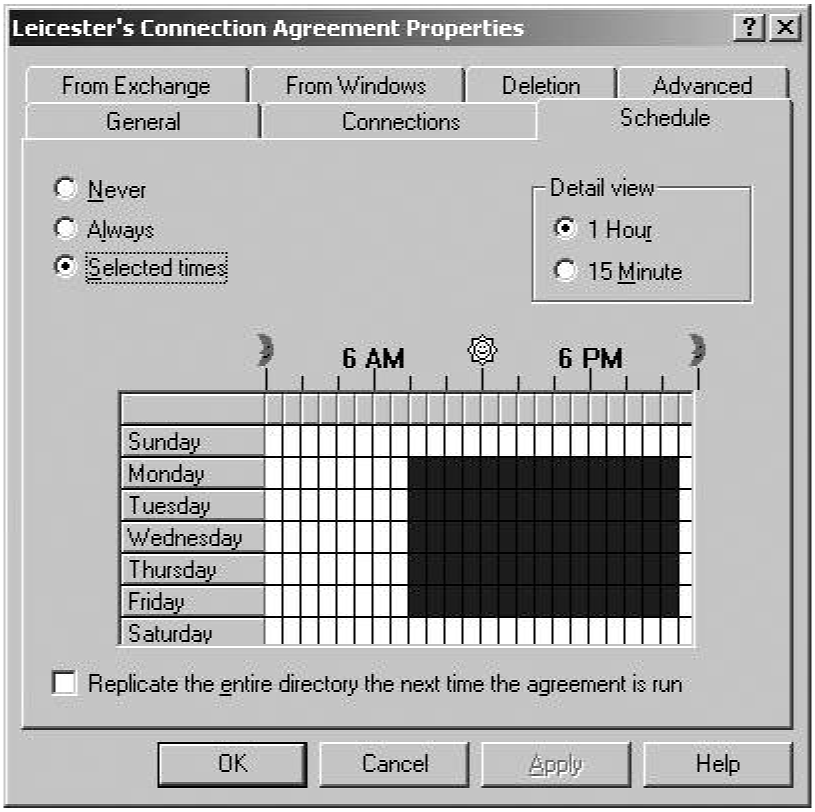
Authentication: Windows Challenge/Response

Connect as: CFS\Administrator

any updates have occurred since last time, so it is important to realize that turning this on will produce a performance hit, however small. Only you will know how much traffic is likely to be replicated between the two databases for your organization, so testing is the only way to see if there is a problem with turning this setting to Always.

The last checkbox is very useful in fully updating one database or another. If you choose to replicate the entire directory, every object in the target is fully updated by every object in the source. But hang on, you may be thinking, if all the items are replicated, what's the point in replicating the whole lot again? Consider that you're setting up the ADC on a new site, replicating from Exchange to Active Directory, and want to make sure that everything works correctly when the data is replicated to Active Directory. To that end, you decide to test-replicate a number of the Exchange Recipients containers to one Active Directory test Organizational Unit. Replication goes well the first time, but you want to do some more tests. You empty the test Organizational Unit of users in Active Directory and then open up the agreement to replicate the entire directory the next time replication takes place. You then can go back to the main agreement, Figure 17-1 , and right-click the agreement to select Replicate Now. Every object is immediately replicated again, just as if this were the first time that the agreement had ever been replicated.

Figure 17-5. Schedule property page



Leicester's Connection Agreement Properties

○ Never
○ Always
● Selected times

Detail view
● 1 Hour
○ 15 Minute

Sunday
Monday
Tuesday
Wednesday
Thursday
Friday
Saturday

□ Replicate the entire directory the next time the agreement is run

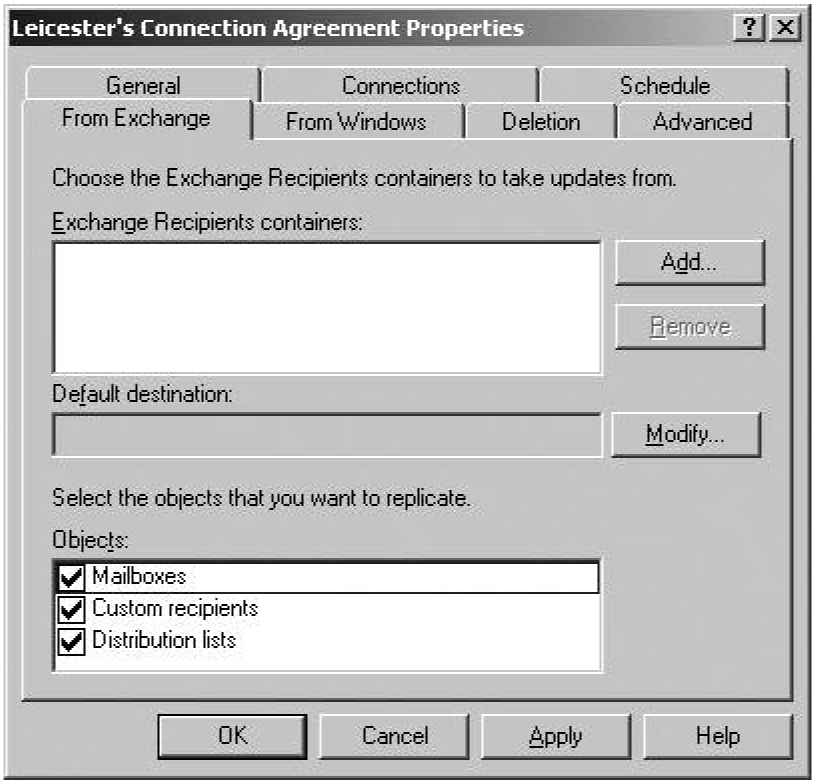
Figure 17-6 shows the property page detailing the settings for replication from Exchange as the source to Active Directory as the target. You can specify for this agreement that mailboxes, custom recipients, and distribution lists will be copied from a series of Recipients containers to a single Organizational Unit in Active Directory.

> Remember that you can have only one target for either direction of a connection agreement. If you want to replicate distribution lists from the Recipients container(s) to a specific Organizational Unit, custom recipients from the Recipients container(s) to another Organizational Unit, and mailboxes to a third Organizational Unit, you need three agreements. Each agreement would replicate one type of source object from multiple recipient containers to a single target Organizational Unit.

The property page relating to replication in the direction from Active Directory to Exchange is very similar, as shown in Figure 17-7 . Here, instead, you specify multiple Organizational Units going to a single Recipients container. Again, users, contacts, and groups can be specified as being copied during replication. In Figure 17-7 , only users are being copied.

The checkbox at the bottom of the screen is used to indicate whether you wish to use or ignore the Access Control Lists that are defined on user, contact, and group objects to filter the items that get replicated. While items that are not mailbox-enabled are

Figure 17-6. From Exchange property page



Leicester's Connection Agreement Properties

Choose the Exchange Recipients containers to take updates from.

Exchange Recipients containers:

Default destination:

Select the objects that you want to replicate.

Objects:

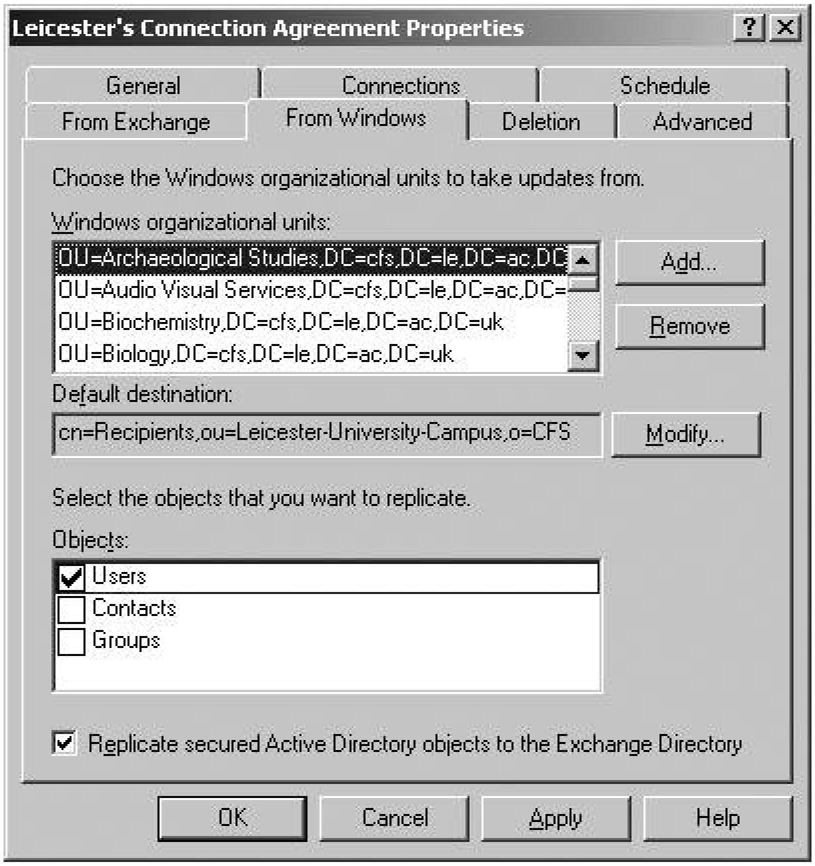
☑ Mailboxes
☑ Custom recipients
☑ Distribution lists

never copied, neither are items whose ACL indicates that they should be filtered out if this checkbox is cleared.

Figure 17-8 indicates what should happen when you replicate through a deletion in either direction. When an Active Directory user is deleted, her mailbox can be removed immediately. Alternatively, the information can be stored in a Comma-Separated-Value (CSV) file for later action using the Bulk Import command in the Exchange Administrator or via a script. If you choose the CSV option, the system sets the Hide Mailbox flag on the object and writes information to a file in this location: *ADC Path\Connection Agreement Name\LocalToRemote\lra.csv.*

The converse also is true. When an Exchange mailbox is deleted, Active Directory users can also be immediately deleted or the information kept in a CSV for later action. In the latter case, the system sets the Mail-Enabled attribute to False and records the deletion information into the file: *ADCPath\Connection Agreement Name\RemoteToLocal\lra.csv* . If you want to use this CSV file to delete the users later, the file first has to be converted to an LDAP Data Interchange File Format (LDF) and then imported into Active Directory using the LDIF Directory Synchronization Bulk Import/Export tool found on a DC: *%systemroot%\system32\ldifde.exe* . The option that you choose depends on your own environment and whether you wish to keep users that have no mailbox or mailboxes that have no corresponding user for a time period to comply with internal regulations.

Figure 17-7. From Windows property page



Choose the Windows organizational units to take updates from.

Windows organizational units:

OU=Archaeological Studies,DC=cfs,DC=le,DC=ac,DC
OU=Audio Visual Services,DC=cfs,DC=le,DC=ac,DC=
OU=Biochemistry,DC=cfs,DC=le,DC=ac,DC=uk
OU=Biology,DC=cfs,DC=le,DC=ac,DC=uk

Default destination:

cn=Recipients,ou=Leicester-University-Campus,o=CFS

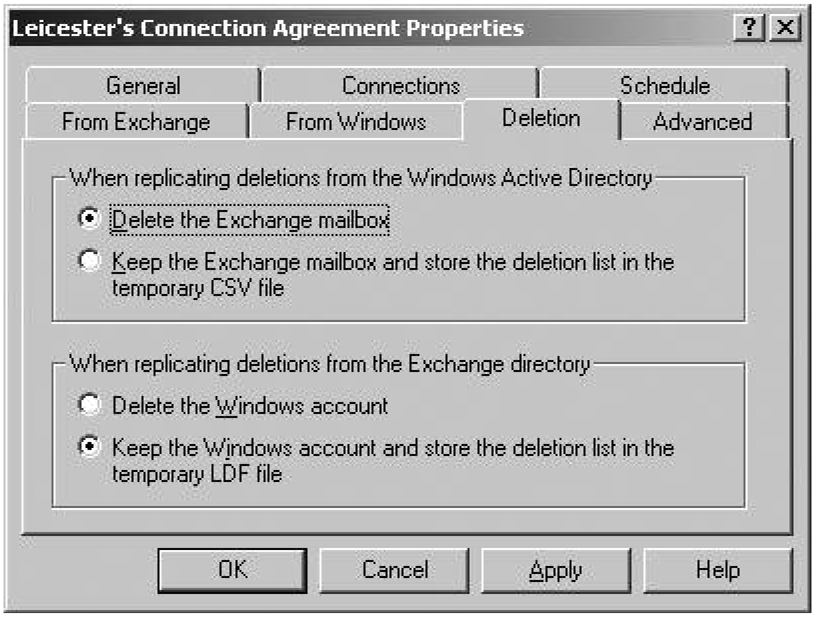
Select the objects that you want to replicate.

Objects:

☑ Users
☐ Contacts
☐ Groups

☑ Replicate secured Active Directory objects to the Exchange Directory

Figure 17-8. Deletion property page



When replicating deletions from the Windows Active Directory

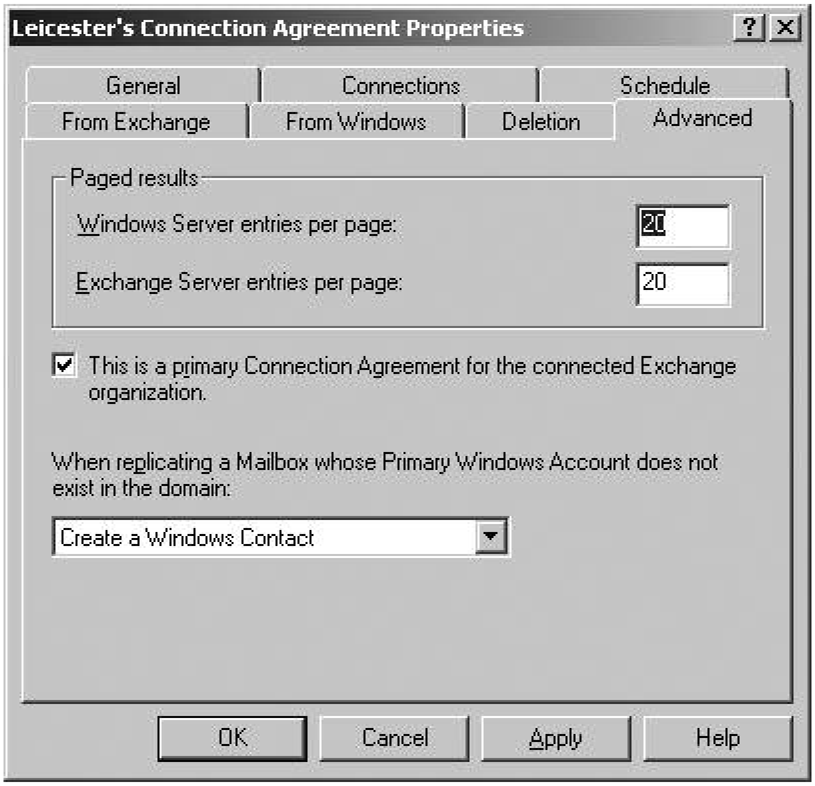
● Delete the Exchange mailbox
○ Keep the Exchange mailbox and store the deletion list in the temporary CSV file

When replicating deletions from the Exchange directory

○ Delete the Windows account
● Keep the Windows account and store the deletion list in the temporary LDF file

The last property page, Advanced, shown in Figure 17-9 , is a selection of items that don't fit anywhere else.

Figure 17-9. Advanced property page



Paged results

Windows Server entries per page: 20

Exchange Server entries per page: 20

☑ This is a primary Connection Agreement for the connected Exchange organization.

When replicating a Mailbox whose Primary Windows Account does not exist in the domain:

Create a Windows Contact

There are certain times when so many changes have been made and need replicating in a single run that the memory needed to store and send them is too large for the DC to cope with. To combat this before it becomes a problem, the ADC can page results, so that the updates are placed on multiple pages, each holding a certain set of updates. Each page is sent to Exchange, and then the system waits for the page to complete updating before continuing. This slows down the process slightly but is much less likely to impede or cripple any systems. The Advanced page allows you to specify the number of entries that you wish to hold for each direction. In normal operations, there shouldn't be any need to alter these values. However, if you do have a lot of memory and believe that your system can cope with hundreds or thousands of updates in one go, you can modify these values.

The simple Primary Connection Agreement checkbox tucked away here belies its importance. A primary connection agreement is one that can create objects in a target directory service; a secondary connection agreement can update only existing objects in a directory service. Here this agreement is a primary agreement, so it has full authority. We can create a number of secondary agreements on other DCs if we wish to enable fault tolerance and load balancing.

Finally, when a mailbox is replicated without an associated user, the system allows one of three options.

A Windows contact can be created, a disabled user can be created, or a fully specified user can be created and enabled. This covers the fact that certain mailboxes may be placeholders for external contacts that do not have associated user accounts, and the ADC needs to know what you want to do with these sorts of replicated items.

The limitations of the ADC are that it is not possible from looking at the set of multiple agreements to see which agreements go in which direction and which containers are copied over in each direction. We think it would have been more useful to have a second tool that acts almost as a map, which says that agreement A replicates mailboxes only from these Active Directory Organizational Units to this Exchange container, and agreement B is bidirectional and replicates all objects in this single Exchange container to this Active Directory Organizational Unit, and vice versa. For complex Active Directory and Exchange organizations that will be slowly adopting Active Directory and Exchange 2000 or 2003, this would have been a useful addition. The only way to do this at present is to somehow incorporate this information into the name of the agreement. That's the only gripe we have, and compared to the usefulness of the tool, it's a very small one indeed.

17.3.2. Mailbox-Enabling Objects via the GUI

Now that the ADC is installed and configured and the schemas have been modified, you can run the Active Directory Users and Computers tool on any client that has Active Directory Connector Management MMC installed on it and see extra property pages relating to the Exchange attributes of users. You will need to enable Advanced view from the View menu of the MMC to see all three pages. Unless a user or group object has been mailbox- or mail-enabled, you will not see any Exchange property pages in ADUC. To mailbox- or mail-enable a user or group, simply right-click on the object and select Exchange Tasks.

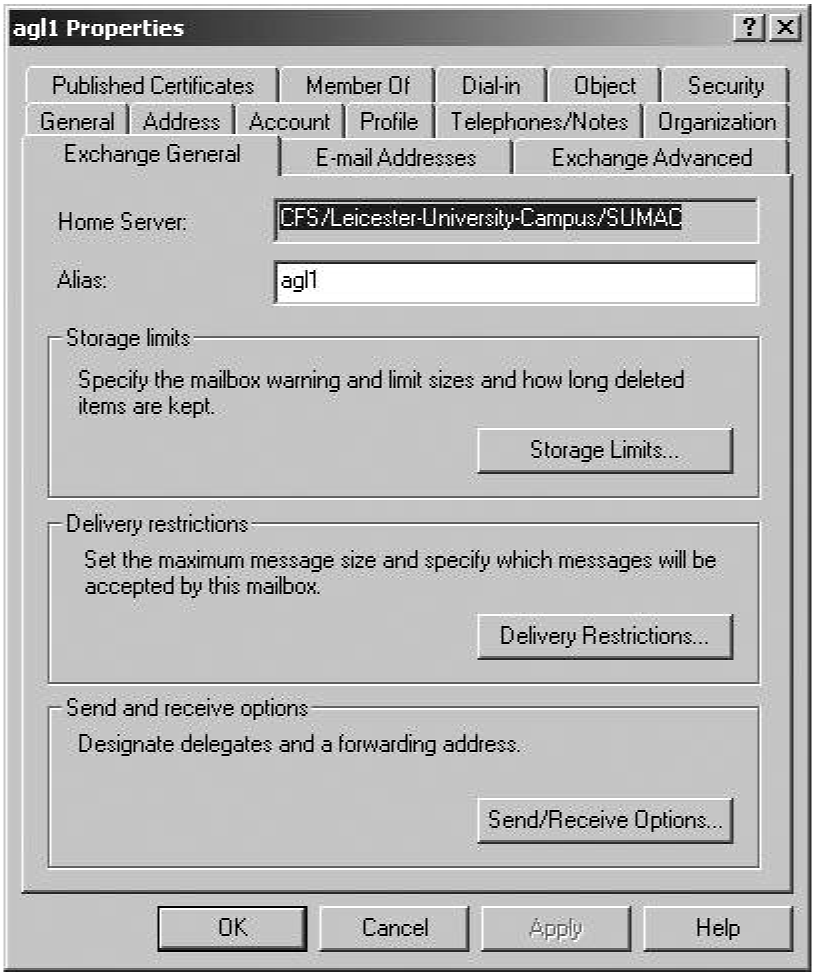
> The extra property pages are not visible from a client that does not have Active Directory Connector Management MMC or Exchange System Manager (ESM) installed on it.

Figure 17-10 shows the Exchange General tab, the first of the three new property pages available to you. It allows you to configure various options that you used to need the Exchange Administrator program to do directly. The property page shown in Figure 17-11 allows you to set new email addresses in any of the available types that Exchange supports.

The page shown in Figure 17-12 allows you to configure the less used and more advanced settings.

If we now go back to the Exchange General property page and click on the Storage Limits button, the screen shown in Figure 17-13 appears. We are not going to go through every option in this manner, but Figure 17-13 serves to highlight an example of when you can get into problems.

Figure 17-10. Exchange General property page



Home Server: CFS/Leicester-University-Campus/SUMAC

Alias: agl1

Storage limits

Specify the mailbox warning and limit sizes and how long deleted items are kept.

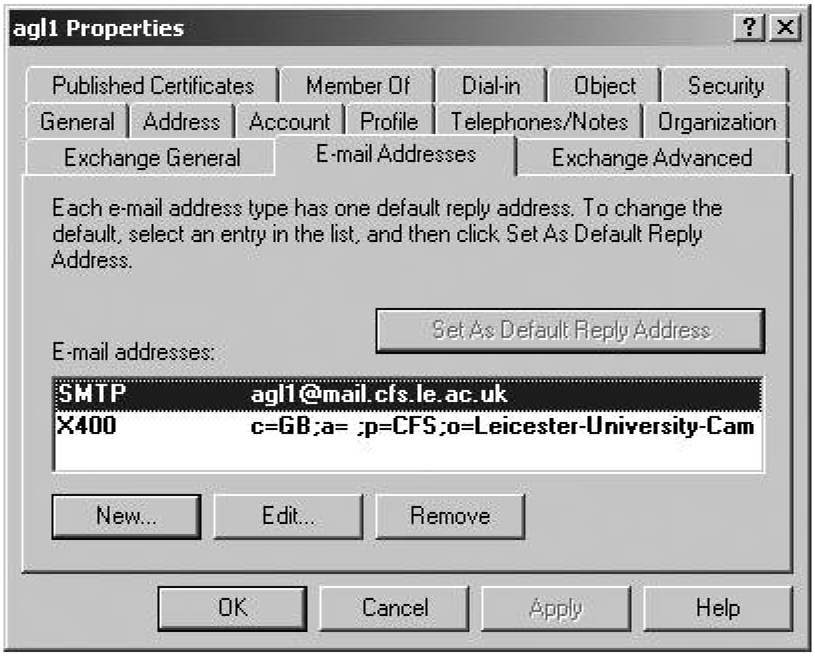
Delivery restrictions

Set the maximum message size and specify which messages will be accepted by this mailbox.

Send and receive options

Designate delegates and a forwarding address.

Figure 17-11. Exchange E-mail Addresses property page



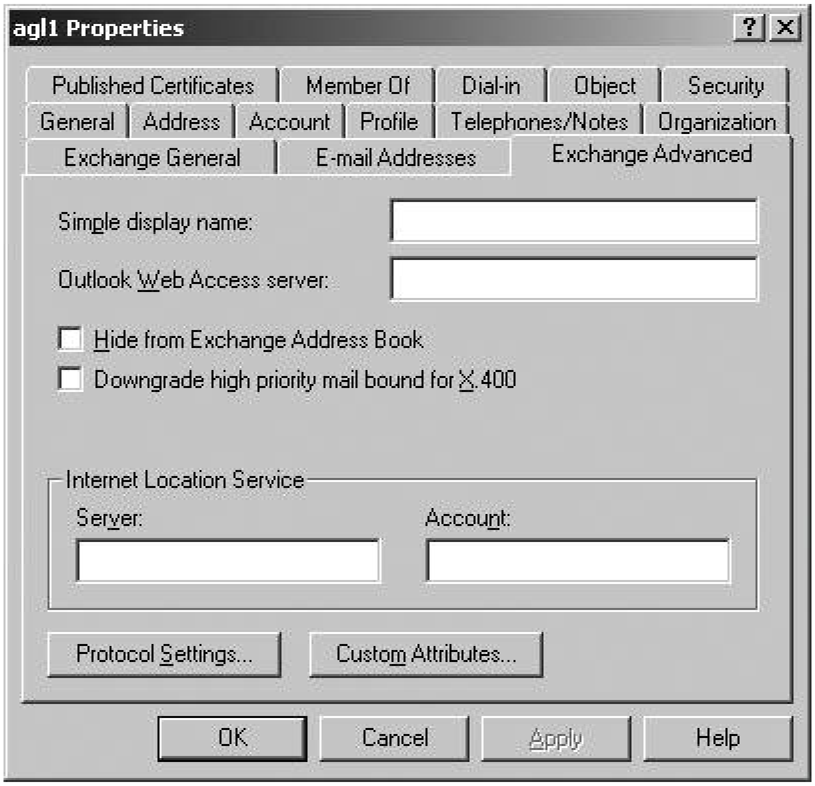
agl1 Properties

Each e-mail address type has one default reply address. To change the default, select an entry in the list, and then click Set As Default Reply Address.

E-mail addresses:

```
SMTP        agl1@mail.cfs.le.ac.uk
X400        c=GB;a= ;p=CFS;o=Leicester-University-Cam
```

Figure 17-12. Exchange Advanced property page



agl1 Properties

Simple display name:

Outlook Web Access server:

☐ Hide from Exchange Address Book

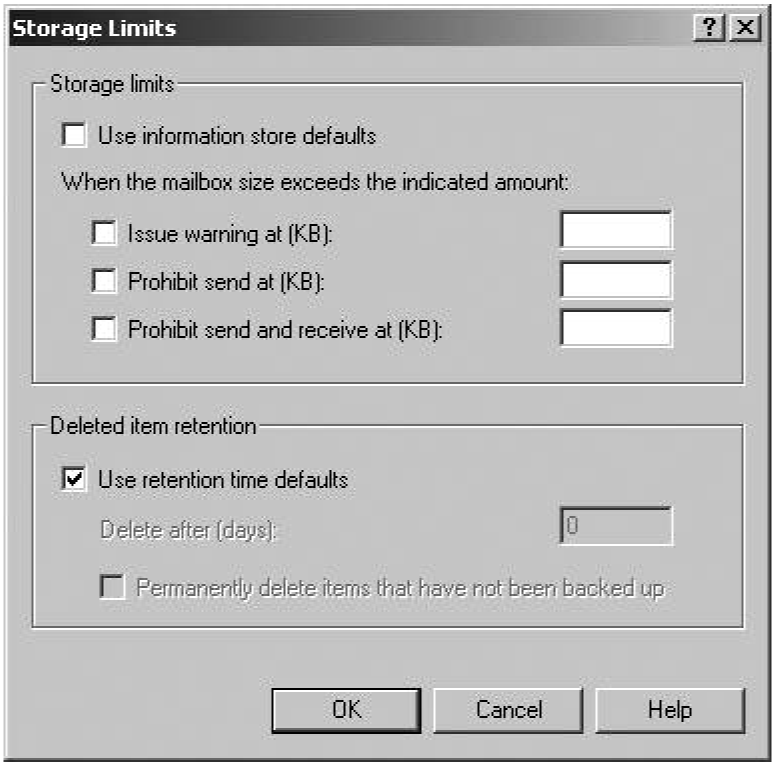
☐ Downgrade high priority mail bound for X.400

Internet Location Service

Server:

Account:

Figure 17-13. Storage Limits options



Storage Limits

Storage limits

☐ Use information store defaults

When the mailbox size exceeds the indicated amount:

☐ Issue warning at (KB):

☐ Prohibit send at (KB):

☐ Prohibit send and receive at (KB):

Deleted item retention

☑ Use retention time defaults

Delete after (days): 0

☐ Permanently delete items that have not been backed up

Any Exchange mailbox can have a set of three custom storage limits for the private information store, the user's own mailbox. The Exchange service as a whole can also have default limits defined; any users who have no custom limits defined get the defaults. These limits cause warnings to be issued to transgressors on a daily basis by default based on whether certain conditions have been met. In addition, as soon as the user exceeds the Prohibit Send limit, he can send mail no more. When he reaches the Prohibit Receive limit, he cannot receive mail any more, and all further mail to that mailbox is returned to the sender. Figure 17-13 shows that for this particular Active Directory user, the "Use information store defaults" checkbox is not checked but cleared. This means that this user is not using the Exchange information store default limits and instead will use the values indicated on the form. But hang on; there are no values on the form; none of the next three checkboxes has been set. This means that you've told the Exchange system not to use its default limits and not to set any custom limits for this user either. In other words, the user has no limits defined for his mailbox. On the second part of the form, you can see that the Deleted Item Retention time, how long the system keeps messages after they have been deleted by the user, is set to the defaults.

It is now possible to manage a lot of the Exchange user functionality from these property pages. If you are used to managing this data on Exchange, and your ADC connection agreement(s) state that data is being transferred one way from Active Directory to Exchange, you need to get into a new mindset of managing the data on Active Directory now. Otherwise, any data that you change on the Exchange server has the potential to be wiped out during two specific replication cycles:

- When any change is made to the same options for the user in Active Directory

- When the connection agreement is told to replicate all data during the next replication cycle

Of course, this also applies to data being replicated one way from Exchange to Active Directory.

If you have an agreement that replicates only one way (Active Directory to Exchange or Exchange to Active Directory), you should not modify the data on the replication target directory directly. This is very bad practice and liable to cause problems. Instead, you should modify the data on the replication source directory and let the data replicate across naturally or force a replication. This ensures the data in both directories stays in synchronization. If you were to modify only the target directory, there is the potential for data from the source directory to overwrite any changes you made to the target directory at a later point in time.

> Chapter 24 has examples on how to mailbox-enable users and other Exchange tasks via scripts and the command line.

17.3.3. Why Bidirectional Replication May Not Solve Your Problems

While you may think that bidirectional replication will solve the problems, in fact, it probably won't unless your Active Directory Organizational Unit structure tends to mirror the setup of your Exchange Recipients containers. While bidirectional replication appears to specifically link up individual objects in Active Directory with objects in the Exchange directoryso that whenever a change is made in one, the corresponding change is made in the otherthis isn't exactly true. In fact, as shown earlier, to replicate from Active Directory to Exchange, you have to designate one or more Organizational Units in Active Directory as the source and only one Recipient container in Exchange as the target. Then the data can be replicated from Active Directory objects in the source Organizational Units to the target container in Exchange. If you wish to have data going from Exchange to Active Directory, you have to specify one or more Recipient containers in the Exchange directory as the source and one Organizational Unit in Active Directory as the target. The point is that you do not have a one-to-one mapping of the containers; you have a many-to-one mapping .

So no matter which direction one-way replication takes place, with only one target in either connection agreement, we have the following problem, best shown as an example. Let's say that we have Test as the only Organizational Unit as the source in the one-way connection agreement and a Recipients container as the target. If we want Exchange modifications to replicate back to Active Directory, then with a one-to-one mapping existing between containers in the agreement, we can simply set the agreement up bidirectionally. But what would happen if we add a second Organizational Unit to the one-way agreement, called Finance? Now a Test user's data gets replicated over to Exchange as before. But when you want any changes to that user's Exchange mailbox replicated back and set the agreement up bidirectionally, you have to tell the system that the single Recipients container that receives updates from Test and Finance now has to replicate its data back to one and only one Organizational Unit. This is a severe problem.

The only solution is to mirror the Organizational Unit structure that you use in your connection agreement with the same structure of Recipients folders in Exchange. To get proper bidirectional replication, we would need to set up two Exchange recipients containers that represented Test users and Finance users and then set up multiple one-to-one connection agreements.

Obviously, when Exchange 2000 comes along and uses Active Directory as its directory service rather than its own Exchange directory service, there will no longer be any need to worry about the ADC and replication of data.

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17.4. Summary

The importance of Exchange in the enterprise is ever increasing. Exchange has steadily eaten away at the messaging market to the point where it is currently the market leader. In fact, the initial driving force behind the move to Active Directory for many organizations is the need to deploy Exchange. Integrating Exchange into Active Directory is no small feat due to its heavy reliance on AD. For companies migrating from Exchange 5.5, the Active Directory Connector (ADC) can help in the transition, but it introduces additional support overhead.

While Exchange can be the most significant application you'll integrate with Active Directory, it is by no means the only one you can or should integrate. In the next chapter, we will dive into more details around the future of Microsoft's Directory Services strategy and how that impacts integration of applications with Active Directory.

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Chapter 18. Active Directory Application Mode (ADAM)

Shortly after Microsoft released Windows 2000 Active Directory, developers and administrators started asking for a standalone Microsoft LDAP service that was similar to Active Directory but didn't have the baggage of Active Directory. Baggage includes DNS requirements, the FRS requirements, Group Policy, and other domain pieces like Kerberos and the legacy SAM stuffbasically, something light and easy to set up and play with, and then tear back down as required. While you can do this with Active Directory, there tends to be additional clean-up and configuration required, and things unrelated to the LDAP functionality can get confused and cause it all to malfunction.

In November 2003, shortly after Windows Server 2003 Active Directory was released, Microsoft released Active Directory Application Mode (ADAM) V1.0 to the web (RTW). This was the product that the developers and administrators had been asking for: Active Directory Lite. ADAM allows developers and administrators to play with Active Directory on Windows XP or Windows 2003 Servers without promoting the local host to a full domain controller. The only DNS requirement is resolution of the hostname. No FRS, no Kerberos, no group policy, no icky domain stuff. In fact, ADAM runs nicely as a regular Windows application that can leverage any Windows Domain authentication or local machine authentication that is available, as well as offering up its own authentication that is completely application specific. It is just as happy in a domain as it is on a standalone machine.

Over the last couple of years, companies large and small (including Microsoft) have been building and deploying ADAM-based applications. Due to the fact that ADAM was released after the security push and didn't have any legacy requirement baggage other than being programmatically compatible with Active Directory, it is, by default, considerably more locked down. Where Active Directory followed the "on or enabled or open by default" mentality, ADAM followed the new "off/disabled/closed by default" approach. From a security standpoint, this is great. Another huge benefit is that many experienced Active Directory administrators and developers will be able to quickly get familiar with ADAM , which will benefit administration, management, monitoring, and application development since it is so similar to Active Directory.

With all of that going for it, you may wonder why you may not have heard more about ADAM since it certainly hasn't received nearly the amount of press that Active Directory has. One reason for this is that ADAM was only released to the web; this tends to put some people off as they may think the support is not quite what the support is for a product officially released on a CD. That is a reason why ADAM is now being packaged with Windows Server 2003 R2. Instead of going out to the web to download ADAM, you simply go to Add/Remove Windows Components and install it on any Windows Server 2003 R2 Server.

This chapter is meant to serve as an introduction to ADAM, not an all encompassing guide. An entire book could be written on ADAM: the cool tools available for it, and how it can be used both with and without Active Directory. There is a considerable amount of information available concerning ADAM on the Microsoft web site; if you find this chapter insufficient for what you need to do, visit http://www.microsoft.com/adam.

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18.1. ADAM Terms

There are several terms used throughout this chapter; here are some simple definitions to help understand the concepts.

Instance

An instance is a single installation of ADAM on a server. Each server can have multiple instances of ADAM installed; they would all be independently managed and use different LDAP and LDAPS ports.

Configuration set

A collection of ADAM instances that replicate with each other and share a common schema as well as the configuration container. Application partitions can be shared amongst the instances that make up the configuration set as well.

Replica

An instance of ADAM that is part of a configuration set and replicates with other ADAM instances.

Partition/naming context

Unique namespace named after the root DN. ADAM will have at least two partitions per instance: the configuration and schema partitions. ADAM can also have multiple application partitions.

Application partition

Type of partition that contains application data. ADAM can have multiple application partitions per instance.

Configuration partition

Type of partition that contains configuration data for the instance or configuration set.

Schema partition

Type of partition that contains the class and attribute mappings.

Bindable object

An object instantiated from an objectClass that has `msDS-BindableObject` listed as a static auxiliary class in the schema definition for the objectClass. The most common Bindable object is the `user` class. Objects of this type can be authenticated by ADAM directly.

Bindable proxy object

An object instantiated from an objectClass that has `msDS-BindProxy` listed as a static auxiliary class in the schema definition for the objectClass. The most common Bindable proxy object is the `userProxy` class. Objects of this type are authenticated by ADAM by proxying the authentication request to Windows.

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18.2. Differences Between AD and ADAM V1.0

ADAM and AD are quite similar, but obviously there are differences or else there would be nothing to talk about. This section isn't intended to be a comprehensive listing of all differences but rather an attempt to catch the major changes and popular "gotchas."

18.2.1. Standalone Application Service

The most obvious difference is that ADAM is set up to run as a standalone application service; it isn't part of the system-level service NETLOGON. This means that instead of the LDAP functions being handled by the *LSASS.EXE* process, they instead run from the *DSAMAIN.EXE* process. The not-so-obvious upshot of this is that ADAM can be stopped or started on demand without having to reboot the machine. It also means ADAM can be updated as needed, again without rebooting the machine. Anytime you had to go anywhere near the LDAP functionality of a domain controller, you were pretty much guaranteed a reboot and had concerns of it restarting properly and users being impacted. All of these concerns are dramatically reduced now because Active Directory in Application Mode is just an application.

In addition to the benefit of stopping and starting on command, the new service implementation allows you to set up multiple instances of ADAM on a single machine each under a different service. Sc instead of having a single Active Directory instance on a machine responding to requests on port 389, you can have multiple ADAM instances on a machine listening on various ports with each instance having an entirely different schema. Now that's flexibility!

18.2.2. Configurable LDAP Ports

Another difference is that with ADAM , you can actually control what ports the LDAP Service is listening on. Active Directory seemed to have some registry entries you could change to specify what ports it listened on. Unfortunately, it was just a dirty trick: the ports were really hard coded in the binaries so that you could modify them in the registry, but it didn't do anything. This is silly because the DNS SRV records have a field describing what port the service is listening on but just wasn't used by the DC Locator functions.

18.2.3. No SRV Records

ADAM doesn't register SRV records in DNS like Active Directory does and unfortunately even registering your own SRV records on behalf of ADAM doesn't make it so the DC location API calls will work for finding ADAM instances. A network trace shows two reasons for this. The first reason is that the DC Locator services don't look at the port field of the SRV record, so if ADAM is running on a different port, the DC Locator service can't connect to it. The second reason is that the DC Locator services send a special UDP LDAP ping to the host and ADAM doesn't know how to respond to that request. This, of course, all makes sense since ADAM isn't a domain controller, but it would be nice to have that functionality to make use of ADAM a trifle more seamless for applications.

Instead of SRV records, ADAM can publish serviceConnectionPoint (SCP) objects in Active Directory for resource location. These are objects in Active Directory that are usually published under the computer object that the service is installed on (this is configurable). The serviceConnectionPoint objects maintain key pieces of information about the ADAM installation in the keywords and serviceBindingInformation attributes. An example of this information is listed in Example 18-1 .

Example 18-1. ADAM SCP example

```
>keywords: partition:DC=joeware,DC=net
>keywords:  1cf21445-f4f5-4451-bff2-d32f511c478b
>keywords:  42eca3c5-ee95-48c8-ab7d-7524ae887239
>keywords: partition:DC=domain,DC=com
>keywords:  9549ae64-a3ee-461a-918f-828f522b0382
>keywords: partition:CN=newpart
>keywords:  450d8cf9-19de-4c3c-817d-d5443fb968f5
>keywords: partition:CN=user
>keywords: partition:DC=test,DC=etherpunk,DC=local
>keywords:  7547aa81-51ad-416f-9ee6-7bfd1f88853d
>keywords: partition:DC=mytest,DC=com
>keywords:  c4d69674-b673-45f9-ad14-b1e488d4a0c8
>keywords:  0a891bbf-1be6-4fe4-9406-3f21355e144e
>keywords: partition:DC=set-con,DC=org
>keywords:  81b58144-7068-410b-bd93-8248109a329b
>keywords: partition:DC=etherpunk,DC=local
>keywords:   partition:CN=Configuration,CN={E28AE3C2-1228-4F6B-917C-56B9757DB796}
>keywords:  47abf207-536a-4ea4-9295-9ef3c7f1fb8c
>keywords: fsmo:naming
>keywords: fsmo:schema
>keywords: instance:ADAM1
>keywords: site:Default-First-Site-Name
>keywords: 1.2.840.113556.1.4.1791
>keywords: 1.2.840.113556.1.4.1851
>keywords:  14b5dcce-8584-4100-8d5b-139b1e8a95b1
>serviceBindingInformation:   ldaps://adamserver.mycorp.com:636
>serviceBindingInformation:   ldap://adamserver.mycorp.com:389
```

As you can see in the example, the serviceBindingInformation attribute shows the actual hostname and ports in use:

```
    >serviceBindingInformation:  ldaps://adamserver.mycorp.com:636
    >serviceBindingInformation:  ldap://adamserver.mycorp.com:389
```

In the keywords attribute, there is more good info. Here are some of the more useful pieces of info about the partitions that are available:

```
>keywords: partition:DC=joeware,DC=net
>keywords: partition:DC=domain,DC=com
>keywords: partition:CN=newpart
>keywords: partition:CN=user
>keywords: partition:DC=test,DC=etherpunk,DC=local
>keywords: partition:DC=mytest,DC=com
>keywords: partition:DC=set-con,DC=org
>keywords: partition:DC=etherpunk,DC=local
 >keywords:  partition:CN=Configuration,CN={E28AE3C2-1228-4F6B-917C-56B9757DB796}
```

Here are the FSMOs held by this instance:

```
>keywords: fsmo:naming
>keywords: fsmo:schema
```

the site the instance is in:

```
>keywords: site:Default-First-Site-Name
```

the instance name that maps to the actual service name on the host:

```
>keywords: instance:ADAM1
```

and some OIDs describing functionality of the instance:

```
>keywords: 1.2.840.113556.1.4.1791
>keywords: 1.2.840.113556.1.4.1851
```

If you choose, you can add additional keywords to help your applications select the proper instance or naming context. For further discussion on using the `serviceCon-nectionPoint` objects for ADAM , see the following:

- Understanding ADAM service publication:

  http://technet2.microsoft.com/WindowsServer/en/Library/80e08d70-0eb5-4ee7-aee6-cdc3c968c87b1033.mspx

- Service Connection Points for Replicated, Host-Based, and Database Services:

  http://msdn.microsoft.com/library/default.asp?url=/library/en-us/ad/ad/service_connection_points_for_replicated_host-based_and_database_services.asp

18.2.4. No Global Catalog

Active Directory has the global catalog in order to easily query for objects across the entire forest hierarchy. You send a standard LDAP query to a special port and you have access to a subset of attributes for all objects in the forest. A single query will allow you to search across the configuration container, the schema, and every default domain partition in the forest. ADAM has multiple partitions but it doesn't have the matching global catalog functionality. Fortunately, the Windows LDAP server accepts a special LDAP control setting that allows you to use one single query that will scan across all of the partitions (or a subset of the partitions like `DC=com`) of an ADAM instance. Unfortunately, this functionality is not available to ADSI scripts and programs, only from the LDAP API-based applications.

There is an option that could work for ADSI and any third-party applications that don't implement the proper LDAP control. It involves implementing GC functionality yourself by setting up another top-level application partition and synchronizing certain objects and attributes from the other application partitions. You then grant read-only access to applications and users that need to query the entire instance and full control to the syncing application. If you are simply looking for a quick lookup of a DN for an object based on a couple of public attributes like `sAMAccountName` , this option might work for you.

> The server control described above is the `LDAP_SERVER_SEARCH_OPTIONS_OID` control. This control combined with the `SERVER_SEARCH_FLAG_PHANTOM_ROOT` flag enables the special full instance search functionality. The control is also available for Active Directory but generally isn't required due to the global catalog functionality. For more information, see:
>
> http://msdn.microsoft.com/library/default.asp?url=/library/en-us/ldap/ldap/ldap_server_search_options_oid.asp

The loss of the global catalog also impacts a special protocol used by Outlook and Exchange, primarily used for Address Book functionality. The Name Service Provider Interface (NSPI) and the back-end Address Book (AB) support functionality are only provided in the Global Catalog code. Stripping out the GC functions also strips out the NSPI and AB functions.

18.2.5. Top-Level Application Partition Object Classes

In Active Directory, application partitions must all be objectclass `domainDNS` objects. ADAM allows application partitions to be of any objectclass, as long as it is a container type object. This means that you can have application partitions that are of many different types including `organizationalUnit` , `container` , `o` , `c` , `l` , or even `user` .

18.2.6. Group and User Scope

The scope of an ADAM group or user is limited to the partition in which it exists; e.g., a group or user created in partition 1 cannot be used to assign permissions on objects in partition 2 nor be added to a group in partition 2. You can, however, add Windows security principals and ADAM security principals from the configuration partition to the groups in other partitions.

18.2.7. FSMOs

In an Active Directory forest, you have two FSMOs for the entire forest (Schema and Domain Naming) and three FSMOs (PDC, RID, and Infrastructure) for each domain. A single domain forest would have a total of five FSMOs, a two domain forest would have 8 FSMOs, etc. ADAM, on the other hand, only has two FSMO roles regardless of the number of partitions or the number of replicas. The two FSMOs are the Naming FSMO and the Schema FSMO, whose roles map to the Active Directory Domain Naming FSMO and Schema FSMO. Just like with Active Directory, if you want to add a new partition, you must contact the Naming FSMO, and if you want to update the Schema, you must contact the Schema FSMO.

The missing FSMOs are generally not too surprising when you think of the functional changes between AD and ADAM. However the lack of the RID FSMO may confuse some administrators because ADAM still uses Security Identifiers (SIDs), and SIDs need to be unique to be of value. The RID FSMO is used in an Active Directory domain to make sure that each security principal that is created has a unique SID value to uniquely identify it within the domain. This was handled in a well-known way in Active Directory as it followed the basic mechanism used for NT4, where RIDs were incremented as they were passed out. ADAM has changed this process so that a RID Master is no longer needed.

Instead of using RIDs, Microsoft has an algorithm in place based on the GUID generation algorithm to generate unique SIDs. Instead of the SIDs having just a unique RID, the last four sub-authorities in the SID are all generated for each user. While one or more of those sub-authorities may match other groups or users, there shouldn't be a collision with all four values because ADAM tries to enforce the uniqueness. This means a RID master is not needed.

What's in a Security Identifier (SID)?

Most every Windows administrator knows what a SID is: a unique variable length identifier used to identify a trustee or security principal. However, few understand what components a SID is comprised of. A little bit of time spent understanding how SIDs are composed can possibly help an administrator understand the underpinnings of Windows security.

Windows security identifiers

A Windows SID is generally composed of two fixed fields and up to 15 additional fields, all separated by dashes like so:

```
S-v-id-s1-s2-s3-s4-s5-s6-s7-s8-s9-s10-s11-s12-s13-s14-s15
```

The first fixed field (`v`) describes the version of the SID structure. Microsoft has never changed this, so it is always 1.

The second fixed field (`id`) is called the identifier authority. In Windows domains and Windows computers, it uniquely identifies the authority involved such as NULL (0), World (1), Local (2), NT Authority (5), etc.

The next 15 fields (`s1` -`s15`) are not required for every SID and in fact, most SIDs only have a few of these fields populated. These additional fields are called sub-authorities and help uniquely identify the object being referenced. The last sub-authority on most SIDs is generally called the RID. This is the value that a domain or computer increments to create unique SIDs.

With that information, you can now look at a SID such as S-1-5-10 and determine that it is a version 1 SID issued by the NT Authority. This SID is special and is called a Well-Known SID, representing NTAUTHORITY\SELF. Another Well-Known SID is S-1-1-0, which is a version 1 World SID; it represents Everyone.

There are several other Well-Known SIDs with various values. They are easily identifiable because they don't fit the format of normal computer and domain SIDs. These normal SIDs usually look like this:

```
S-1-21-xxx-yyy-zzz-r
```

where the values for *xxx* , *yyy* , and *zzz* are randomly generated when the computer or domain is created. The RID value `r` could either be a consecutive number issued by the RID generation routine or a Well-Known RID assigned to certain security principals that exist in every domain. An example of a Well-Known RID is 500, which translates to the built-in administrator account.

ADAM security identifier

ADAM changed the use of the SID fields for ADAM Trustees and Security Principals slightly. The new format looks like this:

```
S-v-id1-id2-r1-r2-r3-r4
```

The first fixed field (`v`) still describes the version of the SID structure. Although the use of the various fields has been slightly modified, the binary format of the SID structure is identical; Microsoft didn't change the version, and it is still always 1.

The second and third fixed fields (`id1-id2`) are the identifier authority and are specific to the directory partition. Each partition in an ADAM instance will have a unique combination of these values.

The next four fields (`r1` -`r4`) are not required for every SID. The built-in groups will only have `r1` populated, and they will be populated with Well-Known RID values. The built- in groups are Readers (514), Users (513), and Administrators (512). Any other objects created that need SIDs will have r1 -r4 populated with unique combinations of randomly generated values.

It is possible to encounter Windows SIDs inside of ADAM. They are easily identified because they follow the Windows SID format instead of the ADAM format. These Windows SIDs are used to either identify Windows Trustees or grant permissions inside of ADAM to Windows Trustees. For example, you will add the SID for a Windows user to the Administrators group of any partition in order to grant that Windows user administrator rights over the partition.

18.2.8. Schema

The default ADAM schema is a very light-weight schema in comparison to the default AD Schema. Initially it only has 44 classes and 268 attributes, which is quite sparse. Microsoft supplies a couple of LDIF files with ADAM so you can initially build up the schema to instantiate some Microsoft standard objects, such as user and inetOrgPerson objects. Extension of the schema beyond this is fully supported and similar to the process used to extend the AD Schema.

Another difference with the schema is that you can have multiple schemas on a single machine with ADAM. Each instance of ADAM can have its own schema, and you can install multiple instances.

18.2.9. Service Account

AD runs in the LSASS process on domain controllers as LocalSystem . The ADAM service runs as NT AUTHORITY\NetworkService or you can specify any normal Windows user ID.

18.2.10. Configuration/Schema Partition Names

ADAM, like AD, has both configuration and schema partitions. Unlike AD, there is no root domain or root partition, so the names of these critical partitions are based on a randomly generated GUID and have nothing to do with the application partitions that exist in the instancee.g., CN=Configuration,CN={E28AE3C2-1228-4F6B-917C-56B9757DB796} .

18.2.11. Default Directory Security

The default security in Active Directory is extremely open. By default, any user that is from the domain or any trusted domain can look at most attributes of most every object. Attempts to lock down AD can be met with frustration, confusion, and applications blowing up. ADAM completely reversed this. By default, normal users do not have read access to anything but the schema. The only Access Control Entries (ACEs) defined on the application partitions are read permissions for the readers group, full control for administrators, and minimal permissions for replication for the instances group used for replicas.

18.2.12. User Principal Names

Active Directory user principal names follow RFC822 email address formatting rules. ADAM has no so such limitation; instead of using joe@mycorp.com , you can simply use *joe* for the UPN. While Active Directory doesn't enforce userPrincipalName values, ADAM does in fact enforce this uniqueness.

18.2.13. Authentication

There are a few differences that must be mentioned in the area of authentication . To start with, there is some good news. You aren't locked into the type of objects that you can bind with. Any object can be used for binding, as long as it is derived from a class that includes the msDS-BindableObject auxiliary class in the schema definition and has a valid password value set for unicodePwd .

The next difference, unfortunately, is that ADAM V1.0 bindable objects can only use simple bind authentication. This means that if you want secure binding with ADAM users or other ADAM bindable objects, you must set up a certificate and encrypt the communication channel using SSL. In order to use secure authentication without SSL, you have to use simple authentication and security layer (SASL) binds with either Windows local or domain users. By default, an ADAM user can be authenticated over the standard LDAP port with a clear text simple bind. You can override this and force an SSL requirement by setting RequireSecureSimpleBind=1 in the msDS-Other-Settings attribute of the Directory Service attribute.

The last difference to mention here is bind redirection. ADAM allows you to configure a bindable proxy object, which links to a Windows user. The user can use a simple bind to ADAM, which then proxies the authentication request to Windows in a secure manner. This is used when an application cannot use the Windows security principals directly or possibly if you want to disguise the back-end Windows account. Unlike ADAM user simple bind authentication, the default for using a simple bind for userProxy objects is to require an SSL connection. This can be overridden by setting RequireSecureProxyBind=0 in the msDS-Other-Settings attribute of the Directory Service attribute.

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18.3. ADAM R2 Updates

There were several changes in the ADAM R2 release. Unless otherwise noted, these changes apply both to ADAM R2 and the Service Pack 1 release for RTW ADAM V1.0. Most of these changes are directly related to feedback from administrators and developers who took the time to post in the various Active Directory newsgroups or submit requests to Microsoft. The Microsoft Directory Services group is very responsive to feedback; if you have suggestions for improvement or have found issues, be sure to document the ideas and post them in the Active Directory newsgroups.

18.3.1. Users in the Configuration Partition

ADAM now allows you to create `user` and `userProxy` objects in the configuration partition. These users can then be added to any group in any partition. So you could add the user to the configuration partition's administrators group, which is nested in the administrators group of all application partitions. The change allows an ADAM user to administrate an ADAM instance instead of having the requirement to use a Windows user. This new capability is enabled by setting `ADAMAllowADAMSecurityPrin-cipalsInConfigPartition=1` in the `msDS-Other-Settings` attribute of the Directory Service object.

18.3.2. Password Reset/Change Chaining to Windows

Password change requests to bindable proxy objects (such as `userProxy`) are now chained directly to Windows. Previously Windows user passwords needed to be managed within Windows and any requests sent to ADAM returned an error. No configuration changes are required to enable this.

18.3.3. Virtual List View (VLV) Searching

ADAM gets the VLV searching capability available in Windows Server 2003 Active Directory. VLV allows you to display a subset of the result set without returning every entry. No configuration changes are required to enable this.

> Although there isn't anything you have to enable to get VLV to work with ADAM, it is likely that you will want to make some changes to better support it. By default, VLV is not efficient when used against an ADAM directory. Also, due to how VLV is implemented in ADAM, you can actually have LDAP query failures if too many objects match the query filter. See the ADAM Schema section in this chapter for more details.

18.3.4. Confidentiality Bit

The confidentially bit functionality added to AD in Windows Server 2003 Service Pack 1 was also added to ADAM. However, the security model and default permissions of ADAM are so much better, this isn't very exciting because it really isn't needed.

18.3.5. New and Updated Tools

One of the biggest initial complaints with ADAM V1.0 was a lack of tools . Microsoft helped out in this area by creating new tools like *ADAMSync* and *ADSchemaAnalyzer* and updating older tools like LDP by giving a better ACL Editor.

18.3.6. Installation

The installation process for ADAM R2 has matured and is updated to reflect its integration into the base media. Instead of running a separate installation executable, you now select ADAM to be installed from the Add/Remove Windows Components from the Add/Remove Programs dialog. In addition, if you want to add a new instance, you have a Start Menu selection to do so. You no longer have to rerun the entire installation executable.

18.3.7. Authentication

The R2 and ADAM SP1 have added support for Digest authentication of native ADAM principals; this resolves the previous requirement to use SSL for binding with ADAM principals.

18.3.8. R2 ADAM for R2 Server Only

The R2 version of ADAM can only be loaded on Windows Server 2003 R2 servers. This could be a bit of a surprise to some since ADAM V1.0 could be loaded and used on Windows XP or Windows Server 2003. Another change here is that ADAM V1.0 could be redistributed with your applications; this is not the case with ADAM R2. Fortunately, ADAM SP1 can run on XP and be redistributed; you simply need to install it (or upgrade an existing install) like you did with the original V1.0 product.

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18.4. ADAM R2 Installation

A Windows Server 2003 R2 server does not automatically have ADAM up and running. So in order to use it, you must first install it. Fortunately, the installation routine is a rather trivial process that you can complete in short order. Microsoft also delivers on the promise of reduced reboots in that you will not need to reboot after installing ADAM.

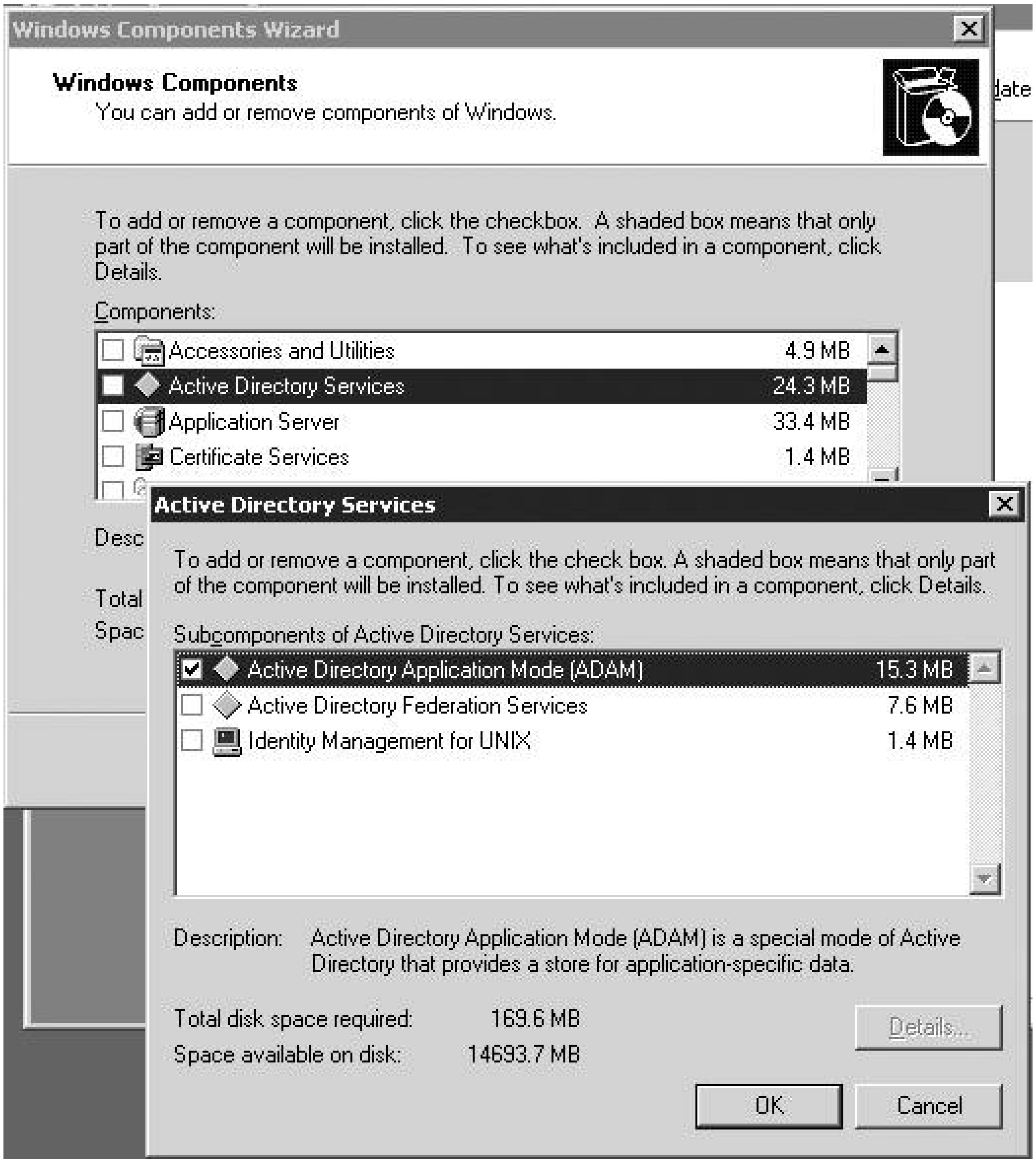
The ADAM installation is broken up into two main pieces, installation of the base components and installation of new instances. The base component installation only needs to occur once per server while new instance installations will occur every time you want to install a new instance or replica of an existing instance.

18.4.1. Installing Components

Base component installation is as simple as opening up the Add/Remove Programs Dialog, selecting Windows Components, clicking on the proper checkbox, and hitting Next a couple of times.

The R2 installation adds a new category of Windows Components named Active Directory Services; if you select the Details button, you will be presented with several new feature packs including ADAM. Select the checkbox that corresponds to this selection (see Figure 18-1), click on OK, and then click Next until you see the dialog indicating you have successfully completed the Windows Component Wizard and are presented with a Finish button.

Figure 18-1. Active Directory Services Windows components



Windows Components

You can add or remove components of Windows.

To add or remove a component, click the checkbox. A shaded box means that only part of the component will be installed. To see what's included in a component, click Details.

Components:

□	Accessories and Utilities	4.9 MB
□	Active Directory Services	24.3 MB
□	Application Server	33.4 MB
□	Certificate Services	1.4 MB

To add or remove a component, click the check box. A shaded box means that only part of the component will be installed. To see what's included in a component, click Details.

Subcomponents of Active Directory Services:

☑	Active Directory Application Mode (ADAM)	15.3 MB
□	Active Directory Federation Services	7.6 MB
□	Identity Management for UNIX	1.4 MB

Description: Active Directory Application Mode (ADAM) is a special mode of Active Directory that provides a store for application-specific data.

Total disk space required: 169.6 MB

Space available on disk: 14693.7 MB

18.4.2. Installing a New ADAM Instance

Now that you have the component installation completed, you will probably want to actually install a new instance of ADAM. This process is also quite simple, though not as trivial as the component install. When you install a new instance, you need to have answers to the questions listed in Table 18-1.

Table 18-1. New instance installation questions

Question	Description	Example
Unique instance or replica? (Figure 18-3)	Do you want to replicate the configuration and schema with an existing instance, or do you want a completely new instance?	Unique instance
Instance name? (Figure 18-4)	This value is appended to the string "ADAM_" to specify the ADAM service name running this instance and listed in the Add/Remove Programs dialog.	AddressBook
LDAP port number? (Figure 18-5)	The TCP port you should listen on for standard LDAP requests.	389
SSL port number? (Figure 18-5)	The TCP port you should listen on for SSL-based Secure LDAP (LDAPS) requests.	636
Create application directory partition? (Figure 18-6)	Select whether you would like to have the instance creation process create an application partition. This is recommended when you first set up ADAM.	Yes
Partition name? (Figure 18-6)	The name to use for the initial application partition, only needed if you decide to have ADAM create the initial partition during instance installation.	`CN=addressbook`
Datafile location? (Figure 18-7)	Where do you want the ADAM datafiles located?	*E:\ADAM\AddressBook\data*
Data recovery files? (Figure 18-7)	Where do you want the ADAM log files located?	*E:\ADAM\AddressBook\data*
Service account? (Figure 18-8)	Service account to use for running this ADAM instance. Network Service is recommended unless the server is member of NT4 Domain or in a workgroup and you need replicas.	Network Service
Initial administrator? (Figure 18-9)	What group or user should be initially assigned administrative rights over this instance?	Currently logged on user
Import LDIF files? (Figure 18-10)	Specifies whether or not you would like to import some of the basic MS schema definitions for user, userProxy, inetOrgPerson, and Authorization Manager.	Import
Files to import? (Figure 18-10)	Select which of the displayed LDIF files you would like to import.	*MS-InetOrgPerson.LDF* *MS-User.LDF* *MS-UserProxy.LDF*

When you are prepared with responses to all of the questions in Table 18-1, you initiate the instance installation by selecting the Create an ADAM Instance menu pick (see Figure 18-2).

This will launch a normal Windows installation wizard. The first dialog of consequence (see Figure 18-3) asks about whether you want to install a unique instance of ADAM or if you would like to create a replica of an existing instance. (Replicas will be covered in the section "Installing an ADAM Replica.") When you install a unique instance, you are creating an instance that has no connection to any other ADAM instance and that has a fresh ADAM schema and all default configuration settings. You will not be able to configure this instance to replicate with any other instances that currently exist, though you could create another new instance and install it as a replica to this instance. The default selection in this dialog is "A unique instance."

Figure 18-2. Create an ADAM Instance menu pick

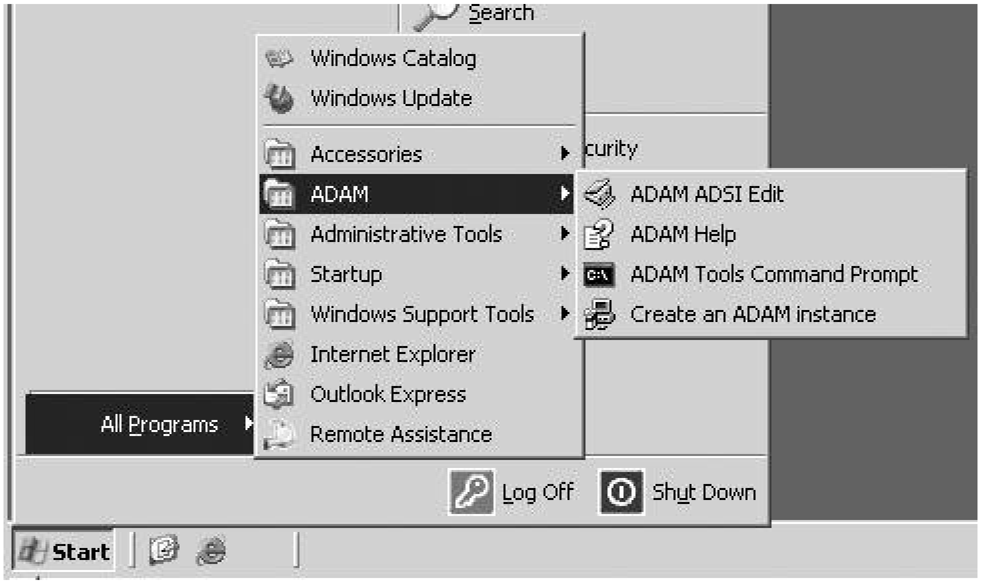
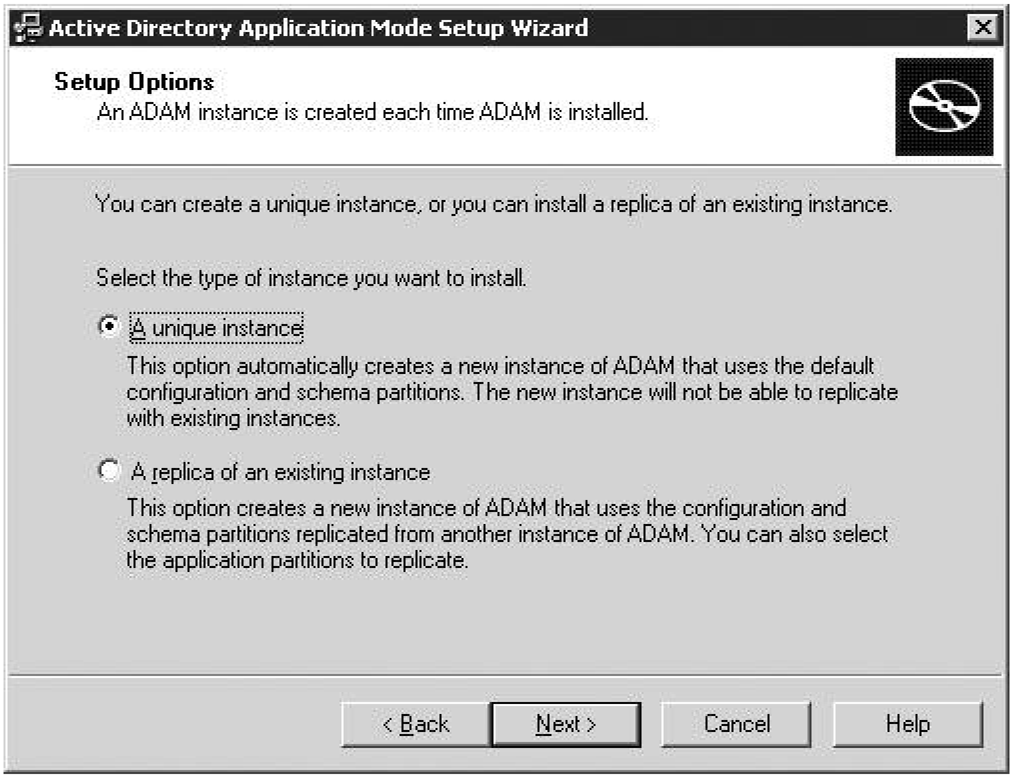


Figure 18-3. Setup Options dialog



Active Directory Application Mode Setup Wizard

Setup Options

An ADAM instance is created each time ADAM is installed.

You can create a unique instance, or you can install a replica of an existing instance.

Select the type of instance you want to install.

● A unique instance

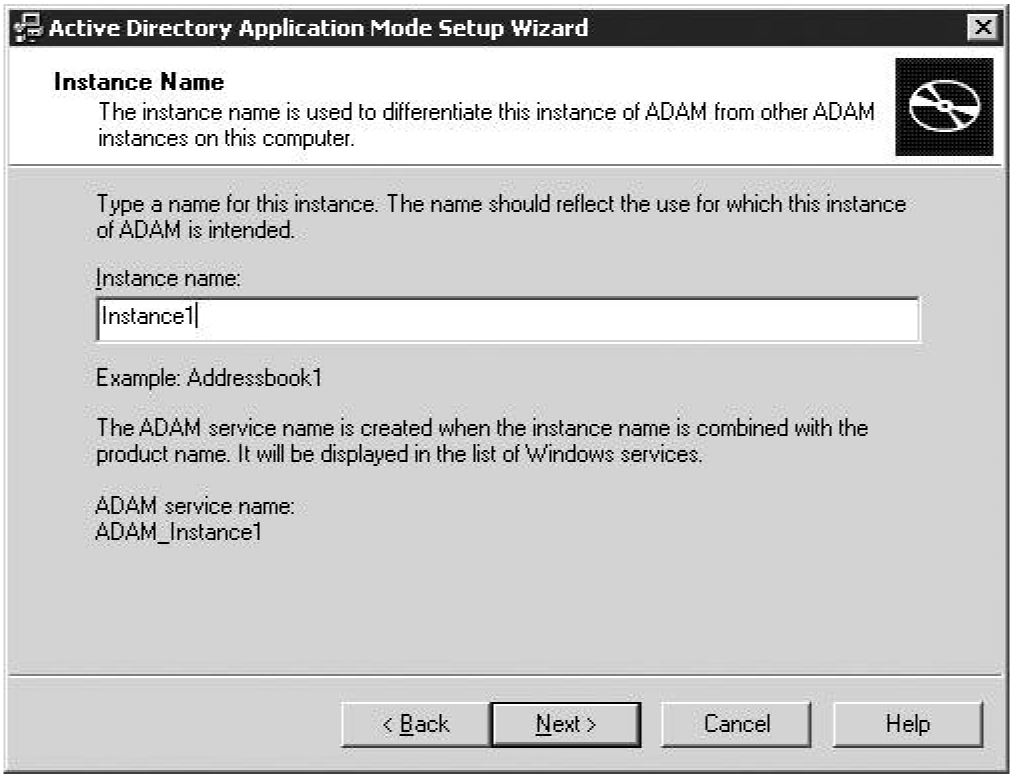
This option automatically creates a new instance of ADAM that uses the default configuration and schema partitions. The new instance will not be able to replicate with existing instances.

○ A replica of an existing instance

This option creates a new instance of ADAM that uses the configuration and schema partitions replicated from another instance of ADAM. You can also select the application partitions to replicate.

The next dialog (see Figure 18-4) allows you to specify the name of the instance. This name is appended to the string `ADAM_` and used for the name of the service running the instance. The name is also used in the Add/Remove Programs dialog, so you can later uninstall this instance if necessary. The default instance name for the first instance installed on a server is *Instance1*. If you use the name Instance1, the next time the default instance name will be *Instance2*, etc.

Figure 18-4. Instance Name dialog



Active Directory Application Mode Setup Wizard

Instance Name

The instance name is used to differentiate this instance of ADAM from other ADAM instances on this computer.

Type a name for this instance. The name should reflect the use for which this instance of ADAM is intended.

Instance name: Instance1

Example: Addressbook1

The ADAM service name is created when the instance name is combined with the product name. It will be displayed in the list of Windows services.

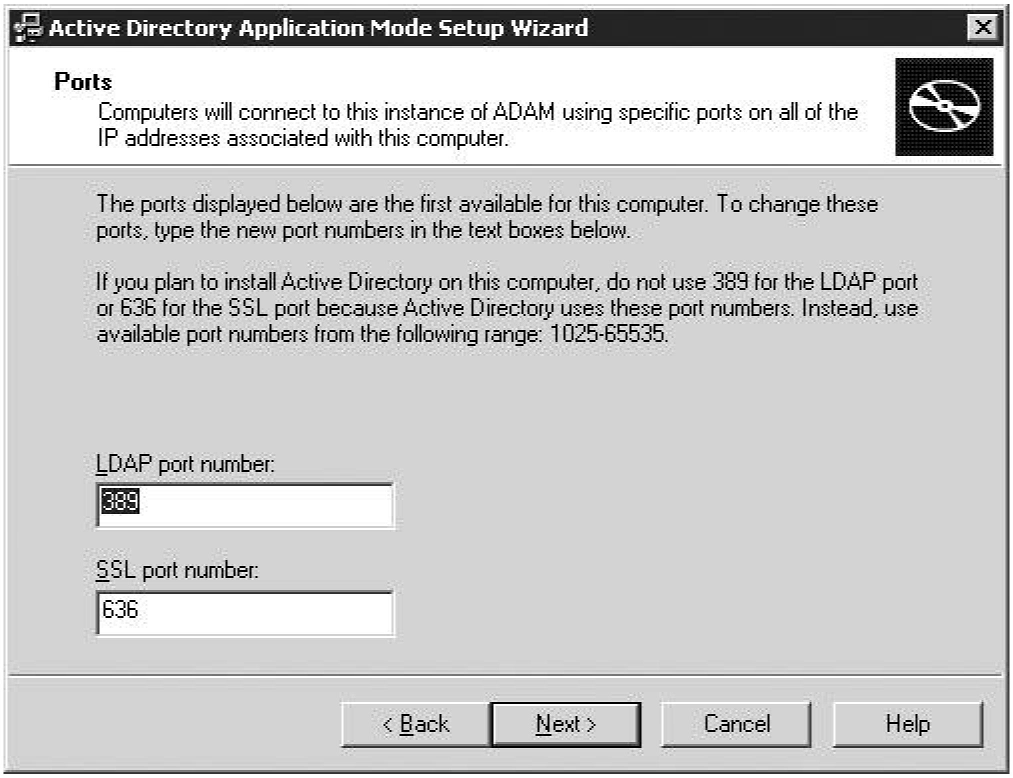
ADAM service name:
ADAM_Instance1

After you choose your instance name, you will be presented with a dialog (see Figure 18-5) that allows you to specify the ports to use both for standard LDAP and LDAPS. The default ports are *389* and *636*; you should stick with these ports unless you know that your applications are flexible enough to allow you to specify different ports.

The only partitions created by default in ADAM are the configuration and schema partitions. The instance installation allows you to create one initial application partition in the Application Directory Partition dialog (see Figure 18-6). The default for this dialog is *No, do not create an application directory partition*. If you change the default, you will enter the DN of the partition you would like to create in the Partition name field.

ADAM allows you to choose where to place your database and log files (see Figure 18-7). The database file location is specified in the "Data files" field and includes the DIT file, as well as the EDB and CHK files. The log file location is specified in the Data recovery files field and includes the log files that hold the ESE transaction information. In high-performance configurations, depending on the disk configuration of the server, it is usually recommended to split up these two sets of files onto separate physical drives. At the very least, you will want to move them from the default location, which is on the system drive in the *Program Files\Microsoft ADAM\<instancename>* folder.

Figure 18-5. LDAP/LDAPS port selection



Active Directory Application Mode Setup Wizard

Ports

Computers will connect to this instance of ADAM using specific ports on all of the IP addresses associated with this computer.

The ports displayed below are the first available for this computer. To change these ports, type the new port numbers in the text boxes below.

If you plan to install Active Directory on this computer, do not use 389 for the LDAP port or 636 for the SSL port because Active Directory uses these port numbers. Instead, use available port numbers from the following range: 1025-65535.

LDAP port number: 389

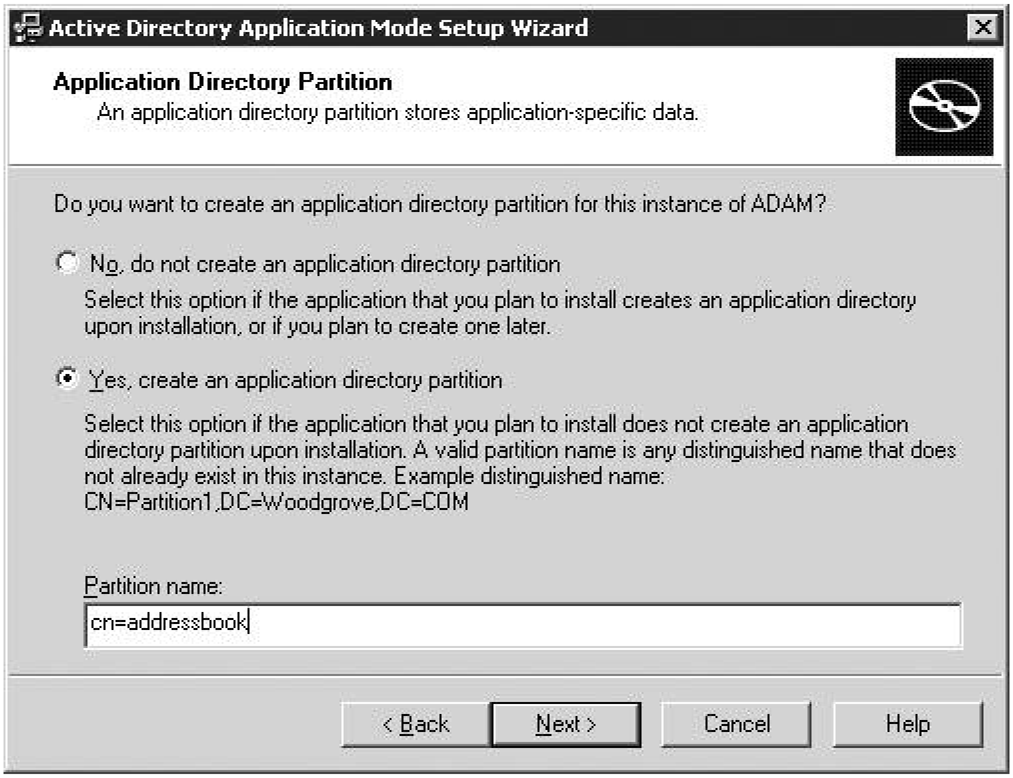
SSL port number: 636

Microsoft has written ADAM so that, by default, it runs as the Network Service account. This is a very good thing, and you should stick with this default. However, if you do not want to run as Network Service, you have the option to change the security context to any Windows user you choose (see Figure 18-8). You should only need to make this change if you are running in a Windows NT4 domain or Workgroup mode and want to have replicas. In that case, ADAM will need to use a Windows userid to enable replication.

The next dialog you encounter is critically important; it is the dialog where you specify the initial administrator(s) of the ADAM instance (see Figure 18-9). The default is the user installing the instance; consider using the local Administrators group instead or, better yet, creating a local group specific to this ADAM instance or domain group if you intend to configure a configuration set.

Quite unlike most other Windows application, the server's Administrators group has no control over ADAM's internal data or configuration unless the group is specifically added to the configuration container's Administrators group (or role if you prefer). This is great from a security standpoint, unless you somehow lose access to the users placed in that group; if that happens, you have lost control of the instance.

Figure 18-6. Application Directory Partition dialog



Application Directory Partition

An application directory partition stores application-specific data.

Do you want to create an application directory partition for this instance of ADAM?

○ No, do not create an application directory partition

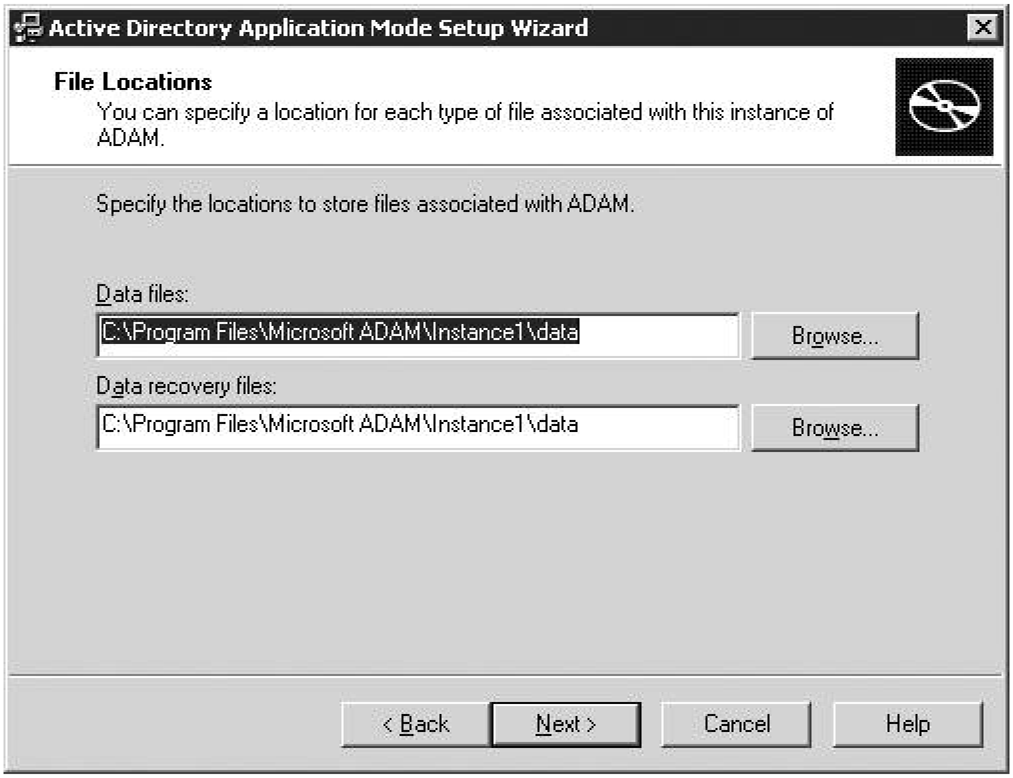
Select this option if the application that you plan to install creates an application directory upon installation, or if you plan to create one later.

● Yes, create an application directory partition

Select this option if the application that you plan to install does not create an application directory partition upon installation. A valid partition name is any distinguished name that does not already exist in this instance. Example distinguished name: CN=Partition1,DC=Woodgrove,DC=COM

Partition name: cn=addressbook

Figure 18-7. ADAM File Location dialog



Active Directory Application Mode Setup Wizard

File Locations

You can specify a location for each type of file associated with this instance of ADAM.

Specify the locations to store files associated with ADAM.

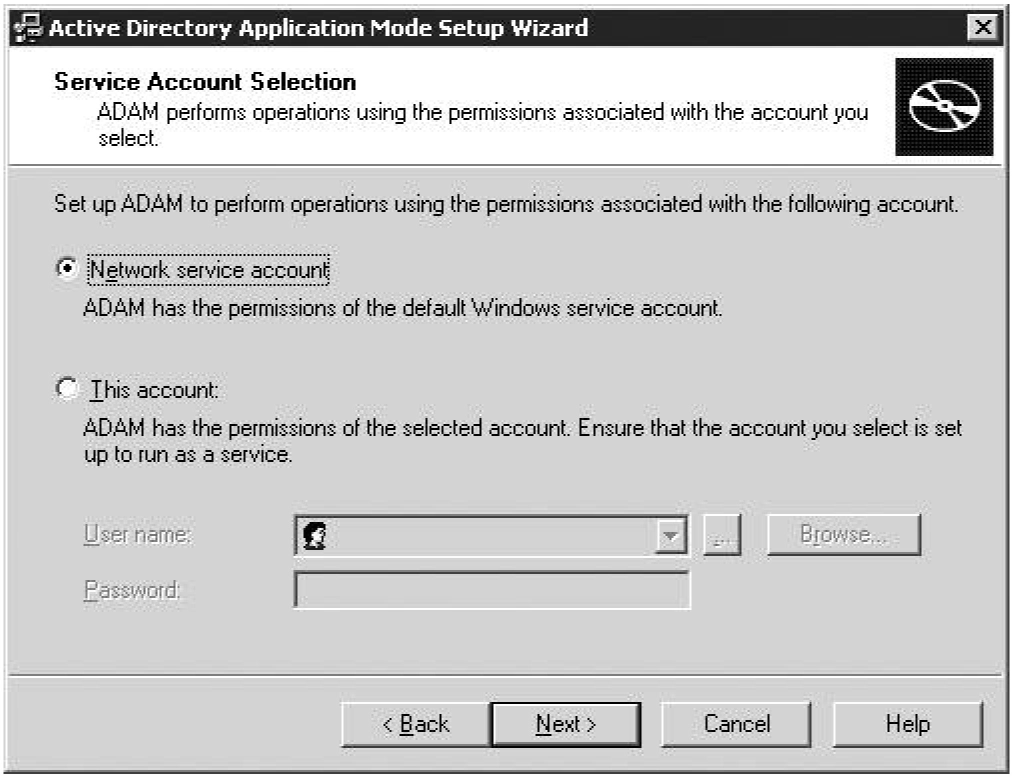
Data files:

C:\Program Files\Microsoft ADAM\Instance1\data

Data recovery files:

C:\Program Files\Microsoft ADAM\Instance1\data

Figure 18-8. Service Account Selection dialog



Active Directory Application Mode Setup Wizard

Service Account Selection

ADAM performs operations using the permissions associated with the account you select.

Set up ADAM to perform operations using the permissions associated with the following account.

● Network service account

ADAM has the permissions of the default Windows service account.

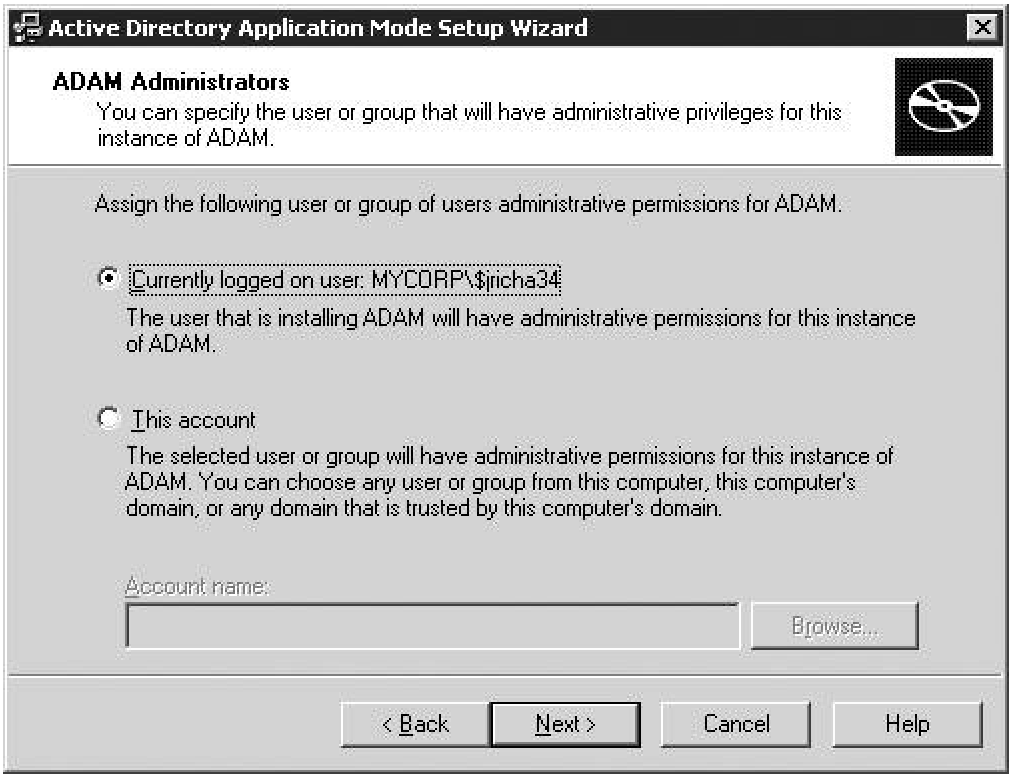
○ This account:

ADAM has the permissions of the selected account. Ensure that the account you select is set up to run as a service.

User name:

Password:

Figure 18-9. ADAM Administrators dialog



Active Directory Application Mode Setup Wizard

ADAM Administrators

You can specify the user or group that will have administrative privileges for this instance of ADAM.

Assign the following user or group of users administrative permissions for ADAM.

● Currently logged on user: MYCORP\$jricha34

The user that is installing ADAM will have administrative permissions for this instance of ADAM.

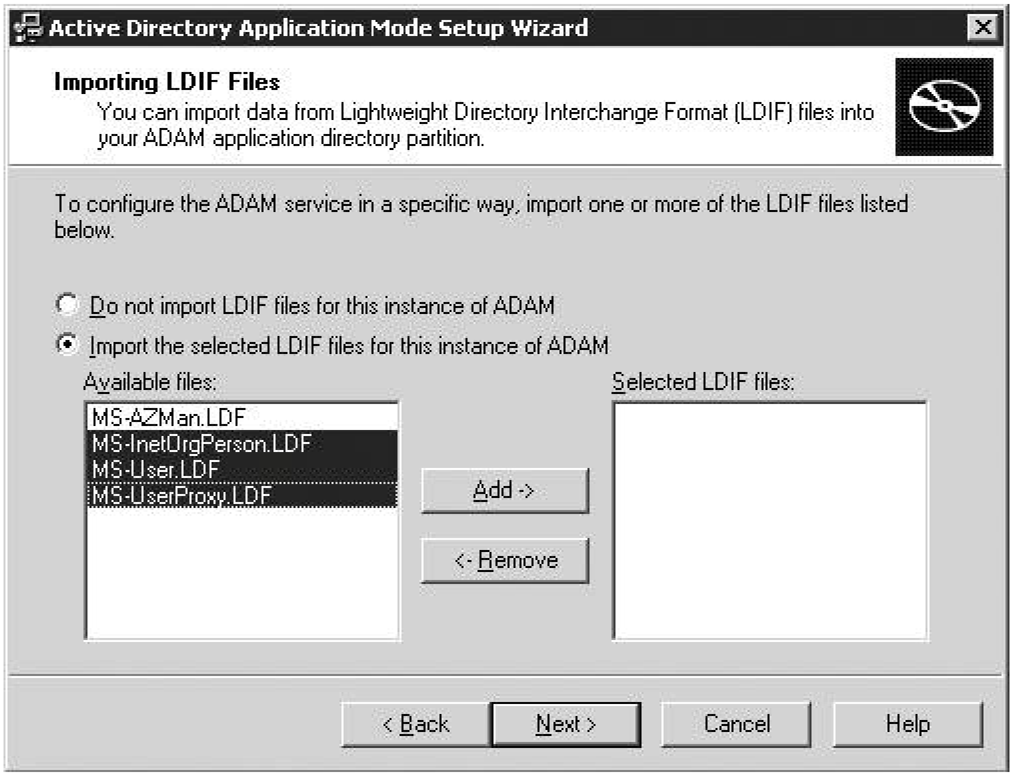
○ This account

The selected user or group will have administrative permissions for this instance of ADAM. You can choose any user or group from this computer, this computer's domain, or any domain that is trusted by this computer's domain.

Account name:

The final dialog that requires a decision, shown in Figure 18-10, concerns what LDIF files ADAM should import. The default is that no files should be imported, which gives you the ADAM base schema only. However, if you want to add the functionality gained through these LDIF files, you should allow the installation to import them. If you decide at a later time you would like to incorporate any of these schema updates, simply use *ldifde.exe* to import them. The LDIF files are located in the folder *%windir%\ADAM*. See Table 18-2 for a description of these LDIF files.

Figure 18-10. ADAM LDIF import dialog



Active Directory Application Mode Setup Wizard

Importing LDIF Files

You can import data from Lightweight Directory Interchange Format (LDIF) files into your ADAM application directory partition.

To configure the ADAM service in a specific way, import one or more of the LDIF files listed below.

○ Do not import LDIF files for this instance of ADAM

● Import the selected LDIF files for this instance of ADAM

Available files:

- MS-AZMan.LDF
- MS-InetOrgPerson.LDF
- MS-User.LDF
- MS-UserProxy.LDF

Selected LDIF files:

Table 18-2. ADAM instance installation LDIF files

Filename	Description
MS-AZMan.LDF	Objects and attributes needed for Microsoft Authorization Manager (AZMan). Framework for roles-based access control.
MS-InetOrgPerson.LDF	`inetOrgPerson` object definition.
MS-User.LDF	Active Directory `user` definition. Bindable object class, trustee exists in ADAM.
MS-UserProxy.LDF	ADAM `userProxy` definition. Bindable object class, trustee exists in Windows (either local or domain).

After completing the LDIF file dialog, you will be presented with a Ready to Install dialog listing the choices made. Click Next if you accept the choices; the ADAM instance will be created, and you will be rewarded with a dialog indicating that you successfully completed the ADAM Setup Wizard . Click on Finish to complete the installation process.

18.4.3. Installing an ADAM Replica

Installing an ADAM replica, also known as joining a configuration set, is very similar to creating a new unique ADAM instance. In addition to the unique instance installation questions, you must answer several questions related to which configuration set you would like to join and what to replicate.

When you join a configuration set, you are choosing to share the configuration and schema partitions with another ADAM instance (or replica) just like domain controllers in the same forest. In addition, you have the option to replicate all, some, one, or none of the application partitions with all, some, one, or none of the other replicas in the configuration set. Figure 18-11 shows a complex configuration set shared between the servers *R2ADAM*, *LJ*, and *Tiny2*.

This may seem very complicated, but is actually quite simple to configure. You need a plan of what partitions should go where; then you simply install each replica one by one setting up the proper application partitions for replication.

The additional questions you need to respond to when installing a replica into a configuration set are listed inTable 18-3.

Table 18-3. Replica installation questions

Question	Description	Example
Source server? (Figure 18-13)	FQDN of any server in the configuration set to replicate initial configurations from.	R2ADAM.mycorp.com
Source server LDAP port? (Figure 18-13)	LDAP port of instance to join.	389
Configuration set administrative credentials? (Figure 18-14)	Credentials of user with administrative permissions in configuration set.	MYCORP\$jricha34
Application partitions to replicate? (Figure 18-15)	Which application partitions, if any, you want to replicate to this specific replica.	`cn=addressbook`

Once you are ready with the responses for the questions in Tables 18-1 and 18-3, you start the instance creation process just like you did when you created a new instance. When you get to the Setup Options dialog, you want to select "A replica of an existing instance" (see Figure 18-12).

Figure 18-11. Complex ADAM configuration set

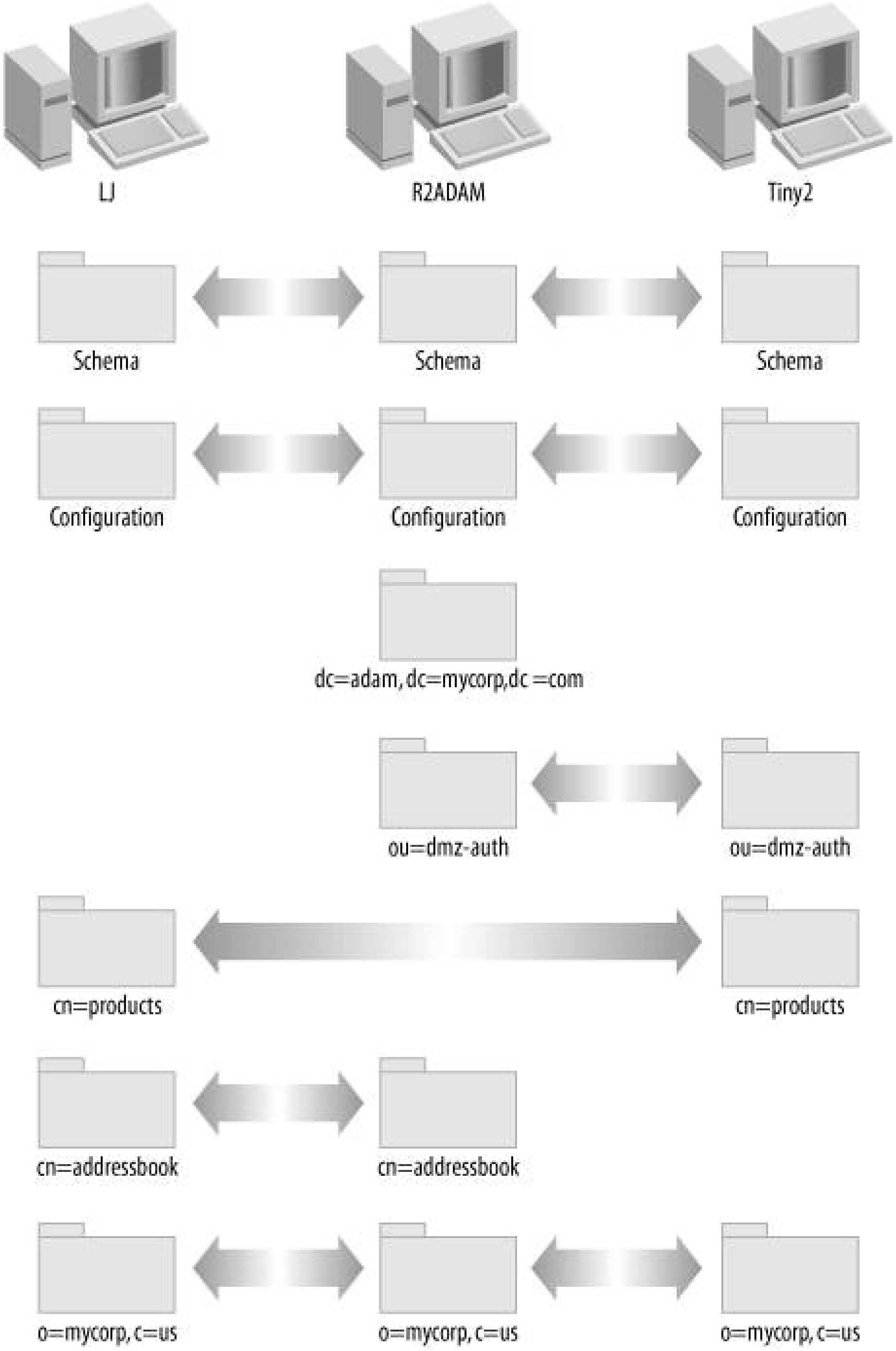
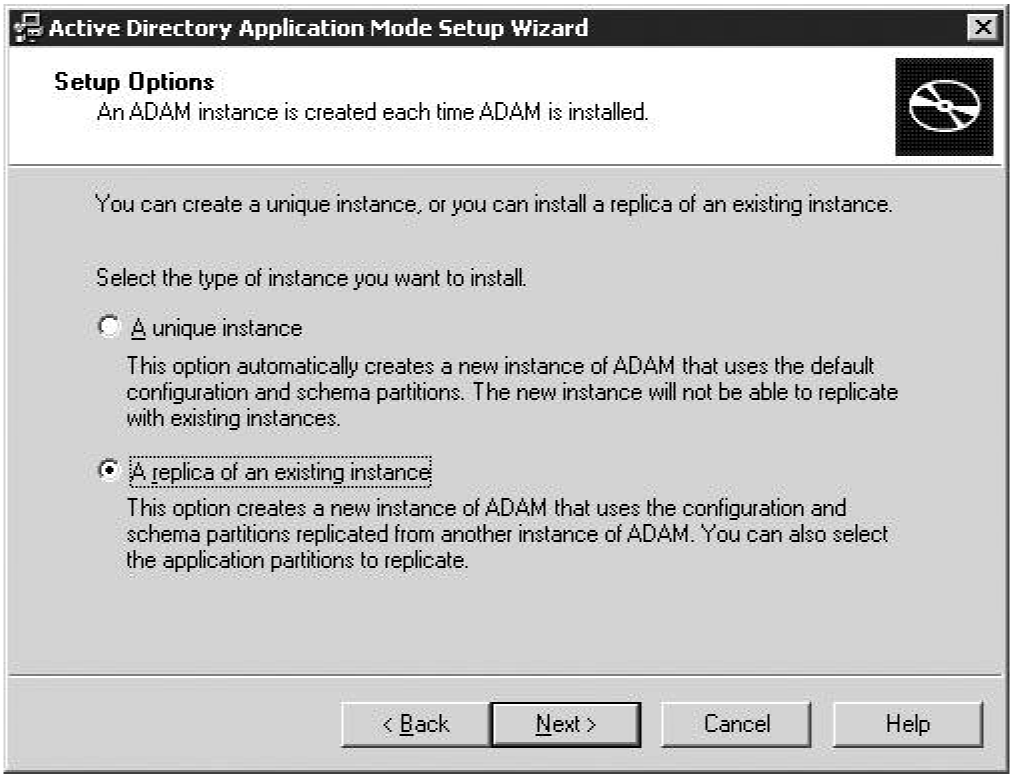


Figure 18-12. Setup Options dialog


Active Directory Application Mode Setup Wizard

Setup Options

An ADAM instance is created each time ADAM is installed.

You can create a unique instance, or you can install a replica of an existing instance.

Select the type of instance you want to install.

○ A unique instance

This option automatically creates a new instance of ADAM that uses the default configuration and schema partitions. The new instance will not be able to replicate with existing instances.

● A replica of an existing instance

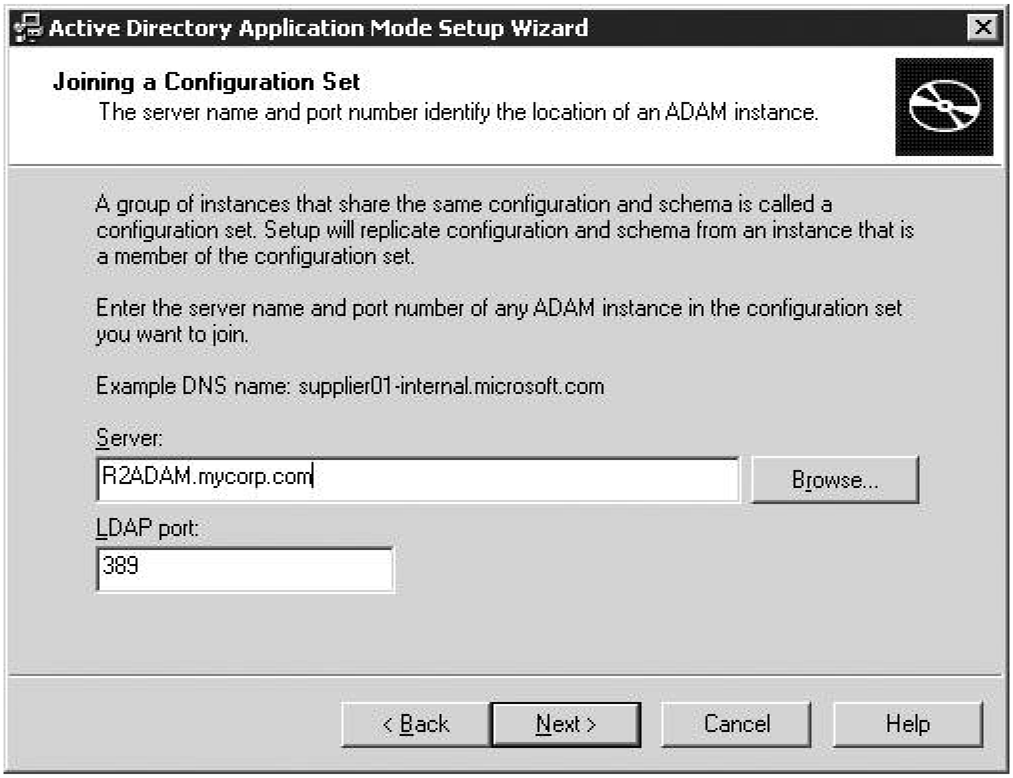
This option creates a new instance of ADAM that uses the configuration and schema partitions replicated from another instance of ADAM. You can also select the application partitions to replicate.

The wizard will continue on the same as when installing a unique instance presenting the dialogs from Figures 18-4 and 18-5. After that, the wizard will start presenting some new dialog boxes. The first new dialog allows you to specify the connection information for an ADAM instance that is part of the configuration set you want to join; see Figure 18-13. You will need to specify both the fully qualified domain name (FQDN) of the server, as well as the port the instance is listening on for LDAP connections.

After you have specified the configuration set instance connection information, you will need to specify some administrative credentials for that configuration set; see Figure 18-14. Obviously, this is so you can actually add a new ADAM instance into the configuration set. It wouldn't be very secure if it just let anyone add new instances.

The last new dialog that will be presented, Figure 18-15, is where you get to choose which application partitions, if any, that you want this specific replica to maintain a copy of. If you refer back to Figure 18-11, you can see that you have the option to select any number of the application partitions that exist in the configuration set. In a very simple configuration set, there may only be one application partition and that partition is shared amongst every replica. In a very complex configuration set, you could have any number of replicas that are or aren't replicating any number of the partitions. Again, the configuration of a complex configuration set is quite simple; monitoring and management, on the other hand, could be another story.

Figure 18-13. Configuration set instance information



Joining a Configuration Set

The server name and port number identify the location of an ADAM instance.

A group of instances that share the same configuration and schema is called a configuration set. Setup will replicate configuration and schema from an instance that is a member of the configuration set.

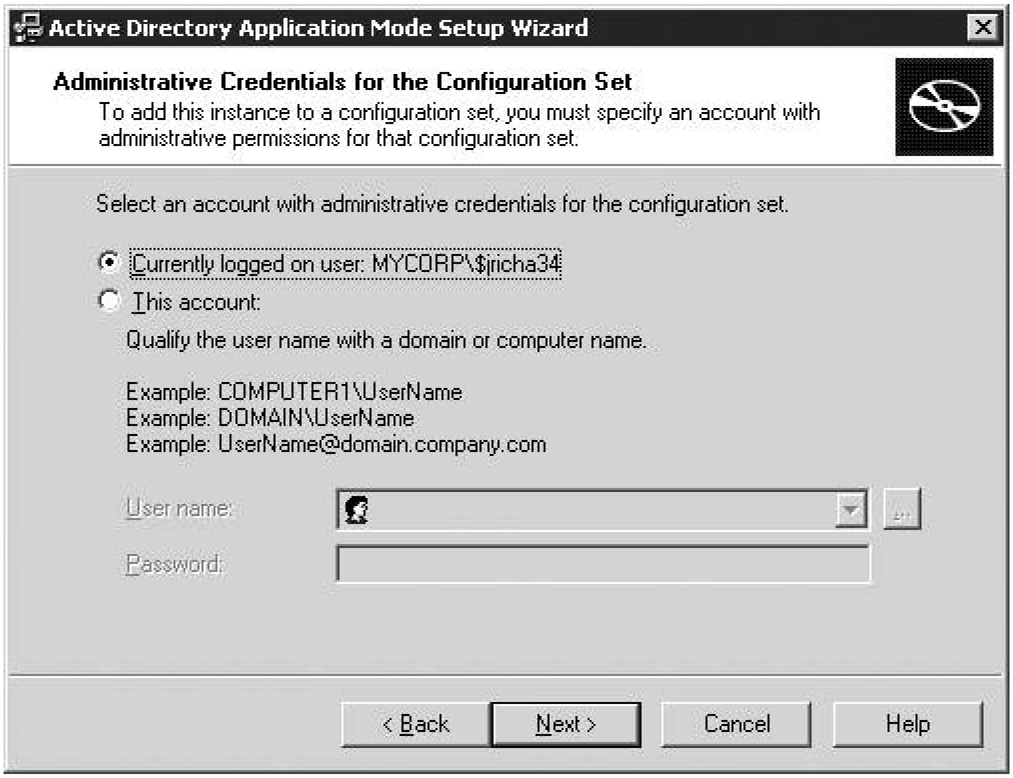
Enter the server name and port number of any ADAM instance in the configuration set you want to join.

Example DNS name: supplier01-internal.microsoft.com

Server: R2ADAM.mycorp.com

LDAP port: 389

Figure 18-14. Credentials for the configuration set join



Active Directory Application Mode Setup Wizard

Administrative Credentials for the Configuration Set

To add this instance to a configuration set, you must specify an account with administrative permissions for that configuration set.

Select an account with administrative credentials for the configuration set.

● Currently logged on user: MYCORP\$jricha34

○ This account:

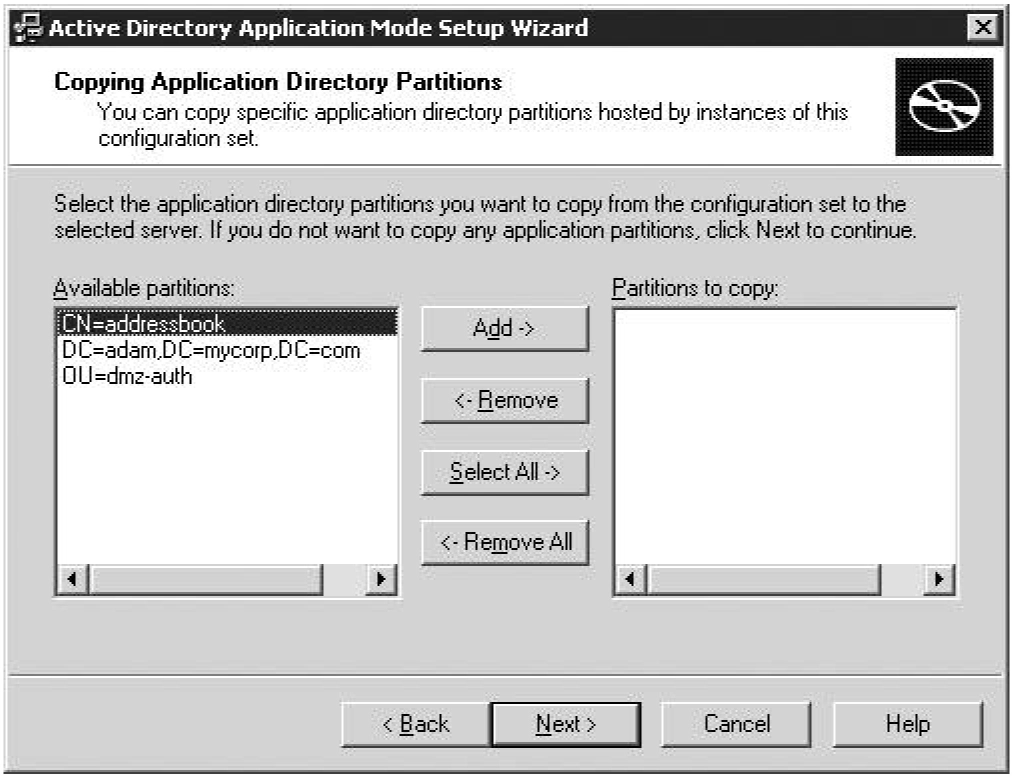
Qualify the user name with a domain or computer name.

Example: COMPUTER1\UserName
Example: DOMAIN\UserName
Example: UserName@domain.company.com

User name:

Password:

Figure 18-15. Application partitions to add to the replica



Active Directory Application Mode Setup Wizard

Copying Application Directory Partitions

You can copy specific application directory partitions hosted by instances of this configuration set.

Select the application directory partitions you want to copy from the configuration set to the selected server. If you do not want to copy any application partitions, click Next to continue.

Available partitions:

CN=addressbook
DC=adam,DC=mycorp,DC=com
OU=dmz-auth

Partitions to copy:

After this dialog, you will return to the normal unique instance installation procedure with the next dialog being the File Locations dialog, shown in Figure 18-7. Walk through the rest of the wizard dialogs, and after you click Finish at the end of the wizard, you will have a new replica.

> After you have configured a replica, you will often notice that the replica immediately has replication connections to the instance you specified in the Join a Configuration Set dialog, but none of the other replicas have replication connections to the new replica. This is perfectly normal; it can take some time for the news of the new replica to circulate throughout the configuration set and the necessary replication topology to be built up with the new replica inserted into it.
>
> If you would like to speed up this process, you can use the *REPAD-MIN.EXE* command-line tool to generate the connections. Specifically, you want the `addrepsto` switch. Help for this switch is available if you type **`repadmin/experthelp`**. If you are not already familiar with the *repadmin* tool, you should be. It is one of the most useful tools available for determining how healthy you are from a replication standpoint and correcting any sore spots you encounter. This applies equally to ADAM and AD.

ADAM has a couple of installation options not previously mentioned. You have the ability to run an unattended install, as well as install applications from media. These options can be specified when you launch the install process from the command line with *adaminstall.exe*. Type **`admainstall/?`** or see the ADAM help file for more information.

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18.5. Tools

ADAM introduces several new tools and updated other tools that should be familiar to most Active Directory administrators. It is worth loading ADAM just to get these tools. Table 18-4 shows all of the tools included with ADAM. All tools are located in the *%windir%\ADAM* directory.

Table 18-4. ADAM tools

Filename	New	Description
ADAM-adsiedit.msc	Yes	View/modify AD and ADAM objects.
ADAM-schmmgmt.dll	Yes	View/Modify ADAM schema objects. This tool will only work on ADAM not AD.
adaminstall.exe	Yes	ADAM instance installer.
adamsync.exe	Yes	Synchronize data from Active Directory to ADAM.
adamuninstall.exe	Yes	ADAM instance remover.
ADSchemaAnalyzer.exe	Yes	Schema comparison to assist with schema differencing/synchronization. Works with AD and ADAM.
csvde.exe	No	CSV directory object import/export. Works with AD and ADAM.
dsacls.exe	No	View/Modify AD and ADAM object ACLs.
dsdbutil.exe	Yes	ADAM instance database management tool.
dsdiag.exe	Yes	Directory diagnosis to assist in directory troubleshooting. Compare with Active Directory DCDiag tool.
dsmgmt.exe	Yes	ADAM instance configuration management tool.
ldifde.exe	No	LDIF directory object import/export. Works with AD and ADAM.
ldp.exe	No	GUI LDAP query tool. Works with AD and ADAM. Great new ACL editor.
repadmin.exe	No	AD and ADAM replication management tool plus much more.

18.5.1. ADAM ADSIEDIT

The *ADAM-ADSIEDIT* GUI tool is similar to *ADSIEDIT* for Active Directory with some slight upgrades to support ADAM. The primary difference is in data entry forms that allow modification of group membership to insert Windows or ADAM Security principals, as well as the ability to connect to ADAM instances.

18.5.2. ADAM Schema Management

The ADAM Schema Management GUI tool is similar to the Schema Management tool for Active Directory with some slight upgrades to support ADAM. The primary difference is in connection dialog and lack of Default Security tab to update the `defaultSD` attribute for the object. This generally isn't much of an issue as there aren't any classes in the base ADAM schema that have any ACEs defined in their `defaultSD`. If you import `user` and `userProxy` classes, they both have a `defaultSD` with an ACE granting the ability for `SELF` to change the password.

18.5.3. ADAM Install

ADAM Install is the GUI tool launched by the Create an ADAM Instance menu selection. You have the option to launch the application directly to enable the advanced installation dialogs, which allow you to install an application partition from a file. You can also specify an unattended installation answer file if you would like to automate the ADAM instance installation.

18.5.4. ADAMSync

This is a command-line tool that offers basic synchronization functions to populate ADAM information from AD. This is made available to administrators who only need a one-way feed and don't need the overhead of *Identity Integration Feature Pack* (IIFP) or *Microsoft Identity Integration Server* (MIIS), both of which allow two-way synchronization.

18.5.5. ADAM Uninstall

This tool allows you to remove ADAM instances from a server at the command line.

18.5.6. AD Schema Analyzer

This is an extremely useful GUI tool that will analyze two schemas (live or from LDIF files) and graphically display differences between them or "deltas." The tool can create an LDIF file with all of the deltas between the two schemas so that you could import the LDIF file to synchronize them. The AD Schema Analyzer is extremely helpful to use with applications that modify the schema where the vendor didn't supply an LDIF file showing the changes for you to easily review.

18.5.7. CSVDE

CSVDE is a command-line tool used to import or export Active Directory objects in CSV format. Unfortunately, the tool will not update objects that already exist. There are no apparent differences in the version of *CSVDE* released with Windows Server 2003 and ADAM.

18.5.8. DSACLS

This command-line tool should be familiar to every Active Directory administrator. It is the most accurate Microsoft supplied tool for displaying ACLs on AD objects. The updates to *DSACLS* are to allow it to properly connect to and manipulate ACLs in ADAM instances, including allowing DNs to be specified for the grant, deny, and revoke switches.

18.5.9. DSDBUTIL

The *DSDBUTIL* command-line tool has a subset of the functionality present in the Active Directory *NTDSUTIL* tool. It is specifically configured to be used with ADAM and cannot be used with Active Directory. You use this tool for all low-level database management such as authoritative restores, compacting files, integrity checks, etc.

18.5.10. DSDiag

This command-line tool is the ADAM equivalent of the *DCDiag* tool. It is used for identifying and troubleshooting directory issues. If you have a problem with replication, this is one of the first tools you should run. In addition, you should run it occasionally to verify current status, in case there are errors or issues you are not currently aware of.

18.5.11. DSMgmt

The *DSMgmt* command-line tool has a subset of the functionality present in the Active Directory *NTDSUTIL* tool. It is specifically configured to be used with ADAM and cannot be used with Active Directory. You use this tool for controlling various ADAM configuration settings, metadata cleanup of retired ADAM instances, and creating and deleting naming contexts.

18.5.12. LDIFDE

LDIFDE is a command-line tool used to import or export Active Directory objects in LDIF format. Unlike *CSVDE*, *LDIFDE* can be used to update as well as create and delete objects in ADAM or Active Directory. LDIF is a standard format used for all LDAP-based directories and is usually the format that you receive schema update information for applications that need schema modifications. It is important for AD and ADAM administrators and developers to be familiar with the LDIF format in general and the *LDIFDE* tool in particular.

18.5.13. LDP

This is a GUI tool used to browse, search, or update AD or ADAM . You have the ability to view the directory in a tree hierarchy or construct a standard LDAP query. *LDP* allows you to check in nearly any LDAP client or server control to enable capability to find deleted objects or other items that require special queries. This version of *LDP* is significantly updated from its Windows Server 2003 predecessor; if you use *LDP* on a regular basis, it is worth loading ADAM just to get the new version of this tool. Microsoft has done a great job of reworking the various data dialogs for inputting information, as well as adding a great new ACL editor interface.

18.5.14. RepAdmin

The base function of the *REPADMIN* command-line tool is to display and manage the replication topology of a set of directory servers. But the more you use *repadmin*, the more things you find that it can do, from displaying object metadata to updating SPNs to displaying trusts to translating time stamps, etc. Once you have figured out everything it can do with the switches displayed when you run `repadmin /?`, you can then start investigating the additional switches that are displayed when you run `repadmin /experthelp`.

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18.6. ADAM Schema

As mentioned previously, the initial ADAM schema is a small subset of the Active Directory schema. The ability to extend the schema is the same as in Active Directory, so you can fully expand the schema to be the same as the AD Schema. Because of this, ADAM is a great place to test schema modifications that want to make in Active Directory. The fact that the extensions work the same and you can quickly destroy and recreate ADAM instances means that you can quickly test new extensions, changing the definitions until you get exactly what you want. You can even have multiple instances on the same computer running at the same time, each with a different version of the schema so you can easily compare and contrast them. For details on working with the schema, AD and ADAM, see Chapters 4 and 12.

18.6.1. Virtual List View (VLV) Index Support

ADAM supports an additional type of index that is not currently supported by Active Directory. The index is a subtree container index and was specifically added to better support VLV operations. Microsoft first introduced this change for ADAM V1.0 as the hotfix for Microsoft Knowledge Base Article 832474 and was only available upon request. The hotfix is now included with ADAM SP1 and ADAM R2 for everyone's benefit.

Creating this index allows any VLV operations using a particular attribute as the sort key to be handled in a significantly more efficient manner. It can also prevent a common failure that causes a VLV query to terminate with a "Critical extension unavailable" error in larger directories. By default, when a VLV query is processed, the directory executes the query and stores the result set in a special internal table called the temp table so it can be sorted. This table can vary in size but can be no larger than the value specified in the `MaxTempTableSize` setting of the `Default Query Policy`. The value for that setting, by default, is only 10,000 records. If the query result set exceeds the size of the current temp table, you will get the Critical extension unavailable error instead of the results. Enabling the subtree container index allows ADAM to avoid using the temp table, which significantly increases performance and avoids the issue of exceeding the temp table size.

Configuring this index is usually done when you use ADAM as an Address Book for Microsoft Outlook. Outlook, by default, supports VLV Address Book access. If you use an ADAM instance for an Address Book and it returns a result set of more than 5000 records for the query `(&(mail=*)(cn=*))`, then it is likely you will experience the Critical extension unavailable error mentioned in the previous paragraph. You can quickly correct this problem by setting up the subtree container index for the `cn` attribute, which is the sort key for the query. You can also correct this by disabling the VLV capability in Outlook; Microsoft has a hotfix to enable this capability.

To enable this index for an attribute, you need to set bit 6 (value 64) and bit 0 (value 1) in the `searchFlags` attribute of the targeted attribute's schema definition. Generally, this means setting a value of 65, but if there are other bits already set, the value could vary. Bit 0 enables the index for the attribute, and bit 6 specifies that the directory should create a subtree container index. If you set bit 6, but fail to set bit 0, no index will be created.

Here is a simple example showing the process to enable the cn attribute to have the subtree container index. Create an LDIF file called *cn_vlv.ldf* with the following contents:

```
# VLV enable cn
dn: CN=Common-Name,DC=X
changetype: modify
replace: searchFlags
searchFlags: 65
-
```

Once you have created the LDIF file, run the following command:

```
> ldifde -i -f cn_vlv.ldf -s <server>:<ldap_port> -c DC=X #schemaNamingContext
```

> A question that may come to mind is, "If ADAM needs this, how come Active Directory doesn't need it as well?" The information on this is sparse, but it appears from various public newsgroup posts written by Microsoft employees that Active Directory is specially configured to handle some special case VLV queries that are common for Exchange/Outlook in an optimal manner. This seems to be tied to some special Address Book functionality that exists in Active Directory but has been stripped from ADAM. If a customer needed better performance for any generic VLV queries against Active Directory like she gets with ADAM, she would need to contact Microsoft and submit a Design Change Request (DCR) to have that index capability added to Active Directory.

18.6.2. Default Security Descriptors

Quite unlike the Active Directory schema, the base ADAM schema classSchema objects do not have ACEs defined in their defaultSD attributes. This causes objects to be created without any explicit ACEs, unless a security descriptor with explicit ACEs is specified during the object creation. The obvious benefit of this is that all of your default security is based on inherited ACEs. As you will recall from Chapter 11's discussion of Active Directory security, this makes it far easier to configure delegation. Although you are not required to follow this model for any classes you add to ADAM, you are *strongly* encouraged to do so. You should have very great reasons to deviate from this practice.

18.6.3. Bindable Objects and Bindable Proxy Objects

As previously mentioned, any objectClass you import into ADAM can be configured to allow bind functionality in ADAM. The two types of bind functionality are covered by bindable objects and bindable proxy objects. A bindable object is an object that is actually authenticated directly by ADAM;

an example would be an ADAM user. A bindable proxy object is an object that is actually authenticated by Windows. ADAM simply proxies the authentication request to Windows; an example would be a `userProxy`.

In order to make it possible to instantiate a bindable object or bindable proxy object of a given objectClass, you must statically associate either the `msDS-BindableObject` or `msDS-BindProxy` classes as an auxiliary class of the given objectClass. If you associate both classes to the given objectClass, `msDS-BindableObject` takes precedence.

Note that you cannot configure existing `classSchema` objects to have either of the auxiliary classes; these classes must be specified when the class is initially defined in the ADAM Schema. The limitation is due to not being able to add mandatory attributes to an existing class definition.

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18.7. Using ADAM

Now that you have an overview of what ADAM is, some of the differences, and how to install it, you are probably sitting there with an empty ADAM wondering, "What next?" This section will walk you through some common simple tasks, including creating an application partition and populating it with some data. These examples assume you have installed an ADAM instance with the *MS-User.LDF* and *MS-UserProxy.LDF* files. All of the examples will use LDIF files and *ldifde.exe* for making the updates because it is available with every server and requires no scripting knowledge. If you are familiar with scripting or other LDAP applications, they could be used as well.

> If you prefer command-line tools over GUI based tools, point your web browser at http://www.joeware.net and download the *ADMOD* and *ADFIND* freeware utilities. These command-line tools are specifically optimized to work with Active Directory and ADAM and have several built-in capabilities that take advantage of special features that aren't available through ADSI.

18.7.1. Creating Application Partitions

Generally, the first thing you need to do with ADAM to add data to it is to create an application partition to house that data. If you had an application partition created during the instance install, then you don't have to worry about this step unless you would like to create an additional application partition within the same instance.

ADAM will allow you to use any container class as an application partition root. If you want the application partition root to be a `container`, `domainDNS`, `organizationalUnit`, `c`, `o`, or even a `user`, you can easily set it up. You only have to specify three pieces of data to create an application partition: the distinguished name (DN), the `objectClass`, and `instanceType`. The `instanceType` attribute must always be 5, so that just leaves you with two attributes you have to figure out: the DN and `objectClass`.

The distinguished name is the full qualified name for the root of the partition. This is the value you will use any time you want to access the application partition. The `objectClass` is the type of object you want the root object to be, and the choice will impact the DN of the root. For instance, if you choose `organizationalUnit`, you know that the least specific part of the DN (left-most part of the DN) will start with `OU=`.

The following example will create several application partitions with different object classes. If you want to create a single partition, only copy the application partition type you would like to use.

Create an LDIF file called *create_app_parts.ldf* with the following contents:

```
# Container type application partition
```

```
dn: cn=AddressBook
changetype: add
objectClass: container
instanceType: 5

# Organizational Unit type application partition
dn: ou=products
changetype: add
objectClass: organizationalUnit
instanceType: 5

# Domain DNS type application partition
dn: dc=mycorp,dc=com
changetype: add
objectClass: domainDNS
instanceType: 5

# Organization (X.500) type application partition
dn: o=mycorp,c=us
changetype: add
objectClass: organization
instanceType: 5
```

Once you have created the LDIF file, run the following command:

```
> ldifde -i -f create_app_parts.ldf -s <server>:<ldap_port>
```

> You can also use *dsmgmt.exe* to create application partitions.

18.7.2. Creating Containers

Creating containers in ADAM is identical to creating containers in Active Directory. The following example will create a several containers under the *AddressBook* application partition root.

Create an LDIF file called *create_containers.ldf* with the following contents:

```
# Users container
dn: cn=users,cn=AddressBook
changetype: add
objectClass: container
```

```
# User proxies container
dn: cn=userproxies,cn=AddressBook
changetype: add
objectClass: container

# Groups container
dn: cn=groups,cn=AddressBook
changetype: add
objectClass: container
```

Once you have created the LDIF file, run the following command:

```
> ldifde -i -f create_containers.ldf -s <server>:<ldap_port>
```

18.7.3. Creating Users

Creating users in ADAM is similar to creating users in Active Directory. A rather obvious difference is that ADAM users do not have the `sAMAccountName` attribute. Although the attribute could be defined and linked to the `user` class, it will not have the same special properties as it does in Active Directory, such as forced uniqueness.

The following example will create several users under the previously created *users* container.

Create an LDIF file called *create_users.ldf* with the following contents:

```
dn: cn=d.m.sauter,cn=users,cn=AddressBook
changetype: add
objectClass: user
userPrincipalName: DMSauter
mail: Diane_Sauter@mycorp.com
displayName: Sauter, Diane
telephoneNumber: 456.555.3452
userPassword: SecureInitialPassword1!

dn: cn=d.v.sauter,cn=users,cn=AddressBook
changetype: add
objectClass: user
userPrincipalName: DVSauter
mail: Dawn_Sauter@mycorp.com
displayName: Sauter, Dawn
telephoneNumber: 456.555.3453
userPassword: SecureInitialPassword1!

dn: cn=k.cinco,cn=users,cn=AddressBook
changetype: add
```

```
objectClass: user
userPrincipalName: KCinco
mail: Kristen_Cinco@mycorp.com
displayName: Cinco, Kristen
 telephoneNumber: 456.555.3455
 userPassword: SecureInitialPassword1!

dn: cn=s.nelson,cn=users,cn=AddressBook
changetype: add
objectClass: user
userPrincipalName: SNelson
mail: Shannon_Nelson@mycorp.com
displayName: Nelson, Shannon
 telephoneNumber: 456.555.3454
 userPassword: SecureInitialPassword1!
```

Once you have created the LDIF file, run the following command:

```
> ldifde -i -f create_users.ldf -s <server>:<ldaps_port>
```

> By default, creating enabled users in Active Directory with *ldifde.exe* requires a 128-bit SSL connection and Base64 encoding of the Unicode version of the password enclosed in quotes. See Microsoft Knowledge Base Article 263991 for more information.

For ADAM, Microsoft enabled the userPassword attribute to function as a write-alias for unicodePwd and removed the requirement for the special formatting unicodePwd required. This allows your LDIF files to have clear-text passwords specified; however, you still have the SSL requirement unless you have relaxed the requirement for secure connections for password operations with *dsmgmt*.

Windows Server 2003 Active Directory has the ability to also use the userPassword attribute instead of unicodePwd; you must enable that capability though the dsheuristics attribute. See:

http://msdn.microsoft.com/library/default.asp?url=/library/en-us/adschema/adschema/a_dsheuristics.asp

The userPassword attribute can only be used for set operations in ADAM and AD; if you need to execute a change password operation instead, then you must use unicodePwd, as mentioned in KB263991.

Passwords are far easier to deal with using ADSI scripts, *ldp.exe*, or command-line tools, such as the previously mentioned freeware tool *admod.exe*.

18.7.4. Creating User Proxies

The userProxy objectClass is new to ADAM. These objects are similar to users in that they represent trustees that can be authenticated; they are different in that they are only a reference to a Windows user instead of the direct representation of a user. The userProxy object points at a Windows user via the objectSID attribute on the object; that attribute can only be set on object creation.

When someone authenticates with a userProxy, by default, they must perform a simple bind over SSL against ADAM with the DN or UPN of the userproxy object. First ADAM accepts the userProxy DN/UPN and password, and then the SID is retrieved from the object and resolved to a Windows user (and domain if necessary); finally, a secure LogonUser API call is executed with the user's SAM name (and NetBIOS domain name if necessary) and password to authenticate the user. If the user successfully authenticates, his security token is generated and he has any access to the directory that is delegated to any of the following security principals:

- userProxy object
- Any groups the Windows userid is a member of
- Any groups the userProxy is a member of

The following example will create a userProxy object under the previously created *userproxies* container.

Create an LDIF file called *create_userproxies.ldf* with the following contents:

```
dn: cn=joeproxy,cn=userproxies,cn=AddressBook
changetype: add
objectClass: userProxy
 objectSID: S-1-5-21-2571958876-650952397-806722693-1108
userPrincipalName: joeproxy
```

Once you have created the LDIF file, run the following command:

```
> ldifde -i -f create_userproxies.ldf -s <server>:<ldap_port>
```

In this example, the objectSID for the user MyCorp\$joe is specified in the objectSID attribute for joeproxy. Any time the joeproxy user is used for binding to ADAM, it will proxy that authentication through LogonUser to Windows.

18.7.4.1. Special considerations

The userProxy object can use any Windows user that can be authenticated through the trust channels of the server the ADAM instance is running on. This includes local computer users, domain users, and trusted domain users. If you choose to use local users, you need to keep in mind that only the computer that the user exists on will be able to authenticate the user. This has obvious implications with replicated instances of ADAM; only a single instance of the configuration set would be able to authenticate the user. Possibly this is what you are looking to do in the case of only allowing access to a single replica, but overall this would be confusing and difficult to troubleshoot if someone who wasn't familiar with this special configuration had to get involved.

Another special consideration with `userProxy` objects concerns object creation. If a Windows user's SID has already been added to the ADAM instance as a `foreignSecurityPrincipal,` you will not be allowed to create a `userProxy` object with the same SID. The directory modification will be rejected with an Unwilling to Perform error.

> Microsoft recommends against the use of `userProxy` and other Bindable Proxy objects. ADAM fully supports Windows users through secure bind, and this capability should be used if possible. The bind proxy functionality was made available for legacy applications or other specific cases where it is not possible to use secure binding.

18.7.5. Renaming Users

A common task in any address book or other application that has user information is rename operations. People are out there getting married, divorced, or just changing their names for some other reason, and one of the things they generally want is to see that change reflected in directories that contain their names.

The following example will rename a couple of users previously created.

Create an LDIF file called *rename_users.ldf* with the following contents:

```
dn: cn=d.v.sauter,cn=users,cn=AddressBook
changetype: modify
replace: userPrincipalName
userPrincipalName: DVSimon
-
replace: mail
mail: Dawn_Simon@mycorp.com
-
replace: displayName
displayName: Simon, Dawn
-

dn: cn=d.v.sauter,cn=users,cn=AddressBook
changetype: modrdn
newrdn: d.v.simon
deleteoldrdn: 1


dn: cn=k.cinco,cn=users,cn=AddressBook
changetype: modify
```

```
replace: userPrincipalName
userPrincipalName: KNiemiec
-
replace: mail
mail: Kristen_Niemiec@mycorp.com
-
replace: displayName
displayName: Niemiec, Kristen
-

dn: cn=k.cinco,cn=users,cn=AddressBook
changetype: modrdn
newrdn: k.niemiec
deleteoldrdn: 1
```

Once you have created the LDIF file, run the following command:

```
> ldifde -i -f rename_users.ldf -s <server>:<ldap_port>
```

Each rename consists of two LDAP operations. The first operation is to replace several of the attributes that house the old name, specifically `userPrincipalName`, `mail`, and `displayName`. The second operation is the rename of the relative distinguished name (RDN) of the object. This update forces a change of the `cn`, `name`, and `distinguishedName` attributes for `user` objects.

18.7.6. Creating Groups

Creating groups in ADAM is similar to creating groups in Active Directory. As with creating users, you do not have a `sAMAccountName` attribute to be concerned with, so you can ignore that attribute.

The following example will create several groups in the previously created *groups* container.

Create an LDIF file called *create_groups.ldf* with the following contents:

```
dn: cn=group1,cn=groups,cn=AddressBook
changetype: add
objectClass: group

dn: cn=group2,cn=groups,cn=AddressBook
changetype: add
objectClass: group

dn: cn=group3,cn=groups,cn=AddressBook
changetype: add
objectClass: group
```

```
 dn: cn=group4,cn=groups,cn=AddressBook
changetype: add
objectClass: group
```

Once you have created the LDIF file, run the following command:

```
> ldifde -i -f rename_users.ldf -s <server>:<ldap_port>
```

18.7.7. Adding Members to Groups

Adding members to groups with *ldifde.exe* is similar to the process followed for Active Directory. You have two options:

1. Specify the DN of the user, group, or other object in an update to the member attribute of the group.
2. Specify the SID of the user, group, or other object as a Base64-encoded string with the format <SID=S-1-xxx-yyyy...>.

Unfortunately, at the present time, a Windows user must be specified in the SID format unless it has already been added to the ADAM application partition as a `userProxy` or `foreignSecurityPrincipal`. Once added as one of these objects, the Windows user can be referenced by the DN of the object.

The following example will add users and groups as members to the groups previously created.

Create an LDIF file called *add_ users.ldf* with the following contents:

```
 dn: cn=group1,cn=groups,cn=AddressBook
changetype: modify
add: member
member: cn=d.v.simon,cn=users,cn=AddressBook
-

 dn: cn=group2,cn=groups,cn=AddressBook
changetype: modify
add: member
member: cn=d.v.simon,cn=users,cn=AddressBook
member: cn=d.m.sauter,cn=users,cn=AddressBook
-

 dn: cn=group3,cn=groups,cn=AddressBook
changetype: modify
```

```
add: member
 member:  cn=group2,cn=groups,cn=AddressBook
member: cn=k.niemiec,cn=users,cn=AddressBook
member: cn=s.nelson,cn=users,cn=AddressBook
-

 dn:  cn=group4,cn=groups,cn=AddressBook
changetype: modify
add: member
member: CN=Administrators,CN=Roles,CN=AddressBook
-
```

Once you have created the LDIF file, run the following command:

```
> ldifde -i -f add_users.ldf -s <server>:<ldap_port>
```

18.7.8. Removing Members from Groups

Removing members from groups with *ldifde.exe* is similar to the process followed for Active Directory. You simply specify the DN of the user, group, or other object that is currently a member that you would like to remove.

The following example will remove members from the groups previously created.

Create an LDIF file called *remove_ users.ldf* with the following contents:

```
 dn:  cn=group1,cn=groups,cn=AddressBook
changetype: modify
delete: member
member: cn=d.v.simon,cn=users,cn=AddressBook
-

 dn:  cn=group2,cn=groups,cn=AddressBook
changetype: modify
delete: member
member: cn=d.v.simon,cn=users,cn=AddressBook
member: cn=d.m.sauter,cn=users,cn=AddressBook
-

 dn:  cn=group3,cn=groups,cn=AddressBook
changetype: modify
delete: member
 member:  cn=group2,cn=groups,cn=AddressBook
member: cn=k.niemiec,cn=users,cn=AddressBook
```

```
member: cn=s.nelson,cn=users,cn=AddressBook
-

 dn: cn=group4,cn=groups,cn=AddressBook
changetype: modify
delete: member
member: CN=Administrators,CN=Roles,CN=AddressBook
-
```

Once you have created the LDIF file, run the following command:

```
> ldifde -i -f remove_users.ldf -s <server>:<ldap_port>
```

18.7.9. Deleting Objects

Deleting objects with *ldifde.exe* is generally pretty straightforward. As long as you have permissions to delete the object in question and it has no children, you should have no issues with the deletion.

The following example will remove various group and container objects previously created.

Create an LDIF file called *remove_ objs.ldf* with the following contents:

```
 dn: cn=group1,cn=groups,cn=AddressBook
changetype: delete

 dn: cn=group2,cn=groups,cn=AddressBook
changetype: delete

 dn: cn=group3,cn=groups,cn=AddressBook
changetype: delete

 dn: cn=group4,cn=groups,cn=AddressBook
changetype: delete

dn: cn=groups,cn=AddressBook
changetype: delete
```

Once you have created the LDIF file, run the following command:

```
> ldifde -i -f remove_objs.ldf -s <server>:<ldap_port>
```

18.7.10. Deleting Application Partitions

Programmatically deleting an application partition in ADAM is not an intuitive process. When you created a partition, you specified the DN, `objectClass`, and `instanceType` and then BAM!! Instant application partition. When you need to delete an application partition, you have to look at the objects in the `cn=parti-tions,cn=configuration,cn={instance GUID}` container. Locate the object with the `nCName` that matches the application partition you want to delete and copy the DN into your LDIF file that has the delete operations.

The following example will delete the `cn=AddressBook` application partition previously created.

Create an LDIF file called *remove_app_part.ldf* with the following contents:

```
#>nCName: CN=AddressBook
dn:
   CN=45d599d5-9bd4-41be-9604-b8209db3f866,CN=Partitions,
   CN=Configuration,CN={92B82A0E-CEC4-4720-9035-D0CA9632C20E}
changetype: delete
```

Once you have created the LDIF file, run the following command:

```
> ldifde -i -f remove_app_part.ldf -s <server>:<ldap_port>
```

> You can also use *dsmgmt.exe* to delete application partitions .

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18.8. Summary

ADAM is an extremely exciting product that is certainly going to find heavy use for both Microsoft and other applications in the enterprise environment. The flexibility it offers allows an Active Directory administrator to say "We can do that" more often now in order to support line of business applications and other functions that they would have never allowed near their domain-based Active Directory. Knowledge and understanding of ADAM will become more and more important to all Active Directory administrators going forward as more and more applications start to leverage it.

In this chapter, basic ADAM concepts, as well as some more advanced concepts, were discussed and explored. Next, differences between ADAM and Active Directory as well as updates in the R2 and SP1 versions of ADAM were discussed. A complete walkthrough of the installation of the core components of ADAM was provided, as well as walkthroughs for the installations of a standard unique instance and a replica instance with screenshots and tables illustrating decision points. Readers were also introduced to the new and updated tools that ship with ADAM. Finally, many *ldifde.exe* examples showing most aspects of creating and deleting objects and partitions were provided and discussed to help a new ADAM administrator quickly get up and running with a new ADAM instance.

The management tools for ADAM are sparse at the moment, but expect a great number of currently existing and all new tools to become available as it becomes more and more widely accepted. Look to ADAM to give a hint as to possible future modifications and strategic direction of Active Directory. We are already hearing about changes to Active Directory for the Longhorn edition of Windows that are directly related to ADAM, such as running as a stand alone service and having a tighter default security model.

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Chapter 19. Interoperability, Integration, and Future Direction

Microsoft's Directory Services strategy has come a long way in the past few years. Even before Active Directory, several Microsoft products utilized a directory, although most used one that was built into the individual product. Some examples include the NetMeeting ILS server and Exchange 5.5, which was the precursor to Active Directory. With the introduction of Active Directory in 1999, Microsoft finally had the first signs of a coherent Directory Services strategy. With the release of Windows Server 2003, plus a major overhaul of Microsoft Metadirectory Server, now called Microsoft Identity Integration Server (MIIS), and the introduction of Active Directory Application Mode, Microsoft has one of the most diverse and robust directory offerings of any of the major directory vendors in the market today. In this chapter, we will discuss Microsoft's future plans for Directory Services and cover how that plan fits in with interoperating with other directories and integrating with applications and services.

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19.1. Microsoft's Directory Strategy

After the initial release of Active Directory, Microsoft thought, like many in the industry, that the direction most companies were headed was deployment of a single enterprise directory that would be all things to all clients. Microsoft's intent was for Active Directory to serve the NOS directory role, replacing NT 4.0, and also the application directory role, which had typically been dominated by SunOne (formerly iPlanet) and OpenLDAP. But after three years of implementations, it became evident that although most companies would like to implement a single directory, in practice it did not work out that way. A lot of applications are developed with a particular directory in mind and in some cases, like Microsoft Exchange, an application can work only with a specific directory. After Microsoft realized that multiple directories would be a reality in most organizations of any size, they decided to rework their strategy. This happened to coincide with their plans to release a major update of the Windows Server operating system, Windows Server 2003.

There are three main components to Microsoft's current Directory Services roadmap: Active Directory Application Mode (ADAM) as the application directory, Microsoft Identity Integration Server (MIIS) as the central provisioning source, and Active Directory as the NOS or Infrastructure directory. We'll now examine each of these products.

19.1.1. Active Directory Application Mode

When Microsoft announced plans in July 2002 to release a "lightweight" version of Active Directory sometime after the release of Windows Server 2003, many AD administrators breathed a sigh of relief. The reason for the relief is that when Active Directory serves as a NOS directory, as it does in the vast majority of implementations, it does not lend itself well to being a flexible application directory. We describe some of the challenges of using Active Directory in both roles later in this chapter and discuss ADAM in depth in Chapter 18.

19.1.2. Microsoft Identity Integration Server

Metadirectories are used to centralize the provisioning of data across disparate systems. They allow you to define rules for how data should flow based on customized business logic. That is, you can set a rule stating that if system Y has attribute A updated, attribute B in system Z should be updated. Metadirectories become increasingly important as the number of directories and databases you have to support in your environment increase. As we mentioned, supporting multiple directories is a necessary evil that most organizations have to cope with, and metadirectories can help reduce the amount of time you have to spend provisioning data in each.

Microsoft's previous metadirectory offering, Microsoft Metadirectory Services (MMS) Version 2.2, was difficult to set up and maintain. In fact, to purchase MMS 2.2, you had to purchase a support contract from Microsoft as well, which included the installation and setup of the product. With a product rename and the release of Microsoft Identity Integration Server 2003, Microsoft has completely revamped the application to make it easier to configure and manage. Microsoft is positioning MIIS 2003 as the glue between Active Directory, ADAM, and any other information repositories you may need to provision or extract data from. With the release of Service Pack 1 for MIIS 2003, Microsoft has further dedicated itself to making MIIS the primary management and provisioning interface for your AD-based directories, whether ADAM or Active Directory.

The challenge with MIIS 2003 is the fundamental issue behind metadirectories: they can be difficult to set up and configure. Other options exist to solve the provisioning problem. If you have in-house programming expertise or can hire contractors, you can write automation scripts that can provision data and accounts between systems. Programming with LDAP is not very complicated, and using ADSI is even easier. Going this route has its own challenges, such as the need for solid expertise and a good idea of exactly what you want to build, so in the long run a metadirectory may be more appealing.

MIIS 2003 comes in two flavors, both requiring Windows Server 2003 Enterprise Edition: MIIS 2003 Enterprise Edition and Identity Integration Feature Pack (IIFP).

IIFP was made available as a free download from Microsoft's web site soon after Windows Server 2003's launch. It requires MSDE (for testing only), SQL Server 2000 Standard Edition, or SQL Server 2000 Enterprise Edition as its database store, and supports AD, ADAM, and Exchange Server 2000/2003 only. This version is meant to help you with compatibility between these core Microsoft directories only. IIFP enables easy and secure synchronization and provisioning of identity information across multiple Active Directory forests, Exchange 2000/2003 implementations for GAL synchronization, as well as Active Directory Application Mode installations.

MIIS 2003 SP1 is a paid-for product from Microsoft, and requires SQL Server Standard Edition or SQL Server 2000 Enterprise Edition as its database store. This edition supports AD, ADAM, DSML 2.0, XML, CSV files, text files, Exchange, LDIF, Lotus Notes/Domino v4.6/v5.0, Sun/iPlanet/Netscape directory 4.x/5.x, SQL Server 7.0, SQL Server 2000, Oracle, IBM DB2, IBM Directory Server, Windows NT4, Novell NDS/eDir, SunOne, Critical Path MetaConnect/X.500, and more. A significant number of partners also provide connectivity for other corporate repositories and directories like SAP and PeopleSoft.

The major changes since MMS 2.2 are as follows:

- MMS 2.2 Zstore was replaced by SQL Server 2000 for the database store to aid performance, scalability, failover clustering, and the like.
- MMS 2.2 Zscript was replaced by any .NET language for scripting purposes.
- MIIS 2003 now supports unicode and double-byte character sets.
- MIIS 2003 now supports self-service, helpdesk password management, and resetting to enable those operations to be performed much more easily.
- MIIS 2003 now is integrated with WMI for the first time.
- MIIS 2003 SP1 now supports password synchronization from Active Directory to other connected data sources.
- MIIS 2003 SP1 incorporates deletion thresholds to prevent accidental deletion of large amounts of directory data.

- MIIS 2003 SP1 offers a full .NET-based management agent SDK for quickly creating your own management agents, allowing you to create connections to additional data sources.

There is a lot inside MIIS that administrators have not been aware of simply due to the restricted nature of MMS 2.2's distribution. We encourage you to go and take a look in detail at MIIS for your organization to see where it might be useful. More details can be found on Microsoft's web site by searching for MIIS or Microsoft Identity Integration Server, or directly from the following site: http://www.microsoft.com/miis/.

19.1.3. Active Directory's Role

Under Microsoft's current direction, the role of Active Directory has been reduced, but its importance has by no means been lessened. Active Directory's primary purpose is that of a NOS directory, where its main function is to authenticate and authorize clients so that they can access directory and network resources. In some cases, applications may still want to integrate directly with Active Directory as opposed to using an application directory such as ADAM. Since Microsoft Exchange is so dependent on the directory store and ties heavily into AD resources such as users, groups, and contacts, it may make sense to keep it integrated directly with Active Directory as opposed to ADAM. Thus, while the general trend will be to move to ADAM in the application space, some applications will still need tight integration with Active Directory. Regardless, ADAM will alleviate a lot of the pressure to integrate all applications with Active Directory and therefore allow you to maintain tight control in your NOS environment.

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19.2. Interoperating with Other Directories

Now that we've covered what Microsoft is doing with their directory products, let's review some of the issues around integrating a mixed directory environment. As we mentioned earlier, supporting multiple directories within a large organization is a necessary practice. You may already have several directories deployed, some of which are not Microsoft-based. A common question in this scenario is how to get your directories to work together.

19.2.1. Getting Data from One Directory to Another

Perhaps the most common use of a directory is to access employee, customer, or student information. One of the problems of supporting multiple directories is that for each directory to be useful, it needs to store similar data. It would be very helpful if there were a standard RFC that defined a replication scheme for LDAP directories, but unfortunately there is not. As a result, each directory vendor has implemented their own way to replicate data between servers. This is where metadirectories come into play. The primary purpose of a metadirectory is to facilitate data flow and provisioning across systems. If you have several directories, and writing your own scripts to replicate data is not a possibility, implementing a metadirectory is a valid option.

19.2.2. Using Common Tools Across Directories

One of the biggest reasons for not wanting to implement multiple directories is that they have to be managed differently. Fortunately, both Active Directory and ADAM are based on LDAP, so any of the standard LDAP SDK tools such as *ldapsearch* and *ldapadd* will work. Also, the Microsoft LDP tool, a graphical user interface for querying and managing content in Active Directory, has become very popular. LDP is an LDAP-based tool and works against any LDAP directory. The same cannot be said for tools such as ADSI Edit and the Active Directory administrative snap-ins, which work only with Active Directory.

One popular approach for managing content in SunONE and OpenLDAP directories is to use the LDAP Data Interchange Format (LDIF). LDIF has a strict format that is both human- and machine-readable, but it is easy to work with. Microsoft provides the *LDIFDE* program on the Windows Server platforms, which allows for importing and exporting LDIF files. You can also use an LDIF-based tool on a non-Windows platform to manage content in Active Directory.

19.2.3. Porting Scripts to Work Across Directories

The story for porting scripts is much the same as the one for using similar tools for managing different directories. Most directories today are LDAP-based, so if your scripts are using an LDAP API, they should work regardless of what directory is being used. That said, there are some fairly significant differences with how Active Directory was implemented that may cause problems in your scripts. Most LDAP directories have a flat namespace; this means you can make a single query to a server and retrieve all objects the server knows about. With Active Directory, it is a little different in multidomain environments. When you implement multiple domains, you are essentially segregating your LDAP namespace. A domain controller knows about only the objects in its domain. For this reason, Microsoft designed the Global Catalog so that you can perform a single query to search against all objects in a forest, but the GC contains only a subset of information for all objects. The impact to scripts may be less than obvious, but to perform a query such as retrieving all attributes for any user in the forest that has a department equal to "Sales," you first must query the GC. To then retrieve all defined attributes for each user, you have to run separate queries against the domains the users are in. The other option is to skip the GC and query the domains individually, but regardless of which option you choose, this simple task can require several queries.

19.2.4. Making Searches Across Directories Seamless

If you foresee supporting multiple directories, you might have the notion of trying to unify the namespace used by each. So perhaps your Active Directory root is `dc=mycorp,dc=com` and you have an OpenLDAP server that has a root at `dc=apps,dc=mycorp,dc=com`. You can create referral objects using the `crossRef` objectclass so that a query for `dc=apps,dc=mycorp,dc=com` against an Active Directory domain controller will refer the client to an OpenLDAP server. The LDIF representation of the referral object looks like the following, where `nCName` is the name of the partition and `dNSRoot` is the hostname to refer clients too:

```
dn: cn=OpenLDAP,cn=Partitions,cn=Configuration,dc=mycorp,dc=com
objectclass: crossRef
nCName: dc=apps,dc=mycorp,dc=com
dNSRoot: openldap.mycorp.com
```

An issue with using referrals to access data in different directories is that clients from each directory typically can't authenticate in the others. Unless you are synchronizing user accounts and passwords between directories or you allow anonymous binds, when the referral passes to the OpenLDAP server, the query will fail due to a logon failure.

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19.3. Integrating Applications and Services

Many applications rely on a directory to access user information and store application data. Because Active Directory was Microsoft's first true directory offering, many application vendors attempted to integrate their products into it, only to find there were a lot of issues from both technology and political perspectives. We'll now discuss some of these challenges.

19.3.1. The Application Integration Challenge

While trying to use Active Directory as both a NOS and application directory can initially reap significant rewards from reduced total cost of ownership, it also presents several challenges as well. In fact, many of the features that make Active Directory a great NOS directory (a repository of user, group, and computer accounts) also make integrating applications much more difficult.

19.3.1.1. Challenges for application vendors

Many of the challenges for application vendors are related more to incompatibilities with integrating with the NOS than directly to insufficiencies with Active Directory. In fact, Active Directory could be used as a pure application directory with few differences from what you would see using a SunONE or OpenLDAP directory server. But that is not how Active Directory is typically being used in the enterprise. In fact, most organizations are still trying to balance the effects of maintaining a stable NOS environment that has consistent reliability and response times with an application directory that could impact the end-user experience with increased server load and directory bloat.

We have seen numerous vendors struggle with trying to integrate products with Active Directory, especially on their first attempt. Most companies do not have a lot of Active Directory or even LDAP expertise, so they make do with what they have, which often results in poorly integrated applications. In fact, it is not sufficient for vendors to have just LDAP expertise, because Active Directory has many features, such as the Global Catalog, never seen in any other directory server product. Often vendors gain the expertise they need only after they have struggled through the painful experiences of several customers that have deployed their product. Some of the major issues application vendors face are described in the following list.

Hierarchical structure

> One of the biggest roadblocks for applications using Active Directory is accessing data in a multidomain model. Most medium- to large-scale Active Directory implementations use multiple domains to segregate data, regulate administrative access, limit exposure during disaster recovery situations, and reduce the amount of data that replicates between domain controllers. Typically, the domains are spread across geographic and sometimes organizational boundaries. Figure 19-1 illustrates an example of a simple geographic domain structure that is commonly

used.

Before Active Directory, most directory-enabled applications could rely on a flat namespace. A single query could search against all objects in the directory. In a multidomain model, it is not that easy. To help combat this problem, Microsoft introduced the Global Catalog. In a lot of situations, the data available in the Global Catalog may be sufficient for applications, but often it is not. If more data is needed for an object than what is provided by the Global Catalog, a second search must be done against a domain controller that is authoritative for the domain the object is in. This can result in many more queries than are needed when searching a flat namespace.

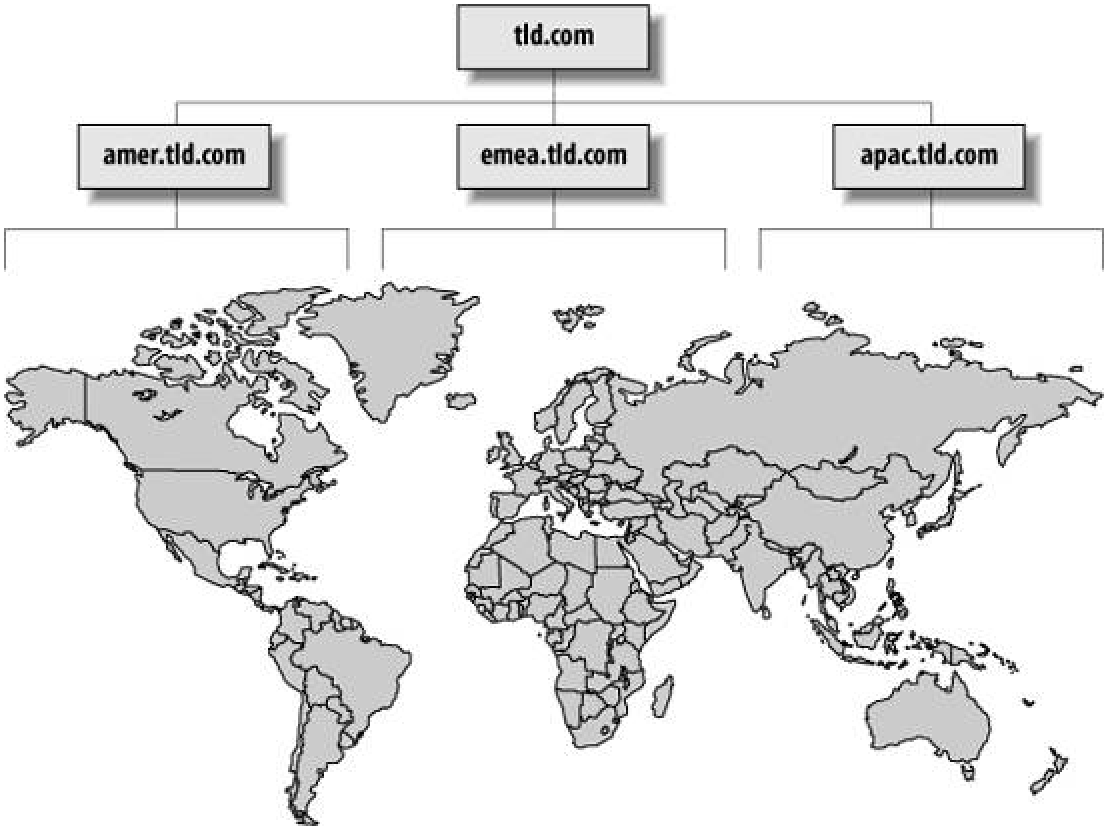
Multimaster replication

A common problem faced by nearly all distributed applications using Active Directory is how to handle multimaster replication . Active Directory is loosely consistent, which means that at no point can you assume that all updates have replicated to all domain controllers. As a rule of thumb, the best thing a directory-enabled application can do is to not assume that updates made to the directory are immediately available unless the same server being queried was used for the updates. In some environments, it can take several hours or even days for updates to replicate to all domain controllers.

Schema extensions

Applications that want to publish data in Active Directory generally need to make schema extensions. The base schema provided by Active Directory contains a lot of classes and attributes, but for anything other than the most trivial application, customized extensions will need to be developed. Updating the Active Directory schema is a very sensitive operation, and Microsoft has done a

Figure 19-1. Typical geographic domain model



good job of communicating the need to have a strict schema update policy. In some cases, we've even heard of administrators refusing to extend the schema because of fear of directory corruption. While it is a good idea to be cautious, extending the schema is a very necessary task. On the other hand, application vendors will not be able to get away with very frequent updates of their extensions. Thus, any schema extensions must be thought out extremely well beforehand and should be flexible so that only minor changes might be required in the future. Anyone familiar with writing large scale applications understands how difficult this can be.

inetOrgPerson support

When Active Directory was first released, many people complained that the `inetOrgPerson` objectclass was not supported for user objects. Microsoft instead decided to use their own `user` objectclass to represent user objects. `inetOrgPerson` is the closest thing to a standard representation of what a user object should look like in an LDAP directory. It was defined in RFC 2798 and is supported by other LDAP directories, including SunOne and OpenLDAP. Although Microsoft's `user` objectclass has many of the same attributes as `inetOrgPerson`, there are numerous differences.

To work with Active Directory, a lot of preexisting directory-enabled applications that were programmed to use `inetOrgPerson` had to be rewritten to support Microsoft's `user` objectclass as well. Microsoft came out with an add-on for Windows 2000 to support `inetOrgPerson`, and it is natively supported in Windows 2003 Active Directory. Unfortunately, many applications have already had to be reworked to use Microsoft's `user` class, and it is unlikely that most administrators will want to switch to `inetOrgPerson`.

Service location

Typically, directory-enabled applications are developed to work against multiple directories, such as Active Directory, OpenLDAP, iPlanet, Novell, etc. For these types of applications, there is generally a configuration process to hardcode the directory server(s) to query. In an Active Directory environment that may be distributed to several locations globally, the application should use the closest server possible. It is possible to use Microsoft APIs to locate domain controllers dynamically as the Microsoft APIs use basic DNS queries of SRV records to locate the nearest directory server. Unfortunately not all directory service applications have jumped into using those record types, even though they are a recognized standard.

RDN attributes

The bulk of the predefined Active Directory classes use `cn` as the relative distinguished name (RDN) attribute, which may not align with some other directory. Further, once a class is defined in the directory with a given attribute as the RDN, changing that attribute to something else is quite non-trivial. Additionally, many directories support multiple attributes in an RDN where Active Directory supports only a single attribute. Bringing back the `inetOrgPerson` class as an example, the default Microsoft definition sets the RDN attribute as `cn` where many other directories often use `uid`. This is rather easily corrected with ADAM since you can modify the LDIF file prior to importing the class, but not so easily corrected with AD because it is a base schema item.

19.3.1.2. Challenges for Active Directory administrators

While application vendors have many challenges in writing well-behaved Active Directory-enabled products, administrators have a different set of challenges facing them. Most of the issues administrators face can be addressed by developing well-defined and documented processes for how applications will be used in Active Directory. Many of the problems become increasingly difficult as the number of applications being supported grows. Some of the major issues that administrators face are described in the following list:

Application engagement and testing

All enterprise Active Directory environments should use a development or test forest for testing applications before moving them into production. As stated earlier, many of the Active Directory-enabled products on the market have serious flaws with how they are integrated with Active Directory. It is extremely important to put an application through its paces in a development forest not only to identify issues that may cause problems in your production environment, but also to understand how the application uses Active Directory.

The other important aspect of testing is having a well-defined application engagement process. Groups that want to integrate their applications with Active Directory need a starting place for engaging your Active Directory team. However you choose for users to start the engagement process, you should document information about each application, including name, contacts, description, directory usage, etc. It is also beneficial to publish guidelines for how to request application account(s), perform load testing, and request consulting services if needed.

If not already apparent, having an application engagement process requires significant resources to support. Someone has to interact with the application groups and support them as they move their application from the test forest to production. The support burden is even more significant for applications that write data to Active Directory since the schema may need to be extended. Those types of applications typically are more complex and thus require a greater understanding of the interaction with Active Directory.

Application accounts

Most Active Directory implementations will not have anonymous access enabled. It is generally not a good idea to allow anonymous access, especially when Active Directory is assuming both the NOS and application directory roles. That means applications need to bind or authenticate to access directory data. Each application needs to have a user account in which to bind. Using a separate account per application is typically a good idea because it is much easier to track down problems if only a single application is using an account. Some of these problems may include account lockout because of failed bind attempts or directory spamming due to inefficient or buggy LDAP queries.

Another issue that must be stressed regarding application accounts is password expiration. Requiring passwords to be changed on a periodic basis is a good practice for user accounts, but it can be difficult to implement for application accounts. This is a significant issue when dealing with accounts that run as a service, which are constantly logged on. It can be extremely difficult to ensure that each logged-on instance of the account is using the correct password when the password has been changed.

One possible workaround to this problem is to use dual accounts. Instead of using one account per application, you could use two. When a password needs to be rotated, instead of changing the account password and making sure all instances of the application are using the new password, you instead change the application to use a different account. At that point, the original account's password can be changed and used during the next iteration. As long as the second account has all the same privileges as the first, using dual accounts can be much easier to implement and lacks the synchronization problem with changing passwords of a single account.

Directory bloat

Any application that needs the schema extended will be storing data in Active Directory. Over time, as more and more applications store data in Active Directory, the AD DIT (Directory Information Tree) file will grow. Although Active Directory is orders of magnitude more scalable than Windows NT when it comes to the amount of data that can be stored, it is crucial to put processes in place to clean out unused data from existing and decommissioned applications. If provisions are not put in place to do this, you may run into issues with storage on your domain controllers or even performance degradation in queries to the directory.

Application conflicts

As you support more applications in Active Directory, the chance for applications to conflict with one another increases. In some cases, applications have had conflicting schema extensions, which could result in serious incompatibilities. It could also be a problem if a particular application is not well behaved and overloads a domain controller, effectively causing a denial of service for other applications that are trying to use it as well.

Poor application failover capability

Active Directory itself and most Microsoft applications and clients using Active Directory are extremely fault tolerant, so a domain controller becoming unavailable generally isn't cause for much alarm. The applications and clients will figure out that there is an issue and simply locate another domain controller and start using it. Most applications designed for other directory services are not this fault tolerant. If the domain controller they are using becomes unavailable, the application will tend to die on the vine until the domain controller is back in action. This is particularly noticeable in LDAP applications originally designed for Unix-based platforms or that are Java based, though not all Microsoft products are necessarily immune. Microsoft Exchange and Microsoft Outlook can have considerable issues when a DC becomes unavailable as well. On the plus side, all of these applications are starting to get corrected and made more robust and non-Microsoft apps are starting to embrace resource location through DNS SRV records to reduce their reliance on specific DNS host records and therefore specific servers.

19.3.1.3. ADAM to the rescue

Fortunately, there is a solution to most of these issues. ADAM allows you to segregate your NOS and application directory needs across different servers. We'll quickly review each of the challenges discussed previously to see whether ADAM will help.

Hierarchal structure

ADAM does not have the concept of a domain, so this isn't inherently a problem. You can set up a hierarchal structure across several ADAM servers, but it is not required.

Multimaster replication

ADAM supports multimaster replication, so this will continue to be an issue that application vendors will need to be cognizant of.

Schema extensions

Since ADAM has its own schema, you can make extensions without impacting Active Directory.

inetOrgPerson support

ADAM fully supports the `inetOrgPerson` class.

Service location

This continues to be an issue, and, due to the fact that ADAM doesn't support automatically registering SRV records, administrators will have to use other means for distributing load across servers. SRV records can be published in DNS on behalf of ADAM but the Windows resource location APIs unfortunately will not work properly as they are designed to specifically find domain controllers. ADAM does generate `serviceConnectionPoints` in Active Directory for resource location if an application understands how to query those objects.

Application engagement and testing

If you are using ADAM, you do not have to be as concerned about the impact it will have on Active Directory, and you will not require testing to be as strenuous.

Application accounts

If you have a business need to allow anonymous access to your directory, you can set that up with ADAM and have much less risk than you would with Active Directory.

Directory bloat

By using ADAM, you can reduce the amount of data stored in Active Directory and the eventual bloat that results.

Application conflicts

With ADAM, application conflicts occur only if you are allowing multiple applications to use the same instance. While an errant application can affect the availability of an ADAM instance, it will not necessarily hurt your NOS performance.

Although ADAM may not solve all the problems, it does provide a lot more flexibility and options for setting up a Microsoft-based directory environment.

19.3.2. Integrating Unix

Most people consider integrating a directory service with applications that need to query employee or customer data to be a no-brainer, but what about your Unix infrastructure? The term "single sign-on" has been buzzing around the industry for many years, but few have to come to realize it. Most have not been able to achieve even reduced sign-on. If reduced sign-on is your goal, and your Active Directory contains a username and password for everyone in your organization, it makes sense to collapse as many authentication repositories as possible. This may include attempting to eliminate the authentication services provided by your Unix infrastructure, such as NIS. There are several aspects of integrating Unix with Active Directory, and we'll review them now.

19.3.2.1. Kerberos and LDAP support

Long before Active Directory supported Kerberos, it was a mainstay in the Unix environment. While many were initially perturbed by Microsoft's extension of Kerberos, primarily because of the lack of documentation, you can use a standard MIT Kerberos client to get a ticket from an Active Directory KDC.

Another benefit of Active Directory supporting standards such as LDAP is that you can use the traditional LDAP tools, such as *ldapsearch*, to query and update Active Directory from a Unix platform. You can also use LDIF for query and update purposes along with any LDAPv3-compliant API, such as the C-style API or Java Naming and Directory Interface (JNDI).

19.3.2.2. Migrating from NIS

Microsoft has expanded the interoperability capabilities with Windows Server 2003 R2 by including Identity Management for Unix (UIdM) and Subsystem for Unix Applications (SUA) . You have a couple of options for migrating away from Sun's Network Information System (NIS). First, there are two NIS gateways available that can act as NIS servers that backend to Active Directory. R2 includes a NIS server that was previously available separately as Microsoft Services For UNIX (SFU) 3.x . PADL Software (http://www.padl.com) also has a NIS/LDAP gateway that can work with different directories, including Active Directory. The PADL gateway can run on a variety of Unix platforms.

Another option is to switch your Unix-based clients to support LDAP natively instead of continuing to use NIS. Luckily, most of the major Unix and Linux vendors provide support for LDAP, although each varies slightly. For more information on how to make Unix clients work with LDAP, check out *LDAP System Administration* by Gerald Carter (O'Reilly).

19.3.2.3. Integrating with NFS

Windows Server 2003 R2, again through the SFU integration, now offers a NFS Server. You can have a Windows server act as an NFS server or allow your R2 servers to access resources on Unix file servers. This means you can consolidate file servers in your environment by allowing both Unix- and PC-based clients to use the same file server.

19.3.2.4. Synchronizing passwords

Windows Server 2003 R2 provides password synchronization that allows you to sync passwords from Unix to Active Directory and vice versa. This means that if all you do is ensure that your Unix users are using the same password as that in Active Directory, you can sync from AD to your Unix hosts. And if you use a Unix-based LDAP directory, such as SunONE, you can use Microsoft Identity Integration Server (MIIS) to synchronize accounts and passwords.

19.3.2.5. Third-party integration tools

The clamor of administrators and customers wanting to quickly and easily integrate Unix and Linux machines into the Microsoft infrastructure and gain the incredible benefits of Enterprise Level

Management available through Windows has brought a couple of vendors into the picture and created a whole new software market. Two companies, *Centrify* (http://www.centrify.com/) and *Vintela* (http://www.vintela.com/), have produced amazing products that can help any company integrate multiple flavors of Unix, Linux, VMWare ESX, and Mac OS X into their Windows infrastructure quickly and easily. These products are a grand slam home run in the world of platform integration and can reduce the time to implement platform integration from months or years to weeks or months. These products have supplied great answers to many of the hard questions involved with integrating Unix or Linux into an Active Directory environment, such as:

- Multi-realm Kerberos support
- Dynamic KDC resource location based on Active Directory Sites and Subnets
- Distributed keytab generation
- Group Policy support similar to what is available for Windows Operating Systems
- Windows password management from the non-Microsoft machines
- SPNEGO and JAVA authentication and authorization via Active Directory

These companies are actually making it possible for many organizations to realize the corporate IT dream of single sign-on across platforms.

As you can see, there are numerous options available for integrating your Active Directory infrastructure with Unix and Linux environments; we've only just scratched the surface here. For more information on AD/Unix integration, see the MIIS website at http://www.microsoft.com/miis or visit the websites of the third-party vendors referenced in this section.

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19.4. Summary

Integrating applications into Active Directory is not an easy task. There are several potential pitfalls not only for Active Directory administrators but for application developers as well. Active Directory Application Mode (ADAM), which is a lightweight version of Active Directory, should help relieve some of the burden from Active Directory as an application directory. Integrating Unix with Active Directory also has its challenges, but it is quite possible especially with the third-party products available.

While integrating applications can be a challenge, getting competing directory services to interoperate is downright difficult. Even though most directory servers are based on standards-based RFCs, such as LDAP, there are no standards that define how they can replicate or authorize seamlessly with each other. The two best options for integrating multiple directories are either through a metadirectory such as MIIS, or a programming interface such as ADSI or LDAP.

This concludes Part II. In Part III, we will cover many of the programmatic concepts and interfaces that can be used to automate and manage your Active Directory environment.

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Part III: Scripting Active Directory with ADSI, ADO, and WMI

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Chapter 20. Scripting with ADSI

This chapter covers the basics of ADSI and VBScript so that even inexperienced programmers and system administrators can understand how to write useful scripts. If you're used to another language, such as Visual Basic (VB), you'll find that it is very easy to convert the ADSI examples from VBScript, which is covered in detail in Chapter 28. In Chapter 28, we also cover how to add VBScript code to HTML web pages so that you can write web applications that utilize ADSI. In Chapter 22, we show you how to use ADO to search Active Directory and retrieve sets of records according to the powerful search conditions that you impose. Other chapters take this knowledge and extend it so that you can manipulate other aspects of Active Directory, such as permissions and auditing (Chapter 26) and modifying the schema (Chapter 27). Several additional references to web pages containing further information and documentation are included at the end of this chapter, so that you can find more information.

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20.1. What Are All These Buzzwords?

First, let's take a look at some of the underlying technologies that you'll use when developing scripts.

20.1.1. ActiveX

ActiveX, the base component of a number of these technologies, enables software components to interact with one another in a networked environment, regardless of the language in which they were created. Think of ActiveX as the method developers use to specify objects that the rest of us then create and access with our scripts in whatever language we choose. Microsoft currently provides three hosts that run scripts to manipulate ActiveX objects: the Internet Information Server (IIS) web server, the Internet Explorer (IE) web browser, and the Windows Scripting Host (WSH). IIS allows scripts called from HTML pages to run on the host server, and IE runs scripts called from HTML pages on the client. WSH allows scripts to run directly or remotely on a host from a command-line or GUI interface. WSH is an integral part of the Windows operating system.

20.1.2. Windows Scripting Host (WSH)

WSH is an important technology for a number of reasons:

- You need no other software to start scripting.
- The development environment for WSH has no special requirements to build or compile programs; your favorite text editor will do.
- You can execute any WSH script with a VBS, JS, or WSF extension just by double-clicking it.
- You can actually execute scripts from the command line, directing window output to that command line. This is possible because WSH has two interpreters, one called *wscript.exe* , which interprets scripts in the GUI Windows environment, and one called *cscript.exe*, which interprets scripts in the command-line environment of a *cmd.exe* session. By default, if you double-click a script called *myscript.vbs*, the system passes that script to *wscript.exe*, just as if you had manually typed `wscript.exe myscript.vbs`. The default interpreter can be changed globally or on a per-script basis along with other settings.
- WSH comes with a series of procedures that allow you to script interactions with the target machine. There are procedures for running programs, reading from and writing to the registry, creating and deleting files and shortcuts, manipulating the contents of files, reading and writing environment variables, mapping and removing drives, and adding, removing, and setting default printers. These procedures are native to WSH, meaning that only scripts executing

under WSH can access them. Being able to access these settings is very useful when configuring users' environments, since you can now write logon scripts using VBScript or JScript if you wish.

> WSH comes bundled with Windows Server 2003, Windows XP, Windows 2000, and Windows 98, and it can be downloaded from:
>
> http://www.microsoft.com/downloads/details.aspx?FamilyId=0A8A18F6-249C-4A72-BFCF-FC6AF26DC390
>
> and installed on Windows 98/ME and Windows NT 4.0 servers and workstations.

20.1.3. Active Server Pages (ASPs)

When a VBScript is wrapped inside an HTML page and executed at the server, it is called an Active Server Page (ASP) because it can contain dynamic (or active) content. This means that the web page displayed to the user differs depending on the results of a script incorporated as part of that web page. Imagine a web server connected to a database. You can write ASPs to contain server-side scripts that query the database and return the results to the user. You can also include client-side scripts to gather information from the user to pass with the query.

20.1.4. Active Directory Service Interfaces (ADSI)

In February 1997, Microsoft released a set of generic interfaces, called the Active Directory Service Interfaces (ADSI), to access and manipulate different directory services. ADSI is a collection of classes and methods that allow developers using any language that supports COM to access and manipulate objects on a server or in a directory service. Contrary to its name, it was written to be generic and extensible rather than specific to Active Directory. This means that developers can write code to access objects on various directory servers without the need to know vendor-specific library routines. ADSI is also extensible, so developers of other directory services can write the underlying Dynamic Link Library (DLL) code that will allow ADSI to interact with their systems. This is possible because Microsoft publishes the specifications that a directory service provider (code that implements the ADSI spec for a particular directory service) must meet to work correctly with ADSI. This means that whenever you call an ADSI procedure or reference any object via ADSI against a valid provider, you can guarantee that the procedure performs according to ADSI's formal documentation no matter who the provider is. Although there are several directory service provider-specific extensions, ADSI also supports Lightweight Directory Access Protocol (LDAP), which provides the majority of functionality that most directory vendors need.

LDAP is a network protocol that is the primary mechanism for accessing directory services over TCP/IP, and it has become the de facto standard for directory service access on the Internet. A directory server simply has to support LDAP 2.0 or later, and ADSI can instantly access the directory service without a provider-specific DLL.

Natively supporting LDAP in ADSI means that the list of directory services that can be accessed is very large. For the older directories such as NT4, several vendors have written providers to support ADSI. The list of supported directory services includes the following:

- Active Directory
- Microsoft Exchange Server
- Windows NT 4.0 and NT 3.51 systems
- NetWare 3.x's bindery-based system
- NetWare and IntraNetware 4.x's and 5.x's Novell Directory Service (NDS)
- Netscape Commerce Server
- Netscape iPlanet/Sun ONE
- OpenLDAP
- IBM's Lotus Notes
- Microsoft's Internet Information Server (IIS) objects
- Microsoft Commercial Internet System's (MCIS's) Address Book Server
- Microsoft Site Server

20.1.5. ActiveX Data Objects (ADO)

In the same way that ADSI is a general set of interfaces to access and manipulate data in any directory service, ActiveX Data Objects (ADO) is a generic interface that allows developers to write scripts and applications to query and manipulate data held in a database server. For a database server to work with ADO, the database server vendor must develop an OLE DB provider. This is relevant to Active Directory because Microsoft wrote an OLE DB provider for ADSI. This allows developers to access Active Directory, or indeed any other directory service, via ADO. This provider effectively considers Active Directory a database and provides extremely fast and powerful searching capabilities. For example, using ADO, you can search Active Directory for all computers whose names begin with CF or all users whose accounts are disabled and get back the ADsPath of each one using a SQL-based query language or a standard LDAP filter. While it is possible to search and retrieve sets of records using standard ADSI calls, you would have to write your own set of routines to iterate through a directory service. When the developers of ADSI came to this requirement, they developed a provider so that the database searching algorithms that already existed in ADO could be leveraged for use by ADSI.

There is, however, one important caveat for ADO use with ADSI: the ADSI OLE DB provider is read-only even as of Windows Server 2003, so many of the useful ADO methods for updating data aren't available. Until this changes, you can use ADO only for searching and retrieving data.

20.1.6. Windows Management Instrumentation (WMI)

The Windows Management Instrumentation (WMI) API was developed by Microsoft in 1998 in response to the ever-growing need for developers and system administrators to have a common, scriptable API to manage the components of the Windows operating system. Before WMI, if you wanted to manage some component of the operating system, you had to resort to using one of the component-specific Win32 API's, such as the Registry API or Event Log API. Each API typically had its own implementation quirks and required way too much work to do simple tasks. The other big problem with the Win32 API's is that scripting languages such as VBScript could not use them. This really limited how much an inexperienced programmer or system administrator could do to programmatically manage systems. WMI changes all this by providing a single API that can be used to query and manage the Event Log, the Registry, processes, the file system, or any other operating system component. For more information on WMI, check out Chapter 29.

20.1.7. .NET and .NET Framework

Unless you've been hiding in a cave in recent years, you've undoubtedly heard of Microsoft's latest initiative, called .NET. At a high level, .NET is a move to embrace web technologies such as XML Web Services in an effort to better integrate Microsoft products and other third-party applications. At a low level, .NET is the basis for a new programming platform, including a completely new set of APIs, called the .NET Framework, to manage Microsoft-based products and develop Windows applications. Microsoft even released a new programming language in conjunction with .NET called C# (C-sharp). The .NET Framework is a new set of interfaces intended to replace the old Win32 and COM APIs. A couple of the major design goals for the .NET Framework were to make programming in a Windows environment much simpler and more consistent. The .NET Framework has two major components: the common language runtime (CLR) and the .NET Framework class library. For information on these technologies, check out Chapter 31.

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20.2. Writing and Running Scripts

The third part of this book is dedicated to showing you techniques to access and manipulate Active Directory programmatically. It not only contains a plethora of useful scripts that you will be able to adapt for use in your organization, but it also contains a lot of information on how you can write your own scripts to access Active Directory to do whatever you need. Let's take a quick look at how to get started writing and running scripts.

20.2.1. A Brief Primer on COM and WSH

Since the release of Windows 2000, each operating system Microsoft has produced comes with a technology called the Windows Scripting Host, more commonly known as WSH, which allows scripts to execute directly on the client. WSH-based scripts can open and read files, attach to network resources, automate Word and Excel to create reports and graphs, automate Outlook to manipulate email and news, change values in the registry, and so on. The reason these scripts can be so versatile is that WSH supports scripting access to all Component Object Model (COM) objects installed on the client.

COM is a Microsoft technology that allows programmers to automate and manipulate virtually anything you require on a host by defining each host component as a set of objects. When someone needs to create or manage a new component on a Windows-based host, she creates a COM interface, which can be thought of as the definition of the object and the entire set of operations that can be performed on that object. Interfaces normally are stored in DLL files.[*]

[*] There are other file types, such as OCX controls that define graphical forms and windows you can use in your scripts, but they are beyond the scope of this book.

For example, if you want to manipulate a file, you actually need to manipulate a file COM object. The file COM object definition is stored in an interface held in a DLL. The interface also holds all of the operations, such as creating the file, deleting the file, writing to the file, and so on. The interface also defines a series of properties of the object, such as the filename and owner, which can be accessed and modified. Procedures that operate on an object are known as methods, whereas the properties of an object are known simply as properties.

In addition to methods and properties provided by interfaces, each scripting language that you use has a series of defined functions, such as writing to the screen or adding two numbers together.

You can write scripts that execute using WSH and access any COM objects available to you using the methods and properties defined in the interface for that object and any functions in your chosen scripting language. By default, you can use Microsoft VBScript or Microsoft JScript (Microsoft's version of JavaScript). WSH is fully extensible, so other language vendors can provide installation routines that update WSH on a client to allow support for other languages. A good example is PerlScript, the WSH scripting language that provides support for the Perl language.

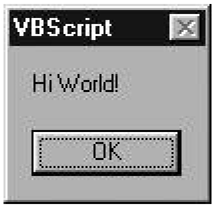
20.2.2. How to Write Scripts

WSH scripts are simple to write. The following example is a very simple script written in VBScript and called *simple.vbs*:

```
MsgBox "Hi World!"
```

All you have to do is open up your favorite text editor type in the command, then save the file with a specific filename extension (VBS for VBScript or JS for JScript). Then you can double-click the script and it will run using WSH. Figure 20-1 shows the output of the script, which is a simple dialog box with a text string in it. The script uses the VBScript `MsgBox` function.

Figure 20-1. Output from a very simple script



Now let's take a look at a slightly more complex script called *simple adsi.vbs.* This script makes use of ADSI to display the description of a user.

```
Dim objUser 'A variable representing my user

Set objUser = _
  GetObject("LDAP://cn=Richard Lang,ou=Pre-Sales,ou=Sales,dc=mycorp,dc=com")

MsgBox objUser.Description

Set objUser = Nothing
```

The first line is a variable declaration. We are declaring that `objUser` is the name for an object we are going to retrieve from Active Directory. The `Dim` keyword is used to declare a variable, and the apostrophe (`'`) indicates that everything following it is a comment that will not be executed.

The second line is too long to print on the page, so we have broken it into two with an underscore (`_`) continuation character at the end of the line. It tells the interpreter that it should read the next line as if it were joined to the end of the first. The entire line, ignoring the underscore, uses the `objUser` variable to hold a reference to a user object via a call to VBScript's `GetObject` function, passing the ADsPath of the user.

The third line simply uses the VBScript MsgBox function again to print out the description of the Richard Lang user object. The dot signifies that we are accessing a property method available for the specific type of object we are accessing, which in this case is a user.

The last line simply discards the reference to Richard Lang, and objUser becomes empty again. Strictly speaking, at the end of a script, the system discards all references anyway, but we are including it for completeness.

As you can see, printing out properties of objects in Active Directory isn't very hard at all.

20.2.3. WSH 2.0 Versus 5.6

WSH 2.0 comes bundled with Windows 2000 and Windows 98, while WSH 5.6 comes bundled with Windows Server 2003 and Windows XP. WSH is also available for download for Windows 95 and Windows NT. Do not be alarmed by the dramatic increase in version numbers; 5.6 was the next major version after 2.0. In fact, for most people writing scripts, the differences between 2.0 and 5.6 are not significant enough to worry about. Version 5.6 offers a new security model and, perhaps most importantly, the ability to execute scripts remotely, but neither of these affects our ADSI-based scripts to a large extent.

As of WSH 2.0, two types of file formats are supported. The first is traditional script files, which contain pure VBScript or JScript and have a language-specific file extension (e.g., *.vbs*), and the second is Windows Script File (WSF), which has a *.wsf* extension.

WSF is actually an Extensible Markup Language (XML) file, with the scripting code embedded inside <script> ... </script> tags, which is then embedded in <job> ... </job> tags. The following example shows how the *simple.vbs* example would look using the WSF format:

```
<job>
<script language="VBScript">

MsgBox "Hello World"

</script>
</job>
```

The XML defines that the file contains a single script (a job) and that the script to be run is written in VBScript. At its simplest, to write WSF scripts instead the traditional script files, all you have to do is prefix your code with the first two lines and end your code with the last two lines, as shown here:

```
<job>
<script language="VBScript">

Dim objUser 'A variable representing my user
```

```
Set objUser = _
  GetObject("LDAP://cn=Richard Lang,ou=Pre-Sales,ou=Sales,dc=mycorp,dc=com")

MsgBox objUser.Description

Set objUser = Nothing

</script>
</job>
```

To keep the examples straightforward and the focus on scripting Active Directory, only the code will be shown and not the tags necessary to make a WSF file. You can then decide whether you want to utilize the WSF format or just use the traditional script file.

We also encourage you to find out more about WSH to fully utilize its capabilities. For more information on WSH, including advanced functionality and running scripts using WSF, check out *Windows Script Host Programmer's Reference* by Dino Esposito (Wrox Press) or Bob Wells's WSH articles in *Windows Scripting Solutions* (http://www.win32scripting.com). Finally, the WSH help file can be a very useful reference. It is available for download at http://msdn.microsoft.com/scripting/.

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20.3. ADSI

Before you can start writing scripts that use ADSI, you first need to understand the basic COM concept of interfaces and ADSI's concepts of namespaces, programmatic identifiers (ProgIDs), and ADsPaths.

20.3.1. Objects and Interfaces

A COM interface defines the properties associated with an item, how to access those properties, and how to access specific functionality of the item, more commonly referred to as an object. For example, WSH has a number of objects that represent files, shortcuts, network access, and so on. ADSI provides a specification for interfaces that each directory service provider must implement to maintain uniformity. Each ADSI interface normally supports methods that can be called to perform a specific action, and properties (or property methods) to retrieve information about the object.

A method is a procedure or function that is defined on an object and interacts with the object. So an interface to access Active Directory group objects would have `Add` and `Remove` methods, so that members could be added or removed from a group. Methods are normally represented as `Interface::MethodName` when referenced, and this is the form we adopt in this book. Objects also have properties that are retrieved using the `IADs::Get` or `IADs::GetEx` methods and set or replaced using the `IADs::Put` or `IADs::PutEx` methods.

Each ADSI object supports an IADs interface that provides six basic pieces of information about that object:

Name

Relative name for the object (RDN in the case of Active Directory)

ADsPath

Unique identifier for object

GUID

128-bit Globally Unique Identifier of object

Class

Objectclass of the object

Schema

ADsPath to the objectclass of the object

Parent

ADsPath to the parent object

If you wanted to retrieve the `objectGUID` property of an object, you would use the following:

```
strGUID = objX.Get("objectGUID")
```

You can see that we are calling the `IADs::Get` method on the object called `objX` ; the dot (.) indicates the invocation of a property or method. The `IADs::Get` method takes as its one parameter the property to retrieve, which in this case is the `objectGUID` , and passes it out to a variable that we have called `strGUID` . So that you do not have to use the `IADs::Get` method for the most common properties, certain interfaces define these common properties with property methods. In these specific cases, you use the dotted method notation to retrieve the property by using the property method with a similar name, GUID. In the previous GUID example, the `objectGUID` attribute has a property method of the same name (i.e., `IADs::GUID`). We could therefore retrieve the GUID with:

```
strGUID = objX.GUID
```

We won't go into the interfaces in any more depth here; we just want to give you a feel for the fact that methods and properties can be accessed on an object via ADSI interfaces. Although an object can support more than one interface without a problem, each object supports only the interfaces that are relevant to it. For example, the user object does not support the interface that works for groups. The other interfaces, of which there are around 40, begin with the prefix IADs. Interfaces can relate to many different types of objects, including objects that reside in directory services (e.g., `IADsUser` and `IADsGroup`), transient objects that don't exist in a directory service (e.g., `IADsPrintJob`), and security-related objects (e.g., `IADsOpenDSObject` and `IADsAccessControlList`). Note that not all objects have a specific IADs interface that applies its objectclass (e.g., `IADsUser`), so in those cases you have to use the more generic `IADs` or `IADsContainer` interfaces.

Because each directory service is slightly different, not every ADSI interface method and property works in every directory service. If you make a method call to a directory service that doesn't support that method, you'll receive an error message specifying that the provider doesn't support that method. According to the ADSI specification, each service provider must reject inappropriate calls with the correct ADSI error message.

20.3.2. Namespaces, ProgIDs, and ADsPaths

To reference different types of servers (e.g., Windows NT 4.0, NetWare, etc.) with ADSI, you must use the namespaces that correspond to the ADSI providers used by that directory service. ADSI uses a unique prefix called a ProgID to distinguish between these namespaces. Each ProgID is synonymous with a particular namespace and directory provider.

In a script, you specify the ProgID, which is used behind the scenes to correctly connect and bind to the corresponding directory service. For example, you specify WinNT:// to access individual Windows NT 3.51, 4.0, Windows 2000, and Windows Server 2003 systems; you use LDAP:// to access Active Directory and other LDAP directories. When ADSI encounters the ProgID, ADSI loads an appropriate ADSI-provider DLL to correctly process the bind request and method invocations.

ProgIDs are case-sensitive. WinNT:// will work, whereas WINNT:// will not.

Since each ProgID is synonymous with a particular namespace, the term ProgID is usually dropped. For example, individual systems are accessed using the ProgID `WinNT` :. However, conventionally, this namespace is referred to as the *WinNT namespace* rather than the *WinNT ProgID* . This is the convention adopted in the book.

The following example references JoeB, a user on computer MOOSE in WORKGROUP:

```
WinNT://WORKGROUP/MOOSE/JoeB
```

This references JoeB, a user on computer MOOSE:

```
WinNT://MOOSE/JoeB
```

Each namespace has a unique format for the ADsPath string, so you need to make sure that you're using the correct ADsPath notation. For example, each of these ADsPaths references a unique object.

The following ADsPath references JoeB, a user in DOMAIN:

```
WinNT://DOMAIN/JoeB, User
```

This next one references JoeB, a user in the Finance Organizational Unit (OU) within the Mycorp organization of the IntraNetWare tree called MyNetWareTree:

```
NDS://MyNetWareTree/O=MYCORP/OU=FINANCE/CN=JoeB
```

This one references JoeB, a NetWare 3.x or 4.x (bindery services) user that exists on server *MYSERVER*.

```
NWCOMPAT://MYSERVER/JoeB
```

Finally, this one references the WWW service component of IIS running on the local host:

```
IIS://localhost/w3svc/1
```

In the preceding examples, NDS: refers to IntraNetWare 5.x and 4.x. (Because IntraNetWare 5.x is LDAP-compliant, you also can use LDAP paths with it.) NWCOMPAT: refers to NetWare 4.x, 3.2, 3.12, and 3.11 servers in bindery-emulation mode. IIS: refers to metabase paths on a host running IIS 3.0 or later

One of the most commonly used namespaces is the LDAP namespace. You can use LDAP with ADSI to access a variety of directory services, including Active Directory. Although you can use the WinNT namespace to access Active Directory, you need to use the LDAP namespace to fully utilize all of ADSI's methods and properties. For this reason, our primary focus will be on the LDAP namespace.

You can use several formats to refer to LDAP directories. For example, all the following ADsPaths reference the Administrator object within the Users container of the *moose* directory server in the *mycorp.com* zone:

```
LDAP://cn=administrator,cn=users,dc=mycorp,dc=com
LDAP://moose.mycorp.com/cn=administrator,cn=users,dc=mycorp,dc=com
LDAP://moose/cn=administrator,cn=users,dc=mycorp,dc=com
LDAP://DC=com/DC=mycorp/CN=Users/CN=Administrator
LDAP://moose.mycorp.com/DC=com/DC=mycorp/CN=Users/CN=Administrator
```

In these examples, CN stands for common name, and DC stands for domain component. These examples show that you can specify the LDAP namespace ADsPath going down or up the hierarchical Directory Information Tree (DIT). Most people have adopted the naming style used in the first three examples, where the most specific element of an object is used first. Also note that you can specify either a NetBIOS name or a fully qualified Domain Name System (DNS) server name after LDAP://, using a forward slash character (/) to separate the DNS server name from the rest of the path.

If a name includes some unusual characters, such as a forward slash or a comma, you can use double quotation marks ("/ ") or a single backslash (\/) to specify that the character should be interpreted as part of the ADsPath itself. For example, if you have a user called AC/DC on the server, this is wrong:

```
LDAP://cn=ac/dc,cn=users,dc=amer,dc=mycorp,dc=com
```

This will interpret the path using `cn=ac` , followed by `dc` , followed by `cn=users` , and so on. As dc on its own is not a valid part of the path, the ADsPath is invalid. Here are the correct paths:

```
LDAP://cn=ac\/dc,cn=users,dc=amer,dc=mycorp,dc=com
```

```
LDAP://"cn=ac/dc",cn=users,dc=amer,dc=mycorp,dc=com
```

Obviously, as the backslash is a special character, you would need to do the following for an object called `cn=hot\cold` :

```
LDAP://cn=hot\\cold,cn=users,dc=amer,dc=mycorp,dc=com
LDAP://"cn=hot\cold",cn=users,dc=amer,dc=mycorp,dc=com
```

The first specifies that the character following the first backslash is to be interpreted as part of the name, and the latter says to specify that the whole first name is a valid string.[*]

[*] Unfortunately, the latter, while valid, will not work with VBScript's GetObject function due to the extra quotation marks ("/ ").

20.3.3. Retrieving Objects

Now that you know how to use ADsPaths to distinguish between different namespaces, we'll demonstrate how to establish a connection and authenticate to the server containing the directory service you want to access. Authenticating a connection isn't always necessary; some directories, such as Active Directory, can allow anonymous read-only access to certain parts of the directory tree if you configure it that way. In general, allowing anonymous access is not a good practice. It can make things much more difficult to troubleshoot if you discover that one of your domain controllers is being impacted by an overzealous client. When using ADSI, if authentication is not done explicitly, the credentials of the account the script is running under will be used. If the account running the script is not part of either the Active Directory you want to query or in a trusted domain, you will not be able to do very much. If you just want to use the current account's credentials to bind to a directory server to get a reference to an object, use the `GetObject` function:

When to Use the LDAP and WinNT Namespaces

Contrary to popular belief, the fact that the WinNT namespace is used to access Windows NT servers does not mean it is useless for Windows 2000 and Windows Server 2003. Actually, while the LDAP namespace is used to access Active Directory, the WinNT namespace is used to access users, groups, and other objects on individual computers. Active Directory objects only exist on DCs in your forest. If you have a server or client that is a member of a workgroup or domain, that machine also has objects on it. These could be local users, such as Administrator or Guest, printers, shares, and so on. Obviously, these objects are not part of Active Directory if they are stored on the local machine. As individual machines do not support direct access via LDAP, you have to use the WinNT namespace.

```
Dim strPath       'path to the directory server
Dim objMyObject   'root object of the directory
```

```
    strPath = "LDAP://dc=amer,dc=mycorp,dc=com"

    Set objMyObject = GetObject
(strPath)
```

The code begins by declaring two variables with VBScript `Dim` statements. The first variable, `strPath` , is an ADsPath. The prefix `str` specifies that this ADsPath is a text string; see the sidebar about typical VBScript naming conventions. The second variable, `objMyObject` , is a pointer to the object in the directory that the ADsPath represents. The prefix `obj` specifies that the variable is an object.

Next, we assign the `strPath` variable to the path of the directory server we want to bind to, in this case, `LDAP://dc=amer,dc=mycorp,dc=com` . You need to enclose this path in quotation marks, because it is a tex string.

Finally, we use VBScript's `Set` statement with the `GetObject` method to create a reference between the variable we declared and the existing object we want to interact with. In this case, we're creating a reference between `objMyObject` and the existing object that the ADsPath `LDAP://dc=amer,dc=mycorp,dc=com` represents (i.e., the domain object of the *amer.mycorp.com* domain). After we've established this reference, we can use other IADs-based interfaces to interact with that object.

Variable Prefix Conventions

You can use whatever name you like for a variable. However, the consensus is to use a prefix with a descriptive name. The prefix, which represents the type of data, typically contains one lowercase character or three lowercase characters. Commonly used three-character prefixes include:

- str = string
- int = integer
- bol = boolean
- obj = object
- arr = array
- lgn = long integer
- sgl = single precision value
- dbl = double precision value

In the descriptive name, you capitalize the first letter of each word but don't put hyphens between wordsfor example, `strMyPassword` .

To explicitly authenticate to a directory server, use the IADsOpenDSObject interface, which contains only one method: OpenDSObject , which takes four parameters (also known as arguments):

- ADsPath to authenticate to
- User DN or UPN to bind as
- User's password
- Additional security setting(s)

The following listing shows how to use IADsOpenDSObject::OpenDSObject to authenticate to a directory server. We begin by declaring three string variables (strPath , strUsername , and strPassword) and two object variables (objNamespaceLDAP and objMyObject):

```
Dim strPath            'path to authenticate to in the directory service
Dim strUsername        'DN of the username
Dim strPassword        'plain text password
Dim objNamespaceLDAP   'ADSI namespace object
Dim objMyObject        'root object of the directory

strPath = "LDAP://dc=amer,dc=mycorp,dc=com"
strUsername = "cn=Administrator,cn=Users,dc=amer,dc=mycorp,dc=com"
strPassword = "the password goes here in plain text"

Set objNamespaceLDAP = GetObject("LDAP:")
 Set objMyObject = objNamespaceLDAP.OpenDSObject(strPath,strUsername,strPassword,0
```

We then assign the strPath , strUsername , and strPassword variables the appropriate ADsPath, username, and password strings. The username string can take several formats, Distinguished Name (DN), User Principal Name (UPN), and SAM Format. DN references the username's exact location in the directory. UPN typically has the format of username@ForestDnsName (e.g., administrator@mycorp.com). The SAM format is the standard Windows NT format of of username or domain\username (e.g., administrator or mycorp\administrator).

The strPath is used to authenticate to a specific point in Active Directory if you wish. This can be used if the user authenticating does not have permission to work at the root and has to authenticate further down the tree.

Next, we use a Set statement with GetObject to create a reference for the variable called objNamespaceLDAP . Notice that we're using "LDAP:" rather than strPath as an argument to GetObject . Using the LDAP namespace might seem unusual, but it is necessary so that in the next line, you can call the IADsOpenDSObject::OpenDSObject method on the LDAP namespace that ADSI returns. The last IADsOpenDSObject::OpenDSObject argument is to specify any security settings that should be applied to the connection. When set to 0 or left blank, no security is enabled for the connection. That is typically not the optimal choice, considering that all traffic between client and server will be sent in plain text over the network.

The following two constants are important to use if at all possible:

ADS_SECURE_AUTHENTICATION (0x1)

Negotiates with the server to use the most secure authentication possible. For the WinNT provider, NT LAN Manager (NTLM) will be used. For Active Directory, Kerberos is the first option with NTLM being used if Kerberos isn't available.

ADS_USE_ENCRYPTION/ADS_USE_SSL (0x2)

Encrypts the data between client and server. SSL must be available on the target domain controller.

You use multiple constants by adding them together i.e., (ADS_SECURE_AU-THENTICATION + ADS_USE_ENCRYPTION) as they represent integer values. While these are defined constants, they cannot be used by name from VBScript. The entire set of values from the ADS_AUTHENTICATION_ENUM enumerated type can be found under the MSDN Library (http://msdn.microsoft.com/library/), by following this path: Networking and Directory Services → Active Directory, ADSI and Directory Services → SDK Documentation → Directory Services → Active Directory Service Interfaces → Active Directory Service Interfaces Reference → ADSI Enumerations → ADS_AUTHENTICATION_ENUM.

> We want to emphasize the importance of using encryption. If encryption is not used, anyone using a network sniffer such as NetMon or Ethereal on the network might be able to see the information being passed, including, possibly, the username and password specified in the `IADsOpenDSObject::OpenDSObject` call.

The following code is slightly modified from the previous example to show how to enable ADS_SECURE_AUTHENTICATION and ADS_USE_ENCRYPTION for a connection:

```
Const ADS_SECURE_AUTHENTICATION = 1
Const ADS_USE_ENCRYPTION        = 2

Dim strPath            'path to authenticate to in the directory service
Dim strUsername        'DN of the username
Dim strPassword        'plain text password
Dim objNamespaceLDAP   'ADSI namespace object
Dim objMyObject        'root object of the directory

strPath = "LDAP://dc=amer,dc=mycorp,dc=com"
strUsername = "cn=Administrator,cn=Users,dc=amer,dc=mycorp,dc=com"
strPassword = "the password goes here in plain text"

Set objNamespaceLDAP = GetObject("LDAP:")
Set objMyObject = objNamespaceLDAP.OpenDSObject(strPath, _
                               strUsername, strPassword, _
               ADS_USE_ENCRYPTION + ADS_SECURE_AUTHENTICATION)
```

While securing the connection to the domain controller is an important precaution to take, including an administrator's password in a script can obviously be pretty insecure. If you don't want to include plain-text passwords, you have several options. The first option is to assign a value to strPassword from the VBScript InputBox function. The following listing shows this:

```
Const ADS_SECURE_AUTHENTICATION = 1
Const ADS_USE_ENCRYPTION        = 2

Dim strPath               'path to authenticate to in the directory service
Dim strUsername           'DN of the username
Dim strPassword           'plain-text password
Dim objNamespaceLDAP      'ADSI namespace object
Dim objMyObject           'root object of the directory

strPath = "LDAP://dc=amer,dc=mycorp,dc=com"
strUsername = "cn=Administrator,cn=Users,dc=amer,dc=mycorp,dc=com"
strPassword = InputBox("Enter the Administrator password","Password entry box")

Set objNamespaceLDAP = GetObject("LDAP:")
Set objMyObject = objNamespaceLDAP.OpenDSObject(strPath, _
                               strUsername, strPassword, _
               ADS_USE_ENCRYPTION + ADS_SECURE_AUTHENTICATION)
```

When you run the script, the InputBox prompts you to enter the administrator's password. However, the InputBox echoes the password in plain text while you type it into the password entry box, so this approach isn't terribly secure either.

Three other options are secure. However, because VBScript doesn't natively support password retrieval boxes, you can't use these solutions without some work:

- One solution requires that you obtain a custom ActiveX component for VBScript to extend WSH's functionality to natively support password dialog boxes. One such control is available for by downloading the code from the *Windows Script Host Programmer's Reference* by Dino Esposito, which can be found at http://www.wrox.com .

- The second solution is to write a script in a language other than VBScript that supports password boxes natively. For example, you can use the Perl Tk modules to create an Entry widget with the -show parameter as an asterisk. For Perl aficionados, this Entry widget would look like this:

  ```
  $dlg->Entry(qw/-show * -width 35/)->pack(   ); # arbitrary width
  ```

- The third solution requires that you write the script from within Active Server Pages (ASP). You use the password field in an ASP form to retrieve the password.

If you want to authenticate a connection but have already logged on to the directory, you can use the default credentials for your existing connection. You simply use the VBScript vbNullString constant in both the username and password fields, as the following listing shows:

```
Dim strPath             'path to authenticate to in the directory service
Dim objNamespaceLDAP    'ADSI namespace object
Dim objMyObject         'root object of the directory

strPath = "LDAP://dc=amer,dc=mycorp,dc=com"

Set objNamespaceLDAP = GetObject("LDAP:")
Set objMyObject = objNamespaceLDAP.OpenDSObject(strPath, vbNullString, _
  vbNullString,0)
```

From now on, most of the scripts will use `GetObject` for simplicity, but if you need to, you can just as easily use `IADsOpenDSObject::OpenDSObject` without modifying any of the other code.

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20.4. Simple Manipulation of ADSI Objects

Let's now take a look at simple manipulation of Active Directory objects using ADSI. We are using Active Directory as the primary target for these scripts, but the underlying concepts are the same for any supported ADSI namespace and automation language. All the scripts use `GetObject` to instantiate objects and are assuming you are logged in already with an account that has administrative privileges over the objects manipulated. If you aren't, you need to use `IADsOpenDSObject::OpenDSObject` as shown earlier in the chapter.

The easiest way to show how to manipulate objects with ADSI is through a series of real-world examples, the sort of simple tasks that form the building blocks of everyday scripting. To that end, imagine that you want to perform the following tasks on the *mycorp.com* Active Directory forest:

1. Create an Organizational Unit called Sales.
2. Create two users in the Sales OU.
3. Iterate through the Sales OU and delete each user.
4. Delete the Organizational Unit.

This list of tasks is a great introduction to how ADSI works because we will reference some of the major interfaces using these examples.

20.4.1. Creating the OU

The creation process for the Sales Organizational Unit is the same as for any object. First you need to get a pointer to the container in which you want to create the object. You do that using the following code:

```
Set objContainer = GetObject("LDAP://dc=mycorp,dc=com")
```

> While VBScript and VB have the `GetObject` function, Visual C++ (VC++) has no such built-in function. ADSI provides the ADsGetObject function for use by those languages that need it.

Because we are creating a container of other objects, rather than a leaf object, you can use the

IADsContainer interface methods and properties. The IADsContainer::Create method is used to create a container object, as shown in the following code:

```
Set objSalesOU = objContainer.Create("organizationalUnit","ou=Sales")
```

Here we pass two arguments to IADsContainer::Create: the objectclass of the class of object you wish to create and the Relative Distinguished Name (RDN) of the object itself. We use the ou= prefix because the type of object is an Organizational Unit. Most other objects use the cn= prefix for the RDN.

The IADsContainer interface enables you to create, delete, and manage other Active Directory objects directly from a container. Think of it as the interface that allows you to manage the directory hierarchy. A second interface called IADs goes hand in hand with IADsContainer, but while IADsContainer works only on containers, IADs will work on any object.

To commit the object creation to Active Directory, we now have to call IADs::SetInfo:

```
objSalesOU.SetInfo
```

ADSI implements a caching mechanism in which object creation and modification are first written to an area of memory called the property cache on the client executing the script. Each object has its own property cache, and each cache has to be explicitly written out to Active Directory using IADs::SetInfo for any creations or modifications to be physically written to Active Directory. This may sound counterintuitive but in fact makes sense for a number of reasons, mostly involved with reducing network traffic. The property cache is discussed in more detail in Chapter 21.

Each object has a number of properties, some mandatory and some optional. Mandatory properties have to be defined during the creation of an object. They serve to uniquely identify the object from its other class members and are necessary to make the object usable in Active Directory. If you need to create an object with a large number of mandatory properties, it makes sense to write them all into a cache first and then commit them to Active Directory in one operation, rather than perform a sequence of SetInfo operations.

Although the Organizational Unit example has no other mandatory properties, other objects do. For example, in Windows 2000 Active Directory, user, group, and computer objects require sAMAccountName to be set before they can be written out successfully. In addition, you can also choose to set any of the optional properties before you use IADs::SetInfo.

Putting it all together, we have our first simple script that creates an OU:

```
Set objContainer = GetObject("LDAP://dc=mycorp,dc=com")
Set objSalesOU = objContainer.Create("organizationalUnit", "ou=Sales")
objSalesOU.SetInfo
```

20.4.2. Creating the Users

We now will move to the second task of creating a couple user objects. Creating user objects is not much different from creating an OU in the previous task. We use the same `IADsContainer::Create` method again as in the following:

```
Set objUser1 = objSalesOU.Create("user", "cn=Sue Peace")
objUser1.Put "sAMAccountName", "SueP"
objUser1.SetInfo

Set objUser2 = objSalesOU.Create("user", "cn=Keith Cooper")
objUser2.Put "sAMAccountName", "KeithC"
objUser2.SetInfo
```

The `IADs::Put` method is used here to set the SAM Account Name. The SAM Account Name is the name of the user as it would have appeared in previous versions of NT and is used to communicate with down-level NT domains and clients. It is still required because Active Directory supports accessing resources in down-level Windows NT domains, which use the SAM Account Name.

> Windows Server 2003 Active Directory changed the mandatory requirement of the `sAMAccountName` attribute being populated during object creation. If you do not specify it, `sAMAccountName` will be set to a random value, such as $KJK000-H4GJL6AQOV1I.

It is also worth pointing out that the `IADs::SetInfo` calls can be put at the end of the script if you want to. As long as they go in the right order (i.e., the OU must exist before the user objects within that OU exist), the following works:

```
Set objContainer = GetObject("LDAP://dc=mycorp,dc=com")
Set objSalesOU = objContainer.Create("organizationalUnit", "ou=Sales")

Set objUser1 = objSalesOU.Create("user", "cn=Sue Peace")
objUser1.Put "sAMAccountName", "SueP"

Set objUser2 = objSalesOU.Create("user", "cn=Keith Cooper")
objUser2.Put "sAMAccountName", "KeithC"

objSalesOU.SetInfo
objUser1.SetInfo
objUser2.SetInfo
```

This works because the property cache is the only thing being updated until the `SetInfo` call is issued.

Because ADSI works against the property cache and not Active Directory directly, you could put off the SetInfo calls until the end of your scripts. There is no special benefit to doing scripts this way, and it can lead to confusion if you believe incorrectly that properties exist in the underlying service during later portions of the script. In addition, if you bunch up cache writes, and the server crashes, none of your writes will have gone through, which you could see as a good thing. However, we will not be using this method as we prefer to flush the cache as soon as feasible. Bunching caches to write at the end of a script encourages developers to neglect proper error checking and progress logging to a file from within scripts.

20.4.3. Tearing Down What Was Created

As you've seen, creating objects is a breeze with ADSI. Deleting objects is also very straightforward. Let's iterate through the Sales OU and delete the two users we just created:

```
For Each objUser in objSalesOU
   objUser.DeleteObject(0)
Next
```

We used a For Each loop to enumerate over the objects in objSalesOU. The objUser variable will get set to a reference of each child object in the Sales OU. We then use IADsDeleteOps::DeleteObject method to delete the object. The value 0 must be passed in to DeleteObject, but it does not hold any special significance (it is reserved for later use).

The final step is to delete the Sales OU using the same method (IADsDeleteOps::De-leteObject) that we used to delete users:

```
 objSalesOU.DeleteObject(0)
Set objSalesOU = Nothing
```

The IADsDeleteOps::DeleteObject method can delete all the objects within a container, so it wasn't really necessary for us to delete each user object individually. We could have instead used DeleteObject on the Sales OU to delete the OU and all child objects within the OU. This method should be used with care since a lot of objects can be wiped out by using DeleteObject on the wrong container. If this is a serious concern and you would like more control over the deletions, consider using the IADsContainer::Delete method, which can only be used to delete leaf objects and childless sub containers.

The `Nothing` keyword in VBScript is used to disassociate an object variable from any object. This prevents you from being able to use the variable later in your code. Setting the value of each object to `Nothing` may seem less than worthwhile when the script is due to end soon. However, you must get into this habit, and we can't stress its importance enough. After you have deleted an object from the underlying directory service, the property cache for that object still exists. If you do not remove the reference to it, and you use it again later, it refers to data that no longer exists. Trying to do a `SetInfo` (or a `GetInfo`, which is covered in the next chapter) on a deleted object's property cache generates a failure.

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20.5. Further Information

This is by no means an in-depth discussion on ADSI. For more information, you should look at the Microsoft Developer Network (MSDN) library documentation, which contains all of the documentation on the specifics of VBScript, JScript, ADO, ADSI, and WSH. There are a few ways to get hold of the MSDN library: you can purchase an MSDN library subscription from Microsoft and get quarterly CD/DVDs with all of the documentation, or you can access the documentation directly via the Internet. MSDN online can be found at http://msdn.microsoft.com/library/. Once you enter the MSDN library from the CD-ROM or the Web, you will see a list of contents on the left-hand menu, which you can browse.

Table 20-1 lists some useful Internet sites to find additional information on the topics covered in this chapter.

Table 20-1. Useful Internet sites

Description	URL
Microsoft's main scripting web site.	http://msdn.microsoft.com/scripting/
MSDN Library root.	http://msdn.microsoft.com/library/
WSH docs.	http://msdn.microsoft.com/library/default.asp?url=/library/en-us/script56/html/wsoriwindowsscripthost.asp
Microsoft's universal data access components site (including the official pages for ADO).	http://www.microsoft.com/data/
A fantastic site for developers of ASP, ADSI, and ADO pages and scripts (including a superb ADSI mailing list).	http://www.15seconds.com
O'Reilly's Windows and VB sites detailing its resources and books.	http://windows.oreilly.com http://vb.oreilly.com
Clarence Washington's repository for scripting solutions on the Internet.	http://cwashington.netreach.net
Wrox publishes books on ADSI, ADO, VB, and WSH.	http://www.wrox.com
Windows IT Pro Magazine (formerly many things, but most	http://www.windowsitpro.com http://www.win32scripting.com

Description	URL
recently *Windows and .NET Magazine*) is published monthly, as is the Windows Scripting Solutions (formerly Win32 Scripting Journal), both of which provide a lot of good information on Active Directory and scripting.	
Robbie Allen's scripting home page. Robbie is the author of several O'Reilly Windows Cookbook series books, as well as the author of the second edition of this very book.	http://www.rallenhome.com/scripting.html
Microsoft TechNet Script Center.	http://www.microsoft.com/technet/scriptcenter/default.mspx

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20.6. Summary

Hopefully, you now understand the basics of ADSI enough to be useful. It's a very robust API that allows you to interface to all aspects of Active Directory as well as Windows NT, Windows 2000, and Windows Server 2003 servers. Even though the majority of this chapter covers Microsoft operating systems, the code does use the LDAP namespace and is portable to many other directory services. One of ADSI's biggest strengths is its ability to communicate with a variety of directory services using either LDAP or a provider-specific namespace.

In the next chapter, we will cover the IADs interface in more depth along with a discussion of the Property Cache. A chapter covering ADO will follow that, which should give you all the necessary tools to query and manipulate Active Directory.

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Chapter 21. IADs and the Property Cache

Each object in a directory has a series of attributes, or properties, that uniquely define it. Although properties can vary from object to object, ADSI supports the manipulation of a core set of six properties common to all objects using the IADs interface. These properties are common to all objects because IADs is the most basic interface in ADSI.

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21.1. The IADs Properties

The IADs properties are as follows:

Class

The object's schema class

GUID

The object's Globally Unique ID (GUID)

Name

The object's name

ADsPath

The ADsPath to the object in the current namespace

Parent

The ADsPath to the object's parent

Schema

The ADsPath to the object's schema class

Each of these properties has a corresponding property method in the IADs interface. You can use the property method, which has the same name as the property, to access that property's value. Example 21-1 contains code to display the six IADs properties for a user object.

Example 21-1. Using the explicit property methods to display the six IADs properties

```
Dim objUser 'An ADSI User object
Dim str     'A text string

' User object using the WinNT namespace
Set objUser=GetObject("WinNT://MYCORP/Administrator,User")
str = "Name
: " & objUser.Name & vbCrLf
str = str & "GUID: " & objUser.GUID & vbCrLf
str = str & "Class: " & objUser.Class & vbCrLf
str = str & "ADsPath: " & objUser.ADsPath & vbCrLf
str = str & "Parent: " & objUser.Parent & vbCrLf
str = str & "Schema: " & objUser.Schema & vbCrLf & vbCrLf
Set objUser = Nothing

' User object using the LDAP namespace
Set objUser=GetObject("LDAP://cn=Administrator,cn=Users,dc=mycorp,dc=com")
str = str & "Name: " & objUser.Name & vbCrLf
str = str & "GUID: " & objUser.GUID & vbCrLf
str = str & "Class: " & objUser.Class & vbCrLf
str = str & "ADsPath: " & objUser.ADsPath & vbCrLf
str = str & "Parent: " & objUser.Parent & vbCrLf
str = str & "Schema: " & objUser.Schema & vbCrLf & vbCrLf

WScript.Echo str

Set objUser = Nothing
```

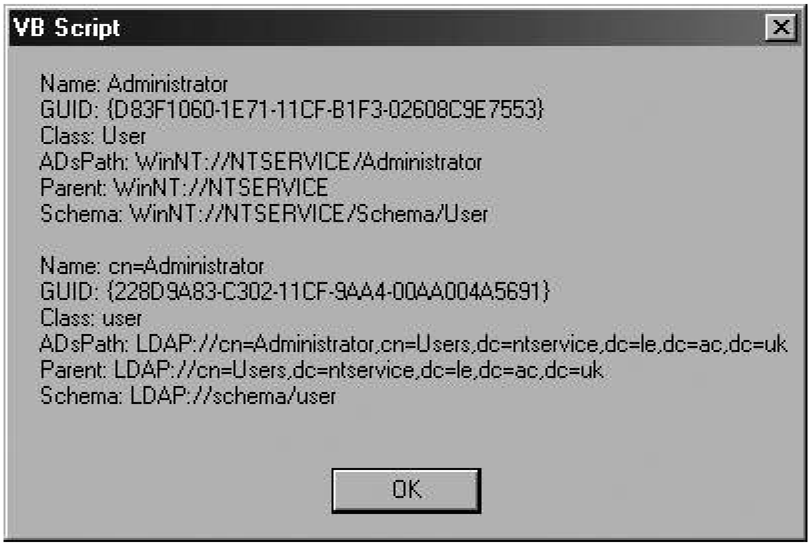
To begin, we declare two variables (i.e., `str` and `objUser`), invoke the `GetObject` method to create a reference to the user object, and assign it to `objUser`. We then set the `str` variable to the string `"Name:"` and apply the `IADs::Name` property method (i.e., `objUser.Name`) to retrieve the `Name` property's value (i.e., Administrator). The carriage-return line-feed constant (`vbCrLf`) specifies to move to the start of a new line. At this point, `str` represents the string `"Name: Administrator"`.

In the next line, we use the `IADs::GUID` property method (`objUser.GUID`) to retrieve the GUID property's value (i.e., {D83F1060-1E71-11CF-B1F3-02608C9E7553}). We are appending the GUID to previous value `set` in `str` so the new `str` represents the `Name` property value and the `GUID` property value. This was repeated until all six core properties in both the WinNT and the LDAP namespaces were retrieved.

You might be surprised to find out that enumerating properties in different namespaces produces different output, as Figure 21-1 shows. For example, the `Name` property under the LDAP namespace has `"cn="` included, whereas the `Name` property under the WinNT namespace doesn't.

Both the code and the figure demonstrate another important point: the type of directory can affect the results. For example, using the `IADs::Parent` property makes sense when you're using the LDAP namespace to access a hierarchical directory such as Active Directory, because you can see parent-child relationships (e.g., you can see that the Users container is the parent for the Administrator User object). However, using the `IADs::Parent` property to look at NT's Security Accounts Manager (SAM) doesn't make sense where domains are concerned because the contents are all in one flat namespace.

Figure 21-1. The IADs properties from the WinNT and LDAP namespaces



```
Name: Administrator
GUID: {D83F1060-1E71-11CF-B1F3-02608C9E7553}
Class: User
ADsPath: WinNT://NTSERVICE/Administrator
Parent: WinNT://NTSERVICE
Schema: WinNT://NTSERVICE/Schema/User

Name: cn=Administrator
GUID: {228D9A83-C302-11CF-9AA4-00AA004A5691}
Class: user
ADsPath: LDAP://cn=Administrator,cn=Users,dc=ntservice,dc=le,dc=ac,dc=uk
Parent: LDAP://cn=Users,dc=ntservice,dc=le,dc=ac,dc=uk
Schema: LDAP://schema/user
```

21.1.1. Using IADs::Get and IADs::Put

While you can use property methods to access most of an object's properties, you can also use the IADs interface's `IADs::Get` and `IADs::Put` methods to retrieve any attribute on the object.

In other words, the following two sets of statements are equivalent:

```
strName = objUser.description
objUser.description = strName

strName = objUser.Get("description")
objUser.Put "description", strName
```

However, using the `IADs::Get` and `IADs::Put` methods is more of a performance hit as it involves internally doing a search for the property specified. Compared to this, the direct use of a property is what is known as a *direct vtable binding* per the COM documentation and is the faster of the two. `IADs::Get` and `IADs::Put` should be used only when a generic browser or program is written to work with any ADSI object. See Table 21-1 for the full set of methods and property methods for the IADs interface.

Table 21-1. The main IADs methods and properties

IADs methods and properties	Action
Get method	Retrieves a single item from the property cache
Put method	Sets a single item in the property cache
GetEx method	Retrieves single or multi-valued items from the property cache
PutEx method	Sets single or multi-valued items in the property cache
GetInfo method	Retrieves all of an object's properties into the property cache
GetInfoEx method	Retrieves one or more of an object's properties into the cache
SetInfo method	Writes out all the items in the property cache to the directory
get_Name method	Gets the name of the object[a]
get_GUID method	Gets the GUID of the object
get_Class method	Gets the schema class name of the object
get_ADsPath method	Gets the ADsPath of the object
get_Parent method	Gets the parent ADsPath of the object
get_Schema method	Gets the ADsPath of the object's schema class
Class property	Represents the schema class of the object
GUID property	Represents the GUID of the object
Name property	Represents the name of the object
AdsPath property	Represents the ADsPath of the object
Parent property	Represents the ADsPath to the parent of this object
Schema property	Represents the ADsPath of the object's schema class

[a] A VC++ method. We won't include these in the future interface definitions, but they do serve as an example that VC++ does not support setting properties in a similar way to VBScript.

> Why Microsoft couldn't have named `IADs::SetInfoPutInfo`, or renamed `IADs::Put` and `IADs::PutEx` `Set` and `SetEx` for consistency is beyond us.

For example, the next script shows how you use `IADs::Get` and `IADs::Put` to retrieve, change, and return the mail property. After we set the `objGroup` variable to the pointer to the Managers group, we use the `IADs::Get` method (`objGroup.Get`) with the "mail" argument to retrieve the mail property's value. The `WScript.Echo` method displays the results in a window.

Changing the value and returning it to the property cache is just as simple. You use the `IADs::Put` method with the argument "mail." You don't put the argument in parentheses when you use the IADs::Put method: the method is a sub-procedure, not a function, and it doesn't return a value. The string that follows the IADs::Put function contains the Managers group's new mail contact address. To write the new mail property to Active Directory, you use IADs::SetInfo:

```
Set objGroup = GetObject("LDAP://cn=Managers,ou=Sales,dc=mycorp,dc=com")
WScript.Echo objGroup.Get("mail")

 objGroup.Put "mail", "agl1@mycorp.com"
objGroup.SetInfo
```

21.1.2. The Property Cache

Having looked at properties and property methods, let's take a look at the property cache, a location in memory on the local machine running the script that stores properties for objects. Each object that you bind to has a personal property cache; the OS creates this cache the instant the bind succeeds. However, the OS doesn't immediately populate the cache with values.

Accessing the Property Cache with Microsoft Visual C++

VC++ cannot use the same property method mechanism that automation languages like VBScript can use to get and set values in the property cache. Instead, Microsoft designed a variety of nonautomation interfaces, methods, and properties VC++ can make use of.

For example, when setting properties for a group, VC++ has access to the IADs::Get and IADs::Put methods in the same way that VBScript does. In addition, it also has access to the IADsGroup::get_Description and IADs::put_Description methods. This is because VC++ cannot use the IADs::Description property method. Code in VC++ would look like this using IADs::Put:

```
// Declare the variables
IADsGroup  *pGroup;
IADs       *pObject;
ADsGetObject(
  TEXT("LDAP://cn=Managers,ou=Sales,dc=mycorp,dc=com"),
  IID_IADsGroup,
  (void**) &pGroup);
// Set using IADs::Put method
pGroup->QueryInterface(IID_IADs,(void **) &pObject);
pObject->Put("Description",TEXT("My new group description goes here"))
pGroup->SetInfo;
```

Code in VC++ would look like this when using the IADsGroup::put_Description method:

```
// Declare the variables
IADsGroup  *pGroup;
IADs       *pObject;
ADsGetObject(
  TEXT("LDAP://cn=Managers,ou=Sales,dc=mycorp,dc=com"),
  IID_IADsGroup,
  (void**) &pGroup);
// Set using IADsGroup::put_Description property method
pGroup->put_Description(TEXT("My new group description goes here"));
pGroup->SetInfo;
```

When you use the IADs::Get method to retrieve an object's property, ADSI doesn't go to Active Directory to retrieve the value. Instead, ADSI reads the value from the property cache on the client executing the script. If ADSI doesn't find the property in the property cache when the call comes in, the system implicitly executes an IADs::GetInfo call to read all the properties for the current object into the cache. (You also can explicitly use the IADs::GetInfo method to populate the property cache with an object's properties.) The IADs::Get method then reads the appropriate value from the newly created cache.

Microsoft designed the property cache with efficiency in mind. The property cache lets you access an object's properties with a minimum number of calls, thereby minimizing network traffic. Retrieving all of an object's properties with one IADs::GetInfo call is more efficient than individually retrieving each property. Similarly, the process of writing all of an object's properties first to the cache and then to Active Directory with one IADs::SetInfo call is more efficient than writing each property individually to Active Directory.

21.1.3. Be Careful

The IADs::GetInfo and IADs::SetInfo methods are two of the most important methods you'll use. However, you need to be aware of two possible problems.

The first problem can arise if you try to access a property that doesn't have a value. For example, when you create a group object, the mail property doesn't automatically receive a value; you must provide a value, such as agl1@mycorp.com. When you use the IADs::GetInfo method, only those properties that have values appear in the property cache. Thus, if you don't give the mail property a value and you use IADs::GetInfo, the mail property value won't be in the property cache. If you try to access a property that doesn't exist in the cache, the script will throw an error that you need to catch.

> Later on we talk about navigating the property cache. If you want to see a good example of how this actually works, try this: create a new object of type `group`, which has around 21 properties set by the system by default. You then use `IADs::GetInfo` in a script and display the number of properties, and possibly their names, in a dialog box. Then set the description. Now, when you rerun the script, you will find that you have one more property in the cache than you did before the description. In other words, the description does not appear in the cache until you do an `IADs::GetInfo` after it has been set.

Another problem can arise if you forget to use `IADs::SetInfo` after modifying a property. For example, suppose you want to change the Managers group's mail property value and you create the script shown in Example 21-2.

Example 21-2. Making the mistake of forgetting the SetInfo call

```
Dim objGroup  'An ADSI group object

Set objGroup = GetObject("LDAP://cn=Managers,ou=Sales,dc=mycorp,dc=com")

'**********************************************************************
'Get and write the mail property value, which forces an
'implicit GetInfo call
'**********************************************************************
WScript.Echo objGroup.Get("mail")

'**********************************************************************
'Set the new mail address in the cache
'**********************************************************************
objGroup.Put "mail", "new-address@mycorp.com"

'**********************************************************************
'Use an explicit GetInfo call to again retrieve all items into the cache
'**********************************************************************
objGroup.GetInfo

WScript.Echo objGroup.mail
```

In Example 21-2, we set the `objGroup` variable to the pointer to the Managers group. To display the current `mail` property value in a window, we use the `WScript.Echo` method with the `IADs::Get` method, which forces an implicit `IADs::GetInfo` call. We then set the new value for the `objGroup`'s `mail` property, after which we use an explicit `IADs::GetInfo` call to again retrieve all the object's properties into the cache. Finally, we use the `WScript.Echo` method to display the results in a window.

When you run the script, two windows pop up. To your dismay, both windows state the original value of the `mail` property, which means that the system didn't write the new mail address to Active

Directory. This cache write didn't occur because you need to explicitly call the IADs::SetInfo method to write out data from the cache to Active Directory. To fix the script, you need to insert the line:

```
objGroup.SetInfo
```

between the line setting the new mail address and the line making the explicit IADs::GetInfo call.

21.1.4. More Complexities of Property Access: IADs::GetEx and IADs::PutEx

Using the IADs interface's IADs::Get method works well for properties with a single value. However, some properties have multiple values, such as a user with several telephone numbers. If a property stores multiple values, you need to use the IADs interface's IADs::GetEx[*] and IADs::PutEx methods to retrieve and return the values.

[*] You also can use IADs::GetEx and IADs::PutEx for single-value properties.

21.1.4.1. Using IADs::GetEx

The following script shows how to use IADs::GetEx. In this script, we pass the multiple-value property as an argument to the IADs::GetEx method. We then use a For Each...Next loop on the resulting list.

```
Dim objUser        'An ADSI user object
Dim arrPhoneList   'An array of phone numbers
Dim strPhoneNumber 'An individual phone number
Set objUser=GetObject("LDAP://cn=administrator,cn=Users,dc=mycorp,dc=com")
arrPhoneList = objUser.GetEx("telephoneNumber")
For Each strPhoneNumber In arrPhoneList
  WScript.Echo strPhoneNumber
Next
```

When we make the IADs::GetEx call, the system makes an implicit IADs::GetInfoEx call rather than an implicit IADs::GetInfo call to Active Directory. You can use an explicit IADs::GetInfoEx call to get one or more properties if you don't want to use IADs::GetInfo to get all the property values. However, few scriptwriters use IADs::GetInfoEx for this purpose, because they typically use implicit calls or use IADs::GetInfo to read all values into the property cache. In addition, if you use IADs::GetEx for every property retrieval rather than using IADs::GetInfo, your underlying network traffic will increase. Instead of sending one request to the server for all the information, you'll be sending several requests for smaller amounts of information.

Although IADs::GetInfoEx isn't a good substitute for IADs::GetInfo, it works well for selectively reading properties into the property cache. Example 21-3 shows how to selectively retrieve only two properties.

Example 21-3. Selectively reading properties into the property cache usin the GetInfo method

```
Dim objUser  'An ADSI user object
Dim arrProps 'An array of properties to return

Set  objUser=GetObject("LDAP://cn=administrator,cn=Users,dc=mycorp,dc=com")

'***********************************************************************
'Set the list of properties to return
'***********************************************************************
ArrProps = Array("cn","ADsPath")

'***********************************************************************
'Get the specified properties
'***********************************************************************
objUser.GetInfoEx  arrProps,  0

WScript.Echo objUser.cn & vbTab & objUser.ADsPath
```

After we set the objUser variable, we create an array containing the properties we want (i.e., cn and ADsPath). Next, we pass that array to the IADs::GetInfoEx method as the first parameter. (The second parameter must be 0 for all actions; however, it is reserved and could be used in a later version of ADSI.) Then, the last line uses the WScript.Echo method to print the cn and ADsPath attributes, separating them with a tab.

21.1.4.2. Using IADs::PutEx

To set multi-value properties, you use the IADs::PutEx method. This is slightly more complicated than using IADs::GetEx. Suppose a property already has three values (e.g., pager numbers), and you want to put in two more. You must let IADs::PutEx know whether it needs to overwrite, update, or add to the existing values. You use the constants in Table 21-2 to tell IADs::PutEx what to do.

Table 21-2. The constants for updating the property cache with the PutE method

Constant name	Value	Action
ADS_PROPERTY_CLEAR	1	Use when clearing all values

Constant name	Value	Action
ADS_PROPERTY_UPDATE	2	Use when replacing all existing values
ADS_PROPERTY_APPEND	3	Use when adding to existing values
ADS_PROPERTY_DELETE	4	Use when deleting specific values

Use the constant name only if you're using VB. If you use VBScript with the WSH, you must either define the constants, as we've done in Example 21-4, or use the values directly. The four values are fairly straightforward to use, as the example script shows.

Example 21-4. Using constants with the PutEx method to update the property cache

```
Const ADS_PROPERTY_CLEAR = 1
Const ADS_PROPERTY_UPDATE = 2
Const ADS_PROPERTY_APPEND = 3
Const ADS_PROPERTY_DELETE = 4

Dim objUser  'An ADSI User object
Dim strPager 'A text string holding a phone number

Set objUser=GetObject("LDAP://cn=Administrator,cn=Users,dc=mycorp,dc=com")

'**********************************************************************
'Set three pager numbers for the Administrator account
'**********************************************************************
objUser.PutEx ADS_PROPERTY_UPDATE, "pager", _
  Array("123-1234", "234-2345", "345-3456")
objUser.SetInfo
objUser.GetInfo
For Each strPager in objUser.telephonePager
  WScript.Echo strPager
Next

'**********************************************************************
'Delete the first and last number
'**********************************************************************
objUser.PutEx ADS_PROPERTY_DELETE, "pager", Array("123-1234", "345-3456")
objUser.SetInfo
objUser.GetInfo
For Each strPager in objUser.telephonePager
  WScript.Echo strPager
Next

'**********************************************************************
'Add a new pager number without deleting the remaining number
'**********************************************************************
```

```
objUser.PutEx  ADS_PROPERTY_APPEND,  "pager",  Array("456-4567")
objUser.SetInfo
objUser.GetInfo
For Each strPager in objUser.telephonePager
  WScript.Echo strPager
Next

'**********************************************************************
'Delete all values
'**********************************************************************
objUser.PutEx ADS_PROPERTY_CLEAR, "pager", vbNull
objUser.SetInfo
objUser.GetInfo
For Each strPager in objUser.telephonePager
  WScript.Echo strPager
Next
```

After binding to the user object, three pager numbers are set for the Administrator account, wiping out any existing values. The property cache is then reloaded explicitly to make sure it contains the new values that were just set. Now, a `For Each` loop is used to go through the newly set property to show the individual pager numbers. The first and last pager numbers of the new property are deleted in the cache and written to Active Directory with `SetInfo`.

At this point, Active Directory should contain only one pager number, which is displayed by looping through the values again. Next we append a number to the value held for that property in the cache and subsequently write it out to Active Directory, leaving two numbers in Active Directory for that property. Looping through the values again shows there are two numbers. Finally, all values in the property cache for that property are deleted, and the changes are updated in Active Directory. Using the `For Each` loop one last time should show no values.

Knowing now that you can access all of an object's properties from the cache individually, it would make sense if there were a way to count the number of items, display their names as well as their values, and so on. For this purpose, Microsoft provided three interfaces: `IADsPropertyList`, `IADsPropertyEntry`, and `IADsPropertyValue`.

PREV NEXT

21.2. Manipulating the Property Cache

There will be times when you need to write a script that queries all the values that have been set in the underlying directory for a particular object. For example, suppose you're one of several systems administrators who work with your company's Active Directory implementation. You need to write a script that queries all the property values that the administrators have set for a particular user.

Discovering the set property values for an object can be a long, tedious job. Fortunately, ADSI provides a quick method. If someone has set a value for a property, it must be in that object's property cache. So all you need to do is walk through the property cache, displaying and optionally modifying each item as you go.

In this section, we'll describe the property cache mechanics and show you how to write scripts that use several ADSI methods and properties to add individual values, add a set of values, walk through the property cache, and write modifications to the cache and to the directory. Although these examples access the Lightweight Directory Access Protocol (LDAP) namespace, you can just as easily substitute the WinNT namespace in any of the scripts and run them against Windows NT servers.

Details of the property cache interfaces can be found in the MSDN Library at:

> http://msdn.microsoft.com/library/default.asp?url=/library/en-us/adsi/adsi/property_cache_interfaces.asp

21.2.1. Property Cache Mechanics

Every object has properties. When you perform an explicit `IADs::GetInfo` call (or an implicit `IADs::GetInfo` call using `IADs::Get`) on an object that you previously bound to, the OS loads all the properties for that specific object into that object's property cache. Consider the property cache a simple list of properties. The `PropertyList` object represents this list. You can use several `IADsPropertyList` methods to navigate through the list and access items. For example, you can navigate the list and access each item, every *n*th item, or one particular item based on its name.

Each item in the property list is a property entry represented by the `PropertyEntry` object. You use the `IADsPropertyEntry` interface to access property entries. A property entry can have one or more property values. To access values in a property entry, you use the `IADsPropertyValue` interface.

To summarize, use `IADsPropertyList` to navigate through and access property entries in the property list. When you want to manipulate a property, use `IADsPropertyEntry`. To access the values of that property entry, use `IADsPropertyValue`.

21.2.2. Adding Individual Values

To show you how to add an individual value, we'll expand on one of the examples from the previous section: the pager property of the User object. The pager property is an array of text strings representing multiple pager numbers.

Consider that any property represents data. Data can take several forms, including a string, an integer, or a Boolean value. In the cache, each property has two attributes: one attribute specifies the type of data the property represents, and the other attribute specifies the value of that data type. For example, each pager property has two attributes: a Unicode string (the type of data) and the pager number (the value of that Unicode string). The User object's lastLogon property, which specifies the time the user last logged on, has the two attributes: a LargeInteger (type of data) and a date/time stamp (the value of that LargeInteger).

The pager and lastLogon properties are instances of the PropertyValue object, so you manipulate them with the method and property methods of the IADsPropertyValue interface. For example, you use the IADsPropertyValue::ADsType property method to set the PropertyValue's type of data. Table 21-3 shows some of the corresponding constant names and values that you can set for the IADsPropertyValue::ADsType property.

Table 21-3. Constants for the IADsPropertyValue::ADsType property

Constant name	IADsPropertyValue property method (if appropriate)	Value
ADSTYPE_INVALID	None	0
ADSTYPE_DN_STRING	IADsPropertyValue::DNString	1
ADSTYPE_CASE_EXACT_STRING	IADsPropertyValue::CaseExactString	2
ADSTYPE_CASE_IGNORE_STRING	IADsPropertyValue::CaseIgnoreString	3
ADSTYPE_PRINTABLE_STRING	IADsPropertyValue::PrintableString	4
ADSTYPE_NUMERIC_STRING	IADsPropertyValue::NumericString	5
ADSTYPE_BOOLEAN	IADsPropertyValue::Boolean	6
ADSTYPE_INTEGER	IADsPropertyValue::Integer	7
ADSTYPE_OCTET_STRING	IADsPropertyValue::OctetString	8
ADSTYPE_UTC_TIME	IADsPropertyValue::UTCTime	9
ADSTYPE_LARGE_INTEGER	IADsPropertyValue::LargeInteger	10
ADSTYPE_PROV_SPECIFIC	None	11
ADSTYPE_OBJECT_CLASS	None	12
ADSTYPE_CASEIGNORE_LIST	None	13
ADSTYPE_OCTET_LIST	None	14
ADSTYPE_PATH	None	15
ADSTYPE_POSTALADDRESS	None	16
ADSTYPE_TIMESTAMP	None	17
ADSTYPE_BACKLINK	None	18

Constant name	IADsPropertyValue property method (if appropriate)	Value
ADSTYPE_TYPEDNAME	None	19
ADSTYPE_HOLD	None	20
ADSTYPE_NETADDRESS	None	21
ADSTYPE_REPLICAPOINTER	None	22
ADSTYPE_FAXNUMBER	None	23
ADSTYPE_EMAIL	None	24
ADSTYPE_NT_SECURITY_DESCRIPTOR	IADsPropertyValue::SecurityDescriptor	25
ADSTYPE_UNKNOWN	None	26

Suppose you want to add a PropertyValue object with the value of "Hi There!" The two attributes of PropertyValue that need to be set include a case-sensitive string (i.e., the type of data, or IADsPropertyValue::ADsType property) and "Hi There!" (i.e., the value of that case-sensitive string, or the IADsPropertyValue::CaseExactString property). The IADsPropertyValue::ADsType constant for a case-sensitive string is ADSTYPE_CASE_EXACT_STRING, which has a numeric value of 2. As shown in Table 21-3, IADsPropertyValue::CaseExactString is one of a number of IADsProper-tyValue property methods, each relating to a specific data type. It is the value in IADsPropertyValue::ADsType that determines which of the property methods are actually used to get and set the data.

The following script shows how to create this new PropertyValue object. We begin by setting the ADSTYPE_CASE_EXACT_STRING constant to its numeric value (i.e., 2) and declaring the objPropValue variable. As we mentioned earlier, if you use VBScript with WSH, you must either define the constants, as the script does, or use the values directly:

```
 Const ADSTYPE_CASE_EXACT_STRING = 2

Dim objPropValue   'An ADSI PropertyValue object

Set objPropValue = CreateObject("PropertyValue")
objPropValue.ADsType = ADSTYPE_CASE_EXACT_STRING
objPropValue.CaseExactString = "Hi There!"
```

We use VBScript's CreateObject method to create an instance of the PropertyValue object and set it to the objPropValue variable. Then two attributes are assigned to the PropertyValue object. The objPropValue's IADsPropertyValue::ADsType property method is used to assign the property's data type to the ADSTYPE_CASE_EXACT_STRING constant. Finally, we use objPropValue's IADsPropertyValue::CaseExactString property method to assign the property's value to "Hi There!"

21.2.3. Adding Sets of Values

As we mentioned previously, some properties hold one value (e.g., the lastLogon property); others hold multiple values in an array (e.g., the pager property). The PropertyEntry object holds the entire set of values for a property, be it one value or many values.

However, the PropertyEntry object does more than store values. This object's properties dictate how you can manipulate those values. The PropertyEntry object supports the IADsPropertyEntry interface that has four property methods:

IADsPropertyEntry::Name

The IADsPropertyEntry::Name property method sets the name of the property that you want to manipulate (e.g., pager).

IADsPropertyEntry::Values

The IADsPropertyEntry::Values property method sets an array containing those values you want to manipulate (e.g., the pager numbers).

IADsPropertyEntry::ADsType

The IADsPropertyEntry::ADsType property method determines the data type of those values (e.g., Unicode string).

IADsPropertyEntry::ControlCode

The IADsPropertyEntry::ControlCode property method tells the cache whether to overwrite, update, or add to the property's existing values. You use the constants in Table 21-4 with the IADsPropertyEntry::ControlCode property. These constants are the same as the constants for the IADs::PutEx method described earlier. Because IADsPropertyEntry::ControlCode constants work the same way as the IADs::PutEx method constants, we won't go through them again here.

Table 21-4. The constants for the IADsPropertyEntry::ControlCode property method

Constant name	Value	Action
ADS_PROPERTY_CLEAR	1	Use when clearing all values
ADS_PROPERTY_UPDATE	2	Use when replacing all existing values
ADS_PROPERTY_APPEND	3	Use when adding to existing values
ADS_PROPERTY_DELETE	4	Use when deleting specific values

The next script shows how to create a PropertyEntry object from one property value:

```
Const ADSTYPE_CASE_IGNORE_STRING = 3
Const ADS_PROPERTY_UPDATE = 2

Dim objPropValue 'An ADSI PropertyValue object
Dim objPropEntry 'An ADSI PropertyEntry object


Set objPropValue = CreateObject("PropertyValue")
objPropValue.ADsType = ADSTYPE_CASE_IGNORE_STRING
objPropValue.CaseIgnoreString = "0123-456-7890"

Set objPropEntry = CreateObject("PropertyEntry")
objPropEntry.Name = "pager"
objPropEntry.Values = Array(objPropValue)
objPropEntry.ADsType = ADSTYPE_CASE_IGNORE_STRING
objPropEntry.ControlCode = ADS_PROPERTY_UPDATE
```

The first part of the script is similar to the previous one. We begin by setting the constants to their numeric values and declaring the variables. Next , we create an instance of the PropertyValue object and set it to the objPropValue variable. We then use the IADsPropertyValue::ADsType property method to assign the property's data type to the ADSTYPE_CASE_IGNORE_STRING constant and the IADsPropertyValue::CaseIgnoreString property method to assign the property's value to 0123-456-7890.

The second part of the script begins by creating an instance of the PropertyEntry object and setting it to the objPropEntry variable. Then all four PropertyEntry properties are set. For the IADsPropertyEntry::Values property, you must use the VBScript Array( ) function to force the values into an array, even if you set only one value. For the IADsPropertyEntry::ControlCode property, you're replacing the existing values with the ones you're passing in.

21.2.4. Walking Through the Property Cache

For any object, the property cache consists of PropertyEntry objects that correspond to each property. When you use the IADs::Get method, it reads the cache's PropertyEntry for that particular property.

As we've previously mentioned, whenever you call GetObject or IADsOpenDSOb-ject::OpenDSObject, as explained later, the object that is returned can use the IADs interface in addition to any interface designed for that object. The IADsPropertyList interface also is directly available for any object. It is of no real use without a call to GetInfo first, without which the property cache will be empty. Once the cache is populated, however, the methods and properties come into their own. Table 21-5 lists the IADsPropertyList methods and properties.

Table 21-5. IADsPropertyList methods and properties

IADsPropertyList methods and properties	Action
Next method	Retrieves the value of the next item in the property list
Skip method	Skips a number of items in the property list
Reset method	Puts the pointer back to the beginning of the list
Add method	Adds a new property to the list
Remove method	Removes a property from the list
Item method	Gets an item from the property list
GetPropertyItem method	Gets an item in the property list
PutPropertyItem method	Puts an item in the property list
ResetPropertyItem method	Resets an item in the property list back to its original value
PurgePropertyList method	Deletes all items in the property list
PropertyCount property	The number of properties in the property list

The PropertyList object represents the entire set of properties for an object. The methods and property methods of the IADsPropertyList interface can be used to manipulate the PropertyList object. Example 21-5 uses several of those methods and property methods to demonstrate three ways of walking through the property cache.

Example 21-5. Walking through the property cache with the IADsPropertyList interface

```
Option Explicit

'**********************************************************************
'Force error checking within the code using the Err.Number property
'method in approaches 2 and 3
'**********************************************************************
On Error Resume Next

'**********************************************************************
'Declare the variables
'**********************************************************************
Dim objGroup      'The group whose property list you want to investigate
Dim strText       'A text string that displays results in one message box
Dim intPropCount  'The number of properties
Dim intIndex      'The index used while looping through the property list
Dim objPropEntry  'An individual property entry used in a loop

Set objGroup = GetObject("LDAP://cn=Managers,ou=Sales,dc=mycorp,dc=com")
```

```
objGroup.GetInfo

intPropCount = objGroup.PropertyCount
WScript.Echo "There are " & intPropCount & " values in the property cache."

'**********************************************************************
'Approach 1: PropertyCount property
 method
'**********************************************************************
strText = ""
For intIndex = 0 To (intPropCount-1)
  strText = strText & objGroup.Item(intIndex).Name & vbTab _
  & objGroup.Item(intIndex).ADsType & vbCrLf
Next
WScript.Echo strText

'**********************************************************************
'Approach 2: Next method
'**********************************************************************
strText = ""
Set objPropEntry = objGroup.Next
While (Not (IsNull(objPropEntry)) And Err.Number = 0)
  strText = strText & objPropEntry.Name & vbTab & objPropEntry.ADsType
           & vbCrLf
  Set objPropEntry = objGroup.Next
Wend
WScript.Echo strText
Set objPropEntry = Nothing

'**********************************************************************
'Approach 3: Next and Skip methods
'**********************************************************************
strText = ""
objGroup.Reset
Set objPropEntry = objGroup.Next
While (Not (IsNull(objPropEntry)) And Err.Number = 0)
  strText = strText & objPropEntry.Name & vbTab & objPropEntry.ADsType
           & vbCrLf
  objGroup.Skip(2)
  Set objPropEntry = objGroup.Next
Wend
WScript.Echo strText
Set objPropEntry = Nothing
```

The script begins by using VBScript's `Option Explicit` statement (which requires you to declare all variables before using them) and the `On Error Resume Next` statement (which allows you to do error handling). Then, after declaring the variables, the `GetObject` method is used to bind to the group whose property cache we want to look at. In this case, we want to view the properties for the Manager group object. Next, the `IADs::GetInfo` method is called to load the property cache for this group. Since we won't be using the IADs::Get method in the script, the system won't implicitly use the IADs::GetInfo method to load the cache, so we have to explicitly load it in.

Each object in objGroup has a PropertyList object, so we use the IADsProperty-List::PropertyCount property method to count each PropertyList object. We store the count for later use by setting it to the intPropCount variable, and we print it out in a message box using WSH's Echo method.

We now know how many properties objGroup has, but we need to find out the values of those properties. We can use one of three approaches to walk through the property cache to get this information.

21.2.4.1. Approach 1: Using the IADsPropertyList::PropertyCount property method

We begin by walking through the property list by counting the items in the index 0 through intPropCount-1. We need to specify this index, because the property list index starts at 0 rather than 1. For example, a property list with 15 items has an index ranging from 0 to 14.

For each item in the index, you concatenate (&) two property methods to retrieve the property's IADs::Name and IADsPropertyValue::ADsType. The script processes concatenated statements from left to right, so it first uses the IADsPropertyList::Item method with the intIndex value as the item number to retrieve a property entry, to which it applies the IADs::Name property method to get the property's name. The script then uses the same process to retrieve the same property entry, to which it applies the IADsPropertyValue::ADsType property method to get the property's datatype. Forcing the script to process IADsPropertyList::Item twice is inefficient. We processed it twice only to illustrate how to walk through the property list. The concatenated code includes more than just the two property methods. The code also concatenates a tab (vbTab) between the two property methods and a carriage-return line-feed (vbCrLf), or new line, after the second property method. But even more important, the code first concatenates the existing strText variable onto the front (i.e., strText = strText & property method 1 & property method 2), which means that, in the output, these property values are appended to the existing strText string. As a result, the WSH displays all the property values in one message box if you use WSH's *wscript.exe* scripting engine to run the script. If you're using WSH's *cscript.exe* scripting engine, using this append technique makes no difference. If you don't concatenate the strText variable (i.e., strText = property method 1 & property method 2), WSH displays a separate message box for each property.

When the script finishes looping through the property list index, it prints the appended strText string in the message box. Approaches 2 and 3 also use the append technique to display all their output in one message box.

21.2.4.2. Approach 2: Using the IADsPropertyList::Next method

We start this approach by resetting the strText variable to a zero-length string to ensure that no values from the previous approach are left in the string. Then the IADsPropertyList::Next method is called to retrieve a copy of the first property entry and set the result to the objPropEntry variable. Because we called the IADsPropertyList::Next method, we can use a while loop to iterate through the cache until we encounter a null value, which specifies that we're at the end of the list.

Providing that the first property entry isn't a null entry, we enter the while loop. The And Err.Number

= 0 code designates a test to see whether an error has occurred. A value of 0 indicates no error; any other value specifies an error. If a valid entry (i.e., not a null entry) is retrieved and an error hasn't occurred (i.e., the error number is equal to 0), we enter the loop. Within the loop, the property name and data type are appended to the strText string in a similar manner as before. To move to the next property entry in the property cache, we again call the IADsPropertyList::Next method. As long as this value isn't null and isn't generating an error code, the process continues until it hits a null entry, which means we're at the end of the list. The wend keyword signifies the end of the while loop. Finally, the results are printed.

21.2.4.3. Approach 3: Using the IADsPropertyList::Next and IADsPropertyList::Skip methods

The code in this approach is identical to the code used in Approach 2, except for the addition of two lines. The IADsPropertyList::Reset property method sets the property list pointer to the first property entry in the cache. If we don't use the IADsPropertyList::Reset property method, the pointer will be at the end of the cache, which would generate a null entry. The IADsPropertyList::Skip code tells the IADsPropertyList::Next property method to skip the next two property entries. In other words, the IADsPropertyList::Next property method is retrieving every third property, so this approach returns only property entries 1, 4, 7, 10, and so on.

21.2.5. Writing the Modifications

Now that we've shown how to walk through the cache, next we will review how to write modifications to the cache and back to the directory. Example 21-6 illustrates these procedures. This script is an amalgam of the code in the earlier examples. As such, it shows how to assemble the pieces of code into a usable script.

Example 21-6. Writing modifications to the cache and back to the director

```
Option Explicit

'**********************************************************************
'Force error checking within the code using the Err.Number property
'method in approaches 2 and 3
'**********************************************************************
On Error Resume Next

'**********************************************************************
'Declare the constants and variables
'**********************************************************************
Const ADSTYPE_CASE_IGNORE_STRING = 3
Const ADS_PROPERTY_UPDATE = 2

Dim objPropValue  'An ADSI PropertyValue object
Dim objPropEntry  'An ADSI PropertyEntry object
Dim objUser       'The user whose property list you want to investigate
Dim strText       'A text string that displays results in one message box
Dim intPropCount  'The number of properties
Dim intIndex      'The index used while looping through the property list

Set objUser = GetObject("LDAP://cn=AlistairGLN,ou=Sales,dc=mycorp,dc=com")
objUser.GetInfo

'**********************************************************************
'Section A: Calculate the property count, and enumerate each
'property's name and datatype
'**********************************************************************
intPropCount = objUser.PropertyCount
WScript.Echo "There are " & intPropCount _
  & " values in the property cache before adding the new one."

strText = ""
For intIndex = 0 To (intPropCount-1)
  strText = strText & objUser.Item(intIndex).Name & vbTab _
    & objUser.Item(intIndex).ADsType & vbCrLf
Next
WScript.Echo strText

'**********************************************************************
'Section B: Create a property entry, and write it to the cache
'**********************************************************************
Set objPropValue = CreateObject("PropertyValue")
objPropValue.ADsType = ADSTYPE_CASE_IGNORE_STRING
objPropValue.CaseExactString  =  "0123-456-7890"

Set objPropEntry = CreateObject("PropertyEntry")
objPropEntry.Name = "pager"
objPropEntry.Values = Array(objPropValue)
objPropEntry.ADsType = ADSTYPE_CASE_IGNORE_STRING
objPropEntry.ControlCode = ADS_PROPERTY_UPDATE

objUser.PutPropertyItem(objPropEntry)

'**********************************************************************
'Section C: Write out the cache to Active Directory and read the new
'cache explicitly back in from the object
'**********************************************************************
objUser.SetInfo
objUser.GetInfo

'**********************************************************************
'Section D: Recalculate the property count, and re-enumerate each
'property's name and datatype to see the changes
'**********************************************************************
intPropCount = objUser.PropertyCount

WScript.Echo "There are " & intPropCount _
```

```
  & " values in the property cache after adding the new one."

strText = ""
For intIndex = 0 To (intPropCount-1)
  strText = strText & objUser.Item(intIndex).Name _
    & vbTab & objUser.Item(intIndex).ADsType & vbCrLf
Next
WScript.Echo strText
```

The script begins with `Option Explicit` and `On Error Resume Next`, after which it sets the constants, declares the variables, and sets the `objUser` variable to the AlistairGLN user object. The script then divides into four sections:

Section A

Determines the `User` object's property count and lists each property's name and data type.

Section B

Creates a property entry and writes it to the cache. The last line uses the `IADsPropertyList::PutPropertyItem` method to write the new property entry for objUser to the cache. However, the `IADs::SetInfo` method must be used to write this entry to the directory.

Section C

Contains new code. The first line uses the `IADs::SetInfo` method to write the cache to the directory. The second line uses the explicit `IADs::GetInfo` method to read it back into the cache. Although the second line might not seem necessary, it is. If we don't use an explicit `IADs::GetInfo` call, we'll be accessing the same cache that we accessed before we added the new property entry. The explicit `IADs::GetInfo` call retrieves any new properties that anyone else has updated since the last implicit or explicit `IADs::GetInfo` call.

Section D

Recalculates the property count and reenumerates each property's name and data type so that we can see the modifications. If we see the property count increase by one after we write the cache to the directory, the script has successfully executed.

21.2.6. Walking the Property Cache: The Solution

Example 21-7 is quite long. It walks through the property cache for an object and prints the name, data type, and values of each entry. Some of the properties are not printable strings, so printing them in a text format makes little sense. Thus, this script prints only the text strings. We used a VBScript dictionary object to map the data type integers (ADsType) to descriptive names. A dictionary is similar in nature to an associative array or hash, which are common in other programming languages. After instantiating a dictionary object, you can use the Add method to add new key value pairs to it.

Example 21-7. Walking through the property cache of an object

```
Option Explicit
On Error Resume Next

'**********************************************************************
'Declare the hash (dictionary), constants and variables
'**********************************************************************
Dim dicADsType
Set dicADsType = CreateObject("Scripting.Dictionary")
dicADsType.Add 0, "INVALID"
dicADsType.Add 1, "DN_STRING"
dicADsType.Add 2, "CASE_EXACT_STRING"
dicADsType.Add 3, "CASE_IGNORE_STRING"
dicADsType.Add 4, "PRINTABLE_STRING"
dicADsType.Add 5, "NUMERIC_STRING"
dicADsType.Add 6, "BOOLEAN"
dicADsType.Add 7, "INTEGER"
dicADsType.Add 8, "OCTET_STRING"
dicADsType.Add 9, "UTC_TIME"
dicADsType.Add 10, "LARGE_INTEGER"
dicADsType.Add 11, "PROV_SPECIFIC"
dicADsType.Add 12, "OBJECT_CLASS"
dicADsType.Add 13, "CASEIGNORE_LIST"
dicADsType.Add 14, "OCTET_LIST"
dicADsType.Add 15, "PATH"
dicADsType.Add 16, "POSTALADDRESS"
dicADsType.Add 17, "TIMESTAMP"
dicADsType.Add 18, "BACKLINK"
dicADsType.Add 19, "TYPEDNAME"
dicADsType.Add 20, "HOLD"
dicADsType.Add 21, "NETADDRESS"
dicADsType.Add 22, "REPLICAPOINTER"
dicADsType.Add 23, "FAXNUMBER"
dicADsType.Add 24, "EMAIL"
dicADsType.Add 25, "NT_SECURITY_DESCRIPTOR"
dicADsType.Add 26, "UNKNOWN"

Const ADS_PROPERTY_CLEAR = 1
Const ADS_PROPERTY_UPDATE = 2
Const ADS_PROPERTY_APPEND = 3
Const ADS_PROPERTY_DELETE = 4

Dim objPropValue  'An individual property value within a loop
Dim objPropEntry  'An ADSI PropertyEntry object
Dim objObject     'The object whose property list we wish to investigate
Dim strText       'A text string used to display results in one go
Dim intPropCount  'The number of properties in
Dim intIndex      'The index used while looping through the property list
Dim intCount      'Used to display property values in a numbered sequence

'***********************************************************************
'Uncomment one of these lines and modify it to your own environment.
'The first uses the LDAP namespace; the second uses the WinNT namespace.
'***********************************************************************
' Set objObject = GetObject("LDAP://cn=administrator,cn=users,dc=mycorp,dc=com")
' Set objObject = GetObject("WinNT://WINDOWS/Managers,Group")
objObject.GetInfo
if (Err.Number > 0) Then
   Wscript.Echo "Object not found, returning..."
   Wscript.Quit
End if

'***********************************************************************
'Write out the current property cache total to the string that is
'storing output
'***********************************************************************
intPropCount = objObject.PropertyCount
strText = "There are " & intPropCount & _
           " values in the property cache." & vbCrLf

'***********************************************************************
'The extra vbTabs used in the first loop are to space the results so
'that they are nicely formatted with the list of values in the second loop
'***********************************************************************
For intIndex = 0 To (intPropCount-1)

  Set objPropEntry = objObject.Item(intIndex)
  strText = strText & objPropEntry.Name & vbCrLf

  strText = strText & vbTab & "Type:" & vbTab & vbTab & _
            dicADsType.Item(objPropEntry.ADsType) & vbCrLf

  '***********************************************************************
  'Go through each property value in the property entry and use the AdsType
  'to print out the appropriate value, prefixed by a count (intCount), i.e.:
  '
  '  Value #1: Vicky Launders
  '  Value #2: Alistair Lowe-Norris
  '  Value #3: Robbie Allen
  '***********************************************************************
  intCount = 1

  For Each objPropValue In objPropEntry.Values

    If (dicADsType(objPropValue.ADsType) = "STRING") Then
      strText = strText & vbTab & "Value #" & intCount & ":" _
```

```
        & vbTab & objPropValue.DNString & vbCrLf

    ElseIf (dicADsType(objPropValue.ADsType) = "CASE_EXACT_STRING") Then
      strText = strText & vbTab & "Value #" & intCount & ":" _
        & vbTab & objPropValue.CaseExactString & vbCrLf

    ElseIf (dicADsType(objPropValue.ADsType) = "CASE_IGNORE_STRING") Then
      strText = strText & vbTab & "Value #" & intCount & ":" _
        & vbTab & objPropValue.CaseIgnoreString & vbCrLf

    ElseIf (dicADsType(objPropValue.ADsType) = "PRINTABLE_STRING") Then
      strText = strText & vbTab & "Value #" & intCount & ":" _
        & vbTab & objPropValue.PrintableString & vbCrLf

    ElseIf (dicADsType(objPropValue.ADsType) = "NUMERIC_STRING") Then
      strText = strText & vbTab & "Value #" & intCount & ":" _
        & vbTab & objPropValue.NumericString & vbCrLf

    ElseIf (dicADsType(objPropValue.ADsType) = "BOOLEAN") Then
      strText = strText & vbTab & "Value #" & intCount & ":" _
        & vbTab & CStr(objPropValue.Boolean) & vbCrLf

    ElseIf (dicADsType(objPropValue.ADsType) = "INTEGER") Then
      strText = strText & vbTab & "Value #" & intCount & ":" _
        & vbTab & objPropValue.Integer & vbCrLf

    End If

    intCount=intCount+1

  Next
Next

WScript.Echo strText
```

This script also illustrates how you can just as easily use the WinNT namespace rather than the LDAP namespace to display properties of objects, and how you can run the script against Windows NT domains and Windows NT or later member servers rather than Active Directory.

The script displays every value in the property cache for an object. However, there may come a time when you wish to see the entire potential property cache for an object and list which of all possible values have been set. To do that, you need to query the formal schema class definition for the object. This leads us to the final section on the property cache.

21.2.7. Walking the Property Cache Using the Formal Schema Class Definition

There is one other way to walk the property list for a particular object: using its schema class details. Chapter 4 explained how the schema is the blueprint for objects in Active Directory. As each schema class actually is stored in Active Directory, you can navigate the object's properties by using the IADsClass interface to display each individual item according to its formal name in the schema class. To do this, we first obtain a reference to the object in the normal manner. We then obtain a reference to the schema class for that object. We can do this using the IADs::Schema property method, which returns the full ADsPath of the schema class. For example, the user objectclass in the *mycorp.com* domain has the following schema ADsPath:

```
LDAP://cn=User,cn=Schema,cn=Configuration,dc=mycorp,dc=com
```

Then we can use the IADsClass::MandatoryProperties and IADsClass::OptionalProperties methods to retrieve the appropriate properties. The following example nicely brings together IADs::GetEx for retrieving multiple properties and writing to a file, which is required due to the large number of properties.

Example 21-8 uses On Error Resume Next because all properties may not display, and the program will fail if any do not. The script also differs from the previous script in that it lists all possible properties and whether they've been set. The previous example listed only those that had been set. The following script is also generic; it will print out the property cache for any object class. Just change the ADsPath passed to GetObject.

Example 21-8. Walking the property cache using the formal schema class definition

```
Option Explicit
'***********************************************************************
'Force error checking within the code using the Err.Number property
'method in approaches 2 and 3
'***********************************************************************
On Error Resume Next

'***********************************************************************
'Declare the constants and variables
'***********************************************************************
Dim objObject    'Active Directory object
Dim objClass     'ADSI Class object
Dim objProp      'An individual property
Dim intCount     'Incremental counter for display
Dim fileadsect   'A FileSystemObject
Dim outTextFile  'A TextStream Object

'***********************************************************************
'Create a VBScript file object and use it to open a text file. The
'second parameter specifies to overwrite any existing file that exists.
'***********************************************************************
```

```
Set fileadsect = CreateObject("Scripting.FileSystemObject")
Set outTextFile = fileadsect.CreateTextFile("c:\out.txt", TRUE)

'**********************************************************************
'Bind to the object and get a pointer to the appropriate schema class,
'i.e., User in this case
'**********************************************************************
Set objObject =
           GetObject("LDAP://cn=administrator,cn=Users,dc=mycorp,dc=com")
Set objClass = GetObject(objObject.Schema)

intCount = 1

'**********************************************************************
'Iterate through all the mandatory properties
'**********************************************************************
For Each objProp in objClass.MandatoryProperties
  EnumerateProperties objProp, outTextFile, objObject
   intCount=intCount+1
Next

'**********************************************************************
'Iterate through all the optional properties
'**********************************************************************
For Each objProp in objClass.OptionalProperties
  EnumerateProperties objProp
   intCount=intCount+1
Next

outTextFile.Close

'**********************************************************************
'Subroutine EnumerateProperties
'**********************************************************************
Sub EnumerateProperties(ByVal objProp, ByVal tsFile, ByVal objObj)

  Dim objProperty  'ADSI Property object
  Dim arrElement   'Array of elements

  '**********************************************************************
  'Get pointer to the schema property object
  '**********************************************************************
  Set objProperty = GetObject("LDAP://Schema/" & objProp)

  '**********************************************************************
  'Check whether property requires GetEx using IADsProperty::MultiValued
  '**********************************************************************
  If objProperty.MultiValued Then
    tsFile.WriteLine intCount & ") " & objProp & _
      " (" & objProperty.Syntax & ") (MULTI-VALUED)"

    '**********************************************************************
    'Check whether array returned from GetEx is empty using VBScript
     function
    '*********************************************************************
    If (IsEmpty(objObj.GetEx(objProp))) Then
      tsFile.WriteLine vbTab & "= " & "NO VALUES SET!"
    Else
      For Each arrElement in objObj.GetEx(objProp)
        tsFile.WriteLine vbTab & "= " & arrElement
      Next
    End If

  Else
    tsFile.WriteLine intCount & ") " & objProp _
      & " (" & objProperty.Syntax & ")"

    Err.Clear
    If Err=0 Then
      tsFile.WriteLine vbTab & "= " & objObj.Get(objProp)
    Else
      tsFile.WriteLine vbTab & "= " & "Not Set!"
    End If

  End If
End Sub
```

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21.3. Checking for Errors in VBScript

It is worthwhile to look at error handling in a little more detail now. Normally errors that occur in a script are termed fatal errors. This means that execution of the script terminates whenever an error occurs. When this happens, a dialog box opens and gives you the unique number and description of the error. While this is useful, sometimes you may like to set errors to be nonfatal, so that execution continues after the error. To do this, you include the following line in your code:

```
On Error Resume Next
```

Once you have done this, any line with an error is ignored. This can cause confusion, as can be seen from the following code. Note the missing P in LDAP:

```
On Error Resume Next

Set objGroup = GetObject("LDA://cn=Managers,ou=Sales,dc=mycorp,dc=com")

objGroup.GetInfo
WScript.Echo objGroup.Description
objGroup.Description = "My new group description goes here"
objGroup.GetInfo
WScript.Echo objGroup.Description
```

This script fails to execute any of the lines after the `On Error Resume Next` statement, as the first LDAP call into the `objGroup` variable failed. However, it will not terminate as usual with an error after the `GetObject` line, due to the `On Error` statement. To get around this, you should add a couple lines to do error checking . Example 21-9 is a good example of error checking in a different script.

Example 21-9. Error checking in VBScript

```
On Error Resume Next

'***********************************************************************
'Clear errors
'***********************************************************************
Err.Clear

'***********************************************************************
'Get a pointer to the Administrator account
'***********************************************************************
Set objUser = GetObject ("LDAP://cn=Administrator,cn=Users,dc=mycorp,dc=com")
If Hex
(Err.Number)="&H80005000"  Then
  WScript.Echo "Bad ADSI path!" & vbCrLf & "Err. Number: " _
    & vbTab & CStr
(Hex(Err.Number)) & vbCrLf & "Err. Descr.: " _
    & vbTab & Err.Description
  WScript.Quit
End If

'***********************************************************************
'Explicitly call GetInfo for completeness
'***********************************************************************
objUser.GetInfo

'***********************************************************************
'Clear any previous errors
'***********************************************************************
Err.Clear

'***********************************************************************
'Try and get a pointer to the "moose" attribute of the user (which
'doesn't exist)
'***********************************************************************
x = objUser.Get("moose")

'***********************************************************************
'Check for property does not exist error
'***********************************************************************
If  Hex(Err.Number)="&H8000500D"  Then
  WScript.Echo "No such property!" & vbCrLf & "Err. Number: " _
    & vbTab & CStr(Hex(Err.Number)) & vbCrLf & "Err. Descr.: " _
    & vbTab & Err.Description
End If
```

This is a simple example; the path does exist and the `moose` property does not exist for the user. ADSI errors start at 80005 in hexadecimal, and 8000500D is the error indicating that there is no such property. The `&H` prefix indicates that the following string is a hexadecimal number. You must use the

Err::Clear method from the Err interface to clear any existing error information, prior to making a call that could generate an error. If an error has occurred, the value of Err.Number is nonzero; if Err.Number is 0, no error occurred. If an error has occurred, Err.Description contains any description that has been set for that error.

We use the functions Hex and CStr in the example one after the other to print out the hexadecimal string of the error number. We choose to do this because Microsoft specifies error numbers in hexadecimal, and if you are to look them up easily in Microsoft's documentation, you need to see the hexadecimal rather than getting out a calculator. The CStr function converts the newly converted hexadecimal value to a text string that can be printed out.

Because most calls to the Err interface will be to retrieve the Err::Number property, the Err::Number property is set as the default property method, meaning that you don't have to state it explicitly. For example, these two statements are equivalent:

```
If Hex(Err)="&H8000500D" Then
If Hex(Err.Number)="&H8000500D" Then
```

In addition, as Hex(0) is the same as 0, most sample code that you will see using VBScript looks like this:

```
On Error Resume Next


'Some_code_goes_here

Err.Clear
Set x = GetObject(something_goes_here)
If Err=0 Then
  'No error occurred
  Some_success_code_goes_here
Else
  'Error occurred
  Some_failure_code_goes_here
End If
```

Finally, to reset error checking back to the default as if the On Error Resume Next statement had not been included, we use the following code:

```
'The last character is a zero, not a capital "o"
On Error Goto 0
```

A full list of ADSI errors can be found in the MSDN library at http://msdn.microsoft.com/library/default.asp?url=/library/en-us/adsi/adsi/adsi_error_codes.asp.

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21.4. Summary

Over the last two chapters, we've covered the interfaces, methods, and property methods that allow you to use access and manipulate generic objects in Active Directory. These interfaces include:

- IADs
- IADsContainer (covered more fully later)
- IADsPropertyList
- IADsPropertyEntry
- IADsPropertyValue

We've also looked at how to supply credentials to authenticate with alternate credentials using the ADsOpenDSObject interface.

In the next chapter, we cover how to search Active Directory using a database query interface called ADO.

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Chapter 22. Using ADO for Searching

Microsoft's ADO technology lets you conduct database searches and retrieve the results through a flexible interface called resultsets. ADO also lets you update information in a database directly or with stored procedures. Because Microsoft created an ADO database provider for ADSI (the ADSI OLE DB provider), you can also use ADO's database query technology to query Active Directory. However, the ADSI OLE DB provider is currently read-only, so many of the useful ADO methods for updating data aren't available yet. You can use ADO only for searching and retrieving objects. Despite the read-only limitation, using ADO is still a boon. It is significantly faster to search Active Directory using ADO than it is to use ADSI to bind to each object recursively down a branch. Even using `IADsContainer::Filter` is slow in comparison. So if you need to search Active Directory rapidly for attributes that match certain criteria, ADO is exactly what you should use. The ADO object model consists of nine objects (`Command`, `Connection`, `Error`, `Field`, `Parameter`, `Property`, `Record`, `Recordset`, and `Streams`) and four collection objects (`Errors`, `Fields`, `Parameters`, and `Properties`). However, some of these objects aren't useful if you're using the ADSI OLE DB provider, as they are more often used for accessing full-fledged database services. For example, the `Parameter` object lets you pass parameters to stored procedures, but this object is of little use because the ADSI provider doesn't support stored procedures.

The objects that are appropriate to ADSI in a read-only environment are the `Command`, `Connection`, `Error`, `Field`, `Property`, and `Recordset` objects. We use them to show you how to perform complex searches. For a full description of the ADO object model and the available functions, check out the following in the MSDN Library at:

> http://msdn.microsoft.com/library/default.asp?url=/library/en-us/ado270/htm/dasdkadooverview.asp.

> If you wish to make use of the tools in this chapter in a VB project rather than a VBScript script, you need to include the Microsoft ActiveX Data Objects 2.x library from the Reference item on the Project menu of the Visual Basic Environment.

One point to note: ADO is written to work with all types of databases , so there are a number of ways to do exactly the same thing. We will attempt to cover examples of each different way as they crop up so that you will be able to choose the method that suits you best or that you are familiar with.

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22.1. The First Search

The easiest way to explain basic searching using ADO is with an example. Here we'll build an ADO query to search and display the ADsPaths of all users in Active Directory. You can create a simple script to do this search in six steps.

22.1.1. Step 1: Define the Constants and Variables

For this script, you need to define one constant and three variables . The constant is adStateOpen, which we set to 1. If you're using VBScript, you use this constant later to determine whether you made a successful connection to the database. If you're using Visual Basic (VB), you don't have to include this constant because VB has already defined it. The two main variables are objConn (an ADO Connection object that lets you connect to the AD database) and objRS (an ADO Recordset object that holds the retrieved resultset). The third variable holds the output of the resultset, as shown in the following example:

```
Option Explicit

Const adStateOpen = 1

Dim objConn    'ADO Connection object
Dim objRS      'ADO Recordset object
```

The Option Explicit statement at the beginning of the script is optional, but we recommend that you include it. This statement forces the script to declare variables, so you can quickly spot errors.

22.1.2. Step 2: Establish an ADO Database Connection

To perform an ADO query, you need to establish an ADO connection, which is completely separate from any ADSI connections you may have opened with IADsOpenDSObject::OpenDSObject. Before you can establish this connection, you must create an ADO Connection object to use. This object can be created the same way you create a filesystem object: use the CreateObject method, with "ADODB.Connection" as a parameter. You use the ADODB prefix to create all ADO objects, and Connection is the top-level object in the ADO object model:

```
Set objConn = CreateObject("ADODB.Connection")
```

Just as you use different programmatic identifiers (ProgIDs) (e.g., WinNT:, LDAP:) to tell ADSI which directory to access, you use different OLE DB providers to tell ADO which query syntax to use. An OLE DB provider implements OLE DB interfaces so that different applications can use the same uniform process to access data. The ADSI OLE DB connector supports two forms of syntax: the SQL dialect and the LDAP dialect. Although you can use the SQL dialect to query the ADSI namespace, most scriptwriters use the LDAP dialect because Active Directory is an LDAP Directroy. However, the default for the `Connection` object's read/write property, `objConn.Provider`, is MSDASQL, which specifies the use of SQL syntax. Because you want to use the ADSI provider, you need to set `objConn.Provider` to `"ADsDSOObject,"` which specifies the use of the LDAP syntax. By setting this specific provider, you force the script to use not only a specific syntax but also a specific set of arguments in the calls to the `Connection` object's methods.

```
objConn.Provider = "ADSDSOObject"
```

22.1.3. Step 3: Open the ADO Connection

You can open a connection to the directory by calling the `Connection::Open` method. When describing the methods and property methods of COM interfaces in text, the established notation is to use a double colon (`::`) separator. For example, `Connection::Open` specifies the `Open` method of the `Connection` object, as shown in the following example:

```
objConn.Open _
  "", "CN=Administrator,CN=Users,dc=mycorp,dc=com", "mypass"
```

As the code shows, the `Open` method takes three parameters. The first parameter is the `Connection::ConnectionString` parameter, which contains information that the script needs to establish a connection to the data source. In this case, it is blank. The second parameter contains the user DN, UPN, or legacy domain\user to bind with, and the third is the user's password.

In this code, you're authenticating with a username DN, UPN, or legacy Domain\UserID (the second parameter) and the user's password (the third parameter). You can leave the first parameter blank. Here's why: in ADO, you can perform the same task many ways because the `Command`, `Connection`, and `Recordset` objects heavily interrelate. If you set the properties of one object, you can use those same properties to open the connection of another object as long as you're not setting any new options. Such is the case in the preceding section of code; you're opening the connection without setting any new options. You then use an `If...Then...Else` statement to see whether the `Open` call worked. If the call succeeded (i.e., the connection state has a value of 1), the script prints the message "Authentication Successful" and proceeds to the query. If the call didn't work (i.e., the connection state has a value of 0), the script prints the message "Authentication Failed" and quits, setting the returned error code to 1:

```
If objConn.State = 1 Then
  WScript.Echo "Authentication Successful!"
```

```
Else
  WScript.Echo "Authentication Failed."
   WScript.Quit(1)
End If
```

22.1.4. Step 4: Execute the Query

The Connection::Execute method is used to perform a query. Connection::Execute accepts a string containing four arguments separated by semicolons:

```
Set objRS = objConn.Execute _
  ("<LDAP://dc=mycorp,dc=com>;(&(objectCategory=person)" _
  & "(objectClass=user));Name,ADsPath;SubTree")
```

> If the string contains spaces before or after the semicolons, the code will fail. It's easy to forget this, and it's very annoying to try to debug, as the error just states that a parameter is invalid. You must also remember to enclose the parameter in parentheses because you're passing the Execute method's result to a variable.

The four arguments for any LDAP query you want to execute are:

Search base

The search base specifies the point in the directory from which the search will start. You must use a full ADsPath to specify the search base and enclose the ADsPath in angle brackets (< >). In this script, we are starting from the directory's root (i.e., LDAP://dc=mycorp,dc=com).

Filter

The filter defines criteria to match objects with. You must enclose this argument in parentheses. You also must use the format defined in RFC 2254. Filters are covered in greater detail later in the Section "Understanding Search Filters." The previous script used the search filter (&(objectCategory=person)(objectClass=user)), which means that only user objects will be returned.

Attributes

The attributes argument is a comma-delimited list of attributes to return. You must specify each attribute individually. Unlike the IADs::Get method, which executes an implicit GetInfo call to obtain all attributes, this ADO search returns only the specified attributes in the resultset. In this case, the ADO search will return the Name and ADsPath attributes. The ADsPath is a useful attribute to retrieve because it lets you use ADSI to bind to that object. You then can perform an explicit GetInfo to obtain all the attributes for that object.

Scope

The scope specifies how far down from the query's starting point (i.e., search base) to search. You can specify one of three string constants: Base, OneLevel, or Subtree. If you set the scope to Base, the ADO search will only check the object specified by the search base for a match to the search filter. If you set the scope to OneLevel, the ADO search checks any object directly under the search base, one level down. If you set the scope to Subtree, as this script does, the ADO search checks the search base and every container and object under the search base.

22.1.5. Step 5: Navigate Through the Resultset

The objRS variable holds the resultset, also known as the recordset. Recordset objects have a table-like structure. The structure's columns are fields, and the rows are records. Fields correspond to the attributes you want to return and assume the titles of those attributes (e.g., Name or ADsPath). ADO also numbers the fields from left to right, starting with 0. Thus, you can access fields using attribute names or index numbers. Records correspond to the values of those attributes.

To manage the members of objRS, the simplest approach is to use the Recordset::MoveNext method (which navigates to the next record in the resultset) while checking the Recordset::EOF (end-of-file) method. The RecordSet::EOF method returns true if you're at the end of the resultset. The following code sample uses both of these methods:

```
While Not objRS.EOF
  Wscript.Echo objRS.Fields.Item("Name").Value _
    & vbCrLf & objRS.Fields.Item("ADsPath").Value
  objRS.MoveNext
Wend
```

As this section of code shows, we're using these two methods in a simple while loop to move through each record. If Recordset::EOF returns a value of false (i.e., you're not at the end of the resultset), the script outputs the contents of the record for each field and moves on to the next record. If Recordset::EOF returns a value of true (i.e., end of the resultset), the script exits the while loop.

To access the values of each matching object, we are using objRS.Fields, which is a Fields collection object. As with all collections, Fields has a method called Item. The Fields::Item method takes an argument that equates to either the name of the field or its index number. The Fields::Item method returns a Field object, which has a Value property method that allows us to get the value for that specific property of the object. In other words, the code:

```
objRS.Fields.Item("Name").Value
```

returns the value of the individual field called Name from the collection of all possible fields in the recordset. We'll come back to this more in the later examples on navigating resultsets.

22.1.6. Step 6: Close the ADO Connection

The Connection::Close method is used to close the ADO connection to the directory. To be complete, you may also want to set the Recordset object to Nothing to make sure it doesn't mistakenly get reused. That isn't mandatory if your script is done at that point, because it will automatically get cleaned up, but it is good practice nonetheless. That way, if you later add code to the end of the script, you can't mistakenly reuse the now-defunct objRS variable without reinitializing it first. Here is example code illustrating how to properly close down an ADO session:

```
Set objRS = Nothing
objConn.Close
```

22.1.7. The Entire Script for a Simple Search

The following is the entire script:

```
Option Explicit

Const adStateOpen = 1

Dim objConn  'ADO Connection object
Dim objRS    'ADO Recordset object

Set objConn = CreateObject("ADODB.Connection")
objConn.Provider = "ADSDSOObject"
objConn.Open "","CN=Administrator,CN=Users,dc=mycorp,dc=com", "mypass"
If objConn.State = adStateOpen Then
  WScript.Echo "Authentication Successful!"
Else
  WScript.Echo "Authentication Failed."
  WScript.Quit(1)
End If

Set objRS = objConn.Execute _
  ("<LDAP://dc=mycorp,dc=com>;(&(objectCategory=person)" _
  & "(objectClass=user));Name,ADsPath;SubTree")

While Not objRS.EOF
  Wscript.Echo objRS.Fields.Item("Name").Value _
```

```
    & vbCrLf & objRS.Fields.Item("ADsPath").Value
  objRS.MoveNext
Wend

Set objRS = Nothing
objConn.Close
```

> While we open and close the connection within the short script, we could keep the connection open for every query if we had many queries to execute. This is how ADO is normally used.

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22.2. Other Ways of Connecting and Retrieving Results

As mentioned earlier, there are a number of ways of authenticating an ADO connection to Active Directory. The simplest is the way outlined earlier using the Connection::Provider set with the username and password as second and third arguments:

```
Set objConn = CreateObject("ADODB.Connection")
objConn.Provider = "ADSDSOObject"
objConn.Open "", _
             "CN=Administrator,CN=Users,dc=mycorp,dc=com", _
             "mypass"
```

Because ADO is designed for databases, it is often necessary to specify a number of other requirements when opening a connection. These include a different provider, a different server, or a specific database. All of these items can be set prior to opening the connection. However, none of these make a difference to the AD provider. If you wish to open a connection by setting these values in the ConnectionString property, then do so as shown in the following code:

```
Set objConn = CreateObject("ADODB.Connection")
objConn.Provider = "ADSDSOObject"
objConn.ConnectionString = _
  "DSN=;UID=CN=Administrator,CN=Users,dc=mycorp,dc=com;PWD=mypass"
objConn.Open
```

Semicolons separate the arguments, with the expected DataSourceName (DSN) specified as empty at the start of the string.

One important point: do not authenticate using both methods with the same connection use one or the other. The following code uses both methods to illustrate what not to do:

```
Set objConn = CreateObject("ADODB.Connection")
objConn.Provider = "ADSDSOObject"
objConn.Open _
  "DSN=;UID=CN=Administrator,CN=Users,dc=mycorp,dc=com;PWD=mypass", _
  "CN=Administrator,CN=Users,dc=mycorp,dc=com", "mypass"
```

This is a slightly different version, but still wrong:

```
Set objConn = CreateObject("ADODB.Connection")
objConn.Provider = "ADSDSOObject"
objConn.ConnectionString = _
  "DSN=;UID=CN=Administrator,CN=Users,dc=mycorp,dc=com;PWD=mypass"
objConn.Open "", "CN=Administrator,CN=Users,dc=mycorp,dc=com", _
  "mypass"
```

22.2.1. Searching with SQL

You can retrieve resultsets in a variety of ways and get exactly the same values. We will now discuss how to use the Command object and the Recordset::Open method, using SQL -formatted queries to retrieve resultsets. SQL is a powerful query language that is the de facto standard to query database tables. We do not propose to go through the details of SQL here, but we will cover some examples for those who may already be familiar with SQL and would find using it to be a more comfortable way of querying Active Directory than using LDAP search filters.

22.2.1.1. Using the Connection::Execute method

You can pass a SQL select statement to a connection using the Execute method as we've done previously with LDAP-based queries:

```
Set objConn = CreateObject("ADODB.Connection")
objConn.Provider = "ADSDSOObject"
objConn.Open "", "CN=Administrator,CN=Users,dc=mycorp,dc=com", "mypass"

Set objRS = objConn.Execute("Select Name, ADsPath" _
  & " FROM 'LDAP://dc=mycorp,dc=com' where objectCategory = 'person'" _
  & " and objectClass = 'user'")
```

22.2.1.2. Using the Recordset::Open method

Next we will set the Recordset::ActiveConnection and Recordset::Source properties before the Recordset::Open method is called; the second passes values directly to the Recordset::Open method.

Setting the properties first:

```
Set objConn = CreateObject("ADODB.Connection")
objConn.Provider = "ADSDSOObject"
objConn.Open "", "CN=Administrator,CN=Users,dc=mycorp,dc=com", "mypass"
```

```
'Open a recordset based on a SQL string by presetting the properties

Set objRS = CreateObject("ADODB.Recordset")
objRS.ActiveConnection = objConn
objRS.Source = "Select Name, ADsPath FROM " _
  & "'LDAP://dc=mycorp,dc=com' where objectCategory = 'person' " _
    & " and objectClass = 'user'"
objRS.Open
```

Passing values directly:

```
Set objConn = CreateObject("ADODB.Connection")
objConn.Provider = "ADSDSOObject"
objConn.Open "", "CN=Administrator,CN=Users,dc=mycorp,dc=com", "mypass"

'Open a recordset based on a SQL string

'Set the SQL search string
strSource = "Select Name, ADsPath FROM 'LDAP://dc=mycorp,dc=com' " _
  & " objectCategory = 'person' and objectClass = 'user'"

'Pass what will become the Source and ActiveConnection properties to
'the Recordset::Open call
objRS.Open strSource, objConn
```

22.2.1.3. Executing a specific command

You can use the Command object's methods and properties to pass a complete command to an already open connection:

```
Set objConn = CreateObject("ADODB.Connection")
objConn.Provider = "ADSDSOObject"
objConn.Open "", "CN=Administrator,CN=Users,dc=mycorp,dc=com", "mypass"

'Opening a recordset based on a command object

Set objComm = CreateObject("ADODB.Command")
Set objComm.ActiveConnection = objConn
objComm.CommandText = "Select Name, ADsPath FROM" _
  & " 'LDAP://dc=mycorp,dc=com' where objectCategory = 'person'" _
  & " and objectClass = 'user'"

Set objRS = objComm.Execute(  )
```

Or you can do this:

```
Set objConn = CreateObject("ADODB.Connection")
objConn.Provider = "ADSDSOObject"
objConn.Open "", "CN=Administrator,CN=Users,dc=mycorp,dc=com", "mypass"

'Opening a recordset based on a Command object


Set objComm = CreateObject("ADODB.Command")
Set objComm.ActiveConnection = objConn

Set objRS = objComm.Execute("Select Name, ADsPath FROM" _
  & " 'LDAP://dc=mycorp,dc=com' where objectCategory = 'person'" _
  & " and objectclass = 'user'")
```

Controlling How a Search Is Conducted

When conducting a search, the `Command` object can take a number of extra parameters . For example, a parameter can dictate how many results are returned (`Page Size`), how long in seconds the command can take before it fails (`Timeout`), how far to search in the database (`Searchscope`), and whether the resultset is cached in memory for faster access at a later date (`Cache Results`). These four values are shown in the following code section:

```
Const ADS_SCOPE_SUBTREE = 2
Set objComm = CreateObject("ADODB.Command")
objComm.Properties("Page Size") = 1000
objComm.Properties("Timeout") = 60
objComm.Properties("Searchscope") = ADS_SCOPE_SUBTREE
objComm.Properties("Cache Results") = False
```

For more information, consult the ADO Command object in MSDN.

22.2.1.4. The Command object and Recordset::Open

You can even combine the `Command` object and `Recordset::Open`, like this:

```
Set objConn = CreateObject("ADODB.Connection")
objConn.Provider = "ADSDSOObject"
objConn.Open "", "CN=Administrator,CN=Users,dc=mycorp,dc=com", "mypass"

Set objComm = CreateObject("ADODB.Command")
Set objComm.ActiveConnection = objConn
objComm.CommandText = "Select Name, ADsPath FROM" _
  & " 'LDAP://dc=mycorp,dc=com' where objectCategory = 'person'" _
  & " and objectclass = 'user'"

'Pass what will become the Source and ActiveConnection properties to
'the Recordset::Open call
objRS.Open objComm, objConn
```

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22.3. Understanding Search Filters

When you use the LDAP dialect with the ADSI OLE DB provider to conduct a search, you must use an LDAP search filter to specify your search criteria. In a simple case, `(objectclass=user)` would be used to select every object with the user objectClass under the search base. You can in fact use a filter to match the presence of a value (or not) for any attribute of an object. This enables you to create powerful searches with complex criteria. For example, you can search for any group object that has a certain user as a member and that has a description matching a certain substring.

> Filters must follow the format specified in RFC 2254. You can download RFC 2254 from http://www.ietf.org/rfc/rfc2254.txt.

Although filters let you conduct powerful searches, working with them can seem complex because of the format used, known as prefix notation. To make it easier to understand, we have divided the discussion of filters into two parts: items within a filter and items connecting filters.

22.3.1. Items Within a Filter

Within a filter, you can have three types of items :

Operators

A filter can include one of three operators . The equal-to (`=`) operator checks for exact equivalence. An example is `(name=janet)`. The greater-than-or-equal-to (`>=`) and less-than-or-equal-to (`<=`) operators check for compliance with a range. Examples are `(size>=5)` and `(size<=20)`.

> The equal-to operator can be modified to specify a bitwise comparison. The format of the filter is attribute:matching_rule_oid:=value. The two matching rule OIDs are 1.2.840.113556.1.4.803 for a bitwise AND match and 1.2.840.113556.1.4.804 for a bitwise OR match. For example, the filter (userAccountControl: 1.2.840.113556.1.4.803:=2) searches for objects that have bit 1 (value 2) enabled, which means they are marked as disabled.

Attributes

You can include attributes in filters when you want to determine whether an attribute exists. You simply specify the attribute, followed by the = operator and an asterisk (*). For example, the (mooseHerderProperty=*) filter searches for objects that have the mooseHerderProperty attribute populated.

Substrings

You can include substrings in filters when you want to search for objects with specific strings. Test for substrings by placing the attribute type (e.g., cn for common name, sn for surname) to the left of the = operator and the substring you're searching for to the right. Use the * character to specify where that substring occurs in the string. The (cn=Keith*) filter searches for common name (CN) attributes that begin with the substring "Keith"; the (cn=*Cooper) filter searches for CN strings that end with the substring "Cooper." Depending on the search, the latter form of substring searches can take a long time to return. Under Windows Server 2003, the substring searches perform much better than previously.

You can place several substrings together by using an asterisk character several times. For example, the (cn=Kei*Coo*) filter searches for two substrings in the string: the first substring begins with "Kei," followed by the second substring that begins with "Coo." Similarly, the (cn=*ith*per) filter searches for strings that have two substrings: the first substring ends in "ith" followed by the second substring that ends in "per."

The resultset of a substring search might contain objects that you don't want. For example, if you use the filter (cn=Kei*Coo*) to search for the object representing "Keith Cooper," your resultset might contain two objects: one representing "Keith Cooper" and another representing "Keith Coolidge." To address that issue, you can connect multiple filter strings together to refine your search even more.

22.3.2. Connecting Filters

Compound filters can be created by using the ampersand (&), the vertical bar (|), and the exclamation mark (!). Let's start by creating a filter to find all computers whose common name begins with the letter a. The following is the filter for this search:

```
(&(objectCategory=computer)(cn=a*))
```

This filter actually consists of two filters: (objectCategory=computer) and (cn=a*), but because you're enclosing the filters in parentheses, you're treating them as one filter. The & prefix specifies the use of the logical AND operator. In other words, you're searching for objects that are in the computer objectCategory and have a cn that begins with the letter a.

You can continue to add additional filters to narrow the search even more. Suppose that in computers whose cn begins with the letter a, you want to find only those computers whose dNSHostName ends with the substring *mycorp.net*. To perform this search, you use the following filter:

```
(&(objectCategory=computer)(cn=a*)(dNSHostName=*mycorp.net))
```

You also can widen a search. Instead of using the & operator, you use the | prefix, which specifies the logical OR operator. For example, if you want to find all group or user objects, you use the following filter:

```
(|(objectCategory=group)(&(objectCategory=person)(objectclass=user)))
```

You can nest sets of filters, as long as each filter conforms to the correct notation. For example, if you want to find all groups whose cn begins with the letter a or whose description begins with the substring "Special groups," you use the following filter:

```
(&(objectCategory=group)(|(cn=a*)(description=Special groups*)))
```

So far, we've been searching for objects that have a certain characteristic. You can also search for objects that don't have a certain characteristic. Use the ! prefix, which specifies the NOT, or negation, operator. For example, you can search for all objects that do not have an objectClass equal to user with the following filter:

```
(!(objectClass=user))
```

By combining the &, |, and ! operators, you can perform powerful searches. For example, consider the following query:

```
(&
  (|(objectCategory=container)(objectCategory=organizationalUnit))
  (!(MyCorpSpecial=*))
  (|(cn=*cor*)(cn=J*))
)
```

This query is searching for any container or organizational unit (OU) that doesn't contain the MyCorpSpecial property and whose cn contains the letters "cor" or starts with the letter J. Here's how to include this filter in a script:

```
filterStr = _
  "(&(|(objectCategory=container)(objectCategory=organizationalUnit))" & _
    "(!(MyCorpSpecial=*))" & _
    "(|(cn=*cor*)(cn=J*))" & _
  ")"
```

There are no spaces in the string, yet the quotation marks do not overly detract from the formatting.

As you can see, this is a very powerful specification.

> If a value you are trying to match contains an asterisk, forward slash, backslash, NUL, or parenthesis, which are special characters used in filters, those characters must be specially encoded with escape sequences. These escape sequences are the hexadecimal representation of the ASCII values of the characters; e.g., an asterisk should be encoded as \2a, and a backslash should be encoded as \5c. Please see Search Filter Syntax in the MSDN Library: http://msdn.microsoft.com/library/default.asp?url=/library/en-us/adsi/adsi/search_filter_syntax.asp.

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22.4. Optimizing Searches

Whether you are searching Active Directory using filters or with SQL, there are some important guidelines to follow that can help reduce load on the domain controllers, increase performance of your scripts and applications, and reduce the amount of traffic generated on the network. It is also important to socialize these concepts with others as much as possible. It takes only a couple of badly written search filters in a heavily used application to severely impact the performance of your domain controllers!

22.4.1. Efficient Searching

Understanding how to write efficient search criteria is the first important step to optimizing searches. By understanding a few key points, you can greatly improve the performance of your searches. It is also important to reuse data retrieved from searches or connections to Active Directory as much as possible. Microsoft has provided a paper on creating more efficient Active Directory Enabled applications. This paper has a lot of detailed information concerning efficient queries, you can find the paper at the URL:

> http://msdn.microsoft.com/library/default.asp?url=/library/en-us/dnactdir/html/efficientadapps.asp

The following list describes several key points to remember about searching:

- Use at least one indexed attribute per search. Certain attributes are marked as "indexed" in Active Directory, which allows for fast pattern matching. They are typically single-valued and unique, which means searches using indexed attributes can determine which objects match them very quickly. If you don't use indexed attributes, the database equivalent of a full table scan must be done to determine the matches.

- Use `objectCategory` or a combination of `objectClass` and `objectCategory` in every search. The problem with using only `objectClass` is that it is not indexed in a default Active Directory installation. `objectCategory` , on the other hand, is indexed and much more efficient to use. See the next section for more information.

- Try to limit the use of trailing `(name=*llen)` or middle match `(name=*lle*)` searches. Active Directory, by default, is not optimized to handle these types of searches, and they should be avoided if possible. The use of these queries disables the ability to use the attribute's index and forces the AD to check every entry in directory for that attribute. In some cases, these types of searches can take anywhere from 10-15 seconds to several hours to complete! If there is an attribute in your directory that is often queried in this way, you may consider enabling a Tuple or Medial Index for the attribute. See Chapter 4 and the discussion on the searchFlags schema attribute.

- Avoid using the NOT (`!`) operator in search filters unless absolutely required. The use of a NOT operator on an indexed attribute precludes the use of the index, which forces Active Directory to look at every object within the scope of the search. Another "gotcha" when using NOT is that the result set can return "false positives" with objects that you do not have permission to view the attribute on even if the attribute has the value you are trying to avoid.

- Limit use of bitwise matching filters as they severely impact the use of the attribute's index.
- In Windows 2000 Active Directory, try to enumerate back link attributes versus querying forward link attributes. Although the attributes are implicitly linked, searching against the forward link is considerably slower than enumerating the backlink. For example, if you want to find which objects someone manages, you can query the managedBy forward link attribute of all objects or you can enumerate the managedObjects back link attribute of the user in question. Another example is the forward link member and back link memberOf attributes used for specifying group membership. This shortcoming is corrected in Windows Server 2003 and querying the forward link has comparable performance as enumerating the back link.
- Use the appropriate search scope. Avoid using subtree searches unless you truly want to search more than one level down. If you only want to search directly below the search base, use the OneLevel scope.
- Use paged searching for queries that can potentially return thousands of entries. Most subtree searches should have paging enabled unless you are positive the search will not return more than 1,000 entries or do not want it to return more than 1,000 entries.

> Microsoft allows this limit to be modified by changing the MaxResultSize value in the directory's LDAP policy as indicated in KB315071. There are multiple issues that can result from modifying this policy, and therefore we highly discourage using this method to solve page size issues; instead, use paged searching.

- Reuse ADO Connection and Command objects as much as possible. ADO Connection and Command objects can be used for multiple searches, so there is no need to create additional ones.

22.4.2. Objectclass Versus Objectcategory

It is very important to understand the differences between objectClass and objectCategory and how they should be used during searches. The first point to be aware of from a searching standpoint is that objectClass is not indexed. Initial concerns of the indexing code in the Windows 2000 alpha and beta periods indicated that indexed attributes should be unique single-valued attributes. Even though the indexing process was corrected to allow for efficient indexing and retrieval of multi-valued attributes, objectClass indexing was not implemented in the OEM product. It is possible to index this attribute, however, and several large companies have found it quite desirable from a performance standpoint. See the Chapter 4 discussion on searchFlags for more information on this.

> Microsoft has finally indexed objectClass in Longhorn Server, which won't be released until 2007 or 2008.

Another major difference is that objectClass is a multi-valued attribute that contains the objectClass hierarchy for an instantiated object. For example, a user object has the following values as part of its `objectClass` attribute:

- `top`
- `person`
- `organizationalPerson`
- `user`

That is because the `user` class inherits from the `organizationalPerson` class, which inherits from the `person` class, which inherits from the `top` class. When a class inherits from another, the attributes of the inherited class (also known as the parent class) are available for the inheriting class to use. A class can inherit attributes from abstract and structural classes, which would show up in the `objectClass` attribute for an instantiated object, but auxiliary classes that get statically associated with a particular class do not. Statically associated auxiliary classes allow for a grouping of attributes to be associated with one or more classes in a similar manner to just adding attributes directly to a class's definition and this association can be determined by looking at the schema. Windows Server 2003 Active Directory in forest functional mode allows for dynamically associated auxiliary classes; these classes do show up in the `objectClass` attribute for the instantiated object because you can dynamically associate auxiliary classes on an object by object basis.

`ObjectCategory` , on the other hand, is a single-value *indexed* attribute, which specifies a classification for a type of object. `ObjectCategory` is intended to be an easy way to query for a certain "category" of objects, such as "Person." As an example, both user and contact objects have an `objectcategory` of Person, so by simply searching for (`objectcategory=Person`), you could possibly retrieve user or contact objects.

For the reasons listed previously, queries should use `objectCategory` or a combination of `objectClass` and `objectCategory` as part of the search filter or SQL. The primary reasons for not using just `objectClass` is that it is not indexed and is multi-valued, which does not make for an efficient query. The other classic problem with using only `objectClass` is that you can end up with more object types than you were expecting. This is a common problem with using (`objectClass=user`). You would think you'd only get user objects back using that filter, but you can also potentially get computer objects as well, since the computer `objectClass` is inherited from the user class (therefore causing it to be one of the values for the `objectClass` attribute for every computer object). And even though it would be efficient to use only `objectCategory` because it is indexed, it falls into the same trap as `objectClass` , because additional objects other than the one you are targeting may get returned (e.g., user objects and contact objects). It is for these reasons that you should try to use a combination of `objectClass` and `objectCategory` in your searches.

Several examples are included next to illustrate what using various combinations of `objectClass` and `objectCategory` can return:

People (i.e., Users and Contacts)

```
    (objectCategory=person)
```

Contacts

```
(&(objectClass=contact)(objectCategory=person))
```

Users

```
(&(objectClass=user)(objectCategory=person))
```

Users and computers (not optimized)

```
(objectClass=user)
```

Users and computers (optimized)

```
(&(|(objectCategory=person)(objectCategory=computer))(objectClass=user))
```

Groups

```
(&(objectClass=group)(objectCategory=group))
```

Containers

```
(&(objectClass=container)(objectCategory=container))
```

Organizational Units

```
(&(objectClass=organizationalunit)(objectCategory=organizationalUnit))
```

22.4.3. Filtering an Existing Resultset

An optimization technique that can be used when you need to perform a lot of queries is to instead perform one large query and repeatedly filter the resultset to get the subset of entries you want. It is possible to select particular items from a resultset by using the `Recordset::Filter` property method. Once the `Recordset::Filter` property has been set, you can access only the items in the resultset that match the filter. Properties such as the `Recordset::RecordCount` return only the number of items that match the filter. If you then set the filter back to an empty string, the whole resultset is available again. Because filtering a resultset relies on data that is present in the resultset, you can only filter using the `Fields` object and its values. For example, if you only specify to return the `givenName` and `sn` attributes in a query, you can use only those attributes to filter the resultset later. If you do not return `cn` as a field, there is no way to filter on it later.

Being able to filter an existing resultset is a useful tool, but only in certain situations. In our experience, it is especially useful in three situations:

- You want to use filtered resultsets to access entries instead of multiple queries.
- You want to refine a large resultset without looping through every value.
- You want to reduce the load on Active Directory by performing one large query as opposed to several separate queries.

Let's consider a contrived example where use of the `Recordset::Filter` makes some sense. Let's say we want to count how many usernames begin with each of the 26 letters of the alphabet. The most intuitive method is probably to execute 26 ADO searches and record the `Recordset::RecordCount` property for each. However, this will hit Active Directory with 26 separate searches. Now let's expand the requirement and say we need these totals recorded continually in a file every minute or so. By now, you may be unwilling to keep hitting Active Directory with this sort of traffic every minute. The other alternative is to execute a single search for all users and loop through the resultset using `Recordset::MoveNext` , updating an array of 26 counts as we go. This hits Active Directory only once, but it iterates through every item. This process is fast for a moderate number of users, but for a really large number of users, it is much slower. If your resultset returns, say, 20,000 users in a single search, you need to use `Recordset::Filter` .

To solve the problem, we can write a piece of code that executes one search and then sets 26 separate filters, recording the `Recordset::RecordCount` value at each stage. Example 22-1 contains the sample code, from which the values are written to the *C:\out.txt* file.

Example 22-1. Using recordset filters to reduce the load on Active Director

```
Option Explicit

Const adStateOpen = 1

Dim objFileSystem 'A FileSystemObject
Dim objOutput     'A TextStream Object
Dim objConn       'An ADO Connection object
Dim objRS         'An ADO Recordset object
Dim intCount      'An integer

'*****************************************************************************
'Create the file if it doesn't exist or truncate it if it does exist
'*****************************************************************************
Set objFileSystem = CreateObject("Scripting.FileSystemObject")
Set objOutput = objFileSystem.CreateTextFile("c:\out.txt", TRUE)

'*****************************************************************************
'Write out the current time and date using the VBScript 'Now' function
'*****************************************************************************
objOutput.WriteLine "Starting..." & Now

Set objConn = CreateObject("ADODB.Connection")
objConn.Provider = "ADSDSOObject"
objConn.Open "", "CN=Administrator,CN=Users,dc=mycorp,dc=com", ""
If objConn.State = adStateOpen Then
  objOutput.WriteLine "Authentication Successful!"
Else
  objOutput.WriteLine "Authentication Failed."
  WScript.Quit(1)
End If

Set objRS = objConn.Execute _
  ("<LDAP://dc=mycorp,dc=com>;(&(objectClass=user)(objectCategory=person)); "_
   & "cn;SubTree")

'*****************************************************************************
'Loop through the ASCII characters letters Asc("a") to Asc("z")
'where Asc("a") = 97 and Chr(97) = "a"
'*****************************************************************************
For intCount = 97 To 122
  objRS.Filter = "cn LIKE '" & Chr(intCount) & "*'"
  objOutput.WriteLine(Chr(intCount) & " = " & objRS.RecordCount)
Next

objConn.Close
Set objRS = Nothing

objOutput.Close
```

The filter property must be set using a SQL-like query string, not an LDAP search filter. The recordset filter notation is fairly simple to use. The string can be an empty string (""), which removes the current filter; a criteria string; or an array of bookmarks . Bookmarks will be explained in more detail shortly.

22.4.3.1. Using a criteria string

The criteria string can take a number of different forms, which basically can be broken down to:

```
Field-name  operator  value-to-check
```

Here are some simple examples:

```
Name = vicky     'Checks for exact equivalence (=)
size < 10         'Checks for less-than (<)
size > 10         'Checks for greater-than (>)
size >= 5         'Checks greater-than-or-equal-to (>=)
size <= 20        'Checks less-than-or-equal-to (<=)
size <> 10        'Checks for not-equal-to (<>)
```

Dates are simple to check if you surround them with pound signs (#):

```
Date = #12/12/99#
```

You also can use the keyword LIKE:

```
cn LIKE 'a*'            'Checks for all cn's beginning with "a"
cn LIKE 'ca%'           'Checks for all three-letter cn's beginning with "ca"
cn LIKE '*eithCoo*'
```

You can also use AND and OR:

```
size > 10 AND size < 20
cn LIKE 'a*' OR cn LIKE 'b*'
```

However, there is a strict rule to follow if you want to group a criteria string containing OR with another string using AND. Again, this is sloppy, and Microsoft should look to fixing it in a later release:

```
(cn LIKE 'a*' OR cn LIKE 'b*') AND (size <> 10)                'This is WRONG!
(cn LIKE 'a*' AND size <> 10) OR (cn LIKE 'b*' AND size <> 10) 'This is CORRECT!
```

That should be enough to get you started.

22.4.3.2. Using bookmarks

Each object in a resultset has a bookmark associated with it. You can always obtain the bookmark for the current record and store it for later use by retrieving the value of `ResultSet::Bookmark` . After recording the bookmark, you can instantly jump to that record in the resultset at any time by writing the recorded value back to the bookmark property. For example:

```
'Record the bookmark for the current record
objBookMark = objRS.Bookmark

'Do something

'Now return the current record to the record indicated by the bookmark
objRS.Bookmark = objBookMark
```

> If you read up about the ADO object model on the MSDN site, you will come across the `Recordset::Clone` method for cloning a resultset. Cloning a resultset will clone bookmarks. However, each recordset's bookmarks can be used only with its own resultset.

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22.5. Advanced Search Function: SearchAD

We will now take many of the concepts from this chapter and apply them in a useful example called SearchAD. SearchAD can be included in any VBScript and used immediately as is.

SearchAD takes five parameters and returns a Boolean indicating whether it succeeded or failed in the search. You should recognize most of these parameters:

- The base ADsPath to start the search from
- A valid ADO criteria string
- The depth that you wish to search, represented by one of the exact strings `Base`, `OneLevel`, or `SubTree`
- The comma-separated list of attributes that is to be returned
- A variable that will hold the returned results of the search in an array

The last parameter does not have any values when passed in, but if SearchAD is successful, the array contains the resultset.

Here is an example use of SearchAD:

```
bolIsSuccess = SearchAD("LDAP://ou=Finance,dc=mycorp,dc=com", _
  "(cn=a*)", "Base", "cn,description", arrSearchResults)
```

You can also use it as part of an `If...Then` condition:

```
If SearchAD("LDAP://dc=mycorp,dc=com", "(description=moose)", "SubTree", _
  "ADsPath,cn,description", arrSearchResults) Then
  'success code using arrSearchResults
Else
  'failure code
End If
```

The array that is returned is a two-dimensional array of attributes that match the criteria. If there were 12 results returned for the preceding query, this is how you access the results:

```
arrSearchResults(0,0) 'ADsPath of first result
arrSearchResults(0,1) 'CN of first result
arrSearchResults(0,2) 'Description of first result
arrSearchResults(1,0) 'ADsPath of second result
arrSearchResults(1,1) 'CN of second result
arrSearchResults(1,2) 'Description of second result
arrSearchResults(2,0) 'ADsPath of third result
arrSearchResults(2,1) 'CN of third result
arrSearchResults(2,2) 'Description of third result
arrSearchResults(3,0) 'ADsPath of fourth result
arrSearchResults(3,1) 'CN of fourth result
arrSearchResults(3,2) 'Description of fourth result
.
.
.
arrSearchResults(11,0) 'ADsPath of 11th result
arrSearchResults(11,1) 'CN of 11th result
arrSearchResults(11,2) 'Description of 11th result
```

You can loop through these values in your own code using VBScript's built-in function `UBound` to find the maximum upper bound of an array:

```
UBound(arrSearchResults,1) 'This results in a value of 11

UBound(arrSearchResults,2) 'This results in a value of 2
```

The first `UBound` gives the upper bound of the array's first dimension, and the second gives the upper bound of the second dimension. Thus, you can loop through an index from 0 to these values to iterate through the array. For example:

```
'Iterate through the entire set of records
For i=0 To UBound(arrSearchResults,1)
  'Now for each record iterate through the list of that record's values
  For j=0 To UBound(arrSearchResults,2)
    'Do something with arrSearchResults(i,j), e.g., the next line
    MsgBox arrSearchResults(i,j)
  Next
Next
```

So, without further ado, here is Example 22-2, which contains the SearchAD function.

Example 22-2. SearchAD, an advanced search function

```
'**********************************************************************
'SearchAD Function (returns Boolean success or failure)
'**********************************************************************
Function SearchAD(ByVal strLDAPBase, ByVal strCriteria, ByVal strDepth, _
  ByVal strAttributeList, ByRef arrResults(  ))

  Dim objConn, objComm, objRS
  Dim objDisconRS, intArrayIndex, attrib
  Dim intAttributeArrayIndex, arrAttributes, arrAttributesUb

  '**********************************************************************
  'Split out attributes to build disconnected recordset
  '**********************************************************************
  arrAttributes = Split(strAttributeList,",")
  arrAttributesUb = UBound(arrAttributes)

  On Error Resume Next

  '**********************************************************************
  'Create a disconnected recordset that we will use
  ' for temporary data storage
  '**********************************************************************
  Const adUseClient = 3
  Const adVarChar = 200
  Const maxCharacters = 255

  Set objDisconRS = CreateObject("ADODB.Recordset")
  objDisconRS.CursorLocation = adUseClient
  For intAttributeArrayIndex = 0 To arrAttributesUb
    attrib=arrAttributes(intAttributeArrayIndex)
    objDisconRS.Fields.Append attrib, adVarChar, MaxCharacters
  Next
  objDisconRS.Open

  '**********************************************************************
  'Used to specify an unsuccessful ADO connection
  '**********************************************************************
  Const adStateClosed = 0

  '**********************************************************************
  'Defined in ADS_SCOPEENUM (in the ADSI documentation) for a full
  'subtree search starting at the defined root
  '**********************************************************************
  Const ADS_SCOPE_SUBTREE = 2

  Set objConn = CreateObject("ADODB.Connection")
  Set objComm = CreateObject("ADODB.Command")
  Set objRS = CreateObject("ADODB.Recordset")

  objConn.Provider = "ADSDSOObject"
  objConn.Open "", vbNullString, vbNullString

  '**********************************************************************
  'If connection failed, then return FALSE
  '**********************************************************************
  If objConn.State = adStateClosed Then
    SearchAD = False
    Exit Function
  End If

  '**********************************************************************
  'Link the now-open connection with the empty command object
  '**********************************************************************
  Set objComm.ActiveConnection = objConn

  '**********************************************************************
  'Populate the command object in order to execute a query through the
  'linked connection. Set the text of the query command (i.e., the search),
  'the max number of results to return, the timeout in seconds to wait
  'for the query, and whether the results are to be cached.
  '**********************************************************************
  objComm.CommandText = "<" & strLDAPBase & ">;" & strCriteria & ";" _
    & strAttributeList & ";" & strDepth
  objComm.Properties("Page Size") = 1000
  objComm.Properties("Timeout") = 60
  objComm.Properties("searchscope") = ADS_SCOPE_SUBTREE
  objComm.Properties("Cache Results") = False

  '**********************************************************************
  'Execute the command through the linked connection
  '**********************************************************************
  Err.Clear
  Set objRS = objComm.Execute

  '**********************************************************************
  'If there was an error, then return FALSE
  '**********************************************************************
  If Err Then
    objConn.Close
    Set objRS = Nothing
    SearchAD = False
  Else
    '**********************************************************************
    'If we're pointing at the end of the resultset already (EOF) then there
    'were no records returned (although the query did search the AD), so
    'return FALSE
    '**********************************************************************
    If objRS.EOF Then
      objConn.Close
      Set objRS = Nothing
      SearchAD = False
    Else
```

```
      'Loop through the resultset and populate the disconnected recordset,
      'which we will then use to build the array
      While Not objRS.EOF
        objDisconRS.AddNew
         For intAttributeArrayIndex = 0 To arrAttributesUb
          attrib=arrAttributes(intAttributeArrayIndex)
          objDisconRS.Fields.Item(attrib) = objRS.Fields.Item(attrib)
        Next
        objDisconRS.Update
        objRS.MoveNext
      Wend

      '***********************************************************************
      'Close the connection
      '***********************************************************************
      objConn.Close
      Set objRS = Nothing

      '***********************************************************************
      'Now in order to place all the resulting attributes into the array that
      'we'll pass back out, we need to redimension the array so that it is
      'large enough to hold the records. The array is multidimensional in
      'order to hold all the attribute fields.
      '***********************************************************************

       ReDim arrResults((objDisconRS.RecordCount - 1),arrAttributesUb)

      '***********************************************************************
      'Loop through the newly redimensioned array, starting at zero, and add
      'each field to the array
      '***********************************************************************
      intArrayIndex = 0
      objDisconRS.MoveFirst
      While Not objDisconRS.EOF
         For intAttributeArrayIndex=0 To arrAttributesUb
          attrib=arrAttributes(intAttributeArrayIndex)
          arrResults(intArrayIndex,intAttributeArrayIndex) = _
                                       objDisconRS.Fields.Item(attrib)
        Next
         intArrayIndex = intArrayIndex + 1
        objDisconRS.MoveNext
      Wend
      Set objDisconRS = Nothing
      SearchAD = True
    End If
  End If
End Function
```

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22.6. Summary

In this chapter, we reviewed the basics of ADO, which provides a robust search interface for Active Directory. While originally intended for databases, ADO was adapted to Active Directory to allow queries based on LDAP search filters or SQL. Several techniques for optimizing searches in Active Directory were reviewed, including a discussion of using `objectClass` versus `objectCategory`. We ended the chapter by covering a fully functional SearchAD procedure that can be used as-is in any VBScript to easily search Active Directory based on specified criteria. SearchAD hides all the underlying ADO logic, including connection setup, query execution, and recordset manipulation.

After providing a good background for ADSI and ADO in the last three chapters, we are now ready to move to more practical applications. The next several chapters show some of the capabilities these interfaces provide and a lot of sample code to get you started.

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Chapter 23. Users and Groups

In this chapter, we will show you how to automate the creation and manipulation of user and group accounts . Although tools to create user and group accounts already exist (e.g., the Windows 2000 Resource Kit's *Addusers* utility), ADSI's versatility lets you quickly write a script that creates 1,000 fully featured user or group accounts based on whatever business logic you require. You can also create command-line utilities or web-based interfaces using the techniques shown in this chapter to perform such functions as unlocking locked-out user accounts or adding users to groups.

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23.1. Creating a Simple User Account

You can quickly create a user account with minimal attributes with ADSI. The following code shows how to create a user in an NT domain, a local computer, and an Active Directory domain:

```
Option Explicit
Dim objDomain, objUser
'Creating a user in a Windows NT domain

Set objDomain = GetObject("WinNT://MYDOMAIN")
Set objUser = objDomain.Create("user","vlaunders")
objUser.SetInfo

'Creating a local user on a computer or member server
 'Valid for Windows NT/2000/2003
Set objComputer = GetObject("WinNT://MYCOMPUTER,Computer")
Set objUser = objComputer.Create("user","vlaunders")
objUser.SetInfo

'Creating a user in Active Directory
Set objDomain = GetObject("LDAP://cn=Users,dc=mycorp,dc=com")
Set objUser = objDomain.Create("user","cn=vlaunders")
objUser.Put "sAMAccountName", "vlaunders"
objUser.Put "userPrincipalName", "vlaunders@mycorp.com"
objUser.SetInfo
```

The code is composed of three sections. The first two sections use the WinNT provider to create a user account in an NT 4.0 domain, and then on a local computer that could be a member server or part of a workgroup. The third section uses the LDAP provider to create a user account in an Active Directory domain.

When you create users in an Active Directory domain, you need to be aware of two important User object attributes: `sAMAccountName` and `userPrincipalName` . The User object has several mandatory attributes. The system sets many of these mandatory attributes, except for one, `sAMAccountName`, which allows Active Directory-based clients to interact with older clients and NT domains. You must set the `sAMAccountName` attribute before you call `IADs::SetInfo` or the creation will fail. The `userPrincipalName` attribute isn't mandatory, but it is recommend so users can log on using an email-style address, as defined in RFC 822 (http://www.ietf.org/rfc/rfc822.txt).

> Windows Server 2003 Active Directory changed the mandatory requirement of `sAMAccountName` being populated during object creation. If you do not specify it, you will get a randomly generated `sAMAccountName` like $KJK000-H4GJL6AQOV1I.

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23.2. Creating a Full-Featured User Account

Creating user accounts as we've done previously is fine for an introduction, but typically you'll need to set many more attributes to make them usable in your environment. The approaches you use to create fully featured users in the NT and Active Directory environments differ slightly; Active Directory offers considerably more properties than NT, such as the office and home addresses of users, as well as lists of email addresses and pager, fax, and phone numbers.

You can manipulate User objects with a special interface called `IADsUser`. `IADsUser's` methods and property methods let you directly set many of the User object's property values. Tables 23-1 through 23-3 contain the methods, read-write property methods, and read-only property methods, respectively, for the `IADsUser` interface. The corresponding Active Directory attribute is included in parentheses for the property methods that can be set with the LDAP provider.

Table 23-1. IADsUser methods

Method	Description
`IADsUser::ChangePassword`	Changes the existing password.
`IADsUser::SetPassword`	Sets a new password without needing the old one.
`IADsUser::Groups`	Gets a list of groups of which the user is a member. You can use the `IADsMembers` interface to iterate through the list.

Table 23-2. IADsUser read-write property methods

Property method	Available with WinNT or LDAP?
`IADsUser::AccountDisabled`	WinNT, LDAP (userAccountControl mask).
`IADsUser::AccountExpirationDate`	WinNT, LDAP (accountExpires).
`IADsUser::Department`	LDAP (department).
`IADsUser::Description`	WinNT, LDAP (description).
`IADsUser::Division`	LDAP (division).
`IADsUser::EmailAddress`	LDAP (mail).
`IADsUser::EmployeeID`	LDAP (employeeID).
`IADsUser::FaxNumber`	LDAP (facsimileTelephoneNumber).
`IADsUser::FirstName`	LDAP (givenName).

Property method	Available with WinNT or LDAP?
`IADsUser::FullName`	WinNT, LDAP (displayName).
`IADsUser::GraceLoginsAllowed`	Neither.
`IADsUser::GraceLoginsRemaining`	Neither.
`IADsUser::HomeDirectory`	WinNT, LDAP (homeDirectory).
`IADsUser::HomePage`	LDAP (wWWHomePage).
`IADsUser::IsAccountLocked`	WinNT, LDAP (userFlags/lockoutTime). This method is unreliable for detemining locked status with the LDAP provider, only use it with the WinNT provider.
`IADsUser::Languages`	LDAP (languages).
`IADsUser::LastName`	LDAP (sn).
`IADsUser::LoginHours`	WinNT, LDAP (logonHours).
`IADsUser::LoginScript`	WinNT, LDAP (scriptPath).
`IADsUser::LoginWorkstations`	WinNT, LDAP (userWorkstations).
`IADsUser::Manager`	LDAP (manager).
`IADsUser::MaxLogins`	WinNT.
`IADsUser::MaxStorage`	WinNT, LDAP (maxStorage).
`IADsUser::NamePrefix`	LDAP (personalTitle).
`IADsUser::NameSuffix`	LDAP (generationQualifier).
`IADsUser::OfficeLocations`	LDAP (physicalDeliveryOfficeName).
`IADsUser::OtherName`	LDAP (middleName).
`IADsUser::PasswordExpirationDate`	WinNT.
`IADsUser::PasswordMinimumLength`	WinNT.
`IADsUser::PasswordRequired`	WinNT, LDAP (userAccountControl mask).
`IADsUser::Picture`	LDAP (thumbNailPhoto).
`IADsUser::PostalAddresses`	LDAP (postalAddress).
`IADsUser::PostalCodes`	LDAP (postalCode).
`IADsUser::Profile`	WinNT, LDAP (profilePath).
`IADsUser::RequireUniquePassword`	WinNT.
`IADsUser::SeeAlso`	LDAP (seeAlso).
`IADsUser::TelephoneHome`	LDAP (homePhone).
`IADsUser::TelephoneMobile`	LDAP (mobile).
`IADsUser::TelephoneNumber`	LDAP (telephoneNumber).
`IADsUser::TelephonePager`	LDAP (pager).
`IADsUser::Title`	LDAP (title).

Table 23-3. IADsUser read-only property methods

Property method	Available with WinNT or LDAP?
`IADsUser::BadLoginAddress`	Neither
`IADsUser::BadLoginCount`	WinNT, LDAP (badPwdCount)
`IADsUser::LastFailedLogin`	LDAP (badPasswordTime)
`IADsUser::LastLogin`	WinNT, LDAP (lastLogin)
`IADsUser::LastLogoff`	WinNT, LDAP (lastLogoff)
`IADsUser::PasswordLastChanged`	LDAP (pwdLastSet)

For more information on IADsUser, check out the following location in the MSDN Library at:

http://msdn.microsoft.com/library/default.asp?url=/library/en-us/adsi/adsi/iadsuser.asp

Now let's apply some of this knowledge to two examples. The first shows how to create a fully featured user in Windows NT , and the second shows how to create a fully featured user in Active Directory.

> The `IADsUser::IsAccountLocked` method has never worked properly with the LDAP Provider. It can give a false reading of the current locked status of the account. There is a new attribute in Windows Server 2003 called `msDS-User-Account-Control-Computed`, which will show expired and locked status. Unfortunately the attribute is constructed so you cannot use it for a query, but you can return the value for any objects returned from another query. Like the normal `userAccountControl` attribute, this attribute is a grouping of bitflags. It will correctly identify if the user is locked or expired. When the account is locked, bit 4 (value 16) will be set. When the account is expired, bit 23 (8388608) will be set.

23.2.1. WinNT Provider

Example 23-1 uses several `IADsUser` property methods and several constant values to create a fully featured user in NT.

Example 23-1. Creating a full-featured user account in Windows NT

```
Option Explicit
```

```
'**********************************************************************
'Flag constants. See the later sidebar on "Boolean Arithmetic with
'Hexadecimal Values."
'**********************************************************************
Const UF_SCRIPT = &H1
Const UF_ACCOUNTDISABLE = &H2
Const UF_LOCKOUT = &H10
Const UF_PASSWD_NOTREQD = &H20
Const UF_PASSWORD_CANT_CHANGE = &H40
Const UF_ENCRYPTED_TEXT_PASSWORD_ALLOWED = &H80
Const UF_DONT_EXPIRE_PASSWD = &H10000

Dim objDomain, objUser, fso, intUserFlags, intNewUserFlags
Dim fldUserHomedir, wshShell

Set objDomain = GetObject("WinNT://MYDOMAIN")
Set objUser = objDomain.Create("user","vlaunders")

'**********************************************************************
'Write the newly created object out from the property cache and read
'all the properties for the object, including the ones set by the
'system on creation
'**********************************************************************
objUser.SetInfo
objUser.GetInfo

'**********************************************************************
'Set the properties
'**********************************************************************
objUser.AccountDisabled = False
objUser.AccountExpirationDate = "02/05/04"
objUser.Description = "My description goes here!"
objUser.FullName = "Victoria Launders"
objUser.IsAccountLocked = False
objUser.LoginScript = "login.vbs"
objUser.PasswordRequired = True

'**********************************************************************
'Set all the properties for the user and read back the data, including
'any default so that you can set the flags
'**********************************************************************
objUser.SetInfo
objUser.GetInfo

'**********************************************************************
'Make sure the password never expires and the user can't change it
'**********************************************************************
intUserFlags = objUser.Get("userFlags")
intNewUserFlags = intUserFlags Or UF_DONT_EXPIRE_PASSWD
intNewUserFlags = intNewUserFlags Or UF_PASSWORD_CANT_CHANGE
objUser.Put "userFlags", intNewUserFlags
objUser.SetInfo
```

```
'***********************************************************************
'Set the password
'***********************************************************************
objUser.SetPassword "thepassword"
```

Most of the code in the script is self-explanatory, except for making sure the password never expires. We used two hexadecimal constants to explicitly force the new user account to have a password that never expires and that the user can't change. The code to set these password requirements might seem complicated, but it involves simple arithmetic; the sidebar "Boolean Arithmetic with Hexadecimal Values" explains this arithmetic. If you prefer not to use hex constants, you might be able to use a User object property method. For example, you can use the `IADsUser::AccountDisabled` property method instead of the UF_ACCOUNTDISABLE constant to disable an account. Similarly, you can use the `IADsUser::IsAccountLocked` property method instead of the UF_LOCKOUT constant to unlock an account. These IADs property methods hide the arithmetic within a simple Boolean value.

23.2.2. LDAP Provider

Example 23-2 shows how to create a fully featured user in Active Directory. This script is similar to the last one, with a couple of major differences. The property name `userFlags` changes to `userAccountControl` for the extended settings. Home directory attributes are set along with creation of the home directory folder if it doesn't exist. However, the account is not modified to disallow the password to be changed by the user. In Active Directory with the LDAP provider, this requires changing permissions on the user object and cannot be done with a simple flag change in the `userAccountControl` attribute. The password set operation is implemented prior to enabling the account; this is required when you have a password length policy. Other minor differences exist, such as the use of more constants and property methods. Active Directory lets you set many property values for users, including multi-value properties that you set via an array. For example, you can list several telephone numbers for the `TelephoneNumber`, `TelephoneMobile`, and `TelephoneHome` properties. Through the use of constants, you can even set up Active Directory to let users log on with smart cards.

Example 23-2. Creating a full-featured user account in Active Directory

```
Option Explicit

'***********************************************************************
'WshShell::Run constants
'***********************************************************************
Const vbMinimizedNoFocus = 6

'***********************************************************************
'Flag constants. See the previous sidebar on "Boolean Arithmetic with
'Hexadecimal Values."
```

```
'*********************************************************************
Const UF_SCRIPT = &H1
Const UF_ACCOUNTDISABLE = &H2
Const UF_HOMEDIR_REQUIRED = &H8
Const UF_PASSWD_NOTREQD = &H20
Const UF_PASSWORD_CANT_CHANGE = &H40
Const UF_ENCRYPTED_TEXT_PASSWORD_ALLOWED = &H80
Const UF_DONT_EXPIRE_PASSWD = &H10000
Const UF_MNS_LOGON_ACCOUNT = &H20000
Const UF_SMARTCARD_REQUIRED = &H40000
Const UF_TRUSTED_FOR_DELEGATION = &H80000
Const UF_NOT_DELEGATED = &H100000

Const ADS_PROPERTY_UPDATE = 2

Dim objDomain, objUser, fso, intUserFlags, intNewUserFlags
Dim fldUserHomedir, wshShell

Set objDomain = GetObject("LDAP://cn=Users,dc=mycorp,dc=com")
Set objUser = objDomain.Create("user","cn=vlaunders")
objUser.Put "sAMAccountName", "vlaunders"
objUser.Put "userPrincipalName", "vlaunders@mycorp.com"

'*********************************************************************
'Write the newly created object out from the property cache and read
'all the properties for the object, including the ones set by the
'system on creation
'*********************************************************************
objUser.SetInfo
objUser.GetInfo

'*********************************************************************
'Set the password
'*********************************************************************
objUser.SetPassword "thepassword"
'*********************************************************************
'Set the properties
'*********************************************************************
objUser.AccountDisabled = False
objUser.AccountExpirationDate = "02/05/01"
objUser.Description = "My description goes here!"
objUser.LoginScript = "login.vbs"
objUser.Profile = "\\MYDOMAIN\DFS\Users\vlaunders\profile"
objUser.PasswordRequired = True
objUser.TelephoneHome = Array("0123-555-7890")
objUser.PutEx ADS_PROPERTY_UPDATE, "otherHomePhone", _
  Array("0123 555 7891", "0123 555 7892")
objUser.TelephoneNumber = Array("0123 555 7890")
objUser.PutEx ADS_PROPERTY_UPDATE, "otherTelephone", _
  Array("0123 555 7891", "0123 555 7892")
objUser.TelephoneMobile = Array("0123 555 7890")
objUser.PutEx ADS_PROPERTY_UPDATE, "otherMobile", _
```

```
  Array("0123 555 7891", "0123 555 7892")
objUser.NamePrefix = "Ms."
objUser.FirstName = "Victoria"
objUser.LastName = "Launders"
objUser.DisplayName = "Victoria Launders"

'**********************************************************************
'Set the drive that you'll map to
'**********************************************************************
objUser.HomeDirectory = "\\MYDOMAIN\DFS\Users\vlaunders"
objUser.Put "homeDrive", "Z:"

'**********************************************************************
'Set all the properties for the user and read back the data, including
'any defaults, so that you can set the flags
'**********************************************************************
objUser.SetInfo
objUser.GetInfo

'**********************************************************************
'Make sure the password never expires
'**********************************************************************
intUserFlags = objUser.Get("userAccountControl")
intNewUserFlags = intUserFlags Or UF_DONT_EXPIRE_PASSWD
objUser.Put "userAccountControl", intNewUserFlags
objUser.SetInfo

'**********************************************************************
'Create the home directory
'**********************************************************************
Set fso = CreateObject("Scripting.FileSystemObject")
If Not fso.FolderExists("\\MYDOMAIN\DFS\Users\vlaunders") Then
Set fldUserHomedir = fso.CreateFolder("\\MYDOMAIN\DFS\Users\vlaunders")
End If

'**********************************************************************
'Set full rights for the user to the home directory
'**********************************************************************
Set wshShell = WScript.CreateObject("Wscript.Shell")
wshShell.Run "cacls.exe \\MYDOMAIN\DFS\Users\vlaunders /e /g vlaunders:F",
vbMinimizedNoFocus, True
```

Boolean Arithmetic with Hexadecimal Values

Assume that you want an attribute of an object (e.g., userFlags of the User object) to set eight values. You use an 8-bit binary number to represent those eight values. If you want the attribute to hold 11 values, you use an 11-bit binary number.

The binary system is a base-2 system in which 0 typically represents a false condition and 1 typically represents a true condition. In this example, 0 means the value isn't set, and 1 means the value is set. If you want to set only the third and eighth values of an 8-value attribute, you set the third and eighth bits of an 8-bit binary number to 1, or &B10000100. (You read binary numbers from right to left.) The prefix &B specifies that the number is binary.

However, attributes store data as decimal values. Thus, you need to convert the binary number into a decimal value, which is base-10. For example, the binary number &B10000100 translates into:

$2^7 + 2^2 = 128 + 4 = 132$

You use the Boolean AND operator to check whether a bit is set and the OR operator to set a bit. For example, suppose you want to see whether the fourth bit is set in an 8-bit binary number that has a decimal value of 132. You can check for the existence of this bit using the AND operator to compare the number to a binary mask indicating that the fourth bit is set. The equation to do this is:

&B10000100 AND &B00001000 = &B00000000

You solve this equation by resolving the AND operation for each bit individually. For example, the first bit in &B10000100 is 0, and the first bit in &B00001000 is 0: 0 AND 0 is 0. The second bit in &B10000100 is 0, and the second bit in &B00001000 is 0: 0 AND is 0. The third bit in &B10000100 is 1, and the third bit in &B00001000 is 0; 1 AND 0 is 0. When you calculate all eight bits, the result is &B00000000. In other words, the fourth bit isn't set.

```
1    0    0    0    0    1    0   0
0    0    0    0    1    0    0   0
0    0    0    0    0    0    0   0
```

Suppose you want to test whether the third bit is set:

&B10000100 AND &B0000100 = &B00000100

Because the third bit in &B10000100 is 1, and the third bit in &B0000100 is 1, the resulting bit is 1 (1 AND 1 is 1), which specifies that the value for the third bit is set.

```
1    0    0    0    0    1    0   0
0    0    0    0    0    1    0   0
0    0    0    0    0    1    0   0
```

Let's translate this binary equation into decimal and hex equations:

&B10000100 AND &B0000100 = &B00000100

132 AND 4 = 4
&H84 AND &H4 = &H4

If the return value is 0 or &H0, the bit isn't set. If the return value is the bit's actual value (in this case, 4 or &H4), the bit is set.

132 OR 8 = 140
&H84 OR &H8 = &H8C

Just like the AND operator, the OR operator works with binary, decimal, and hex systems. Taking the example just given, let's try to set the third bit, which happens to be already set:

&B10000100 OR &B0000100 = &B10000100
132 OR 4 = 132
&H84 OR &H4 = &H84

```
1    0    0    0    0    1    0   0
0    0    0    0    0    1    0   0
1    0    0    0    0    1    0   0
```

In other words, the result is the new value with that bit set. Because that bit was already set, nothing changes. Let's try setting the fourth bit, which isn't already set:

&B10000100 OR &B00001000 = &B10001100

```
1    0    0    0    0    1    0   0
0    0    0    0    1    0    0   0
1    0    0    0    1    1    0   0
```

The result includes a newly set fourth bit. You can even set two bits at once. For example, here's how you set the fourth and fifth bits:

&B10000100 OR &B00011000 = &B10011100
132 OR 24 = 156
&H84 OR &H18 = &H9C

```
1    0    0    0    0    1    0   0
0    0    0    1    1    0    0   0
1    0    0    1    1    1    0   0
```

Although the Boolean mathematics is straightforward, luckily you don't have to include this code in a script. Instead, you typically use constants. For example, if you declare the constant:

```
    Const UF_DONT_EXPIRE_PASSWD = &H10000
```

you just need to specify that constant in the script. To determine this bit's existence, use the code:

```
If intUserFlags And UF_DONT_EXPIRE_PASSWD = 0 Then

'UF_DONT_EXPIRE_PASSWD is not set

Else

'UF_DONT_EXPIRE_PASSWD is set

End If
```

You set bits in a similar fashion. For example, to set the &H10000 bit, use the code:

```
intUserFlags = intUserFlags Or UF_DONT_EXPIRE_PASSWD
```

We created the home directory by obtaining a reference to a FileSystemObject object and calling the `FileSystemObject::CreateFolder` method if the directory doesn't already exist. The permissions were set by running the *cacls.exe* command available from the Resource Kit using the `WshShell::Run` method. When calling `WshShell::Run`, you need to include three parameters. The first parameter is the command you want to execute; the second parameter can be any of the following constant values that describe how you want to treat the new window produced by executing the command:

```
Const vbHide = 0                ` hides the window
Const vbNormalFocus = 1         ` displays the window
Const vbMinimizedFocus = 2      ` minimizes the window with focus
Const vbMaximizedFocus = 3      ` maximizes the window with focus
Const vbNormalNoFocus = 4       ` displays the window w/o focus
Const vbMinimizedNoFocus = 6    ` minimizes the window w/o focus
```

The last parameter to the `WshShell::Run` method should be to set to true if you want the script to wait until CACLS finishes before continuing to the next line.

> As an alternative to using CACLS to set permissions, you could write a script that makes use of the interfaces described in Chapter 26, or you could use the *ADsSecurity.dll* provided available in the Platform SDK.

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23.3. Creating Many User Accounts

User-specific scripts work well if you have to create only a few user accounts. If you need to create many user accounts at one time, or if you create new accounts often, using a script with an input file is more efficient. The input file includes the user data so that you can use the script to create any user account. For example, the output shown below represents the *users-to-create.txt* input file that provides the user data for the universal script in Example 23-3. Although this input file includes only four data sets, you can include as many data sets as you want. You include a data set for each user account that you want to create.

```
vlaunders:12/09/01:The description:Victoria Launders:onebanana
aglowenorris:08/07/00:Another user:Alistair Lowe-Norris:twobanana
kbemowski:03/03/03:A third user:Karen Bemowski:threebanana
jkellett:08/09/99:A fourth user:Jenneth Kellett:four
```

Example 23-3. Creating many user accounts using a script with an input file

```
Option Explicit

Const ForReading = 1

Dim objDomain, objUser, fso, tsInputFile, strLine, arrInput
Dim fldUserHomedir, wshShell

Set objDomain = GetObject("LDAP://cn=Users,dc=mycorp,dc=com")
Set fso = CreateObject("Scripting.FileSystemObject")

'**********************************************************************
'Open the text file as a text stream for reading.
'Don't create a file if users-to-create.txt doesn't exist
'**********************************************************************
Set tsInputFile = fso.OpenTextFile("c:\users-to-create.txt", ForReading, False)

'**********************************************************************
'Execute the lines inside the loop, as long as you're not at the end
'of the file
'**********************************************************************
While Not tsInputFile.AtEndOfStream

  '**********************************************************************
```

```
'Read a line, and use the Split function to split the data set into
'its separate parts
'**********************************************************************
strLine = tsInputFile.ReadLine
arrInput = Split(strLine, ":")

Set objUser = objDomain.Create("user","cn=" & arrInput(0))
objUser.Put "sAMAccountName", arrInput(0)
objUser.Put "userPrincipalName", arrInput(0) & "@mycorp.com"

'**********************************************************************
'Write the newly created object out from the property cache
'Read all the properties for the object, including
'the ones set by the system on creation
'**********************************************************************
objUser.SetInfo
objUser.GetInfo

'**********************************************************************
'Set the password
'**********************************************************************
objUser.SetPassword arrInput(4)

'**********************************************************************
'Set the properties
'**********************************************************************
objUser.AccountDisabled = False
objUser.AccountExpirationDate = arrInput(1)
objUser.Description = arrInput(2)
objUser.LoginScript = "\\MYDOMAIN\DFS\Loginscripts\" & arrInput(0) & ".vbs"
objUser.Profile = "\\MYDOMAIN\DFS\Users\" & arrInput(0) & "\profile"
objUser.PasswordRequired = True
objUser.DisplayName = arrInput(3)

'**********************************************************************
'Set the drive that you'll map to
'**********************************************************************
objUser.HomeDirectory = "\\MYDOMAIN\DFS\Users\" & arrInput(0)
objUser.Put "homeDrive", "Z:"
objUser.SetInfo

'**********************************************************************
'Create the home directory
'**********************************************************************
If Not fso.FolderExists("\\MYDOMAIN\DFS\Users\" & arrInput(0)) Then
  Set fldUserHomedir = fso.CreateFolder("\\MYDOMAIN\DFS\Users\" & arrInput(0))
End If

'**********************************************************************
'Set full rights for the user to the home directory
'**********************************************************************
Set wshShell = WScript.CreateObject("Wscript.Shell")
```

```
  wshShell.Run "cacls \\MYDOMAIN\DFS\Users\" & arrInput(0) _
    & " /e /g " & arrInput(0) & ":F", 1, True

  '**********************************************************************
  'Stop referencing this user
  '**********************************************************************
  Set objUser = Nothing
Wend

'Close the file
tsInputFile.Close
```

As the output shows, each data set goes on a separate line. A data set can contain as many values as you want. The data sets in the *users-to-create.txt* file have five values: username, expiration date, description, full name, and password. You use colons to separate the values.[*]

[*] While comma-separate-value (CSV) files are the norm for this sort of thing, the comma is more often used in properties that will be added for users, so the colon is used here instead.

The script reads in the user data to create the user accounts. As the script shows, you use FileSystemObject (FSO) and TextStream (TS) objects to manipulate the user data. For information about FSO and TS objects, see http://msdn.microsoft.com/library/default.asp?url=/nhp/Default.asp?contentid=28001169. After you create a reference to an FSO object and assign that reference to the `fso` variable, apply the `FileSystemObject::OpenTextFile` method to open the *users-to-create.txt* file, setting the user data to the `tsInputFile` TS variable. Then use a while loop with the `TextStream::AtEndOfStream` method to loop through each line in `tsInputFile` until the end of the file. Once you reach the end of the file, use the `TextStream::Close` method to end the script.

The while loop is the heart of the script. Begin the while loop by applying the `TextStream::ReadLine` method to read in one line of `tsInputFile` at a time. The `strLine` string variable holds the retrieved data from that line, which you pass to VBScript's `Split` function. Using the colon as the separator, this function splits the data set into its five parts, assigning the data to the `arrInput` array variable. This array has index values that correspond to the five parts: 0 represents the username, 1 represents the expiration date, 2 represents the description, 3 represents the full name, and 4 represents the password.

The code in the middle of the while loop is similar to the code used earlier. After we create a reference to an ADSI User object and assign that reference to the `objUser` variable, we set that user's property values (including the home drive). We then use `IADs::SetInfo`, set the password, create the home directory, and set the directory permissions. However, instead of explicitly specifying each user's username, expiration date, description, full name, and password in the code, we specify the appropriate array index value. For example, for those property values in which you need to specify the username, you specify `arrInput(0)` instead of vlaunders, aglowenorris, kbemowski, or jkellett.

The while loop ends with setting `objUser` to `Nothing`. We need to clear `objUser` because we use this variable again when the `TextStream::ReadLine` method reads in the next line from `tsInputFile` to create the next user account.

Instead of reading in user data from a text file, you can read in data from other sources, such as a web-based form, a Microsoft Word document, an Excel spreadsheet, a database, or even a specially formatted Microsoft Outlook email message. You also can use command-line arguments to pass in user data, as we will show in a later example.

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23.4. Modifying Many User Accounts

Once you have created the user accounts in a domain, you will more than likely need to modify them at some point. The modifications may consist only of changing individual properties of a user, such as the description or name fields. In these cases, you can perform the change manually or write a command-line script as shown in the next section. In some situations, you will need to make a large number of changes to your user accounts, as would be the case if you changed the name of your login script and wanted to point all users to the new script.

For Windows NT and even Active Directory domains, you can use the `IADsContainer::Filter` method to iterate through all the objects of a particular type. Thus, changing all users' login script is a pretty easy to do:

```
Option Explicit
On Error Resume Next
Dim objDomain, objUser
Set objDomain = GetObject("WinNT://MYCORP")
objDomain.Filter = Array("User")
'**********************************************************************
' Iterate over each user and set the LoginScript
' Print an error if one occurs
'**********************************************************************
for each objUser in objDomain
   objUser.LoginScript = "login-new.vbs"
   objUser.SetInfo

   if Err.Number <> 0 Then
      Wscript.Echo objUser.Name & " error occurred"
      Err.Clear
   Else
      Wscript.Echo objUser.Name & " modified"
   End if
next
```

While the previous code is straightforward, it is also limiting. The only filter option you have is object type, such as all users, and no additional criteria are allowed. That is why in most cases with Active Directory domains, you will want to use ADO to find objects, as explained in Chapter 22. So for our next example, let's say that we want to change the login script for all users in the domain that have a department attribute equal to "Sales." Example 23-4 shows how this can be done using ADO.

Example 23-4. Modifying the login script for all users in Sales

```
Option Explicit
On Error Resume Next
Dim objConn, objComm, objRS, objUser
Dim strBase, strFilter, strAttrs, strScope
'**********************************************************************
'Set the ADO search criteria
'**********************************************************************
strBase   = "<LDAP://dc=mycorp,dc=com>;"
strFilter = "(&(objectclass=user)(objectcategory=person)(department=Sales));"
strAttrs  = "ADsPath;"
strScope  = "Subtree"

set objConn = CreateObject("ADODB.Connection")
objConn.Provider = "ADsDSOObject"
objConn.Open
'**********************************************************************
'Need to enable Paging in case there are more than 1000 objects returned
'**********************************************************************
Set objComm = CreateObject("ADODB.Command")
Set objComm.ActiveConnection = objConn
objComm.CommandText = strBase & strFilter & strAttrs & strScope
objComm.Properties("Page Size")  = 1000
Set objRS = objComm.Execute(  )
While not objRS.EOF
  Set objUser = GetObject( objRS.Fields.Item("ADsPath").Value )
  objUser.LoginScript = "login-sales.vbs"
  objUser.SetInfo
  if Err.Number <> 0 Then
     Wscript.Echo objUser.Name & " error occurred"
     Err.Clear
  Else
     Wscript.Echo objUser.Name & " modified"
  End if
  objRS.MoveNext
Wend
```

Note that we enabled Paging by setting up an ADO Command option and set the Page Size property to 1,000. This will ensure that we get all matching records. If we did not set Page Size, the maximum number of records returned would be whatever the administrative limit is for your Active Directory (the default is 1,000).

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23.5. Account Unlocker Utility

Imagine that you need a utility that quickly enables and unlocks an NT or Active Directory user account. The account was locked because the password was entered incorrectly too many times in succession or because the account exceeded its expiration date. Writing a user-specific script is inefficient if you have many users. Using an input file to pass in the needed user data to a script also is inefficient. You'd have to create the input file just before running the script, because you can't predict whose account you need to unlock. The best approach is to use command-line arguments to pass in the user data as you need it.

Examples 23-5 and 23-6 use this approach to enable and unlock NT and Active Directory user accounts, respectively. If you have a mixed NT and Active Directory network, you can even combine these two utilities into one script.

Example 23-5 implements the unlocker with the WinNT provider.

Example 23-5. Account unlocker utility for Windows NT

```
'**********************************************************************
'How to unlock and enable a Windows NT user via arguments to this script
'
'Parameters should be <domain> <username>
'**********************************************************************
Option Explicit

Dim wshArgs, objUser, strOutput

On Error Resume Next

'**********************************************************************
'Get the arguments
'**********************************************************************
Set wshArgs = Wscript.Arguments

'**********************************************************************
'If no arguments passed in, then quit
'**********************************************************************
If wshArgs.Count = 0 Then
  WScript.Echo "ERROR: No arguments passed in." & vbCrLf & vbCrLf _
    & "Please use NTUNLOCK <domain> <username>" & vbCrLf & vbCrLf
  WScript.Quit
End If
```

```
'**********************************************************************
'Error checking of the arguments could go here if we wanted
'**********************************************************************

'**********************************************************************
'Attempt to bind to the user
'**********************************************************************
Set objUser = GetObject("WinNT://" & wshArgs(0) & "/" & wshArgs(1) & ",user")
If Err Then
  Wscript.Echo "Error: Could not bind to the following user: " & vbCrLf _
    & vbCrLf & "WinNT://" & wshArgs(0) & "/" & wshArgs(1) & vbCrLf & vbCrLf
  WScript.Quit
Else
  strOutput = "Connected to user WinNT://" & wshArgs(0) & "/" & wshArgs(1) _
    & vbCrLf
End If

'**********************************************************************
'Attempt to enable the user (but don't quit if you fail)
'**********************************************************************
Err.Clear
objUser.AccountDisabled = False
objUser.SetInfo
If Err Then
  strOutput = strOutput & vbTab & "Error: Could not enable the user account." _
    & vbCrLf
Else
  strOutput = strOutput & vbTab & "User account enabled." & vbCrLf
End If

'**********************************************************************
'Attempt to unlock the user
'**********************************************************************
Err.Clear
objUser.IsAccountLocked = False
objUser.SetInfo
If Err Then
  strOutput = strOutput & vbTab & "Error: Could not unlock the user account." _
    & vbCrLf
Else
  strOutput = strOutput & vbTab & "User account unlocked." & vbCrLf
End If

WScript.Echo strOutput
```

You pass in two arguments, domain and username, to the script. We use the `Wscript::Arguments` property method to retrieve the arguments. The `Wscript::Argu-ments` property method stores the arguments as a collection, indexing them from 0 to the number of arguments minus 1. The `wshArgs` collection in the script includes the argument `wshArgs(0)`, which represents the domain, and wshArgs(1), which represents the username.

We use the WshArguments::Count method to count the number of arguments. If the count is 0, the script sends an error message and then quits. Use the Wscript.Echo method to display the error message so that you can use *cscript.exe* or *wscript.exe* to run the script. If you use the VBScript MsgBox function (which displays messages as dialog boxes) in a script that you run from *cscript.exe*, the error messages will be illegible in the command window.

Next, we use the GetObject method to try to connect to the user account. Instead of specifying the actual ADsPath to the User object (which would make the script user-specific), we concatenated (&) the following elements in this order: WinNT:// (i.e., the provider), wshArgs(0) (i.e., the domain name), / (i.e., the slash that separates the domain name and username), wshArgs(1) (i.e., the username), and ,user (i.e., a comma and the object class).

If the connection attempt fails, the script writes an error message and then quits. If the attempt succeeds, the script puts the output from that attempt into the strOutput text string variable. That way, if you're running *wscript.exe* rather than *cscript.exe*, the results appear in one dialog box.

The next two sections attempt to enable and unlock the user account. However, the script doesn't quit if an attempt fails. The Err::Clear method, which works only if you enable On Error Resume Next, clears the error object so that you can detect the next error.

Whether an attempt succeeds or fails, the output goes to the strOutput string variable, where it's appended to any existing text. The vbTab constant and the vbCrLf constant ensure that any new text that we concatenate appears in separate indented lines underneath the user's ADsPath. Finally, we use the WScript::Echo method to print the results in strOutput.

This script is simple but powerful. You can easily add to the script to perform other tasks, such as changing passwords and account expiration dates.

Because Active Directory supports the WinNT namespace, you can use the previous listing to enable and unlock Active Directory user accounts. However, we recommend that you instead use the script in Example 23-6, because accessing Active Directory via the LDAP provider is a more elegant and efficient approach.

Example 23-6. Account unlocker utility for Active Directory using the LDAP provider

```
'**********************************************************************
'How to unlock and enable a Active Directory user via arguments
' to this script
' Parameters should be <domain> <username>, where domain specifies
' a fully qualified AD domain like dc=mycorp,dc=com
'**********************************************************************
Option Explicit

Dim wshArgs, objUser, strOutput, arrSearchResults

On Error Resume Next
```

```
'**********************************************************************
'Get the arguments
'**********************************************************************
Set wshArgs = Wscript.Arguments

'**********************************************************************
'If no arguments passed in, then quit
'**********************************************************************
If wshArgs.Count = 0 Then
  WScript.Echo "ERROR: No arguments passed in." & vbCrLf & vbCrLf _
    & "Please use AD-UNLOCK <domain> <username>" & vbCrLf & vbCrLf
  WScript.Quit
End If

'**********************************************************************
'Error checking of the arguments could go here if we wanted to
'**********************************************************************

'**********************************************************************
'Use SearchAD function from the end of Chapter 22 to scan the entire
'Active Directory for this user and return the ADsPath. If the search
'failed for whatever reason, then quit
'**********************************************************************
If Not SearchAD("LDAP://" & wshArgs(0), _
  "(&(objectcategory=person)(objectClass=user)(sAMAccountName=" _
      & wshArgs(1) & "))", "SubTree", "ADsPath", arrSearchResults) Then

  WScript.Echo "ERROR: No users found." & vbCrLf & vbCrLf
  WScript.Quit
Else
  '**********************************************************************
  'Attempt to bind to the first ADsPath specified in the array
  '(as there should be only one)
  '**********************************************************************
  Set objUser = GetObject(arrSearchResults(0,0))
  If Err Then
    Wscript.Echo "Error: Could not bind to the following user: " & vbCrLf _
      & vbCrLf & arrSearchResults(0,0) & vbCrLf & vbCrLf
    WScript.Quit
  Else
    strOutput = "Connected to user " & arrSearchResults(0,0) & vbCrLf
  End If

  '**********************************************************************
  'Attempt to enable the user (but don't quit if you fail)
  '**********************************************************************
  Err.Clear
  objUser.AccountDisabled = False
  objUser.SetInfo
  If Err Then
    strOutput = strOutput & vbTab & "Error: Could not enable the user." & vbCrLf
  Else
```

```
    strOutput = strOutput & vbTab & "User enabled." & vbCrLf
  End If

  '**********************************************************************
  'Attempt to unlock the user
  '**********************************************************************
  Err.Clear
  objUser.IsAccountLocked = False
  objUser.SetInfo
  If Err Then
    strOutput = strOutput & vbTab & "Error: Could not unlock the user." & vbCrLf
  Else
    strOutput = strOutput & vbTab & "User unlocked." & vbCrLf
  End If

  WScript.Echo strOutput
End If
```

Although more elegant and efficient, using the LDAP provider is a little tricky because users can exist in any container anywhere in a domain tree. Thus, you can't immediately attempt to bind to the user account because you don't know the ADsPath. You first must conduct an ADO search to obtain the ADsPath.

At the end of Chapter 22, we showed how to use ADO to construct the Active Directory search routine SearchAD. We use the routine here to search Active Directory for the user's ADsPath and store it in `arrSearchResults(0,0)`. The search is executed using a set of arguments, including `wshArgs(0)` and `wshArgs(1)`. If you put the individual filters on separate lines and substitute the domain and username for `wshArgs(0)` and `wshArgs(1)`, the set of arguments looks something like this:

```
LDAP://dc=mycorp,dc=com
(&(objectcategory=person)(objectClass=user)(sAMAccountName=vlaunders))
ADsPath
SubTree
arrSearchResults
```

If the search fails, the script displays an error message and then quits. If the search succeeds, the script attempts to bind to the ADsPath. The rest of the script proceeds similarly to the one for Windows NT.

> This script requires you to know which user is currently locked out. If you need to find all users who are locked out in an Active Directory domain, check out the command-line tool *unlock.exe* freely available on the web site http://www.joeware.net. Unlock will quickly find and unlock all locked out accounts.

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23.6. Creating a Group

Now we will move on to creating groups . Creating a group is very similar to creating a user. You use the same IADsContainer::Create method:

```
Set objGroup = objSalesOU.Create("group", "cn=Managers")
objGroup.Put "sAMAccountName", "Managers"
objGroup.SetInfo
```

This code assumes we already have a pointer to an OU in the objSalesOU variable. The IADs::Put method is used to set the sAMAccountName, a mandatory attribute in Windows 2000 AD with no default value, just like with users.

The IADsGroup interface that operates on group objects supports four methods and one property that is specific to the group object, as listed in Table 23-4.

Table 23-4. The IADsGroup interface

IADsGroup methods and properties	Action
Add	Adds users to the group as members
Remove	Removes user members from the group
IsMember	Tests to see if a user is a member of a group
Members	Returns a list of all the members of the group
Description	Returns the text describing the group

In Example 23-7, we show how to create a group with both the WinNT and LDAP providers.

Example 23-7. Creating a group with both the WinNT and LDAP providers

```
Option Explicit

Dim objDomain, objGroup, objComputer

'Creating a group in a Windows NT domain
Set objDomain = GetObject("WinNT://MYDOMAIN")
Set objGroup = objDomain.Create("group","MyGroup")
ObjGroup.SetInfo

'Creating a local group on a computer or member server

'Valid for Windows NT, Windows 2000 and Windows Server 2003
Set objComputer = GetObject("WinNT://MYCOMPUTER")
Set objGroup = objComputer.Create("group","My Group")
ObjGroup.SetInfo

'Creating a group in Active Directory
Set objDomain = GetObject("LDAP://cn=Users,dc=mycorp,dc=com")
Set objGroup = objDomain.Create("group","cn=My Group")
ObjGroup.Put "sAMAccountName", "MyGroup"
ObjGroup.SetInfo
```

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23.7. Adding Members to a Group

Adding objects as members of a group can be done with `IADsGroup::Add` , a simple method that takes the DN of the object to be added:

```
objGroup.Add("LDAP://cn=Sue Peace,cn=Users,dc=mycorp,dc=com")
objGroup.Add("LDAP://cn=Keith Cooper,cn=Users,dc=mycorp,dc=com")
```

Groups can contain virtually any other type of object as a member, including users, computers, and other groups.

23.7.1. Adding Many USER Groups to DRUP Groups

In Chapter 11, we described the need to add many user groups as members of several permission groups. Example 23-8 contains the code necessary to implement this functionality. It scans for all groups prefixed with USER_ and DRUP_. It then adds all the USER groups to each DRUP group, except for the group where the suffix matches. In other words, all USER_ groups except USER_Finance are added to DRUP_Finance. This was why the names were set up this way.

Example 23-8. Adding many user groups as members of several permission groups

```
'**************************************************************************
'Search the entire AD for all groups starting USER_ and return the cn
'and AdsPath variables in the following structure
'
'   arrUSERGroup(index,0) = cn attributes
'   arrUSERGroup(index,1) = ADsPath attribute
'
'where index goes from 0 to (the maximum number of results returned -1)
'**************************************************************************
If (SearchAD("LDAP://dc=mycorp,dc=com", _
       "(&(objectCategory=group)(cn=USER_*))", _
           "SubTree", "cn,ADsPath", arrUSERGroup)) Then

  '**************************************************************************
  'As above but for DRUP_ groups
  '**************************************************************************
  If (SearchAD("LDAP://dc=mycorp,dc=com", _
      "(&(objectCategory=group)(cn=DRUP_*))", _
              "SubTree", "cn,ADsPath", arrDRUPGroup)) Then

    '**********************************************************************
    'Set up an index to allow us to iterate through the USER_ groups. The
    'Ubound function here counts the maximum number of rows returned
    '**********************************************************************
    arrUSERGroupsUb = Ubound(arrUSERGroups)
    For intUSERGroupIndex = 0 To arrUSERGroupsUb
      '**********************************************************************
      'As above but for DRUP_ groups
      '**********************************************************************
      arrDRUPGroupsUb = Ubound(arrDRUPGroups)
      For intDRUPGroupIndex = 0 To arrDRUPGroupsUb
        '**********************************************************************
        'Extract the portion of the name that corresponds to all letters after
        'the "USER_" or "DRUP_" parts (i.e., five  letters)
        '**********************************************************************
         txtUSERGroupSuffixName = Right(arrUSERGroup(intUSERGroupIndex,0), _
           Len(arrUSERGroup(intUSERGroupIndex,0))-5)
         txtDRUPGroupSuffixName = Right(arrDRUPGroup(intDRUPGroupIndex,0), _
           Len(arrDRUPGroup(intDRUPGroupIndex,0))-5)
        '**********************************************************************
        'If the two extracted strings are not the same, then add the USER group
        'to the DRUP group
        '**********************************************************************
        If Not txtUSERGroupSuffixName = txtDRUPGroupSuffixName Then
           Set objDRUPGroup = GetObject(arrDRUPGroup(intDRUPGroupIndex,1))
           If NOT objDRUPGroup.IsMember(arrUSERGroup(intUSERGROUPIndex,1)) Then
            objDRUPGroup.Add(arrUSERGroup(intUSERGroupIndex,1))
           objDRUPGroup.SetInfo
          End If
        End If
      Next
    Next
  End If
End If
```

These searches make use of the ADO search function called SearchAD from Chapter 22.

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23.8. Evaluating Group Membership

The IADsGroup::IsMember method takes one argument, the DN of the object to check, just as Add and Remove do. It returns a Boolean; i.e., true or false. That allows you to use it in an If ... Then statement like this:

```
Set objGroup = GetObject("LDAP://cn=Managers,ou=Sales," _
  & "dc=mycorp,dc=com")
If objGroup.IsMember("LDAP://cn=Vicky Launders,ou=Sales," _
  & "dc=mycorp,dc=com") Then
    WScript.Echo "Is a Member!"
Else
    WScript.Echo "Is NOT a Member!"
End If
```

To get a list of members in a group, the IADsGroup::Members method can be used. The IADsGroup::Members function is different from the other IADsGroup methods we have shown so far, since it returns a pointer to an IADsMembers object. Table 23-5 shows the two methods IADsMembers support.

Table 23-5. The IADsMembers interface

IADsMembers methods	Action
Count	The number of items in the container. If there is a filter set, only the number of items that match the filter are returned.
Filter	A filter, consisting of an array of object class strings, which can restrict the number of objects returned during enumeration of the container.

There are a number of ways of enumerating the members of a group. The For Each ... In ... Next loop is the most common. This is how it works:

```
Set objGroup = GetObject("LDAP://cn=Managers,ou=Sales," _
  & "dc=mycorp,dc=com")
WScript.Echo "Number of members of the group: " & objGroup.Members.Count
For Each objMember In objGroup.Members
  WScript.Echo objMember.Name
```

```
Next
```

This script displays the number of members and then prints each member's name. As the `For` loop executes, `objMember` ends up holding an IADs object representing each member of the group.

Another useful feature of `IADsMembers` is the `Filter` method. It can be used to filter certain object classes during enumeration just like you can with containers. To view only the members of a group that are users, you would modify the previous example to do the following:

```
objMembers = objGroup.Members
objMembers.Filter = Array("User")
For Each objMember In objMembers
  WScript.Echo objMember.Name
Next
```

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23.9. Summary

In this chapter, we looked at how to create and manipulate properties of user and group objects in Active Directory and the Windows NT SAM. We used this knowledge to show how to write a script to create thousands of users easily from a set of data in a file or from a database. We then showed how to create simple tools, such as an account unlocker, that you can use in your day-to-day management of Active Directory. Next we showed how to create groups and modify group members. Finally, we reviewed how to determine group membership and iterate through all the members of a group.

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Chapter 24. Basic Exchange Tasks

In this chapter, we will show you how to automate some of the basic Exchange settings, specifically concerning users (and by extension inetOrgPersons), groups, and contacts. Although tools to manage Exchange settings already exist (e.g., Active Directory Users and Computers), scripting allows you quickly handle mailbox-enabling or moving thousands of users based on whatever business logic you require. Simple scripts can take the place of Exchange migration or management utilities that you would possibly otherwise need to purchase.

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24.1. Notes on Managing Exchange

Managing Exchange is a little different from managing most other Microsoft applications. The computer where you run the tools or scripts must be a member of a domain in the forest where the Exchange organization resides; this is true whether you are using a script or the GUI. Also, Exchange doesn't allow you to select other organizations to manage. This can be troublesome for someone managing multiple Exchange organizations or a mobile worker who moves between sites or companies and likes to run her workstation in workgroup mode instead of being a member of any specific domain.

Permissions are very important and often misunderstood in Exchange. Permissions can be set up very simply or in a very complicated way; it is tough to find a middle ground. The simplest method is to give your Domain Admin access to your Exchange administrators. This is pretty standard in small companies where the Exchange administrators are doing all aspects of administration. But this practice is usually unacceptable in larger companies where separation of duties and more security is required. Please see the section on Exchange Delegation for more discussion and details on permissions.

Finally, it is preferable to run Exchange in Active Directory native mode (for Windows 2000) or at the Windows Server 2003 forest functional level, as running Exchange in an Active Directory mixed mode environment can be troublesome. If you must run in this mode, try to keep that time frame as short as possible and anticipate that things may not work exactly as expected during that time.

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24.2. Exchange Management Tools

Most of the scripts in this chapter require that the Exchange Management Tools from the Exchange media are loaded. Specifically, many will need the Collaboration Data Objects for Exchange Management (CDOEXM) installed and registered, and those are only installed with the Exchange Management Tools. Although it is possible to load and register the specific DLLs involved, Microsoft does not support that configuration. Additionally, Microsoft does not support loading Outlook and the Exchange Management Tools on the same machine, though they generally interact just fine.

> The primary issue that has been publicly reported when running Outlook and the Exchange Management Tools on the same machine is profile switching in Outlook when Exchange System Manager (ESM) is running. The solution is to simply close out Outlook and ESM, and then you can restart Outlook and choose the alternate profile. If you wish to relaunch ESM then, that will work fine as well.

For more details on the Microsoft guideline, see Microsoft Knowledge Base Article Q266418.

Installation of the tools for most Windows operating systems requires Internet Information Services (IIS), World Wide Web (WWW) service, Simple Mail Transport Protocol (SMTP) service, and the appropriate Admin Pack to be installed on the machine. Windows XP SP2 has eased this requirement to only needing IIS and the Windows Server 2003 Admin Pack. Once the tools are loaded, these requirements can be removed because they aren't actually used. You install the tools by running *<driveletter>:\setup\i386\setup.exe* on the Exchange media; replace *<driveletter>:* with the drive letter of the CD-ROM drive. Once the installation starts, follow the prompts to the component selection screen. Select Custom, then select Install next to Microsoft Exchange System Management Tools. Finally, click Next and complete the remainder of the prompts.

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24.3. Mail-Enabling Versus Mailbox-Enabling

Exchange has two primary mechanisms for hooking users into the mail system. The first mechanism is called mailbox-enabling and associates a mailbox in the Exchange organization to a user. This is the normal setting for users in most organizations that allows them to log into the Exchange system with Outlook, or Outlook Web Access (OWA), or other mail clients that can communicate through standard mail interfaces such as POP3 or IMAP.

The second mechanism is called mail-enabling; this connects one or more email addresses to the user that are external to the Exchange organization. This is used for someone who needs to log into the forest but does not want a mailbox in the Exchange organization. For example, Dr. Amy Gramzow of the Acme Consulting Company could be on a long-term assignment at MyCorp, Inc. and have any email sent to her DrAmy@MyCorp.com email address forwarded on to her AGramzow@AcmeConsulting.com mailbox so that she doesn't have to manage multiple mailboxes.

Mail-enabling is also used to make Exchange aware of contacts and groups. These objects can't be authenticated, so creating a mailbox for them doesn't make sense; they must be mail-enabled instead of mailbox-enabled. Contacts will almost always have an external email address associated with them; a group, on the other hand, will be used as a distribution list to forward messages onto multiple recipients, which could be internal to the organization or outside of it.

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24.4. Exchange Delegation

Exchange delegation is a delicate and complicated topic. It is discussed in this chapter with the scripts so that it is fresh in your mind and so you understand the level of permissions required to do the tasks that are illustrated.

Most of the Exchange permissions are granted through access control lists (ACLs) on objects in Active Directory. These permissions in Active Directory can be delegated in a very granular way. Exchange consolidates the permissions into three main layers of delegation called *roles*:

- Exchange View Only Administrator allows you to look at the Exchange System.
- Exchange Administrator allows you to fully administer Exchange Server computer information.
- Exchange Full Administrator allows you to fully administer Exchange.

Be aware that none of these Exchange Roles give you access rights on user objects themselves. You can be an Exchange Full Administrator and not be able to mailbox-enable a single user. For that, you need to determine what rights you want the Exchange Administrators to have on user objects and grant them separately.

Unfortunately, it is beyond the scope of this book to dig into all of the various ways to delegate rights to Active Directory objects. We will assume for the remainder of this chapter that any administrator who needs to make changes to a user or group, such as mail-enabling or mailbox-enabling a user, mail-enabling a distribution group, creating a contact, etc. is a member of the Account Operators group with the additional permissions outlined in the next paragraph delegated in Active Directory.

By default, Account Operators have permissions to manage user objects, inetOrgPerson objects, and group objects. They do not have permissions to manage contacts or query-based distribution lists. In order for an Account Operator to be able to fully manage mail-specific contents of Active Directory, you must grant permissions separately to create, delete, and manage contacts (i.e., objects with an objectClass of `contact`), and query-based distribution groups (i.e., objects with an objectClass of `msExchDynamicDistributionList`) have to be added separately. For details on Active Directory security and delegation, see Chapter 11.

In this security-aware world we now live in, it would be lax to not discuss delegation best practices. Security best practices dictate a separation of duties for different types of administrators. This is also known as the principle of least privileges. Exchange is definitely large enough to follow this type of model and has a couple of levels where these separations can most logically be made.

The first level involves the Help Desk or Call Center Exchange troubleshooters. These are people who you don't want making changes. You only want them to look at what is in place so they can properly escalate to the next level of support if the issue is truly an Exchange issue. These administrators will just need view-only access to Exchange and Active Directory; this would map to the Exchange View Only Admin Role.

The second level are the Exchange Data Administrators, administrators who are responsible for manipulating which users do and don't get mailboxes, as well as managing contacts and distribution lists. They will need to be able to manipulate users and other mail-enabled objects, but not manipulate the overall Exchange system configuration. This level is often automated and the functionality wrapped into some sort of provisioning system as the requests and responses should be standardized. This level of permission will need Exchange view access and various create/delete/change permissions on the user, contact, and group objects in the forest. This would map to the Exchange View Only Admin Role coupled with the specially delegated Account Operator permissions as specified earlier. The primary tool these administrators use will be the Active Directory Users and Computers (ADUC) snap-in.

> This functionality, placed in a custom web-based application with a proper authentication and authorization system, could be pushed to the Help Desk or even out to the business users so that business management can directly manage who can and can't have email access based on rules specified by Exchange Administrators.

Finally, you have Exchange Service Administrators; these are the main Exchange administrators who are actually managing the overall service. They need to be able to manipulate the servers and the system configuration but don't generally need to manipulate the mail objects, such as users , groups, and contacts. This level would map to Exchange Admin or Exchange Full Admin Roles. This level also requires local Administrator rights on the Exchange Servers. There could be times that these administrators will need additional permissions in Active Directory on User objects, most notably if they are moving mailboxes or reconnecting mailboxes. The primary tool these administrators will use will be the Exchange System Manager (ESM) snap-in.

Depending on the size of your company and the security concerns you have, you may have none of these divisions, a subset of these divisions, or possibly even more divisions.

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24.5. Mail-Enabling a User

You can easily mail-enable a user with very little code using ADSI and CDOEXM. The following code shows you how to mail-enable a single user specified by a known DN:

```
   ' This code mail enables a user.
   Option Explicit
   Dim strUserDN, strEmailAddr, objUser
   ' ------ SCRIPT CONFIGURATION ------
   strUserDN = "<UserDN>"   ' e.g. cn=DrAmy,cn=Users,dc=mycorp,dc=com
   strEmailAddr = "<EmailAddress>"  'e.g. Agramzow@AcmeConsulting.com
   ' ------ END CONFIGURATION ---------
   Set objUser = GetObject("LDAP://" & strUserDN)
   objUser.MailEnable
strEmailAddr
    objUser.Put "internetEncoding",1310720
   objUser.SetInfo( )
   WScript.Echo "Successfully mail-enabled user."
```

> Mail-enabling a user requires Exchange Data Administrator permissions.

This should all be familiar, with the exception of `MailEnable`. `MailEnable` is a method of the `IMailRecipient` CDOEXM interface. For a user, it takes a single argument: the email address to associate with the user. In the background, the specific changes made by the `MailEnable` method are on the `user` object in Active Directory and include changes to the following attributes:

- `targetAddress`
- `mailNickname`
- `mAPIRecipient`
- `legacyExchangeDN`

> You are probably looking at that list of attributes and thinking, "Hey, I can just populate those attributes with LDAP calls; I don't even need to use CDOEXM!" To be honest, that is almost true. It is only "almost" true for two reasons: first, depending on which knowledge base articles you read, you will find confusion on whether or not setting the LDAP attributes is supported by Microsoft or not. Second, you actually don't need to set all of those attributes; the minimum attributes needed are `mailNickname` and `targetAddress`.

In addition to those attributes, the `internetEncoding` attribute should also be set for proper message handling. This is the attribute that is updated if you go into the Advanced tab of the Internet Address Properties screen in ADUC. The default value for this attribute is 1310720, which tells Exchange to use the default settings of the Internet Mail Service. You can specify other values to force email to be converted to various formats. Table 24-1 contains the list of alternate values for the `internetEncoding` attribute.

Table 24-1. internetEncoding attribute values.

Value	Meaning
1310720	Use Internet Mail Service settings
917504	Allow plain text
1441792	Allow plain text or HTML
2228224	Allow plain text/uuencoding
131072	Allow plain text/uuencoding with BinHex

Once all of those attributes are in place, the Recipient Update Service (RUS) sets additional attributes on the user object to make it useable for Exchange.

> Everywhere the objectClass `user` is specified, `inetOrgPerson` can be inserted in its place; for all Exchange intents and purposes, these objects are interchangeable in Exchange.

Table 24-2 lists all methods and properties of the `IMailRecipient` interface.

Table 24-2. IMailRecipient properties and methods

Type	Name	Description
Property	Alias	Specifies alias for email address generation. Also known as `mailNickname`; does not apply to groups.

Type	Name	Description
	ForwardingStyle	Specifies whether email is also delivered to alternative email address.
	ForwardTo	Specifies the URL path to the recipient to which mail is forwarded.
	HideFromAddressBook	Specifies whether the recipient is displayed in the address book.
	IncomingLimit	Specifies the maximum size, in KB, of a message sent to this recipient.
	OutgoingLimit	Specifies the maximum size, in KB, of a message that this user can send.
	ProxyAddresses	List of proxy addresses for the recipient. See note about `proxyAddresses` below.
	RestrictedAddresses	Specifies whether messages from the addresses listed in RestrictedAddressList are to be accepted or rejected.
	RestrictedAddressList	Specifies a list of Microsoft Active Directory paths of senders to be accepted or rejected.
	SMTPEmail	Specifies primary SMTP address used for the recipient. Does not apply to groups.
	TargetAddress	Specifies the delivery address to which email for this recipient should be sent. This property is read-only.
Method	MailEnable	Enables a recipient to receive mail. Recipient can be a user, folder, contact, or group.
	MailDisable	Disables mail to a recipient.

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24.6. Mail-Disabling a User

Now that you have seen how to mail-enable a user, it is a good time to show a code sample illustrating mail-disabling a user:

```
' This code mail disables a user.
Option Explicit
Dim strUserDN, objUser
' ------ SCRIPT CONFIGURATION ------
strUserDN = "<UserDN>"    ' e.g. cn=DrAmy,cn=Users,dc=mycorp,dc=com
' ------ END CONFIGURATION ---------
Set objUser = GetObject("LDAP://" & strUserDN)
objUser.MailDisable
objUser.SetInfo(  )
WScript.Echo "Successfully mail-disabled user."
```

Mail-disabling a user requires Exchange Data Administrator permissions.

Once again, this is a very simple script with one new method, the MailDisable method. This method is aptly named in that it mail-disables a user, and that is all it does. Unfortunately, you cannot use this method to mailbox-disable a user. So when you call this method, you should be sure that the user is mail-enabled versus mailbox-enabled. If you use this method on a mailbox-enabled user, you will get an error such as "E-mail addresses cannot be removed from this user because it has a mailbox." The quick way to ascertain whether a user has a mailbox versus being simply mail-enabled is to check for the existence of the homeMDB attribute. If a user object has homeMDB populated, there is an associated mailbox for that account.

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24.7. Creating and Mail-Enabling a Contact

A `contact` in Exchange 2000 or above is similar to a custom recipient in Exchange 5.5. Contacts can be created in Active Directory like a `user` is created, and mail-enabling a `contact` is identical to mail-enabling a `user`. Because the users and groups chapter didn't discuss creating a `contact`, it will be wrapped up into the script here. You can obviously chop the following script down to just mail-enabling of an existing `contact` or by using the script shown in the previous section and substituting in the `contact` DN for the `user` DN:

```
' This code creates and then mail-enables a contact.
Option Explicit
Dim strOU, strContactCN, strEmailAddr, strDisplayName,
Dim objOU, objContact
' ------ SCRIPT CONFIGURATION ------
strOU = "<OU>" ' e.g. ou=Contacts,dc=mycorp,dc=com
strContactCN = "<ContactCN>" ' e.g. cn=DrAmy
strEmailAddr = "<EmailAddress>" 'e.g. Agramzow@AcmeConsulting.com
strDisplayName = "<Display Name>" 'e.g. Dr. Amy Gramzow
' ------ END CONFIGURATION ---------
' Create Contact
Set objOU = GetObject("LDAP://" & strOU)
Set objContact = objOU.Create("contact",strContactCN)
objContact.Put "displayName",strDisplayName
objContact.SetInfo
WScript.Echo "Successfully created contact."
' Mail-Enable Contact
objContact.MailEnable strEmailAddr
 objContact.Put "internetEncoding",1310720
objContact.SetInfo(  )
WScript.Echo "Successfully mail-enabled contact."
```

> Mail-enabling a contact requires Exchange Data Administrator permissions.

Creating a contact is very simple; there are no mandatory attributes, though a Display Name (`displayName`) is usually set so that the `cn` isn't used for display in the Global Address List (GAL) when the contact is mail-enabled. You will note that the mail-enable process is exactly the same as how it is done for user objects; simply specify the external email address as the parameter to the `MailEnable` method.

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24.8. Mail-Disabling a Contact

Mail-disabling a contact is exactly like mail-disabling a user:

```
' This code mail disables a contact.
Option Explicit
Dim strContactDN, objContact
' ------ SCRIPT CONFIGURATION ------
strContactDN = "<ContactDN>"    ' e.g. cn=DrAmy,ou=Contacts,dc=mycorp,dc=com
' ------ END CONFIGURATION ---------
set objContact = GetObject("LDAP://" & strContactDN)
objContact.MailDisable
objContact.SetInfo(  )
WScript.Echo "Successfully mail-disabled contact."
```

Mail-disabling a contact requires Exchange Data Administrator permissions.

Previously it was mentioned that you needed to know if the user was mail-enabled or mailbox-enabled. This is not the case with contacts because they cannot be mailbox-enabled; you can always use the `MailDisable` method for Exchange contacts.

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24.9. Mail-Enabling a Group (Distribution List)

A mail-enabled group is a group that is used as an Exchange Distribution List. You send email to the group's email address, and all users and contacts in the group that are known to Exchange (either mail- or mailbox-enabled) will receive a copy of the message:

```
' This code mail enables a group.
Option Explicit
Dim strGroupDN, objGroup
' ------ SCRIPT CONFIGURATION ------
strGroupDN = "<GroupDN>"    ' e.g. cn=MyDL,ou=Groups,dc=mycorp,dc=com
' ------ END CONFIGURATION ---------
Set objGroup = GetObject("LDAP://" & strGroupDN)
objGroup.MailEnable
objGroup.SetInfo(  )
WScript.Echo "Successfully mail-enabled group."
```

> Mail-enabling a group requires Exchange Data Administrator permissions.

You probably noticed that the email address wasn't specified when the MailEnable method was called. The email address is automatically created based on the sAMAccountName of the group. Unfortunately, CDOEXM does not allow you to specify the address for the group. It is possible to modify the email address programmatically, but you will need to modify the multi-valued attribute called proxyAddresses directly. This attribute controls the addresses available for a given mail object within the Exchange system.

The proxyAddresses attribute is a collection of addresses for a given mail object. Each value is of the form prefix:addresse.g., SMTP:DrAmy@MyCorp.com. The two prefixes you will always find are smtp and x400, which specify addresses for those mandatory protocols.

The prefix can be in all capital letters or all lowercase; if capitalized, it means that the address is the primary address for that protocol. For example, a prefix with an uppercase SMTP: means the address is the primary SMTP address. A prefix with a lowercase smtp: means the address is a secondary address. You must always have one and only one primary address per protocol. You can, however, add multiple secondary addresses.

One final note on proxyAddresses: the attribute values *MUST* be unique across the entire forest. Exchange queries for proxy addresses on a regular basis throughout the day and duplicates can cause considerable confusion and several additional queries to resolve the confusion. The GUI tools will look for duplicates, but if you change these values programmatically, it is up to you to verify that the values are unique.

Group scope for Distribution Lists is important. If you have a single domain forest deployment, you are free to use any group scope you wish: Domain Local, Global, or Universal. If you have a multi-domain forest, you should stick to Universal groups . All group expansion is handled by querying global catalogs, and Universal groups are the only groups that are guaranteed to have their membership present on all global catalogs in a forest. Universal Group Caching does not help with this, as group expansion requires actual queries to a global catalog.

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24.10. Mail-Disabling a Group

Mail-disabling a group is exactly like mail-disabling a contact:

```
' This code mail disables a group.
Option Explicit
Dim strGroupDN, objGroup
' ------ SCRIPT CONFIGURATION ------
strGroupDN = "<GroupDN>"    ' e.g. cn=MyDL,ou=Groups,dc=mycorp,dc=com
' ------ END CONFIGURATION ---------
Set objGroup = GetObject("LDAP://" & strGroupDN)
objGroup.MailDisable
objGroup.SetInfo(  )
WScript.Echo "Successfully mail-disabled group."
```

Mail-disabling a group requires Exchange Data Administrator permissions.

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24.11. Mailbox-Enabling a User

You can easily mailbox-enable a user with very little code using ADSI and CDOEXM. The following code shows you how to mailbox-enable a single user specified by a known DN:

```
' This code creates a mailbox for a user.
Option Explicit
Dim strUserDN, strEmailAddr, objUser
' ------ SCRIPT CONFIGURATION ------
strUserDN = "<UserDN>"   ' e.g. cn=DrAmy,cn=Users,dc=mycorp,dc=com
strHomeMDB = "<Home MDB DN>"
' e.g. CN=Mailbox Store (SERVER),CN=First Storage Group,CN=InformationStore,
' CN=SERVER,CN=Servers,CN=First Administrative Group,CN=Administrative Groups,
'      CN=MYCORP,CN=Microsoft Exchange,CN=Services,
'      CN=Configuration,DC=mycorp,DC=com"
' ------ END CONFIGURATION ---------
Set objUser = GetObject("LDAP://" & strUserDN)
objUser.CreateMailBox strHomeMDB
objUser.SetInfo(  )
WScript.Echo "Successfully mailbox-enabled user."
```

Mailbox-enabling a user requires Exchange Data Administrator permissions.

That should all be familiar with the exception of `CreateMailBox`. `CreateMailBox` is a method of the `IMailBoxStore` CDOEXM interface. This method takes a single argument, the LDAP URL of the mail store object, to create the mailbox in. In the background, the specific changes made by the `CreateMailBox` method are on the `user` object in Active Directory and include changes to the following attributes:

- `mDBUseDefaults`
- `msExchUserAccountControl`
- `homeMTA`
- `msExchHomeServerName`
- `homeMDB`

- mailNickname
- msExchMailboxGuid
- msExchMailboxSecurityDescriptor
- legacyExchangeDN

Once all of those attributes are in place, the Recipient Update Service (RUS) sets additional attributes on the user object. The mailbox cannot be used nor receive email until the RUS has gone through this stamping process.

> As with mail-enabling a user, mailbox-enabling a user can be accomplished with just setting a few LDAP attributes. Also as before, depending on what knowledge base articles you read, you will find confusion on whether or not setting the LDAP attributes is supported or not by Microsoft. You actually don't need to set all of those attributes; the minimum attributes needed are mailNickname and either homeMDB, homeMTA, or msExchHomeServerName.

Table 24-3 lists all methods and properties of the IMailBoxStore interface.

Table 24-3. IMailBoxStore properties and methods

Type	Name	Description
Property	DaysBeforeGarbageCollection	Specifies the number of days deleted mail is retained before it is permanently deleted.
	Delegates	Specifies the list of URLs of all users that can send email on behalf of the user.
	EnableStoreDefaults	Specifies whether to use default limits for mailbox store limits (quotas).
	GarbageCollectionOnlyAfterBackup	Specifies whether deleted messages can only be permanently deleted after the mailbox has been backed up.
	HardLimit	Specifies the maximum mailbox size, in KB, over which sending and receiving mail is disabled.
	HomeMDB	Specifies the URL of the mailbox store of the recipient. This property is read only.
	OverQuotaLimit	Specifies a size limit, in KB, of a mailbox. If this limit is exceeded, sending mail is disabled.
	OverrideStoreGarbageCollection	Indicates whether this mailbox should use the garbage collection properties set on the mailbox or the properties set on the database.

Type	Name	Description
	RecipientLimit	Specifies the maximum number of people to whom the recipient can send mail.
	StoreQuota	Specifies the maximum size, in KB, allowed for the mailbox.
Method	CreateMailBox	Creates a mailbox.
	DeleteMailBox	Deletes a mailbox.
	MoveMailBox	Moves a mailbox.

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24.12. Mailbox-Disabling a User (Mailbox Deletion)

Now that you have seen how to mailbox-enable a user, it seems a good time to show a code sample illustrating this concept:

```
' This code removes a user's mailbox.
Option Explicit
Dim strUserDN, objUser
' ------ SCRIPT CONFIGURATION ------
strUserDN = "<UserDN>"   ' e.g. cn=DrAmy,cn=Users,dc=mycorp,dc=com
' ------ END CONFIGURATION ---------
Set objUser = GetObject("LDAP://" & strUserDN)
objUser.DeleteMailBox

objUser.SetInfo(  )
WScript.Echo "Successfully deleted user's mailbox."
```

> Mailbox-disabling a user requires Exchange Data Administrator permissions.

Once again, this is a very simple script with one new method, the DeleteMailBox method. Unfortunately, you cannot use this method to mail-disable a user. So when you call this method, you should be sure that the user is mailbox-enabled versus mail-enabled. If you use this method on a mail-enabled user, you will get an error such as "This user does not have a mailbox." The quick way to ascertain whether a user has a mailbox or is simply mail-enabled is to check for the existence of the homeMDB attribute. If a user object has homeMDB populated, there is an associated mailbox for that account.

The DeleteMailBox method is actually not well named because it doesn't really delete the mailbox. In actuality, it disconnects the mailbox from the user. The mailbox, by default, will still exist in the exchange store for 30 days and can be reconnected to the same or any other user object that doesn't have a mailbox associated with it. To actually delete the mailbox, you need to purge the mailbox.

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24.13. Purging a Disconnected Mailbox

In order to truly delete a mailbox out of the store, you must purge the mailbox. The following code shows how to purge a mailbox:

```
' This code purges a deleted mailbox.
Option Explicit
Dim strComputer, strMailbox, objWMI, objDiscMbx, objMbx
' ------ SCRIPT CONFIGURATION ------
strComputer = "<Exchange Server>" 'e.g. ExchServer2
strMailbox = "<Mailbox Alias>"    'e.g. DrAmy
' ------ END CONFIGURATION ---------

set objWMI = GetObject("winmgmts:\\" & strComputer & _
                        "\root\MicrosoftExchangeV2")
set objDiscMbx = objWMI.ExecQuery("Select * from Exchange_Mailbox WHERE " _
                               & "MailboxDisplayName='" & strMailbox & "'",,48)
for each objMbx in objDiscMbx
  objMbx.Purge
next
Wscript.Echo "Successfully purged mailbox."
```

Purging a mailbox requires Exchange Service Administrator permissions.

This script doesn't need CDOEXM; it actually does what it needs to do through Windows Management Instrumentation (WMI). Chapter 29 is entirely devoted to WMI, so the documentation here will be sparse. Suffice to say, this script executes a query against the Exchange server using the WMI `Exchange_Mailbox` class, which is available in Exchange 2003 only, and asks for all mailboxes with the specified name. It then loops through the returned mailboxes and executes the `Purge` method against each which effectively removes it from the store. After a purge, the mailbox can only be recovered by restoring from a backup. If there have been multiple mailboxes disconnected from the given user in the last 30 days, there will be multiple mailboxes to purge.

If you want to narrow down which specific mailboxes are being returned by the query, there are other attributes you can query against, such as DateDiscoveredAbsentInDS or LastLogonTime properties. See the Exchange_Mailbox class documentation in MSDN at the following URL:

http://msdn.microsoft.com/library/default.asp?url=/library/en-us/e2k3/e2k3/_wmiref_cl_Exchange_Mailbox.asp

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24.14. Reconnecting a Disconnected Mailbox

After a mailbox has been disconnected, and prior to it being purged or exceeding its retention period, it can be reconnected to a user object that doesn't currently have a mailbox associated with it. The following code shows how to reconnect a mailbox:

```
' This code reconnects a mailbox to a user.
Option Explicit
Dim strComputer, strUser, strMailbox, objWMI, objDiscMbx, objMbx
strComputer = "<Exchange Server>" ' e.g. ExchServer2
' ------ SCRIPT CONFIGURATION ------
strUser = "<Userid>"              ' e.g. DrAmy
strMailbox = "<Mailbox Alias>"    ' e.g. DrAmy
' ------ END CONFIGURATION ---------

Set objWMI = GetObject("winmgmts:\\" & strComputer & _
                        "\root\MicrosoftExchangeV2")
Set objDiscMbx = objWMI.ExecQuery("Select * from Exchange_Mailbox WHERE " _
                            & "MailboxDisplayName='" & strMailbox & "'",,48)
For Each objMbx In objDiscMbx
  objMbx.Reconnect strUser
Next
WScript.Echo "Successfully reconnected mailbox."
```

> Reconnecting a mailbox requires Exchange Service Administrator permissions, plus additional permissions on user objects. See the section "Exchange Delegation."

This script is like the purge mailbox script and doesn't need CDOEXM; it also does what it needs to do through Windows Management Instrumentation (WMI). This script executes a query against the Exchange server using the WMI `Exchange_Mailbox` class (which is available in Exchange 2003) and asks for all mailboxes with the specified name. It then loops through the returned mailboxes and executes the `Reconnect` method against the mailbox returned. Unfortunately, there are some rather serious flaws with the implementation of the `Reconnect` method, which severely limits its usability in some environments.

The first flaw is that the WMI `Reconnect` method must be run directly on the Exchange Server with the disconnected mailbox so that the script must run on the Exchange server. You can't, for instance, have a script that runs from a workstation that will reconnect mailboxes on any of your Exchange servers.

The second flaw is that you cannot specify the domain of the user you want to reconnect to the mailbox. In a single domain Exchange environment, this will be fine. Trying to reconnect a mailbox in a forest with the same user name in multiple domains could give unexpected results.

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24.15. Moving a Mailbox

There are times when you want to move mailboxes from one Exchange server to another. The reason for the move may be for a migration from an older Exchange server to a new one (e.g., Exchange 5.5 to Exchange 2003), to better load balance mailboxes between Exchange Servers, or any number of other reasons. This is a very simple task to handle through a CDOEXM script. The following code shows how to move a mailbox:

```
' This code moves a mailbox.
Option Explicit
Dim strUserDN, strServer, strSGName, strMailStoreName, strSearch
Dim objSrv, strSg, strSGUrl, strMBUrl, objUser
' ------ SCRIPT CONFIGURATION ------
strUserDN  = "<UserDN>" ' e.g. cn=DrAmy,cn=Users,dc=mycorp,dc=com
strServer  = "<Exchange Server>"          ' e.g. ExchServer2
strSGName  = "<Storage Group Name>"       ' e.g. SG1
strMailStoreName = "<MailBox Store Name>" ' e.g. DB1
' ------ END CONFIGURATION ---------
' Find Storage Group URL and Generate Mailbox Store URL
strSearch = "cn=" & strSGName  & ","
Set objSrv = CreateObject("CDOEXM.ExchangeServer")
objSrv.DataSource.Open strServer
For Each strSg In objSrv.StorageGroups
    If (instr(1,strSg,strSearch,1)>0) Then
      strSGUrl = strSg
      Exit For
   End If
Next
strMBUrl = "LDAP://cn=" & strMailStoreName & "," & strSGUrl

' Attach to user and move mailbox
Set objUser = GetObject("LDAP://" & strUserDN)
objUser.MoveMailbox(strMBUrl)
WScript.Echo "Successfully moved mailbox."
```

> Moving a mailbox requires Exchange Service Administrator permissions, plus additional permissions on user objects. See the section "Exchange Delegation."

The main work of moving a mailbox is handled by the `MoveMailBox` method of the `IMailBoxStore` interface. The trickiest aspect is getting the argument you need to specify for the move, which is the Home MDB URL for the database you want to move the user to. Previously in the MailBox-Enable script, the absolute path of the Home MDB object was specified. The method used here allows you to specify three well-known components (server, storage group, store name), which can be used to determine the proper value.

A mailbox move is an odd operation in terms of permissions. Logically, moving a mailbox is basically a combination of create and delete operations, which is something an Exchange Data Administrator can do just fine. However, to actually move a mailbox, you must have Exchange Administrator Role permissions, with a subset of the permissions that Exchange Data Administrator permissions have on user objects. See Microsoft Knowledge Base Article 842033 for details of the permissions needed.

If you don't handle user mailbox administration through an automated web site, it is recommended that you delegate permissions to the attributes listed in the knowledge base articles to some Active Directory group. Once delegated, add the Exchange Administrator Role users to that group and have them handle all mailbox moves.

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24.16. Enumerating Disconnected Mailboxes

If you want to know which disconnected mailboxes exist on an Exchange server, you can simply enumerate them. The following code shows how to enumerate disconnected mailboxes:

```
' This code enumerates disconnected mailboxes.
Option Explicit
Dim strComputer, objWMI, objDiscMbx, objMbx
' ------ SCRIPT CONFIGURATION ------
strComputer = "<Exchange Server>" 'e.g. ExchServer2
' ------ END CONFIGURATION ---------

Set objWMI = GetObject("winmgmts:\\" & strComputer & _
                        "\root\MicrosoftExchangeV2")

 Set objDiscMbx = objWMI.ExecQuery("Select * from Exchange_Mailbox",,48)
For Each objMbx In objDiscMbx
  If (objMbx.DateDiscoveredAbsentInDS <> "") then
     WScript.Echo objMbx.MailBoxDisplayName & " " & _
                  objMbx.DateDiscoveredAbsentInDS
  End If
Next
WScript.Echo "Successfully enumerated disconnected mailboxes."
```

> Although viewing mailbox details in the Exchange System Manager (ESM) requires only Exchange View Admin role access, in order to do this with a script, the WMI provider also requires local administrator permissions on the Exchange server.

Just like the Purge Mailbox and Reconnect Mailbox scripts, this script uses the WMI `Exchange_Mailbox` class to gather the requested information.

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24.17. Viewing Mailbox Sizes and Message Counts

A common task is to look at an Exchange server and determine the sizes and counts of messages on the server for all mailboxes. The following code shows how simple this is to do:

```
' This code enumerates mailbox sizes and message counts.
Option Explicit
Dim strComputer, objWMI, objMbxs, objMbx
' ------ SCRIPT CONFIGURATION ------
strComputer = "<Exchange Server>" 'e.g. ExchServer2
' ------ END CONFIGURATION ---------

Set objWMI = GetObject("winmgmts:\\" & strComputer & _
                        "\root\MicrosoftExchangeV2")
 Set objMbxs = objWMI.ExecQuery("Select * from Exchange_Mailbox",,48)
For Each objMbx In objMbxs
  WScript.Echo objMbx.MailBoxDisplayName & " " & objMbx.size & "KB  " _
               & objMbx.TotalItems & " items"
Next
WScript.Echo "Script completed successfully."
```

This script is very similar to the script to enumerate disconnected mailboxes. The same basic process is used; we have simply changed the initial query to select the record set to enumerate through. There are actually several properties that can be displayed this way. Table 24-4 lists the properties and their descriptions.

Table 24-4. Exchange_Mailbox properties

Property	Description
LegacyDN	legacyDN of the mailbox. This matches the legacyExchangeDN attribute of the user object in Active Directory.
MailboxGUID	Indicates the globally unique identifier (GUID) that links the mailbox to a user in Active Directory. This value is also populated in the user's Active Directory object as msExchMailboxGuid.
ServerName	Name of the server the mailbox resides on.
StorageGroupName	Indicates the name of the storage group that contains the mailbox.

Property	Description
StoreName	Indicates the name of the message database (MDB) that contains the mailbox.
AssocContentCount	Indicates the total number of messages associated with the mailbox folders.
DateDiscoveredAbsentInDS	Indicates when the store detected that the mailbox no longer had a corresponding user entry in Active Directory; i.e., when the mailbox was disconnected.
DeletedMessageSizeExtended	Indicates the cumulative size of all deleted messages that are still being retained according to retention policy settings.
LastLoggedOnUserAccount	Indicates the account name last used to log onto the mailbox. Note that this doesn't necessarily mean an interactive logon to the mailbox messages; this could be from someone viewing a calendar entry or other innocuous access.
LastLogoffTime	Indicates the time that the last user logged off. See note for LastLoggedOnUserAccount.
LastLogonTime	Indicates the time that the last user logged on. See note for LastLoggedOnUserAccount.
Size	Indicates cumulative size of all of the messages in the mailbox in bytes.
StorageLimitInfo	Contains the storage limit settings on the mailbox.
TotalItems	Indicates the total number of messages in a mailbox.

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24.18. Viewing All Store Details of All Mailboxes on a Server

The following code takes all of the properties from Table 24-2 and displays them for all mailboxes on a specified server:

```
' This code enumerates all store details about all mailboxes
' on a single specified server
Option Explicit
Dim strComputer, objWMI, objMbxs, objMbx
' ------ SCRIPT CONFIGURATION ------
strComputer = "<Exchange Server>" 'e.g. ExchServer2
' ------ END CONFIGURATION ---------
Set objWMI = GetObject("winmgmts:\\" & strComputer & _
                        "\root\MicrosoftExchangeV2")
Set objMbxs = objWMI.ExecQuery("Select * from Exchange_Mailbox",,48)
For Each objMbx In objMbxs
  WScript.Echo "LegacyDN: " _
                      & objMbx.LegacyDN
  WScript.Echo "MailBoxGUID: " _
                      & objMbx.MailboxGUID
  WScript.Echo "ServerName: " _
                      & objMbx.ServerName
  WScript.Echo "StorageGroupName: " _
                      & objMbx.StorageGroupName
  WScript.Echo "StoreName: " _
                      & objMbx.StoreName
  WScript.Echo "AssocContentCount: " _
                      & objMbx.AssocContentCount
  WScript.Echo "DateDiscoveredAbsentInDS: " _
                      & objMbx.DateDiscoveredAbsentInDS
  WScript.Echo "DeletedMessageSizeExtended: " _
                      & objMbx.DeletedMessageSizeExtended
  WScript.Echo "LastLoggedOnUserAccount: " _
                      & objMbx.LastLoggedOnUserAccount
  WScript.Echo "LastLogoffTime: " _
                      & objMbx.LastLogoffTime
  WScript.Echo "LastLogonTime: " _
                      & objMbx.LastLogonTime
  WScript.Echo "Size: " _
                      & objMbx.Size
  WScript.Echo "StorageLimitInfo: " _
                      & objMbx.StorageLimitInfo
  WScript.Echo "TotalItems: " _
                      & objMbx.TotalItems
  WScript.Echo ""
  WScript.Echo ""
Next
WScript.Echo "Script completed successfully."
```

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24.19. Dumping All Store Details of All Mailboxes on All Servers in Exchange Org

The following code takes the preceding script and extends it by extracting all information from all Exchange servers and dumping it to a text file in semi-colon delimited format:

```
'This script dumps all store details of all mailboxes in an
'Exchange ORG to a text file in semi-colon delimited format
Option Explicit
Dim objConn, objComm, objRS
Dim strBase, strFilter, strAttrs, strScope
Dim fso, outfile
Dim strComputer, objWMI, objMbx, objMbxs
' ------ SCRIPT CONFIGURATION ------
strConfigDN = "<Exchange Server>" 'e.g. cn=configuration,dc=mycorp,dc=com
' ------ END CONFIGURATION ---------
'*********************************************************************
'Set the ADO search criteria
'*********************************************************************
strBase   = "<LDAP:// " & strConfigDN & ">;"
strFilter = "(objectcategory=msExchExchangeServer);"
strAttrs  = "name;"
strScope  = "Subtree"
set objConn = CreateObject("ADODB.Connection")
objConn.Provider = "ADsDSOObject"
objConn.Open
'*********************************************************************
'Need to enable Paging in case there are more than 1000 objects returned
'*********************************************************************
Set objComm = CreateObject("ADODB.Command")
Set objComm.ActiveConnection = objConn
objComm.CommandText = strBase & strFilter & strAttrs & strScope
objComm.Properties("Page Size") = 1000
Set objRS = objComm.Execute(  )
'*********************************************************************
'Create a VBScript file object and use it to open a text file. The
'second parameter specifies to overwrite any existing file that exists.
'*********************************************************************
Set fso = CreateObject("Scripting.FileSystemObject")
Set outfile = fso.CreateTextFile("c:\out.txt", TRUE)
'*********************************************************************
'Write header line to file
'*********************************************************************
outfile.WriteLine "LegacyDN;" _
```

```
                  & "MailBoxGUID;" _
                  & "ServerName;" _
                  & "StorageGroupName;" _
                  & "StoreName;" _
                  & "AssocContentCount;" _
                  & "DateDiscoveredAbsentInDS;" _
                  & "DeletedMessageSizeExtended;" _
                  & "LastLoggedOnUserAccount;" _
                  & "LastLogoffTime;" _
                  & "LastLogonTime;" _
                  & "Size;" _
                  & "StorageLimitInfo;" _
                  & "TotalItems"
'***********************************************************************
'Loop through all servers and dump all store info for all mailboxes
'***********************************************************************
While Not objRS.EOF
  strComputer = objRS.Fields.Item("name").Value
  Set objWMI = GetObject("winmgmts:\\" & strComputer & _
                        "\root\MicrosoftExchangeV2")
   Set objMbxs = objWMI.ExecQuery("Select * from Exchange_Mailbox",,48)
  For Each objMbx In objMbxs
    outfile.Write objMbx.LegacyDN
    outfile.Write ";" & objMbx.MailboxGUID
    outfile.Write ";" & objMbx.ServerName
    outfile.Write ";" & objMbx.StorageGroupName
    outfile.Write ";" & objMbx.StoreName
    outfile.Write ";" & objMbx.AssocContentCount
    outfile.Write ";" & objMbx.DateDiscoveredAbsentInDS
    outfile.Write ";" & objMbx.DeletedMessageSizeExtended
    outfile.Write ";" & objMbx.LastLoggedOnUserAccount
    outfile.Write ";" & objMbx.LastLogoffTime
    outfile.Write ";" & objMbx.LastLogonTime
    outfile.Write ";" & objMbx.Size
    outfile.Write ";" & objMbx.StorageLimitInfo
    outfile.WriteLine ";" & objMbx.TotalItems
  Next
  objRS.MoveNext
Wend
outfile.Close
```

While viewing mailbox details in the Exchange System Manager (ESM) only requires Exchange View Admin role access, in order to do this with a script, the WMI provider also requires local administrator permissions on the Exchange server.

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24.20. Summary

In this chapter, we had a basic discussion of some basic concepts of Exchange, such as mail- and mailbox-enabling Active Directory objects and delegation of Exchange permissions. Next, we looked at the mechanisms available to manipulate various Exchange properties of user, contact, and group objects in Active Directory via script interfaces. Then we used these mechanisms to mail- and mailbox-enable various objects, as well as several other admin tasks commonly handled through the Active Directory Users and Computers and Exchange System Manager Tools. Finally, we presented a script to gather all information available from the mailbox store through the `IMailBoxStore` interface for all mailboxes on all Exchange servers and dumped that information to a file in a semi-colon delimited format. This script illustrated how you can take simple concepts and build them up to generate a great deal of useful information about your environment. That simple dump could be used to analyze mailbox use in your organization or be used to track mailbox growth and trending information.

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Chapter 25. Shares and Print Queues

ADSI can be used for much more than just user, group, or generic directory manipulation. ADSI provides many interfaces that you can use to manipulate persistent and dynamic objects for a computer. Persistent objects are permanent parts of a directory or computer, such as shares, services, users, and groups. Dynamic objects aren't permanent but instead are things such as sessions (i.e., connections to a machine) and print jobs that a user initiates. In other words, ADSI lets you do the following:

- Dynamically start, stop, and manage services and manipulate the permanent attributes of those services
- Dynamically manipulate shares, creating and deleting them as required
- Dynamically manipulate computers' open resources and users' active sessions and manipulate the permanent objects representing those computers and users
- Dynamically manipulate print jobs and manipulate the permanent queues

Many of you may already be familiar with the Windows Management Instrumentation (WMI) interface, which overlaps with several of these functions. Depending on your preference, you can use ADSI or WMI for many of these tasks. We describe WMI in more detail in Chapter 26.

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25.1. The Interface Methods and Properties

Rather than describe the various methods and properties as we've done with the earlier interfaces, we'll concentrate on how to use those methods and properties in scripts. You can find complete descriptions of the interface methods and properties we cover in the MSDN Library or Platform SDK. To access the descriptions on the MSDN web site, see http://msdn.microsoft.com/library/default.asp?url=/library/en-us/adsi/adsi/adsi_interfaces.asp. From this point, some of the interfaces you can navigate to include the following:

Core interfaces

- `IADs`
- `IADsContainer`
- `IADsNamespaces`
- `IADsOpenDSObject`

Persistent object interfaces

- `IADsCollection`
- `IADsFileShare`
- `IADsService`
- `IADsPrintJob`
- `IADsPrintQueue`

Dynamic object interfaces

- `IADsServiceOperations`
- `IADsComputerOperations`
- `IADsFileServiceOperations`
- `IADsResource`
- `IADsSession`
- `IADsPrintJobOperations`
- `IADsPrintQueueOperations`

Utility interfaces

- IADsADSystemInfo
- IADsDeleteOps
- IADsNameTranslate
- IADsObjectOptions
- IADsPathname
- IADsWinNTSystemInfo

> The ADSI documentation, however, leaves out three important quirks of the IADsSession and IADsResource interfaces. First, the WinNT provider doesn't currently support the IADsSession::UserPath, IADsSession::Com-puterPath, and IADsResource::UserPath property methods. Second, although the documentation states that the IADsSession::ConnectTime and IADsSession::IdleTime property methods return results in minutes, they actually return results in seconds. Finally, the IADsSession::Compu-ter property method returns NetBIOS names for Windows NT and Windows 9x clients, but returns TCP/IP addresses for Windows 2000 and later clients.

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25.2. Creating and Manipulating Shares with ADSI

The following code shows how easily you can create shares with ADSI:

```
    Dim objComputer, objFileShare

    Set objComputer = GetObject("WinNT://mycomputer/LanmanServer
")

    Set objFileShare = objComputer.Create("FileShare", "MyNewShare")
    objFileShare.Path = "c:\mydirectory"
    objFileShare.Description = "My new Share"
    objFileShare.MaxUserCount = 8
    objFileShare.SetInfo
```

After we declare the `objComputer` and `objFileShare` variables, we bind to the `LanmanServer` object on the computer on which we want to create the shares. `LanmanServer` is the object name of the server service that runs on all Windows NT and later computers. We bind to this object because NT's predecessor was LAN Manager and is still present to a large extent in the Windows OS.

Next, we use the `IADsContainer::Create` method to create an object of class `FileShare` with the name *MyNewShare* and apply the `IADsFileShare` property methods to set the path, description, and maximum number of users. On an NT, Windows 2000, or Windows Server 2003 server, you can grant all users access to a share or limit access to as many users as you want. On a workstation, you can grant all users access to a share or limit access to between 1 and 10 users at a time. The latter restriction is due to the 10-connection limit that the OS imposes. The values that the `IADsFileShare::MaxUserCount` method accepts are -1 (which grants all users access), any numerical value between 1 and 10 on workstations, and, within reason, any numerical value on the server family of OSes.

Finally, we end the script with `IADs::SetInfo`, which writes the information from the property cache to the directory.

Enumerating existing shares is just as easy as creating them. The next piece of code shows how to enumerate normal shares:[*]

```
    Dim objService, objFileShare, strOutput

    strOutput = ""

    Set objService = GetObject("WinNT://workgroup/vicky/LanmanServer")
```

[*] Hidden shares aren't shown due to their very nature.

```
For Each objFileShare In objService
  strOutput = strOutput & "Name of share : " & objFileShare.Name & vbCrLf
  strOutput = strOutput & "Path to share : " & objFileShare.Path & vbCrLf
  strOutput = strOutput & "Description : " & objFileShare.Description & vbCrLf

  If objFileShare.MaxUserCount = -1 Then
    strOutput = strOutput & "Max users : No limit" & vbCrLf
  Else
    strOutput = strOutput & "Max users : " & objFileShare.MaxUserCount & vbCrLf
  End If

  strOutput = strOutput & "Host Computer : " _
    & objFileShare.HostComputer & vbCrLf & vbCrLf
Next

WScript.Echo strOutput
```

This code is similar to that in the previous script for creating a share. This is a sample of the output:

```
Name of share : NETLOGON
 Path to share : C:\WINNT35\system32\Repl\Import\Scripts
Description   : Logon server share
Max users     : No limit
Host Computer : WinNT://WORKGROUP/VICKY

Name of share : Add-ins
Path to share : C:\exchsrvr\ADD-INS
Description   : "Access to EDK objects"
Max users     : No limit
Host Computer : WinNT://WORKGROUP/VICKY

Name of share : Logs
Path to share : C:\exchsrvr\tracking.log
Description   : "Exchange message tracking logs"
Max users     : No limit
Host Computer : WinNT://WORKGROUP/VICKY

Name of share : Resources
Path to share : C:\exchsrvr\RES
Description   : "Event logging files"
Max users     : No limit
Host Computer : WinNT://WORKGROUP/VICKY

Name of share : Drivers
 Path to share : C:\WINNT\system32\spool\drivers
Description   : Printer Drivers
Max users     : No limit
Host Computer : WinNT://WORKGROUP/VICKY
```

```
Name of share : Clients
Path to share : C:\clients
Description   : Network Client Distribution Share
Max users     : No limit
Host Computer : WinNT://WORKGROUP/VICKY
```

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25.3. Enumerating Sessions and Resources

We now want to show you how to use ADSI to do the following:

- Enumerate a client's sessions and resources
- Show which users are currently logged on to a server and count all the logged-on users across a domain's PDCs, BDCs, and other servers

Windows NT, Windows 2000, and Windows Server 2003 machines host two kinds of dynamic objects that you can access with ADSI: sessions (i.e., instances of users connected to a computer) and resources (i.e., instances of file or queue access on a computer). When users connect to a file or a share on a computer, it creates both a session and a resource object. When the user disconnects, these dynamic objects cease to exist.

You can access dynamic objects by connecting directly to the Server service on the machine. Although each Server service has a user-friendly display name that appears in the Computer Management console in Windows 2000 and Windows Server 2003 or the Services applet in the Windows NT Control Panel, each Server service also has a short name that you use when connecting to it with ADSI. For example, *Server* is the display name of the service that has the short name *LanManServer* . If you enumerate all the services on a machine, you can use `IADsService::DisplayName` to print the display name and `IADs::Name` to print the short name.

LanManServer is an object of type `FileService` . `FileService` objects are responsible for maintaining the sessions and resources in their jurisdictions. You can use the `IADsFileServiceOperations` interface to access information about these sessions and resources. This simple interface has two methods: `IADsFileServiceOperations::Ses-sions` and `IADsFileServiceOperations::Resources` . Both methods return collections of objects that you can iterate through with a `For Each...Next` loop. When you're iterating through a collection in this manner, the system is using `IADsCollection::GetObject` to retrieve each item from the collection. As a result, you can use the same `IADsCollection::GetObject` method to retrieve a specific session or resource object. You then can use the `IADsSession` or `IADsResource` interface to manipulate that session or resource object's properties to access information. For example, if you retrieve a session object, you can access such information as the username of the user who is connected and how long that user has been connected.

25.3.1. Identifying a Machine's Sessions

The following script uses `IADsSession` to iterate through all the sessions on a particular machine:

```
On Error Resume Next

Dim objComputer, objSession, strOutput

strOutput = ""
```

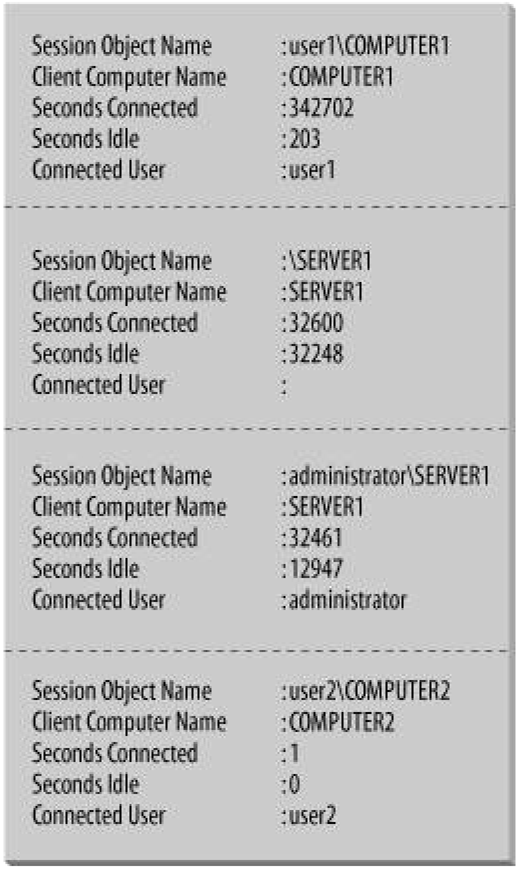
```
Set objComputer = GetObject("WinNT://mycomputer/LanManServer")

For Each objSession In objComputer.Sessions
  strOutput = strOutput & "Session Object Name : " & objSession.Name & vbCrLf
  strOutput = strOutput & "Client Computer Name: " & objSession.Computer & vbCrLf
  strOutput = strOutput & "Seconds connected   : " _
    & objSession.ConnectTime & vbCrLf
  strOutput = strOutput & "Seconds idle        : " & objSession.IdleTime & vbCrLf
  strOutput = strOutput & "Connected User      : " & objSession.User & vbCrLf
  strOutput = strOutput & vbCrLf
Next

WScript.Echo strOutput
```

This is straightforward. It uses the `IADs::Name` property method and `IADsSession` property methods to retrieve data about the session. The `IADs::Name` property method displays the object name, which is the name that you would use with `IADsCollection::GetObject` to retrieve the specific session individually. As Figure 25-1 shows, the object name always follows the format *user \COMPUTER* . In some sessions, the underlying system rather than a person is connecting to the computer. Here, the object name follows the format *\COMPUTER* .

Figure 25-1. The sessions on a computer



```
Session Object Name      :user1\COMPUTER1
Client Computer Name     :COMPUTER1
Seconds Connected        :342702
Seconds Idle             :203
Connected User           :user1
-----------------------------------------
Session Object Name      :\SERVER1
Client Computer Name     :SERVER1
Seconds Connected        :32600
Seconds Idle             :32248
Connected User           :
-----------------------------------------
Session Object Name      :administrator\SERVER1
Client Computer Name     :SERVER1
Seconds Connected        :32461
Seconds Idle             :12947
Connected User           :administrator
-----------------------------------------
Session Object Name      :user2\COMPUTER2
Client Computer Name     :COMPUTER2
Seconds Connected        :1
Seconds Idle             :0
Connected User           :user2
```

You can use IADsSession property methods to retrieve the individual components of the object name. The IADsSession::Computer property method retrieves the computer component (e.g., COMPUTER1). The Connected User and Client Computer Name fields in Figure 25-1 contain the results of these property methods. The IADsSession::User property method retrieves the user component of the object name (e.g., user1).

25.3.2. Identifying a Machine's Resources

The following script enumerates the resources in use on a machine:

```
On Error Resume Next

Dim objComputer, objSession, strOutput

strOutput = ""

Set objComputer = GetObject("WinNT://mycomputer/LanManServer")

For Each objResource In objComputer.Resources
  strOutput = strOutput & "Resource Name: " & objResource.Name & vbCrLf
  strOutput = strOutput & "User         : " & objResource.User & vbCrLf
```

```
      strOutput = strOutput & "Path         : " & objResource.Path & vbCrLf
      strOutput = strOutput & "Lock count   : " & objResource.LockCount & vbCrLf
      strOutput = strOutput & vbCrLf
    Next

    Wscript.Echo strOutput
```

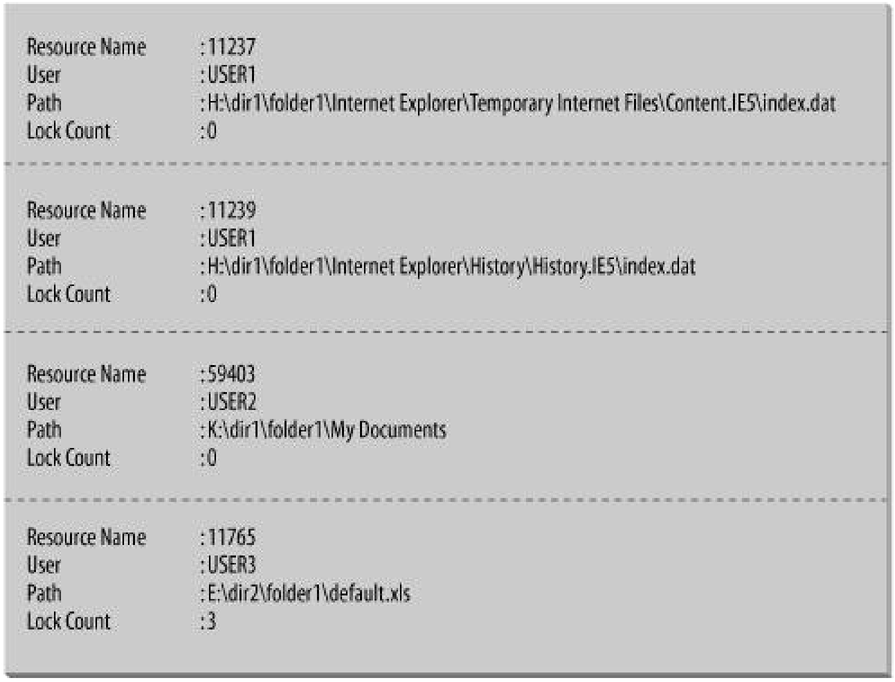
Figure 25-2 shows the output, which lists those files that each user has open. The Microsoft Excel spreadsheet that user3 has open is locked.

> If you want to see locks in action, have one user open a shared document and have another user then try to open it.

25.3.3. A Utility to Show User Sessions

You can use ADSI to write a script that displays which users are currently connected to a server and counts all the connected users across a domain. For simplicity, suppose that you have only two servers in your domain. You want to determine and display the maximum number of simultaneous sessions on each server, the total number of sessions across the domain, the total number of unique connected users on the domain, and an alphabetized list of usernames. Users can simultaneously connect to both servers from their computers. However, you want to count these users only once.

Figure 25-2. The resources on a computer



```
Resource Name      :11237
User               :USER1
Path               :H:\dir1\folder1\Internet Explorer\Temporary Internet Files\Content.IE5\index.dat
Lock Count         :0
--------------------------------------------------------------------------------
Resource Name      :11239
User               :USER1
Path               :H:\dir1\folder1\Internet Explorer\History\History.IE5\index.dat
Lock Count         :0
--------------------------------------------------------------------------------
Resource Name      :59403
User               :USER2
Path               :K:\dir1\folder1\My Documents
Lock Count         :0
--------------------------------------------------------------------------------
Resource Name      :11765
User               :USER3
Path               :E:\dir2\folder1\default.xls
Lock Count         :3
```

You can use the session object to construct *ShowUsers.vbs* , a useful utility that runs from your desktop and displays this user session information. What follows is an overview of how the *ShowUsers.vbs* utility obtains, manipulates, and displays the data. We heavily commented this script to show how it works line by line. The script follows the discussion of how it works.

25.3.3.1. Obtaining the data

ShowUsers.vbs begins by iterating through all your servers. To specify the servers you want to scan, you can either hardcode the server information in the script or have the script dynamically retrieve this information.[*] We've hard coded the server information in *ShowUsers.vbs* .

[*] For Active Directory, a domain's DCs are usually in the domain controllers Organizational Unit off the root of the domain. Member servers will be in the Computers container by default.

When the utility iterates through all the servers, it ignores any empty usernames (which specify interserver connections) and usernames with a trailing dollar sign (which denote users that are actually computers connecting to one another). For each valid session, the script records the username and increments the session count by one.

The script uses a dynamic array (`arrResults`) to store the username data because the number of usernames in the array will change each time you run the utility.

The script uses a multidimensional array (`arrServerResults`) to store the servers' names and maximum number of connected sessions:

```
'*********************************************************************
'Sets up multidimensional array to hold server names and user counts
'*********************************************************************
```

```
arrServerResults(0,0) = "server1"
arrServerResults(0,1) = 0
arrServerResults(1,0) = "server2"
arrServerResults(1,1) = 0
```

The `arrServerResults` array stores this information in a simple table, putting the server names in the first column, the counts in the second column, and the data in the rows. To access data in `arrServerResults` , we include the indexes of first and second dimensions, respectively, in parentheses. For example, `arrServerResults(0,1)` accesses the data in the first row (0), second column (1). Thus, the server names are in `arrServerResults(0,0)` and `arrServerResults(1,0)` . The corresponding session counts are in `arrServerResults(0,1)` and `arrServerResults(1,1)` .

The script can iterate through the servers by using a `For` loop to go from 0 to `UBound (arrServerResults)` . The VBScript `UBound` function retrieves the upper array bound for an array and takes two parameters: the array to check and the dimension to count the upper bound of.

If the second parameter is left off, the first dimension is used; these are equivalent:

```
 UBound(arrServerResults,1)
UBound(arrServerResults)
```

> Note that `UBound` 's second parameter specifying the dimension starts from 1, not 0 as the actual array does.

25.3.3.2. Manipulating the data

After the script iterates through every server, you have a list of server session counts and a list of the usernames of those users who were connected to the servers at that time. This section of code achieves this:

```
For Each objSession In objFSO.Sessions
   If (Not objSession.User = "") And (Not Right(objSession.User,1) = "$") Then
    arrResults(UBound(arrResults)) = objSession.User & vbCrLf
     ReDim Preserve arrResults(UBound(arrResults) + 1)
     arrServerResults(intIndex,1) = arrServerResults(intIndex,1) + 1
  End If
Next
```

Note the use of `ReDim` to preserve the existing contents of the array, while expanding the array's upper bound by one. If the upper bound is 12, you can increase the array to 13 elements with the following code:

```
ReDim Preserve arrResults(13)
```

Using the upper bound of the existing array as the parameter makes the code generic. The following line is used to increase the count of the users by one in the second dimension of the array:

```
arrServerResults(intIndex,1) = arrServerResults(intIndex,1) + 1
```

Because some users might have been connected to both servers and hence might appear in the username list twice, the script uses two subprocedures to manipulate the data. One subprocedure sorts the usernames; the other subprocedure removes duplicate usernames.

25.3.3.3. The sort subprocedure

If you have had any computer science classes, you will likely remember having to perform bubble sorts and shell sorts. Although including a sort function in VBScript would have made sense, Microsoft failed to do so.

The `Quicksort` subprocedure we use in the next example takes in an array indexed from 0 to `UBound(array)` and sorts the values in the array between the two indexes you pass in as arguments. For example, if you specify the following code, `Quicksort` sorts elements 7 through 19 in `arrMyArray` :

```
Quicksort(arrMyArray, 7, 19)
```

`Quicksort` 's own subprocedure has the ability to sort between two indexes in case we ever want to reuse the procedure in another script that needs that functionality. However, in *ShowUsers.vbs* , we need to sort the whole array of usernames between indexes 0 and `UBound(array)` .

25.3.3.4. The duplicate-removal subprocedure

After `Quicksort` sorts the username list, the `RemoveDuplicates` subprocedure removes any duplicate usernames. Like `Quicksort` , `RemoveDuplicates` takes an array and two indexes as arguments.[*]

[*] When we created this subprocedure, we gave it the ability to work between two indexes so that `RemoveDuplicates` and `Quicksort` are comparable.

When `RemoveDuplicates` enumerates through a sorted list, it ignores items with the same name as the next item in the list and then passes the remaining elements to a new array. For example, let's say that a sorted list reads:

```
bill, bill, bill, sandy, sandy, steve
```

RemoveDuplicates reads the list as:

```
<ignore>, <ignore>, bill, <ignore>, sandy, steve
```

This enumerates to:

```
bill, sandy, steve
```

RemoveDuplicates then passes the remaining elements to a new array because placing the results into a second array is faster than manipulating the existing array.

25.3.3.5. Displaying the data

Here are the constants we use for setting the location of the temporary file and opening it for write:

```
Const TEMPFILE = "C:\SHOWUSERS-TEMP.TXT"
Const ForWriting = 2
```

We then open the temporary text file for writing by creating a FileSystemObject and using the FileSystemObject::OpenTextFile method to open it. The third parameter states that if the text file already exists, it should be overwritten:

```
Set fso = CreateObject("Scripting.FileSystemObject")
Set ts = fso.OpenTextFile(TEMPFILE, ForWriting, True)
```

We then use the TextStream::WriteLine and TextStream::Write functions to write the data to the file and ultimately use the TextStream::Close method to close it.

Having the file written is only half the battle. We now want to display the file automatically using *Notepad* , maximize the window, display the results, and delete the file, again automatically, when we close *Notepad* . This is actually accomplished simply, as follows:

```
Set objShell = CreateObject("WScript.Shell")
intRC = objShell.Run ("notepad.exe " & TEMPFILE, vbMaximizedFocus, TRUE)
fso.DeleteFile(TEMPFILE)
```

The `Shell::Run` method allows you to open and use an application such as *Notepad* synchronously or asynchronously with a script. The first parameter uses the temporary file as a parameter to *Notepad* , so that *Notepad* opens the file. The second parameter is one of the VBScript constants that came up before while setting rights to home directories for newly created users. The third parameter indicates whether to run the command synchronously, (true) or asynchronously (false). In this case, we are opening the application synchronously, which means that the script pauses its execution when *Notepad* is open and doesn't start up again until you close *Notepad* . The script effectively stops executing until you close Notepad. When that happens, a return code is placed into the variable `intRC` . This is to accommodate applications and commands that return a value that you may require. In this case, you don't care about a value being returned, so when *Notepad* is closed, the script deletes the file.

The full code for *ShowUsers.vbs* is listed in Example 25-1 .

Example 25-1. The ShowUsers.vbs utility

```
'**********************************************************************
'The ShowUsers.vbs Utility
'**********************************************************************
Option Explicit

On Error Resume Next

'**********************************************************************
'Maximizes the Notepad screen when started
'**********************************************************************
Const vbMaximizedFocus  = 3

'**********************************************************************
'Sets the location of the temporary file
'**********************************************************************
Const TEMPFILE = "C:\SHOWUSERS-TEMP.TXT"

'**********************************************************************
'Opens a file and lets you start writing from the beginning of the
'file
'**********************************************************************
Const ForWriting = 2

'**********************************************************************
'Declare all variables. As arrResults will be continually increased
'in size as more results are fed in, you have to initially declare it
'as an unbounded array
'**********************************************************************
Dim objShell, objFSO, objSession, arrServerResults(1,1), arrResults(   )
Dim arrResults2(   ), fso, ts, intRC, intMaxSessions, intIndex, strItem

'**********************************************************************
```

```
'Sets up multidimensional array to hold server names and user counts
'***********************************************************************
arrServerResults(0,0)  =  "server1"
arrServerResults(0,1)  =  0
arrServerResults(1,0)  =  "server2"
arrServerResults(1,1)  =  0

'***********************************************************************
'Redimensions arrResults to one element to start with
'***********************************************************************
ReDim  arrResults(0)

'***********************************************************************
'Iterates through the array, connecting to the server service of
'each server and looks at each session on that server
'
'If the session has an empty user (is an interserver connection) or
'the user is a computer (the trailing character is a dollar sign), the
'script ignores that session and proceeds to the next session
'
'If the session is valid, the script adds the username to the last
'element of the arrResults array and expands the array by one element
'to cope with the next result when it arrives. The script also
'increments the session count for the corresponding server by one
'***********************************************************************
For intIndex = 0 To UBound(arrServerResults)
  Set objFSO = GetObject("WinNT://" & arrServerResults(intIndex,0) _
                                                     & "/LanmanServer")

  For Each objSession In objFSO.Sessions
    If (Not objSession.User = "") And (Not Right(objSession.User,1) = "$") Then
      arrResults(UBound(arrResults)) = objSession.User & vbCrLf
       ReDim Preserve arrResults(UBound(arrResults) + 1)
       ArrServerResults(intIndex,1) = arrServerResults(intIndex,1) + 1
    End If
  Next

  Set objFSO = Nothing
Next

'***********************************************************************
'Sorts the entire arrResults array and then removes duplicates from
'it, placing the results in arrResults2
'***********************************************************************
Quicksort  arrResults,  0,  UBound(arrResults)
RemoveDuplicates  arrResults,  0,  UBound(arrResults),  arrResults2

'***********************************************************************
'Opens the temporary text file for writing. If the text file already
'exists, overwrite it.
'***********************************************************************
Set fso = CreateObject("Scripting.FileSystemObject")
Set ts = fso.OpenTextFile(TEMPFILE, ForWriting, True)

'**********************************************************************
'Counts the max sessions by iterating through each server and adding
'up the sessions count in the second column of each row of the
'multidimensional array
'
'Writes out the user sessions for each server to the temporary file
'as the script iterates through the list. When the script finishes
'counting, it writes out the max sessions to the file as well.
'**********************************************************************
intMaxSessions = 0
For intIndex = 0 To UBound(arrServerResults)
  ts.WriteLine "Total User Sessions on " & arrServerResults(intIndex,0) _
    & ": " & arrServerResults(intIndex,1)
  intMaxSessions = intMaxSessions + arrServerResults(intIndex,1)
Next
ts.WriteLine "Total User sessions on CFS: " & intMaxSessions
ts.WriteLine

'**********************************************************************
'Writes out the total number of unique users connected to the domain,
'followed by each username in alphabetic order
'**********************************************************************
ts.WriteLine "Total Users on CFS: " & UBound(arrResults2)
ts.WriteLine
For Each strItem in arrResults2
  ts.Write strItem
Next
ts.Close

'**********************************************************************
'Sets the third parameter of the Shell::Run method to TRUE, which
'allows the script to open up the file in Notepad and maximize the
'screen. The script stops executing until you close Notepad, which
'places a return code into intRC. When Notepad is closed, the script
'deletes the file.
'**********************************************************************
Set objShell = CreateObject("WScript.Shell")
intRC = objShell.Run ("notepad.exe " & TEMPFILE, vbMaximizedFocus, TRUE)
fso.DeleteFile(TEMPFILE)

'**********************************************************************
'Subroutine Quicksort
'
'Sorts the items in the array (between the two values you pass in)
'**********************************************************************
Sub Quicksort(strValues(  ), ByVal min, ByVal max)

  Dim strMediumValue, high, low, i

  '**********************************************************************
```

```
'If the list has only 1 item, it's sorted
'*********************************************************************
If min >= max Then Exit Sub

'*********************************************************************
'Pick a dividing item randomly
'*********************************************************************
we = min + Int(Rnd(max - min + 1))
strMediumValue = strValues(i)

'*********************************************************************
'Swap the dividing item to the front of the list
'*********************************************************************
strValues(i) = strValues(min)

'*********************************************************************
'Separate the list into sublists
'*********************************************************************
low = min
high = max
Do
  '*********************************************************************
  'Look down from high for a value < strMediumValue
  '*********************************************************************
  Do While strValues(high) >= strMediumValue
    high = high - 1
    If high <= low Then Exit Do
  Loop

  If high <= low Then
    '*********************************************************************
    'The list is separated
    '*********************************************************************
    strValues(low) = strMediumValue
    Exit Do
  End If

  '*********************************************************************
  'Swap the low and high strValues
  '*********************************************************************
  strValues(low) = strValues(high)

  '*********************************************************************
  'Look up from low for a value >= strMediumValue
  '*********************************************************************
  low = low + 1
  Do While strValues(low) < strMediumValue
    low = low + 1
    If low >= high Then Exit Do
  Loop

  If low >= high Then
```

```
      '**********************************************************************
      'The list is separated
      '**********************************************************************
      low = high
      strValues(high) = strMediumValue
      Exit Do
    End If

    '**********************************************************************
    'Swap the low and high strValues
    '**********************************************************************
    strValues(high) = strValues(low)
  Loop 'Loop until the list is separated.

  '**********************************************************************
  'Recursively sort the sublists
  '**********************************************************************
  Quicksort strValues, min, low - 1
  Quicksort strValues, low + 1, max

End Sub

'**********************************************************************
'Subroutine RemoveDuplicates
'
'Removes duplicate items in the strValues array (between the two
'values you pass in) and writes the results to strNewValues(  )
'**********************************************************************
Sub RemoveDuplicates(ByVal strValues(  ), ByVal min, ByVal max, strNewValues(  ) )

  Dim strValuesIndex, strNewValuesIndex

  ReDim strNewValues(0)
  strNewValuesIndex = 0

  For strValuesIndex = min To max-1
     If Not strValues(strValuesIndex) = strValues(strValuesIndex+1) Then
      strNewValues(strNewValuesIndex) = strValues(strValuesIndex)
       ReDim Preserve strNewValues(strNewValuesIndex + 1)
       strNewValuesIndex = strNewValuesIndex + 1
    End If
  Next
  strNewValues(strNewValuesIndex) = strValues(max)

End Sub
```

25.3.3.6. Room for improvement

Although *ShowUsers.vbs* is useful, this utility is lacking in one area: users can legitimately use two connection slots if their `IADsSession::Computer` names are different, but the utility counts the user only once. For example, user1 might log on to the domain twice, once on *COMPUTER1* and once on *SERVER1* , but our script counts user1 only once because of the `RemoveDuplicates` subprocedure. If you want to make the script even better, you can create an extension to the utility that remedies this situation. For example, the extension might log all user counts to a file every five minutes for later analysis.

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25.4. Manipulating Print Queues and Print Jobs

So far we've shown you how to use ADSI to manipulate persistent and dynamic objects, such as shares, sessions, and resources. Now we're going to examine printer queues and jobs. In this section, we're going to lead you through creating scripts to do the following:

- Identify print queues in Active Directory
- Bind to a print queue[*] and access its properties
- List the print jobs in a print queue and manipulate them

[*] Print queues are logical ADSI names for printers installed on a computer.

> All the code in these scripts for managing printers is done using the WinNT provider, so it will work on Windows NT as well as Active Directory. The LDAP searches will not work on Windows NT.

One point before we go on: at the end of Chapter 22, we detail a function called SearchAD. We need to use it now to search Active Directory for the printer's ADsPath and store it in `arrSearchResults(0,0)`.

25.4.1. Identifying Print Queues in Active Directory

List-Print-Queue.vbs in Example 25-2 is a heavily commented script, so it should be easy to follow.

Example 25-2. List-Print-Queue.vbs identifies print queues in Active Directory

```
Option Explicit
On Error Resume Next

'**********************************************************************
'Active Directory path to start the search from
'**********************************************************************
Const strDomainToSearch = "LDAP://dc=mycorp,dc=com"

'**********************************************************************
'Maximizes the Notepad screen when started
'**********************************************************************
```

```
Const vbMaximizedFocus   = 3

'*********************************************************************
'Sets the location of the temporary file
'*********************************************************************
Const TEMPFILE = "C:\PRINTERLIST-TEMP.TXT"

'*********************************************************************
'Opens a file and lets you start writing from the beginning of the file
'*********************************************************************
Const ForWriting = 2

Dim arrPaths(  ), fso, ts, strItem, intRC, objShell, intIndex

If Not SearchAD(strDomainToSearch,"(objectCategory=printQueue)", _
                                  "SubTree","adspath,cn",arrPaths) Then
  MsgBox "Printer listing failed!"
Else
  '*********************************************************************
  'Opens the temporary text file for writing. If the text file already
  'exists, overwrite it.
  '*********************************************************************
  Set fso = CreateObject("Scripting.FileSystemObject")
  Set ts = fso.OpenTextFile(TEMPFILE, ForWriting, True)

  '*********************************************************************
  ' Writes out the printer ADsPaths
  '*********************************************************************
  ts.WriteLine "Total printers in Active Directory: " & UBound(arrPaths)+1
  ts.WriteLine
  For intIndex=0 To UBound(arrPaths)
    ts.WriteLine arrPaths(intIndex,1)
    ts.WriteLine vbTab & arrPaths(intIndex,0)
  Next
  ts.Close

  '*********************************************************************
  'Sets the third parameter of the Shell::Run method to TRUE, which
  'allows the script to open up the file in Notepad and maximize the
  'screen. The script stops executing until you close Notepad, which
  'places a return code into intRC. When Notepad is closed, the script
  'deletes the file.
  '*********************************************************************
  Set objShell = CreateObject("WScript.Shell")
  intRC = objShell.Run ("notepad.exe " & TEMPFILE, vbMaximizedFocus, TRUE)
  fso.DeleteFile(TEMPFILE)
End If
```

The script uses the search function to search Active Directory for all objects of class `printQueue`, writes their `ADsPath` and `cn` attributes out to a temporary file, displays the file for you in *Notepad*, and then erases the file when *Notepad* is closed. The code for opening and closing files and displaying them with *Notepad* is the same as that in the *ShowUsers.vbs* script earlier in the chapter. Here is an example of the output from this program:

```
Total printers in Active Directory: 3

DC1-ph_stores_hp4000
   LDAP://CN=DC1-stores_hp4000,CN=DC1,OU=Domain Controllers,DC=mycorp,DC=com
SS-0001-Alex&Mark
   LDAP://CN=COMPUTER-0789-Alex&Mark,CN=COMPUTER-0789,OU=Finances, _
    OU=Finance Clients,OU=Clients,DC=mycorp,DC=com
ZZ-NT0089-HP LaserJet 4M Plus
   LDAP://CN=ZZ-0089-HP LaserJet 4M Plus,CN=ZZ-0089,OU=Finances, _
    OU=Finance Clients,OU=Clients,DC=mycorp,DC=com
```

The lines are too long to fit on the page, so we have broken them up with underscores as we would do if this were a script. Each entry would normally appear in a single line.

Let's take a look at the output for a moment. The first `PrintQueue` object is called "DC1-ph_stores_hp4000" and is a subobject under the DC1 domain controller object. The computer called DC1 (actually an Active Directory domain controller) is actually the parent of this `printQueue` object.

25.4.2. Binding to a Print Queue

Unfortunately, we cannot connect to this `printQueue` object and list the jobs because the Active Directory object that we have connected to is only the advertisement or publication that such a queue exists. To connect to the printer object that holds the jobs that we can manipulate, we need to use the WinNT namespace.

While we could provide a simple piece of code to connect to a queue, we'd like to modify the previous script to show you how that could be accomplished. We'll list the queues as before, but this time, we will return an additional attribute, `uNCName`, and also bind to the first queue we find (and only the first) and print out some properties.

To see what we need to do, let's take a look at the first queue in the previous output. The actual printer path that we need to connect to is:

```
WinNT://MYCORP/DC1/stores_hp4000
```

We need to massage the data returned by the SearchAD function to produce the information about the computer name and the printer name. *List-Print-Queue-2.vbs* is the result, a modified version of *List-Print-Queue.vbs* with two extra sets of information provided. The first is a new constant to define the workgroup or domain; the second we'll go through after the script in Example 25-3.

Example 25-3. List-Print-Queue-2.vbs binds to the print queue

```
Option Explicit
On Error Resume Next

'**********************************************************************
'Active Directory path to start the search from
'**********************************************************************
Const strDomainToSearch = "LDAP://dc=mycorp,dc=com"

'**********************************************************************
'Maximizes the Notepad screen when started
'**********************************************************************
Const vbMaximizedFocus    = 3

'**********************************************************************
'Sets the location of the temporary file
'**********************************************************************
Const TEMPFILE = "C:\PRINTERLIST-TEMP.TXT"

'**********************************************************************
'Opens a file and lets you start writing from the beginning of the file
'**********************************************************************
Const ForWriting = 2

Dim arrPaths(  ), fso, ts, strItem, intRC, objShell, intIndex
Dim objPrinter, strUncPath

If Not _
  SearchAD(strDomainToSearch,"(objectCategory=printQueue)","SubTree" _
                                      "adpath,cn,uNCName",arrPaths) Then
    MsgBox "Printer listing failed!"
Else
  '**********************************************************************
  'Opens the temporary text file for writing. If the text file already
  'exists, overwrite it
  '**********************************************************************
  Set fso = CreateObject("Scripting.FileSystemObject")
  Set ts = fso.OpenTextFile(TEMPFILE, ForWriting, True)

  '**********************************************************************
  ' Writes out the printer ADsPaths
  '**********************************************************************
  ts.WriteLine "Total printers in Active Directory: " & UBound(arrPaths)+1
  ts.WriteLine
  For intIndex=0 To UBound(arrPaths)
    ts.WriteLine arrPaths(intIndex,1)
    ts.WriteLine vbTab & arrPaths(intIndex,0)
  Next
  ts.WriteLine

  '*********************************************************************
  'Bind to the first printer and list the properties
  '*********************************************************************
   strUncPath=Replace(arrPaths(0,2),"\","/")
  Set objPrinter = GetObject("WinNT:" & strUncPath)
  ts.WriteLine "Name        : " & objPrinter.Name
  ts.WriteLine "Status      : " & objPrinter.Status
  ts.WriteLine "Model       : " & objPrinter.Model
  ts.WriteLine "Location    : " & objPrinter.Location
  ts.WriteLine "PrinterPath : " & objPrinter.PrinterPath
  ts.Close

  '*********************************************************************
  'Sets the third parameter of the Shell::Run method to TRUE, which
  'allows the script to open up the file in Notepad and maximize the
  'screen. The script stops executing until you close Notepad, which
  'places a return code into intRC. When Notepad is closed, the script
  'deletes the file.
  '*********************************************************************
  Set objShell = CreateObject("WScript.Shell")
  intRC = objShell.Run ("notepad.exe " & TEMPFILE, vbMaximizedFocus, TRUE)
  fso.DeleteFile(TEMPFILE)
End If
```

To bind to the printer and list the properties, we need the Windows Universal Naming Convention (UNC) share path of the print queue; this information is maintained in the uNCName attribute. The path can not be directly used in the ADSI path because of its format; the UNC path has a value with a form of \\hostname\sharename and ADSI requires a format of WinNT://hostname/sharename. VBScript has a function perfect for correcting this problem, the Replace function. Replace takes three strings as parameters, the first string is the original that you need to make replacements in it. The second parameter is the string you want to replace and third parameter is the string to replace it with. Now you simply need to append WinNT: to the string and bind to the printer object on that computer. We finally print out five attributes (IADs::Name, IADsPrintQueueOperations::Status, IADsPrintQueue::Model, IADsPrintQueue::Location, and IADsPrintQueue::PrinterPath) of that printer to confirm that the printer exists.

25.4.3. IADsPrintQueueOperations and Print Queues

Having successfully connected to a print queue, you can then use the IADsPrint-QueueOperations interface to its full extent. This interface has methods with names like Pause, Resume, and Purge that you should recognize; they correspond to specific print queue functions. There is one important property status that is also available and allows you to query the status of the printer. While *List-Print-Queue-2.vbs* just prints out this value as an integer, *Display-Print-Queue-Status.vbs* is a script that binds to the same printer and uses a `Select Case` statement to print the status out using the `MsgBox` function. This script is listed in Example 25-4.

Example 25-4. Display-Print-Queue-Status.vbs uses MsgBox to display printer status

```
'**********************************************************************
'IADsPrintQueueOperations::Status values
'**********************************************************************
Const ADS_PRINTER_PAUSED = &H00000001
Const ADS_PRINTER_PENDING_DELETION = &H00000002
Const ADS_PRINTER_ERROR = &H00000003
Const ADS_PRINTER_PAPER_JAM = &H00000004
Const ADS_PRINTER_PAPER_OUT = &H00000005
Const ADS_PRINTER_MANUAL_FEED = &H00000006
Const ADS_PRINTER_PAPER_PROBLEM = &H00000007
Const ADS_PRINTER_OFFLINE = &H00000008
Const ADS_PRINTER_IO_ACTIVE = &H00000100
Const ADS_PRINTER_BUSY = &H00000200
Const ADS_PRINTER_PRINTING = &H00000400
Const ADS_PRINTER_OUTPUT_BIN_FULL = &H00000800
Const ADS_PRINTER_NOT_AVAILABLE = &H00001000
Const ADS_PRINTER_WAITING = &H00002000
Const ADS_PRINTER_PROCESSING = &H000040000
Const ADS_PRINTER_INITIALIZING = &H00008000
Const ADS_PRINTER_WARMING_UP = &H00010000
Const ADS_PRINTER_TONER_LOW = &H00020000
Const ADS_PRINTER_NO_TONER = &H00040000
Const ADS_PRINTER_PAGE_PUNT = &H00080000
Const ADS_PRINTER_USER_INTERVENTION = &H00100000
Const ADS_PRINTER_OUT_OF_MEMORY = &H00200000
Const ADS_PRINTER_DOOR_OPEN = &H00400000
Const ADS_PRINTER_SERVER_UNKNOWN = &H00800000
Const ADS_PRINTER_POWER_SAVE = &H01000000

'**********************************************************************
' Bind to the printer
'**********************************************************************
Set objPrinter = GetObject("WinNT://DC1/stores_hp4000")

'**********************************************************************
' Print out the queue status
'**********************************************************************
Select Case objPrinter.Status
  Case 0
    MsgBox "On line"
```

```
Case ADS_PRINTER_PAUSED
  MsgBox "Paused"
Case ADS_PRINTER_PENDING_DELETION
  MsgBox "Pending deletion"
Case ADS_PRINTER_ERROR
  MsgBox "Printer error"
Case ADS_PRINTER_PAPER_JAM
  MsgBox "Paper jam"
Case ADS_PRINTER_PAPER_OUT
  MsgBox "Out of paper"
Case ADS_PRINTER_MANUAL_FEED
  MsgBox "Manual feed pending"
Case ADS_PRINTER_PAPER_PROBLEM
  MsgBox "Paper trouble"
Case ADS_PRINTER_OFFLINE
  MsgBox "Offline"
Case ADS_PRINTER_IO_ACTIVE
  MsgBox "We/O active"
Case ADS_PRINTER_BUSY
  MsgBox "Printer busy"
Case ADS_PRINTER_PRINTING
  MsgBox "Printing"
Case ADS_PRINTER_OUTPUT_BIN_FULL
  MsgBox "Output bin full"
Case ADS_PRINTER_NOT_AVAILABLE
  MsgBox "Not available"
Case ADS_PRINTER_WAITING
  MsgBox "Waiting"
Case ADS_PRINTER_PROCESSING
  MsgBox "Processing"
Case ADS_PRINTER_INITIALIZING
  MsgBox "Initializating"
Case ADS_PRINTER_WARMING_UP
  MsgBox "Warming up"
Case ADS_PRINTER_TONER_LOW
  MsgBox "Toner low"
Case ADS_PRINTER_NO_TONER
  MsgBox "Without toner"
Case ADS_PRINTER_PAGE_PUNT
  MsgBox "Page punt"
Case ADS_PRINTER_USER_INTERVENTION
  MsgBox "User intervention required"
Case ADS_PRINTER_OUT_OF_MEMORY
  MsgBox "Out of memory"
Case ADS_PRINTER_DOOR_OPEN
  MsgBox "Door open"
Case ADS_PRINTER_SERVER_UNKNOWN
  MsgBox "Server unknown"
Case ADS_PRINTER_POWER_SAVE
  MsgBox "Power save"
Case Else
  MsgBox "UNKNOWN"
```

```
End Select
```

The final important IADsPrintQueueOperations method that is available to you is IADsPrintQueueOperations::PrintJobs, which returns a collection of print jobs that you can interact with using IADsCollection.

25.4.4. Print Jobs

The IADsPrintQueueOperations::PrintJobs method allows you to obtain a collection object that you then can use in a For Each...Next loop. You can pause and resume the jobs using methods of the same name from the IADsPrintJobOperations interface. In addition, as the collection represents the underlying print jobs, you also can use the IADsCollection::Add and IADsCollection::Remove methods to add and remove print jobs from the collection. The Add method is not of much use here, but the Remove method is, since this allows you to delete jobs from the queue. Assuming we had bound successfully to the queue as before, this section of code would purge the queue manually. The following code gives you some idea of what you can do:

```
    For Each objJob in objPrinter.PrintJobs
      objPrinter.PrintJobs.Remove (objJob.Name)
    Next
```

Example 25-5 demonstrates that each job has a number of attributes from IADsPrintJob and IADsPrintJobOperations you can print. This is not the definitive list, and we urge you to check out MSDN for the full set.

Example 25-5. Display some properties and the status of each print job

```
'**********************************************************************
'IADsPrintJobOperations::Status values
'**********************************************************************
Const ADS_JOB_PAUSED = &H00000001
Const ADS_JOB_ERROR = &H00000002
Const ADS_JOB_DELETING = &H00000004
Const ADS_JOB_PRINTING = &H00000010
Const ADS_JOB_OFFLINE = &H00000020
Const ADS_JOB_PAPEROUT = &H00000040
Const ADS_JOB_PRINTED = &H00000080
Const ADS_JOB_DELETED = &H00000100

'**********************************************************************
' Bind to the printer
```

```
'**********************************************************************
Set objPrinter = GetObject("WinNT://DC1/stores_hp4000")

'**********************************************************************
'Print out some properties and the status of each job
'**********************************************************************
For Each objJob in objPrinter.PrintJobs
  str = "Name: " & objJob.Name & vbCrLf
  str = str & "Position: " & objJob.Position & vbCrLf
  str = str & "Size: " & objJob.Size & vbCrLf
  str = str & "Total Pages: " & objJob.TotalPages & vbCrLf
  str = str & "Pages Printed: " & objJob.PagesPrinted & vbCrLf
  Select Case objJob.Status

    Case 0
      str = str & "Status : " & "OK"
    Case ADS_JOB_PAUSED
      str = str & "Status : " & "Paused"
    Case ADS_JOB_ERROR
      str = str & "Status : " & "Error"
    Case ADS_JOB_DELETING
      str = str & "Status : " & "Deleting"
    Case ADS_JOB_PRINTING
      str = str & "Status : " & "Printing"
    Case ADS_JOB_OFFLINE
      str = str & "Status : " & "Offline"
    Case ADS_JOB_PAPEROUT
      str = str & "Status : " & "Paper Out"
    Case ADS_JOB_PRINTED
      str = str & "Status : " & "Printed"
    Case ADS_JOB_DELETED
      str = str & "Status : " & "Deleted"
    Case Else
      str = str & "Status : " & "Unknown"
  End Select

  MsgBox str
Next
```

Again, just as in *Display-Print-Queue-Status.vbs* , the `IADsPrintJobOperations::Status` property method has a defined set of constants that can be used to tell you about a job. One thing to note is that `IADsPrintJobOperations::Position` is a read/write value, so you can use this to move jobs around in the queue print sequence. Actually, a number of `IADsPrintJob` property methods are also read/write: `IADsPrintJob::StartTime` and `IADsPrintJob::UntilTime` (to set a future time before which the job can be printed), `IADsPrintJob::Priority`, `IADsPrintJob::Description`, and `IADsPrintJob::Notify`, plus `IADsPrintJob::NotifyPath` (the user is contacted when the job is printed).

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25.5. Summary

While the future of automating systems management-related tasks lies with WMI, you can still use ADSI very effectively to accomplish a number of key tasks. In this chapter, we took a look at how you can use ADSI to manipulate persistent objects (like a computer's shares and services) and dynamic objects (computers' open resources, users' active sessions, and print jobs that users initiate) in Active Directory or Windows NT SAM.

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Chapter 26. Permissions and Auditing

Security descriptors (SDs), access control lists (ACLs), and access control entries (ACEs) have been used for files and directories on NTFS file systems for years. The same concepts apply to securing Active Directory objects as well. While the information in this chapter is focused on Active Directory, the principles of creating an SD that contains a discretionary access control list (DACL) and system access control list (SACL) can map over to NTFS files and directories.

ADSI provides four main interfaces we can use:

`IADsAccessControlEntry`

> Manipulates individual ACEs that represent access or audit permissions for specific users or groups to objects and properties in Active Directory

`IADsAccessControlList`

> Manages collections of ACEs for an object

`IADsSecurityDescriptor`

> Manages the different sets of ACLs to an object

`IADsSecurityUtility`

> Gets, sets, and retrieves security descriptors for an object

All of the ADSI security interfaces can be found in the MSDN Library at:

> http://msdn.microsoft.com/library/default.asp?url=/library/en-us/adsi/adsi/security_interfaces.asp

> If you haven't read Chapter 11 in its entirety, you may find this chapter a little confusing.

26.1. How to Create an ACE Using ADSI

Microsoft has a habit of calling a shovel a ground insertion earth management device (GIEMD for short); that is, they like to give names that are not always intuitive to the average person. The contents of the five properties of the ACE object are not all immediately obvious from the names. In addition, as Microsoft uses the ACE for system-audit and permissions entries, a number of values that can go into the properties make sense only in a particular context. To complicate matters further, one property (`AceFlags`) is a catchall area that currently serves as the location for two completely different sets of information.

Creating an ACE is a simple matter, getting it right is a little more difficult. To set up an ACE, you need the following basic pieces of information:

`AccessMask`

What permissions you want to set

`AceType`

Whether you are setting allow/deny permissions or auditing for an object or property

`Trustee`

Who to apply the permissions to

`AceFlags`

What inheritance options you want and, if it is an audit entry, whether you are monitoring successes or failures

`Flags`

`ObjectType`

`InheritedObjectType`

What the ACE applies to if not just the entire object

We will now go through several examples to show you what the seven properties of an ACE will contain based on certain security settings. Let's start with the simple example: giving a user full control permissions to an Organizational Unit. That means the information in Table 26-1 gets stored as an ACE on the SD of the Organizational Unit itself.

Table 26-1. Contents of the ACE properties when giving a user full contro permissions to an Organizational Unit

Name of the property	Value to be stored
trustee	Names the user who is to have the permission.
AccessMask	Gives full control (i.e., give every permission).
AceType	This is an allow permission.
AceFlags	The permission applies to this object. Child objects inherit this ACE.
Flags	Neither ObjectType nor InheritedObjectType is set.
ObjectType	Null.
InheritedObjectType	Null.

The user (TRustee) is allowed (AceType) full control (AccessMask) to the current object and all objects down the tree (AceFlags). The last three properties in the table are not used here, as the permission is a simple one that is being applied to an entire object.

If we were auditing successful and failed modifications to the entire Organizational Unit by the user, the contents of the audit ACE on the Organizational Unit would look like Table 26-2.

Table 26-2. Contents of the ACE properties when auditing successful modifications to an Organizational Unit and all children by a user

Name of the property	Value to be stored
trustee	Names the user who is to be audited.
AccessMask	Gives full control (i.e., audit every action).
AceType	This is an audit ACE.
AceFlags	The auditing applies to this object. Child objects inherit this ACE. This ACE audits successes and failures.
Flags	Neither ObjectType nor InheritedObjectType is set.
ObjectType	Null.
InheritedObjectType	Null.

In this case, we are auditing (AceType) successful and failed (AceFlags) modifications of all types (AccessMask) by a user (TRustee) for this object and all children (AceFlags).

Note the changes to AceFlags as compared to the previous permissions entry. While a permissions entry uses AceType to indicate whether it is set to allow or deny, an auditing entry uses AceFlags to indicate whether it is auditing successes or failures.

Be careful with adding audit entries to Active Directory. Auditing imparts significant overhead to a domain controller's workload, and it is easily possible to enable too much auditing. Too much auditing can cause the domain to not function properly or perform its functions very slowly as well as fill the security log with a lot of entries that probably are not very useful.

Let's take a look at a more complex example: giving the same user the ability to set the description for user objects within the entire branch beneath an Organizational Unit, as shown in Table 26-3. Again, this ACE is set on the SD of the Organizational Unit, yet it doesn't actually apply to the Organizational Unit itself. This ACE applies to the description attribute of user objects, so the Organizational Unit acts only as a carrier. The ACE is inherited down the tree by all objects, but only ever directly affects users. As soon as an object is created in one of those containers, the ACE is instantly added as an ACE on the SD of the object via inheritance rules. When access is being checked, if the object is a user, the ACE is "in effect" and allows the trustee to make the specified change.

Table 26-3. Contents of the ACE properties for a more complex example

Name of the property	Value to be stored
TRustee	Names the user who is to have the permission.
AccessMask	Gives write access to a specific property.
AceType	This is an allow permission.
AceFlags	The permission is inherited only and does not apply to this object. Child objects inherit this ACE.
Flags	Both ObjectType and InheritedObjectType are set.
ObjectType	This is the schemaIDGUID of the description attribute.[a]
InheritedObjectType	This is the schemaIDGUID of the User class.

[a] Globally Unique Identifiers (GUIDs) are used in the schema to distinguish objects and object attributes uniquely across your forest. Specifying that a GUID is used somewhere means that you are using a unique identifier for that item.

The user (TRustee) is allowed (AceType) write access (AccessMask) to a specific attribute of a specific object class (AccessMask and Flags), namely, the description (ObjectType) of user objects (InheritedObjectType). The ACE does not apply to the current object (AceFlags), so the current object is acting only as a propagator of the ACE down the tree (AceFlags).

To audit successful and failed modifications to the description of user objects within the entire branch beneath an Organizational Unit, the contents of the audit ACE on the Organizational Unit would look like Table 26-4.

Table 26-4. Contents of the ACE properties when auditing successful modifications to an Organizational Unit and all children by a user

Name of the property	Value to be stored
trustee	Names the user who is to be audited.
AccessMask	Gives write access to a specific property.
AceType	This is an audit ACE.
AceFlags	The auditing is inherited only and does not apply to this object. Child objects inherit this ACE. This ACE audits successes and failures.
Flags	Both ObjectType and InheritedObjectType are set.
ObjectType	This is the schemaIDGUID of the description attribute.
InheritedObjectType	This is the schemaIDGUID of the User class.

We are auditing (AceType) successful and failed (AceFlags) write access (AccessMask) to a specific attribute of a specific object class (AccessMask and Flags) by a user (trustee), namely, the description (ObjectType) of user objects (InheritedObjectType). The ACE does not apply to the current object (AceFlags), so the current object is acting only as a propagator of the ACE down the tree (AceFlags).

Each ACE property uses a set of values that correspond to the text populating the following tables. Let's consider each of the properties of an ACE in turn to examine the values that can be stored within.

26.1.1. Trustee

The TRustee is the group or user receiving the permissions defined in the AccessMask and AceType fields or the user or group that is being audited. The TRustee can take any of the following forms:

Domain accounts

These are the logon names used in previous versions of Windows NT, in the form *domain**useraccount*, where *domain* is the name of the Windows NT domain that contains the user and *useraccount* is the `sAMAccountName` property of the specified user. An example is AMER\jsmith. This is still valid for Windows 2000 and Windows Server 2003 domains.

Well-known security principals

These represent special identities defined by the Windows NT/Windows 2000/Windows Server 2003 security system, such as Everyone, Authenticated Users, System, Creator Owner, etc. The objects representing the security principals are stored in the Well-Known Security Principals container beneath the Configuration container.

Built-in groups

These represent the built-in user groups defined by the Windows NT security system. They have the form BUILTIN*groupname* where *groupname* is the name of the built-in user group. The objects representing the built-in groups are stored in the Builtin container beneath the domain container. An example is BUILTIN\Administrators.

Security Identifiers (SIDs)

These are specified in string format and represent the `objectSID` property of the specified user or group in Active Directory. An example is `S-1-5-99-427-9`.

User Principal Name (UPN)

This is the `userPrincipalName` property of the specified user or group in Active Directory. An example is Nicole.Hansknecht@mycorp.com.

> When using a `trustee` in an ACE, you should always try to use a group, not a user. Groups are far more flexible in that you can easily change who has permissions or easily grant more trustees the same permission by adding more users to the group. You also need to be very careful of the scope of the group. For example, a domain local group is not a good group scope to use for granting write access to an object in the configuration container in a multi-domain forest because the domain local groups are effective only on domain controllers from the domain the groups exist in. If you find you can write to a configuration container object on a domain controller from one domain but not on a domain controller in another domain, there is a good chance your access was granted through a domain local group.

26.1.2. AccessMask

The `AccessMask` specifies the single or multiple permissions you are setting or auditing for the ACE. Note that this property does not determine whether you are allowing or denying the permission or whether you are auditing successful or failed access, only what the permission is.

> If you are applying the permissions to a specific object or property, you also need to specify the relevant GUID of the object or property that you are giving rights to in the ObjectType or InheritedObjectType properties.

The largest set of values applies to the AccessMask, which is probably what you would expect. See Table 26-5.

Table 26-5. AccessMask constants

ADSI name	Decimal value	Hex value	Description
ADS_RIGHT_GENERIC_READ	2,147,483,648	&H80000000	Right to read from the Security Descriptor, to examine the object and its children, and to read all properties
ADS_RIGHT_GENERIC_WRITE	1,073,741,824	&H40000000	Right to write all properties, write to the DACL, and add/remove the object from the tree
ADS_RIGHT_GENERIC_EXECUTE	536,870,912	&H20000000	Right to list children of the object
ADS_RIGHT_GENERIC_ALL	268,435,456	&H10000000	Right to create/delete children, delete the tree, read/write properties, examine the object and its children, add/remove the object from the tree, and read/write with an extended right
ADS_RIGHT_ACCESS_SYSTEM_SECURITY	16,777,216	&H1000000	Right to get or set the SACL in the SD of the object
ADS_RIGHT_SYNCHRONIZE	1,048,576	&H100000	Right to use the object for synchronization (see ADSI documentation for more information)
ADS_RIGHT_WRITE_OWNER	524,288	&H80000	Right to assume ownership of the object; no right to grant ownership to others (User must be a trustee of the object)
ADS_RIGHT_WRITE_ DAC	262,144	&H40000	Right to write to the DACL of the object
ADS_RIGHT_READ_CONTROL	131,072	&H20000	Right to read from the security descriptor of the object
ADS_RIGHT_DELETE	65,536	&H10000	Right to delete the object
ADS_RIGHT_DS_CONTROL_ACCESS	256	&H100	Right to perform an application-specific extension on the object (GUID=extended right)

ADSI name	Decimal value	Hex value	Description
ADS_RIGHT_DS_LIST_OBJECT	128	&H80	Right to examine the object (if this is missing, the object is hidden from the user)
ADS_RIGHT_DS_DELETE_TREE	64	&H40	Right to delete all children of this object, regardless of the permission on the children
ADS_RIGHT_DS_WRITE_PROP	32	&H20	Right to write properties of the object (GUID=specific property; no GUID=all properties)
ADS_RIGHT_DS_READ_PROP	16	&H10	Right to read properties of the object (GUID=specific property; no GUID=all properties)
ADS_RIGHT_DS_SELF	8	&H8	Right to invoke a validated write update.
ADS_RIGHT_ACTRL_DS_LIST	4	&H4	Right to examine children of the object
ADS_RIGHT_DS_DELETE_CHILD	2	&H2	Right to delete children of the object (GUID=specific child object class; no GUID=all child object classes)
ADS_RIGHT_DS_CREATE_CHILD	1	&H1	Right to create children of the object (GUID=specific child object class; no GUID=all child object classes)
No name defined	-1	&HFFFFFFFFFFFFFFFF	Full control
No name defined	983551	&HF01FF	Full control, alternate value

These values were taken from the ADSI documentation for the ADS_RIGHTS_ENUM enumerated type available from the MSDN Library under the section described at the beginning of the chapter.

The value in the first column is the constant name that Microsoft defined for ADSI. This works fine if you are programming in VB or VC++ or scripting in a language that can make use of the available ADSI libraries, but with VBScript these constants are not defined. In other words, you have to define them in each script you use. To save you time, just copy the Const definitions from any of the ACE scripts provided on the O'Reilly web site for this book. We've included the values in both decimal and in hex for two reasons. First, we will be using hex in the scripts; the decimal values are there in case you want to use them for your own preference. Second, Microsoft defines all their constants in hexadecimal, so that is what you will see in the ADSI documentation. &H is the prefix for a hex number in VBScript, so if you want to specify that a group can list, create, and delete all children, you would use the value &H7, consisting of the rights ADS_RIGHT_ACTRL_DS_LIST + ADS_RIGHT_DS_DELETE_CHILD + ADS_RIGHT_DS_ CREATE_CHILD.

The last two values have no name and are what you use if you want to define full control permissions. Note that in this case, most programmers tend to use the decimal value -1 even if they have used hexadecimal values elsewhere.

The GUIDs relating to properties and children are discussed further under the ACE Flags property.

You probably noticed two different numeric values for full control in Table 26-5. While -1 is the "official" value for full control, you will often find 983551 set in some ACEs that were configured as full control. 983551 is the combination of ADS_RIGHT_WRITE_OWNER, ADS_RIGHT_WRITE_DAC, ADS_RIGHT_READ_CONTROL, ADS_RIGHT_DELETE, ADS_RIGHT_DS_CONTROL_ACCESS, ADS_RIGHT_DS_LIST_OBJECT, ADS_RIGHT_DS_DELETE_TREE, ADS_RIGHT_DS_WRITE_PROP, ADS_RIGHT_DS_READ_PROP, ADS_RIGHT_DS_SELF, ADS_RIGHT_ACTRL_DS_LIST, ADS_RIGHT_DS_DELETE_CHILD, and ADS_RIGHT_DS_CREATE_CHILD.

26.1.3. AceType

This property dictates whether the ACE denies permissions, allows permissions, or audits use of permissions (whether success or failure is defined in AceFlags). The values set here depend on whether the ACE applies to a specific object/property or just applies generally. See Table 26-6.

Table 26-6. AceType constants

ADSI name	Decimal value	Hex value	Description
ADS_ACETYPE_SYSTEM_ALARM_ OBJECT	8	&H8	Not used.
ADS_ACETYPE_SYSTEM_AUDIT_ OBJECT	7	&H7	This is a system-audit entry ACE using a GUID.
ADS_ACETYPE_ACCESS_DENIED_ OBJECT	6	&H6	This is an access-denied ACE using a GUID.
ADS_ACETYPE_ACCESS_ALLOWED_ OBJECT	5	&H5	This is an access-allowed ACE using a GUID.
ADS_ACETYPE_SYSTEM_ AUDIT	2	&H2	This is a system-audit entry ACE using a Windows NT Security Descriptor.
ADS_ACETYPE_ACCESS_ DENIED	1	&H1	This is an access-denied ACE using a Windows NT Security Descriptor.
ADS_ACETYPE_ACCESS_ ALLOWED	0	&H0	This is an access-allowed ACE using a Windows NT Security Descriptor.

Only one value can be set at any one time. This is why the values are not 1, 2, 4, and so on.

These values were taken from the ADSI documentation for the ADS_ACETYPE_ENUM enumerated type available from the MSDN Library under the section described at the beginning of the chapter.

Those ACEs that have a GUID in ObjectType or InheritedObjectType use the top four _OBJECT values. Any ACEs that do not refer to a specific GUID use the bottom three.

26.1.4. AceFlags

This catchall location stores two sets of information: inheritance and auditing. First it stores whether its children can inherit this ACE, whether the ACE applies to this object or is only acting as a propagator to pass it on to other objects, and whether the ACE itself is inherited. Second, for system-audit ACEs, this property indicates whether audit events are generated for success, failure, or both of the AccessMask permissions. See Table 26-7.

Table 26-7. AceFlags constants

ADSI name	Decimal value	Hex value	Description
ADS_ACEFLAG_FAILED_ACCESS	128	&H80	Used in the SACL only; indicates to generate audit messages for failed access attempts
ADS_ACEFLAG_SUCCESSFUL_ ACCESS	64	&H40	Used in the SACL only; indicates whether to generate audit messages for successful access attempts
ADS_ACEFLAG_VALID_INHERIT_ FLAGS	31	&H1F	Indicates whether the inherit flags for this ACE are valid (set only by the system)
ADS_ACEFLAG_INHERITED_ACE	16	&H10	Indicates whether this ACE was inherited (set only by the system)
ADS_ACEFLAG_INHERIT_ONLY_ ACE	8	&H8	Indicates an inherit-only ACE that does not exercise access controls on the object to which it is attached
ADS_ACEFLAG_NO_ PROPAGATE_INHERIT_ACE	4	&H4	Child objects will not inherit this ACE
ADS_ACEFLAG_INHERIT_ACE	2	&H2	Child objects will inherit this ACE

These values were taken from the ADSI documentation for the ADS_ACEFLAG_ENUM enumerated type available from the MSDN Library under the section described at the beginning of the chapter.

There are three unusual aspects to this property:

- The two SACL flags should surely be in AceType, not AceFlags, since AceType already indicates the allow or deny aspects of a DACL ACE. Strangely, they are here instead.

- The ADS_ACEFLAG_INHERIT_ONLY_ACE indicates that the object that this ACE is attached to is acting only as a carrier for the object, rather than being affected by the ACE itself.
- Flags of this nature in ADSI are normally are intended to indicate the presence or absence of something. The flag is set or it is not, giving us two states for whatever the flag refers to. Take a look at the last two flags in the table. The ADS_ ACEFLAG_INHERIT_ACE flag indicates that the ACE will be propagated down to child objects throughout the section of the tree below this object. If the ADS_ACEFLAG_INHERIT_ACE flag is set, ADS_ACEFLAG_NO_PROPAGATE_INHERIT_ACE will not be set. If ADS_ACEFLAG_NO_PROPAGATE_INHERIT_ACE is set, ADS_ACEFLAG_INHERIT_ACE is not, and this prevents the ACE from being inherited by subsequent generations of objects. Don't try to set both at the same time.

26.1.5. Flags, ObjectType, and InheritedObjectType

For the ACE to know whether it contains an ObjectType or InheritedObjectType field, it contains a Flags property. This can have only four values. If the value is 0, neither object is present in the ACE. The other three values (1, 2, and 3) are made up from the two constants displayed in Table 26-8.

Table 26-8. Flag type constants

ADSI name	Decimal value	Hex value	Description
ADS_FLAG_ INHERITED_OBJECT_ TYPE_PRESENT	2	&H2	Indicates that an InheritedObjectType is present in the ACE
ADS_FLAG_OBJECT_ TYPE_PRESENT	1	&H1	Indicates that an ObjectType is present in the ACE

These values were taken from the ADSI documentation for the ADS_FLAGTYPE_ENUM enumerated type available from the MSDN Library under the section described at the beginning of the chapter.

The ObjectType and InheritedObjectType fields store GUIDs or null values that indicate what the ACE actually applies to. Table 26-9 explains it much better.

Table 26-9. How to use ObjectType and InheritedObjectType

ACE requirement	AceFlags	Flags	ObjectType	InheritedObjectType
Permissions are to apply to entire current object.	Effective on current object; not inherited by child objects	Neither	Null (ignored but still set)	Null (ignored but still set)
Permissions are to apply to a specific attribute of the current object.	Effective on current object; not inherited by child objects	`ObjectType` only	`schemaIDGUID` of the `attributeSchema` object that defines the attribute in the schema or rightsGuid of the `controlAccessRight` object that defines the extended right, property set, or validated right in the extended-rights container	Null (ignored but still set)
Permissions are to apply to all child objects.	Not effective on current object; inherited by children	`ObjectType` only	Null[a]	Null (ignored but still set)
Permissions are to apply to child objects that are of a specific class.	Not effective on current object; inherited by children	`ObjectType` only	`schemaIDGUID` of the `classSchema` object that defines the class in the schema or rightsGuid of the `controlAccessRight` object that defines the extended right, property set, or validated right in the extended-rights container	Null (ignored but still set)
Permissions are to apply to a specific attribute of specific child objects.	Not effective on current object; inherited by children	Both	`schemaIDGUID` of the `attributeSchema` object that defines the attribute in the schema or `rightsGuid` of the `controlAccessRight` object that defines the extended right, property set, or validated right in the extended-rights container	`schemaIDGUID` of the classSchema object that defines the class in the schema

[a] Setting null for the `ObjectType` field in the third entry signifies that this ACE applies to all child objects; this is the only time that you do not use a GUID in this property. The system understands that a null value for a required `ObjectType` field is the same as providing the GUIDs for every possible child object all at once.

You do not need to set null items that are ignored; they will be set to null by the system on creation of the ACE.

> Note that Flags, ObjectType, and InheritedObjectType have defaults of 0, null, and null, respectively.

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26.2. A Simple ADSI Example

All of the seven ACE properties are set using property methods of the same names as those in an ADSI interface called `IADsAccessControlEntry`. The ACEs that are created using this are then modified using `IADsAccessControlList` and `IADsSecurityDescriptor`.

Let's go through an example now so you can see how it all fits together. Example 26-1 shows a section of VBScript code that creates an ACE that allows ANewGroup full access to the myOU organizational unit and all its children.

Example 26-1. A simple ADSI example

```
'**************************************************************************
'Declare constants
'**************************************************************************
Const FULL_CONTROL = -1
Const ADS_ACETYPE_ACCESS_ALLOWED = 0
Const ADS_FLAG_INHERITED_OBJECT_TYPE_PRESENT = 2

'**************************************************************************
'Declare variables
'**************************************************************************
Dim objObject     'Any object
Dim objSecDesc    'SecurityDescriptor
Dim objDACL       'AccessControlList
Dim objNewACE     'AccessControlEntry

'**************************************************************************
'Create the new ACE and populate it
'**************************************************************************
Set objNewACE = CreateObject("AccessControlEntry")
objNewACE.Trustee = "AMER\ANewGroup"
objNewACE.AccessMask = FULL_CONTROL
objNewACE.AceType = ADS_ACETYPE_ACCESS_ALLOWED
objNewACE.AceFlags = ADS_FLAG_INHERITED_OBJECT_TYPE_PRESENT

'**************************************************************************
'Add the new ACE to the object and write it to the AD
'**************************************************************************
Set objObject = GetObject("LDAP://ou=myOU,dc=amer,dc=mycorp,dc=com")

'**************************************************************************
'Use IADs::Get to retrieve the SD for the object
```

```
'**************************************************************************
Set objSecDesc = objObject.Get("ntSecurityDescriptor")

'**************************************************************************
'Use IADsSecurityDescriptor:: DiscretionaryAcl to retrieve the existing DACL
'**************************************************************************
Set objDACL = objSecDesc.DiscretionaryAcl

'**************************************************************************
'Use IADsAccessControlList::AddACE to add an ACE to an existing DACL
'**************************************************************************
objDACL.AddAce objNewACE

'**************************************************************************
'Use IADsSecurityDescriptor:: DiscretionaryAcl to put back the modified DACL
'**************************************************************************
objSecDesc.DiscretionaryAcl = objDACL

'**************************************************************************
'Use IADs::Put to replace the SD for the object
'**************************************************************************
objObject.Put "ntSecurityDescriptor", Array(objSecDesc)

'**************************************************************************
'Write out the property cache using IADs::SetInfo
'**************************************************************************
objObject.SetInfo
```

A common error seen by script writers writing their own ACL manipulation scripts is the dreaded "The security ID structure is invalid" error, or error -2147023559. The number one cause of this error is a trustee that cannot be resolved to a SID.

26.2.1. Discussion

First we create the new ACE. This requires use of a `CreateObject` function call to create a new empty instance of an ACE object. We then have to set the four fields that we need. The `TRustee` is the user or group that will have the permission to the myOU object. The `AccessMask` value set to -1 indicates that full permission is being set. To say whether the full permissions are allowed or denied, we use a 0 in the `AceType` field, which indicates that the ACE is a permissions-allowed ACE. Finally, the `AceFlags` field is set to 2 so that child objects will inherit this ACE. This means that the ACE now allows ANewGroup full access to the myOU organizational unit and all its children.

We then go through binding to the object to get the security descriptor and ultimately the DACL so that we can add the new ACE to the DACL. Once that is done, we reverse the steps and set the security descriptor for the object, writing out the property cache as the last step.

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26.3. A Complex ADSI Example

Example 26-2 is an example of a real-life problem that gets asked nearly every week in the Microsoft newsgroups: how to delegate the ability to unlock an account, reset a password, and set the flag that the account must change password on the next logon.

Example 26-2. Delegating unlock, password reset, and must change password flag

```
Option Explicit

'**************************************************************************
'Modify these to change your trustee and target for the ACL mod
'**************************************************************************
Const TRUSTEE="AMER\PasswordAdmin"
Const OBJPATH="ou=myOU,dc=amer,dc=mycorp,dc=com"

'**************************************************************************
'Attribute, Class, Control Access Right constants
'**************************************************************************
Const ATTRIB_LOCKOUTTIME_GUID = "{28630EBF-41D5-11D1-A9C1-0000F80367C1}"
Const ATTRIB_PWDLASTSET_GUID = "{BF967A0A-0DE6-11D0-A285-00AA003049E2}"
Const CLASS_USER_GUID = "{BF967ABA-0DE6-11D0-A285-00AA003049E2}"
Const CAR_RESETPWD_GUID = "{00299570-246D-11D0-A768-00AA006E0529}"

'**************************************************************************
'AccessMask constants
'**************************************************************************
Const ADS_RIGHT_GENERIC_READ = &H80000000
Const ADS_RIGHT_GENERIC_WRITE = &H40000000
Const ADS_RIGHT_GENERIC_EXECUTE = &H20000000
Const ADS_RIGHT_GENERIC_ALL = &H10000000
Const ADS_RIGHT_ACCESS_SYSTEM_SECURITY = &H1000000
Const ADS_RIGHT_SYNCHRONIZE = &H100000
Const ADS_RIGHT_WRITE_OWNER = &H80000
Const ADS_RIGHT_WRITE_DAC = &H40000
Const ADS_RIGHT_READ_CONTROL = &H20000
Const ADS_RIGHT_DELETE = &H10000
Const ADS_RIGHT_DS_CONTROL_ACCESS = &H100
Const ADS_RIGHT_DS_LIST_OBJECT = &H80
Const ADS_RIGHT_DS_DELETE_TREE = &H40
Const ADS_RIGHT_DS_WRITE_PROP = &H20
Const ADS_RIGHT_DS_READ_PROP = &H10
Const ADS_RIGHT_DS_SELF = &H8
Const ADS_RIGHT_ACTRL_DS_LIST = &H4
Const ADS_RIGHT_DS_DELETE_CHILD = &H2
Const ADS_RIGHT_DS_CREATE_CHILD = &H1
Const FULL_CONTROL = -1


'************************************************************************
'AceType constants
'************************************************************************
Const ADS_ACETYPE_SYSTEM_AUDIT_OBJECT = &H7
Const ADS_ACETYPE_ACCESS_DENIED_OBJECT = &H6
Const ADS_ACETYPE_ACCESS_ALLOWED_OBJECT = &H5
Const ADS_ACETYPE_SYSTEM_AUDIT = &H2
Const ADS_ACETYPE_ACCESS_DENIED = &H1
Const ADS_ACETYPE_ACCESS_ALLOWED = &H0

'************************************************************************
'AceFlags constants
'************************************************************************
Const ADS_ACEFLAG_FAILED_ACCESS = &H80
Const ADS_ACEFLAG_SUCCESSFUL_ACCESS = &H40
Const ADS_ACEFLAG_VALID_INHERIT_FLAGS = &H1F
Const ADS_ACEFLAG_INHERITED_ACE = &H10
Const ADS_ACEFLAG_INHERIT_ONLY_ACE = &H8
Const ADS_ACEFLAG_NO_PROPAGATE_INHERIT_ACE = &H4
Const ADS_ACEFLAG_INHERIT_ACE = &H2

'************************************************************************
'Flags constants
'************************************************************************
Const ADS_FLAG_INHERITED_OBJECT_TYPE_PRESENT = &H2
Const ADS_FLAG_OBJECT_TYPE_PRESENT = &H1


'************************************************************************
'Declare variables
'************************************************************************
Dim objObject    'Any object
Dim objSecDesc   'SecurityDescriptor
Dim objDACL      'AccessControlList
Dim objNewACE_1  'AccessControlEntry
Dim objNewACE_2  'AccessControlEntry
Dim objNewACE_3  'AccessControlEntry

'************************************************************************
'Create new ACE, Unlock User Objects
'************************************************************************
Set objNewACE_1 = CreateObject("AccessControlEntry")
objNewACE_1.Trustee = TRUSTEE
objNewACE_1.AccessMask = ADS_RIGHT_DS_WRITE_PROP or ADS_RIGHT_DS_READ_PROP
objNewACE_1.AceType = ADS_ACETYPE_ACCESS_ALLOWED_OBJECT
objNewACE_1.AceFlags = ADS_ACEFLAG_INHERIT_ONLY_ACE _
```

```
                                                 or ADS_ACEFLAG_INHERIT_ACE
 objNewACE_1.Flags= ADS_FLAG_OBJECT_TYPE_PRESENT _
                                  or ADS_FLAG_INHERITED_OBJECT_TYPE_PRESENT
 objNewACE_1.ObjectType= ATTRIB_LOCKOUTTIME_GUID
 objNewACE_1.InheritedObjectType = CLASS_USER_GUID


'**************************************************************************
'Create new ACE, Set/Clear Must change password on next logon
'**************************************************************************
 Set objNewACE_2 = CreateObject("AccessControlEntry")
 objNewACE_2.Trustee = TRUSTEE
 objNewACE_2.AccessMask = ADS_RIGHT_DS_WRITE_PROP or ADS_RIGHT_DS_READ_PROP
 objNewACE_2.AceType = ADS_ACETYPE_ACCESS_ALLOWED_OBJECT
 objNewACE_2.AceFlags = ADS_ACEFLAG_INHERIT_ONLY_ACE _
                                                 or ADS_ACEFLAG_INHERIT_ACE
 objNewACE_2.Flags= ADS_FLAG_OBJECT_TYPE_PRESENT _
                                  or ADS_FLAG_INHERITED_OBJECT_TYPE_PRESENT
 objNewACE_2.ObjectType= ATTRIB_PWDLASTSET_GUID
 objNewACE_2.InheritedObjectType = CLASS_USER_GUID

'**************************************************************************
'Create new ACE, Reset Password
'**************************************************************************
 Set objNewACE_3 = CreateObject("AccessControlEntry")
 objNewACE_3.Trustee = TRUSTEE
 objNewACE_3.AccessMask = ADS_RIGHT_DS_CONTROL_ACCESS
 objNewACE_3.AceType = ADS_ACETYPE_ACCESS_ALLOWED_OBJECT
 objNewACE_3.AceFlags = ADS_ACEFLAG_INHERIT_ONLY_ACE _
                                                 or ADS_ACEFLAG_INHERIT_ACE
 objNewACE_3.Flags= ADS_FLAG_OBJECT_TYPE_PRESENT _
                                  or ADS_FLAG_INHERITED_OBJECT_TYPE_PRESENT
 objNewACE_3.ObjectType= CAR_RESETPWD_GUID
 objNewACE_3.InheritedObjectType = CLASS_USER_GUID

'**************************************************************************
'Add the new ACE to the object and write it to the AD
'**************************************************************************
Set objObject = GetObject("LDAP://" & OBJPATH)

'**************************************************************************
'Use IADs::Get to retrieve the SD for the object
'**************************************************************************
Set objSecDesc = objObject.Get("ntSecurityDescriptor")

'**************************************************************************
'Use IADsSecurityDescriptor:: DiscretionaryAcl to retrieve the existing DACL
'**************************************************************************
Set objDACL = objSecDesc.DiscretionaryAcl

'**************************************************************************
'Use IADsAccessControlList::AddACE to add ACEs to an existing DACL
```

```
'*********************************************************************
objDACL.AddAce objNewACE_1     ' Add Unlock
objDACL.AddAce objNewACE_2     ' Add Set/Clear must change password
objDACL.AddAce objNewACE_3     ' Add Reset password

'*********************************************************************
'Use IADsSecurityDescriptor:: DiscretionaryAcl to put back the modified DACL

'*********************************************************************
objSecDesc.DiscretionaryAcl = objDACL

'*********************************************************************
'Use IADs::Put to replace the SD for the object
'*********************************************************************
objObject.Put "ntSecurityDescriptor", Array(objSecDesc)

'*********************************************************************
'Write out the property cache using IADs::SetInfo
'*********************************************************************
objObject.SetInfo
```

> If you run this script multiple times, you will see the same ACEs being added to the ACL over and over again. It is a very simple script and does not check to see whether the permissions have already been delegated, and the security interface itself is not smart enough to prevent the duplicates.

26.3.1. Discussion

The first thing you will notice is that this script is longer than the last. Do not let that confuse or scare you; it is still quite simple. At the top of the script are two lines that you modify to specify which group (or user) the delegation is being applied for and the object to which the delegation is being applied to. This small little changes makes it much easier to modify the script for your use; you do not have to go looking for other places to make changes.

The next section of the script is dedicated to defining constants for the attributes, classes, and control access rights we are delegating. Once you get past the simple examples of allowing full control to everything or read access to everything, you need to start specifying actual object class types, attributes, control access rights, property sets, and validated writes. Unfortunately, the security interfaces aren't intelligent enough to take simple names like user or `lockoutTime` and set the proper values in the ACEs, so we need to know the proper values and specify them ourselves. For classes and attributes, we need to use the `schemaIDGUID` attribute from the `classSchema` and `attributeSchema` objects involved. For control access rights, property sets, and validated rights, we need to use the `rightsGUID` attribute of the `controlAccessRight` objects in the `cn=extended-rights` container of the configuration naming context.

Now there is a long section of various constants defined for the security interfaces specifying values for the various types of permissions that can be granted, whether they are inherited, etc. These values are from Tables 26-5 through 26-8.

Finally, we reach the core piece of the script, what really makes it different from the simple example. The creation of three new ACEs:

1. Unlock Account
2. Set/Clear "User Must Change Password On Next Logon" Flag
3. Reset Password

26.3.1.1. Unlock account

The first ACE delegates the ability to unlock a user account. In Active Directory, the attribute that controls whether or not an account is locked is the `lockoutTime` attribute; if the value is 0, the account is definitely unlocked. The delegate will need write access so the value can be set to 0 to clear the attribute when it is locked. It would be incorrect to assume that the delegate can already read the `lockoutTime` value, so it is best to grant Read Property (RP) as well as Write Property (WP). While this RP may not be needed initially, it may be needed later if Active Directory is locked down. In order to grant RP and WP, you specify an `AccessMask` of `ADS_RIGHT_DS_WRITE_PROP` combined with `ADS_RIGHT_DS_READ_PROP`. Because these are bit flags, we combine them with the `or` keyword.

Since we are granting permissions to a specific object and attribute, `ADS_ACETYPE_ACCESS_ALLOWED_OBJECT` has to be specified instead of `ADS_ACETYPE_ACCESS_ALLOWED` for the value of `AceType`. This is exactly as specified in Table 26-6.

The next property to be set is the `AceFlags` property, which specifies inheritance. This ACE should only be inherited to user objects, so it requires two flags to be specified that must again be combined with the `or` keyword:

- `ADS_ACEFLAG_INHERIT_ONLY_ACE` to specify that the object we are applying the ACL to should not apply the ACE to itself (i.e., the OU shouldn't apply this).
- `ADS_ACEFLAG_INHERIT_ACE` to specify that the children of the object should apply the ACE (i.e., objects under the OU should apply this).

Finally, the most confusing part of the ACE: the `objectType` and `inheritedObjectType` combined with the `Flags` property. The ACE needs to apply to a specific attribute on a specific objectclass; this means that both the `objectType` and `inheritedObjectType` properties will be populated. That indicates that the two bit flags `ADS_FLAG_OBJECT_TYPE_PRESENT` and `ADS_FLAG_INHERITED_OBJECT_TYPE_PRESENT` both must be combined in the `Flags` property with the `or` keyword. If you think about it, that part is pretty straight-forward; the flag values are well named. So now, what do you use for the `objectType` and `inheritedObjectType` properties? It is actually quite easy once you get the hang of it, even though the names aren't intuitive. The objectclass that you need to have inherit this ACE is placed into the `inheritedObjectType` property; in this case, it is the user class so you set this property to the `schemaIDGUID` value of the user class. That leaves the `objectType` property, and you only have one piece of information left, the attribute you want to delegate, so you set the property equal to the `schemaIDGUID` of the `lockoutTime` attribute.

26.3.1.2. Set/clear "User Must Change Password On Next Logon" flag

This ACE is very similar to the previous Unlock Account ACE; in fact, the only difference is the objectType property. The new value is the schemaIDGUID of the attribute pwdLastSet. Under Windows NT, this capability was handled through a bit flag. Active Directory tracks this now by tracking the last time the password was changed. If the value is set to 0, it means the account must change the password on the next logon. If the value has any other value, it is the time the password was last set and is used to determine the password age for expiration. So once again, only a simple RP and WP needs to be granted, so take the values from the previous ACE and simply change the objectType from the lockoutTime attribute to the pwdLastSet attribute.

26.3.1.3. Reset Password

The final ACE is the Reset Password ACE . This one is a little more involved but still only has two properties that are different from the Unlock Account ACE. You will recall the discussion from Chapter 11 about property sets, control access rights, and validated writes; well resetting a password involves more than writing a single attribute from a permission standpoint. Resetting a password actually updates several attributes so Microsoft has assigned a special right to signify that someone can do this. It is similar to specifying an attribute to be delegated in that you store a GUID for the control access right into the objectType attribute. It is different in that you must get a different GUID, the rightsGuid, from a controlAccessRight object, not an attributeSchema object. These controlAccessRight objects are stored in the cn=extended-rights container of the configuration NC.

The other difference is that you must specify a special AccessMask value. Reset Password isn't an attribute or even a set of attributes you are granting access to, so granting RP and WP doesn't make sense. Because this is a special operation, you instead grant Control Access (CA) permission. This is specified by setting the AccessMask property with ADS_RIGHT_DS_CONTROL_ACCESS.

26.3.2. Making Your Own ACEs

This script should show you how to handle a vast majority of your delegation work via scripts. You only need to fill in the properties of the ACE to describe what you want. For many delegations, you can use the Unlock Account ACE as a model and simply modify the objectType and inheritedObjectType properties. You can change a Grant to a Deny by changing the AceType from ADS_ACETYPE_ACCESS_ALLOWED_OBJECT to ADS_ACETYPE_ACCESS_DENIED_OBJECT.

26.3.2.1. Delegate member attribute on groups

The inheritedObjectType should be the schemaIDGUID for the group class ({BF967A9C-0DE6-11D0-A285-00AA003049E2}). The objectType should be the schemaIDGUID for the member attribute ({BF9679C0-0DE6-11D0-A285-00AA003049E2}). As for the rest of the ACE, you can either grant or deny RP or WP or both.

26.3.2.2. Delegate ability to view Confidential Attribute

As mentioned in Chapter 11, Microsoft does not provide a mechanism to easily grant granular delegated access to attributes marked as Confidential. You are now armed with the information required to write a script to delegate this permission. Two permissions need to be present in order to read a Confidential attribute : the first is obviously RP, and the second is CA. So in order to grant the ability to read a confidential attribute that you added to your schema called `socialSecurityNumber`, you would retrieve the `schemaIDGUID` from the schema for the attribute and set the `objectType` property with that value. You would set the `inheritedObjectType` property to the `schemaIDGUID` for the user class. Finally, you would set the `AccessMask` to RP and CA by using the `or` keyword.

26.3.2.3. How to implement other delegations

All delegation is a combination of very simple values. Sometimes it isn't always easy to ascertain what values should be set for what properties of the Security interface. To help with this, use the GUI or some other delegation tool such as *DSACLS* to set some delegation up and then simply list out the ACL and see what values are set. Once you have done this two or three times, you will be able to quickly put together new scripts to delegate anything you need. To assist you in this process, the last script of this chapter will output the entire Security Descriptor of any object you specify showing raw numeric values for each property, as well as the "decoded" constant names, attributes, classes, property sets, extended rights, and validated writes.

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26.4. Creating Security Descriptors

If you are creating an object from scratch and you don't want it to receive the default DACL and SACL that would normally be applied to objects created, you can write your own DACL and SACL for an object. As you would expect, there are a number of properties associated with security descriptors and ACLs that you need to set. SDs and ACLs can be manipulated with the IADsAccessControlList (see Table 26-10) and IADsSecurityDescriptor (see Table 26-11) interfaces. We'll go through these briefly now and then move on to some more examples.

Table 26-10. IADsAccessControlList methods and properties

IADsAccessControlList methods and properties	Action
AddAce method	Adds an ACE to an ACL
RemoveAce method	Removes an ACE from an ACL
CopyAccessList method	Copies the current ACL
AclRevision property	Shows the revision of the ACL (always set to 4; see later text)
AceCount property	Indicates the number of ACEs in the ACL

Table 26-11. IADsSecurityDescriptor methods and properties

IADsSecurityDescriptor methods and properties	Action
CopySecurityDescriptor method	A copy of an existing SD.
Revision property	The revision of the SD (always set to 4, as noted earlier).
Control property	A set of flags indicating various aspects of the SD (see later text). Generally, you will not need to set this property; instead, you can set the properties listed in this table.
Owner property	The SID of the owner. If this field is null, no owner is set.
OwnerDefaulted property	A Boolean value indicating whether the owner is derived by the default mechanism when created (i.e., assembled out of all the inherited ACEs passed down by its parents) rather than explicitly set by the person or application that created the SD in the first place.

IADsSecurityDescriptor methods and properties	Action
Group property	The SID of the object's primary group, if appropriate. If this field is null, no primary group exists.
GroupDefaulted property	A Boolean value indicating that the group is derived by the default mechanism rather than explicitly set by the person or application that created the SD in the first place.
DiscretionaryAcl property	The discretionary ACL that holds permissions ACEs. The SE_DACL_PRESENT flag must be set in the Control property if a DACL exists. If the flag is set and yet this field is null, full access is allowed to everyone.
DaclDefaulted property	A Boolean value indicating that the DACL is derived by the default mechanism rather than explicitly set by the person or application that created the SD in the first place. This is ignored unless SE_DACL_PRESENT is set.
SystemAcl property	The system ACL that holds auditing ACEs. The SE_SACL_PRESENT flag must be set in the Control property if a SACL exists.
SaclDefaulted property	A Boolean value indicating that the SACL is derived by the default mechanism rather than explicitly set by the person or application that created the SD in the first place. This is ignored unless SE_SACL_PRESENT is set.

Every SD and ACL has a revision level to define the data structures in use. The SD revision level has never changed, so it is fixed at revision level 1. The ACL revision, on the other hand, has gone through several revisions and is now at revision level 4.

Having a revision allows Microsoft to update the security data structures to allow for new properties and concepts. This lets Active Directory know what version of the structures are used so it can properly interpret them.

The Control property can take a number of flags that help to define the properties of an SD. See Table 26-12 for a full description.

Table 26-12. Control constants

ADSI name	Decimal value	Hex value	Description
ADS_SD_CONTROL_SE_OWNER_DEFAULTED	1	&H1	This Boolean flag, when set, indicates that the SID pointed to by the Owner field was provided by the default mechanism rather than set by the person or application that created the SD in the first place. This may affect the treatment of the SID with respect to inheritance of an owner.

ADSI name	Decimal value	Hex value	Description
ADS_SD_CONTROL_SE_GROUP_DEFAULTED	2	&H2	This Boolean flag, when set, indicates that the SID in the Group field was provided by the default mechanism rather than explicitly set by the person or application that created the SD in the first place. This may affect the treatment of the SID with respect to inheritance of a primary group.
ADS_SD_CONTROL_SE_DACL_PRESENT	4	&H4	This Boolean flag, when set, indicates that the security descriptor contains a DACL. If this flag is set and the DiscretionaryAcl field of the SD is null, an empty (but present) ACL is explicitly being specified.
ADS_SD_CONTROL_SE_DACL_DEFAULTED	8	&H8	This Boolean flag, when set, indicates that the field was provided by the default mechanism rather than explicitly set by the person or application that created the SD in the first place. This may affect the treatment of the ACL with respect to inheritance of an ACL. This flag is ignored if the SE_DACL_PRESENT flag is not set.
ADS_SD_CONTROL_SE_SACL_PRESENT	16	&H10	This Boolean flag, when set, indicates that the security descriptor contains a SACL.
ADS_SD_CONTROL_SE_SACL_DEFAULTED	32	&H20	This Boolean flag, when set, indicates that the ACL pointed to by the SystemAcl field was provided by the default mechanism rather than explicitly set by the person or application that created the SD in the first place. This may affect the treatment of the ACL with respect to inheritance of an ACL. This flag is ignored if the SE_SACL_PRESENT flag is not set.
ADS_SD_CONTROL_SE_DACL_AUTO_INHERIT_REQ	256	&H100	The DACL of the SD must be inherited.
ADS_SD_CONTROL_SE_SACL_AUTO_INHERIT_REQ	512	&H200	The SACL of the SD must be inherited.
ADS_SD_CONTROL_SE_DACL_AUTO_INHERITED	1,024	&H400	The DACL of the SD supports auto-propagation of inheritable ACEs to existing child objects.
ADS_SD_CONTROL_SE_SACL_AUTO_INHERITED	2,048	&H800	The SACL of the SD supports auto-propagation of inheritable ACEs to existing child objects.
ADS_SD_CONTROL_SE_DACL_PROTECTED	4,096	&H1000	The DACL of the SD is protected and will not be modified when new rights propagate through the tree.
ADS_SD_CONTROL_SE_SACL_PROTECTED	8,192	&H2000	The SACL of the SD is protected and will not be modified when new rights propagate through the tree.
ADS_SD_CONTROL_SE_SELF_RELATIVE	32,768	&H8000	The SD is held in a contiguous block of memory.

These values were taken from the ADSI documentation for the ADS_SD_CONTROL_ENUM enumerated type available from the MSDN Library under the section described at the beginning of the chapter.

> In your ADSI code, it is possible to specify that the DACL or SACL is either null or empty. While in both cases each ACL contains no ACEs, there is a big difference between the effects of each setting. Specifically, any ACL that has been set to null (vbNull) grants full permissions to everyone while an ACL that exists but contains no ACEs (i.e., is empty) grants no permissions to anyone at all.

Now we have enough information to be able to create our own SD. Example 26-3 does exactly that. While we have defined all of the SD constants, to save space we have defined only the ACE constants that we are using. Also note that this code is not 100% complete; the object creation code is not included.

Example 26-3. Creating your own security descriptor

```
Option Explicit

'**************************************************************************
'AccessMask constants
'**************************************************************************
Const ADS_RIGHT_DS_LIST_OBJECT = &H80

'**************************************************************************
'AceType constants
'**************************************************************************
Const ADS_ACETYPE_ACCESS_DENIED = &H1

'**************************************************************************
'AceFlags constants
'**************************************************************************
Const ADS_ACEFLAG_INHERIT_ACE = &H2


'**************************************************************************
'Security Descriptor constants
'**************************************************************************
Const ADS_SD_CONTROL_SE_OWNER_DEFAULTED = &H1
Const ADS_SD_CONTROL_SE_GROUP_DEFAULTED = &H2
Const ADS_SD_CONTROL_SE_DACL_PRESENT = &H4
Const ADS_SD_CONTROL_SE_DACL_DEFAULTED = &H8
Const ADS_SD_CONTROL_SE_SACL_PRESENT = &H10
Const ADS_SD_CONTROL_SE_SACL_DEFAULTED = &H20
Const ADS_SD_CONTROL_SE_DACL_AUTO_INHERIT_REQ = &H100
Const ADS_SD_CONTROL_SE_SACL_AUTO_INHERIT_REQ = &H200
Const ADS_SD_CONTROL_SE_DACL_AUTO_INHERITED = &H400
Const ADS_SD_CONTROL_SE_SACL_AUTO_INHERITED = &H800
Const ADS_SD_CONTROL_SE_DACL_PROTECTED = &H1000
Const ADS_SD_CONTROL_SE_SACL_PROTECTED = &H2000
```

```
'**********************************************************************************
'Security Descriptor and ACL Revision numbers
'**********************************************************************************
Const ACL_REVISION_DS = 4
Const SECURITY_DESCRIPTOR_REVISION = 1

'**********************************************************************************
'Declare general variables
'**********************************************************************************
Dim objNewObject             'The new object
Dim objSecDesc               'SecurityDescriptor
Dim objDACL                  'AccessControlList object containing permission ACEs
Dim objSACL                  'AccessControlList object containing audit ACEs
Dim objNewACE                'AccessControlEntry

'**********************************************************************************
'Set no permission to view the object for members of DenyGroup
'**********************************************************************************
Set objNewACE = CreateObject("AccessControlEntry")
objNewACE.Trustee = "AMER\DenyGroup"
objNewACE.AccessMask = ADS_RIGHT_DS_LIST_OBJECT
objNewACE.AceType = ADS_ACETYPE_ACCESS_DENIED
objNewACE.AceFlags = ADS_ACEFLAG_INHERIT_ACE

'**********************************************************************************
'Create a new DACL and add the ACE as the sole entry
'**********************************************************************************
Set objDACL = CreateObject("AccessControlList")
ObjDACL.AceCount = 1
ObjDACL.AclRevision = ACL_REVISION_DS
ObjDACL.AddAce objNewACE
Set objNewACE = Nothing

'**********************************************************************************
'Create the SD for the object. Set the SD to use the DACL supplied rather
'than the default one. Set the SD to use the default SACL that will be
'generated from inherited ACEs and defaultSD.

'**********************************************************************************
Set objSecDesc = CreateObject("SecurityDescriptor")
objSecDesc.Revision = SECURITY_DESCRIPTOR_REVISION
objSecDesc.OwnerDefaulted = True
objSecDesc.GroupDefaulted = True
objSecDesc.DiscretionaryAcl = objDACL
objSecDesc.DaclDefaulted = False
objSecDesc.SaclDefaulted = True

'**********************************************************************************
'Create the objObject first [this code is not included here]
'The variable objNewObject should point at the new object
'**********************************************************************************
```

```
'***************************************************************************
'Assign the SD to the existing object
'***************************************************************************
objNewObject.Put "ntSecurityDescriptor", objSecDesc
objNewObject.SetInfo
```

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26.5. Listing the Security Descriptor of an Object

A good example of a useful real-world task is when you are curious to see what ACEs have been set on an object, such as a domain or Organizational Unit. Example 26-4 is a piece of code that can be used as the basis for checking through an Active Directory forest looking for irregularities or be used to help you build the proper values for your own delegation script. The code is fairly simple but very long, due to the fact that it has to check every constant for both the SACL and DACL of each object.

Example 26-4. Examining the security descriptor of an object

```
'***************************************************************************
'Script to list SecurityDescriptor for specified Active Directory Object
'Run script with cscript - cscript sdlist.vbs
'***************************************************************************
Option Explicit

'***************************************************************************
'Declare the variables
'***************************************************************************
Dim objObject, objRootDSE, objSchema, objExtRights, objEnum, objSD
Dim objDACL, objSACL, objACE
Dim SchemaGuids, CARGuids, SDCtlD, AccMaskD, ACEFlagsD, FlagsD
Dim strDC, strSchemaPath, strConfigPath, strGUID, strLDAPPath

'***************************************************************************
'AccessMask constants
'***************************************************************************
Const FULL_CONTROL                      = -1
Const FULL_CONTROL2                     = &HF01FF

Const ADS_RIGHT_GENERIC_READ            = &H80000000
Const ADS_RIGHT_GENERIC_WRITE           = &H40000000
Const ADS_RIGHT_GENERIC_EXECUTE         = &H20000000
Const ADS_RIGHT_GENERIC_ALL             = &H10000000
 Const ADS_RIGHT_ACCESS_SYSTEM_SECURITY = &H1000000
Const ADS_RIGHT_SYNCHRONIZE             = &H100000
Const ADS_RIGHT_WRITE_OWNER             = &H80000
Const ADS_RIGHT_WRITE_DAC               = &H40000
Const ADS_RIGHT_READ_CONTROL            = &H20000
Const ADS_RIGHT_DELETE                  = &H10000
Const ADS_RIGHT_DS_CONTROL_ACCESS       = &H100
Const ADS_RIGHT_DS_LIST_OBJECT          = &H80
Const ADS_RIGHT_DS_DELETE_TREE          = &H40
Const ADS_RIGHT_DS_WRITE_PROP           = &H20
Const ADS_RIGHT_DS_READ_PROP            = &H10
Const ADS_RIGHT_DS_SELF                 = &H8
Const ADS_RIGHT_ACTRL_DS_LIST           = &H4
Const ADS_RIGHT_DS_DELETE_CHILD         = &H2
Const ADS_RIGHT_DS_CREATE_CHILD         = &H1

'****************************************************************************
'AccessMask Dictionary for Flag enumeration
'****************************************************************************
Set AccMaskD = CreateObject("Scripting.Dictionary")
AccMaskD.Add FULL_CONTROL, "FULL_CONTROL"
AccMaskD.Add FULL_CONTROL2, "FULL_CONTROL2"
AccMaskD.Add ADS_RIGHT_GENERIC_READ, "ADS_RIGHT_GENERIC_READ"
AccMaskD.Add ADS_RIGHT_GENERIC_WRITE, "ADS_RIGHT_GENERIC_WRITE"
AccMaskD.Add ADS_RIGHT_GENERIC_EXECUTE, "ADS_RIGHT_GENERIC_EXECUTE"
AccMaskD.Add ADS_RIGHT_GENERIC_ALL, "ADS_RIGHT_GENERIC_ALL"
AccMaskD.Add ADS_RIGHT_ACCESS_SYSTEM_SECURITY, "ADS_RIGHT_ACCESS_SYSTEM_SECURITY"
AccMaskD.Add ADS_RIGHT_SYNCHRONIZE, "ADS_RIGHT_SYNCHRONIZE"
AccMaskD.Add ADS_RIGHT_WRITE_OWNER, "ADS_RIGHT_WRITE_OWNER"
AccMaskD.Add ADS_RIGHT_WRITE_DAC, "ADS_RIGHT_WRITE_DAC"
AccMaskD.Add ADS_RIGHT_READ_CONTROL, "ADS_RIGHT_READ_CONTROL"
AccMaskD.Add ADS_RIGHT_DELETE, "ADS_RIGHT_DELETE"
AccMaskD.Add ADS_RIGHT_DS_CONTROL_ACCESS, "ADS_RIGHT_DS_CONTROL_ACCESS"
AccMaskD.Add ADS_RIGHT_DS_LIST_OBJECT, "ADS_RIGHT_DS_LIST_OBJECT"
AccMaskD.Add ADS_RIGHT_DS_DELETE_TREE, "ADS_RIGHT_DS_DELETE_TREE"
AccMaskD.Add ADS_RIGHT_DS_WRITE_PROP, "ADS_RIGHT_DS_WRITE_PROP"
AccMaskD.Add ADS_RIGHT_DS_READ_PROP, "ADS_RIGHT_DS_READ_PROP"
AccMaskD.Add ADS_RIGHT_DS_SELF, "ADS_RIGHT_DS_SELF"
AccMaskD.Add ADS_RIGHT_ACTRL_DS_LIST, "ADS_RIGHT_ACTRL_DS_LIST"
AccMaskD.Add ADS_RIGHT_DS_DELETE_CHILD, "ADS_RIGHT_DS_DELETE_CHILD"
AccMaskD.Add ADS_RIGHT_DS_CREATE_CHILD, "ADS_RIGHT_DS_CREATE_CHILD"

'****************************************************************************
'AceType constants
'****************************************************************************
Const ADS_ACETYPE_SYSTEM_AUDIT_OBJECT    = &H7
Const ADS_ACETYPE_ACCESS_DENIED_OBJECT   = &H6
Const ADS_ACETYPE_ACCESS_ALLOWED_OBJECT  = &H5

Const ADS_ACETYPE_SYSTEM_AUDIT           = &H2
Const ADS_ACETYPE_ACCESS_DENIED          = &H1
Const ADS_ACETYPE_ACCESS_ALLOWED         = &H0

'****************************************************************************
'AceFlags constants
'****************************************************************************
Const ADS_ACEFLAG_FAILED_ACCESS             = &H80
Const ADS_ACEFLAG_SUCCESSFUL_ACCESS         = &H40
Const ADS_ACEFLAG_VALID_INHERIT_FLAGS       = &H1F
Const ADS_ACEFLAG_INHERITED_ACE             = &H10
Const ADS_ACEFLAG_INHERIT_ONLY_ACE          = &H8
Const ADS_ACEFLAG_NO_PROPAGATE_INHERIT_ACE  = &H4
Const ADS_ACEFLAG_INHERIT_ACE               = &H2
```

```
'****************************************************************************
'AceFlags Dictionary for Flag enumeration
'****************************************************************************
Set ACEFlagsD = CreateObject("Scripting.Dictionary")
ACEFlagsD.Add ADS_ACEFLAG_FAILED_ACCESS, "ADS_ACEFLAG_FAILED_ACCESS"
ACEFlagsD.Add ADS_ACEFLAG_SUCCESSFUL_ACCESS, "ADS_ACEFLAG_SUCCESSFUL_ACCESS"
ACEFlagsD.Add ADS_ACEFLAG_VALID_INHERIT_FLAGS, "ADS_ACEFLAG_VALID_INHERIT_FLAGS"
ACEFlagsD.Add ADS_ACEFLAG_INHERITED_ACE, "ADS_ACEFLAG_INHERITED_ACE"
ACEFlagsD.Add ADS_ACEFLAG_INHERIT_ONLY_ACE, "ADS_ACEFLAG_INHERIT_ONLY_ACE"
ACEFlagsD.Add ADS_ACEFLAG_NO_PROPAGATE_INHERIT_ACE, _
                                       "ADS_ACEFLAG_NO_PROPAGATE_INHERIT_ACE"
ACEFlagsD.Add ADS_ACEFLAG_INHERIT_ACE, "ADS_ACEFLAG_INHERIT_ACE"

'****************************************************************************
'Security Descriptor constants
'****************************************************************************
Const ADS_SD_CONTROL_SE_SACL_PROTECTED         = &H2000
Const ADS_SD_CONTROL_SE_DACL_PROTECTED         = &H1000
Const ADS_SD_CONTROL_SE_DACL_AUTO_INHERITED    = &H400
Const ADS_SD_CONTROL_SE_SACL_AUTO_INHERITED    = &H800
Const ADS_SD_CONTROL_SE_SACL_AUTO_INHERIT_REQ = &H200
Const ADS_SD_CONTROL_SE_DACL_AUTO_INHERIT_REQ = &H100
Const ADS_SD_CONTROL_SE_SACL_DEFAULTED         = &H20
Const ADS_SD_CONTROL_SE_SACL_PRESENT           = &H10
Const ADS_SD_CONTROL_SE_DACL_DEFAULTED         = &H8
Const ADS_SD_CONTROL_SE_DACL_PRESENT           = &H4
Const ADS_SD_CONTROL_SE_GROUP_DEFAULTED        = &H2
Const ADS_SD_CONTROL_SE_OWNER_DEFAULTED        = &H1

'****************************************************************************
'Security Descriptor Dictionary for Flag enumeration
'****************************************************************************
Set SDCtlD = CreateObject("Scripting.Dictionary")
SDCtlD.Add ADS_SD_CONTROL_SE_SACL_PROTECTED, "ADS_SD_CONTROL_SE_SACL_PROTECTED"
SDCtlD.Add ADS_SD_CONTROL_SE_DACL_PROTECTED, "ADS_SD_CONTROL_SE_DACL_PROTECTED"
SDCtlD.Add ADS_SD_CONTROL_SE_SACL_AUTO_INHERITED, _
                                        "ADS_SD_CONTROL_SE_SACL_AUTO_INHERITED"

SDCtlD.Add ADS_SD_CONTROL_SE_DACL_AUTO_INHERITED, _
                                        "ADS_SD_CONTROL_SE_DACL_AUTO_INHERITED"
SDCtlD.Add ADS_SD_CONTROL_SE_SACL_AUTO_INHERIT_REQ, _
                                      "ADS_SD_CONTROL_SE_SACL_AUTO_INHERIT_REQ"
SDCtlD.Add ADS_SD_CONTROL_SE_DACL_AUTO_INHERIT_REQ, _
                                      "ADS_SD_CONTROL_SE_DACL_AUTO_INHERIT_REQ"
SDCtlD.Add ADS_SD_CONTROL_SE_SACL_DEFAULTED, "ADS_SD_CONTROL_SE_SACL_DEFAULTED"
SDCtlD.Add ADS_SD_CONTROL_SE_SACL_PRESENT, "ADS_SD_CONTROL_SE_SACL_PRESENT"
SDCtlD.Add ADS_SD_CONTROL_SE_DACL_DEFAULTED, "ADS_SD_CONTROL_SE_DACL_DEFAULTED"
SDCtlD.Add ADS_SD_CONTROL_SE_DACL_PRESENT, "ADS_SD_CONTROL_SE_DACL_PRESENT"
SDCtlD.Add ADS_SD_CONTROL_SE_GROUP_DEFAULTED, "ADS_SD_CONTROL_SE_GROUP_DEFAULTED"
SDCtlD.Add ADS_SD_CONTROL_SE_OWNER_DEFAULTED, "ADS_SD_CONTROL_SE_OWNER_DEFAULTED"
```

```
'****************************************************************************
'Flags constants
'****************************************************************************
Const ADS_FLAG_INHERITED_OBJECT_TYPE_PRESENT = &H2
Const ADS_FLAG_OBJECT_TYPE_PRESENT           = &H1

'****************************************************************************
'Flags Dictionary for Flag enumeration
'****************************************************************************
Set FlagsD = CreateObject("Scripting.Dictionary")
FlagsD.Add ADS_FLAG_INHERITED_OBJECT_TYPE_PRESENT, _
                               "ADS_FLAG_INHERITED_OBJECT_TYPE_PRESENT"
FlagsD.Add ADS_FLAG_OBJECT_TYPE_PRESENT, "ADS_FLAG_OBJECT_TYPE_PRESENT"

'****************************************************************************
' Misc Constants
'****************************************************************************
Const ADS_SECURITY_INFO_SACL    = &H8
Const ADS_SECURITY_INFO_DACL    = &H4
Const ADS_SECURITY_INFO_GROUP   = &H2
Const ADS_SECURITY_INFO_OWNER   = &H1
Const ADS_OPTION_SECURITY_MASK = &H3          ' Security mask for options
Const ADS_OPTION_SERVERNAME = 0
Const E_ADS_PROPERTY_NOT_FOUND = &H8000500D   ' Property not found in cache

'****************************************************************************
'****************************************************************************
'Main Script Logic Begin
'****************************************************************************
'****************************************************************************
'Retrieve parameter, display usage if necessary
'****************************************************************************
If (WScript.Arguments.Count <> 1) Then
  Out "Usage: sdlist ADsPath"
  Out "   Ex: sdlist LDAP://dc=mycorp,dc=com"
  WScript.Quit
End If
 strLDAPPath=WScript.Arguments.item(0)


'****************************************************************************
'Bind to object
'****************************************************************************
Out "Opening object - " & strLDAPPath
Set objObject = GetObject(strLDAPPath)
strDC = objObject.GetOption(ADS_OPTION_SERVERNAME)
Out "Using domain controller: " & strDC

'****************************************************************************
'Connect to RootDSE, retrieve Schema/Config NCs
'****************************************************************************
Out "Opening RootDSE"
```

```
Set objRootDSE = GetObject("LDAP://" & strDC & "/RootDSE")
strSchemaPath = objRootDSE.Get("schemaNamingContext")
strConfigPath = objRootDSE.Get("configurationNamingContext")

'****************************************************************************
'Connect to schema and retrieve schemaIDGUIDs of attributes and classes
'  schemaIDGUID attribute is an octet string
'Build dictionary object to hold values
'****************************************************************************
Out "Opening Schema"
Set objSchema = GetObject("LDAP://" & strSchemaPath)
Out "Retrieving classes and attributes"
objSchema.Filter=Array("attributeSchema","classSchema")
Set SchemaGuids = CreateObject("Scripting.Dictionary")
For Each objEnum In objSchema
  strGUID=GuidToStr(objEnum.schemaIDGUID)
  SchemaGuids.add UCase(strGUID),objEnum.lDAPDisplayName
Next

'****************************************************************************
'Connect to extended-rights container and retrieve rightsGuids of CA objects
'  rightsGuid is a unicode string
'Build dictionary object to hold values
'  handle validated writes special, MS duplicated a rightsGuid
'****************************************************************************
Out "Opening Extended-Rights container"
Set objExtRights = GetObject("LDAP://cn=extended-rights," & strConfigPath)
Out "Retrieving Property Sets, Extended Rights, and Validated Rights"
objExtRights.Filter=Array("controlAccessRight")
Set CARGuids = CreateObject("Scripting.Dictionary")
For Each objEnum In objExtRights
  strGUID="{" & objEnum.rightsGuid & "}"
  if objEnum.validAccesses = 8 then strGUID = "VWRITE - " & strGUID
  CARGuids.add UCase(strGUID),objEnum.displayName
Next

'****************************************************************************
'Retrieve Security Descriptor
'  Need to check if the property not found in cache error was thrown as it
'  indicates person running script has insufficient rights


'****************************************************************************
On Error Resume Next
Set objSD = objObject.Get("nTSecurityDescriptor")
If Err = E_ADS_PROPERTY_NOT_FOUND Then
  Out ""
  Out "You do not have access to the DACL..."
  WScript.Quit
End If
On Error Goto 0
```

```
'****************************************************************************
'Write out the SDs general information
'****************************************************************************
Out ""
Out "==================================================================="
Out "Security Descriptor"
Out "  SD revision is : " & objSD.Revision
Out "  SD Owner is    : " & objSD.Owner
Out "  SD Group is    : " & objSD.Group
Out "  Control Flags " & HexStr(objSD.Control)
DisplayFlags GetFlagStrs(objSD.Control,SDCtlD),"      "
Out "+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++"

'****************************************************************************
'Write out the DACL general information
'****************************************************************************
Set objDACL = objSD.DiscretionaryAcl
Out "Discretionary ACL"
Out "  DACL revision : " & objDACL.AclRevision
Out "  DACL ACE Count: " & objDACL.AceCount
Out "-------------------------------------------------------------------"

'****************************************************************************
'Loop through ACEs
'****************************************************************************
EnumACEs(objDACL)
Out "-------------------------------------------------------------------"
Out "-------------------------------------------------------------------"

'****************************************************************************
'Retrieve SACL
'   The SACL requires enhanced permissions to retrieve. Because of this
'   and how the Security Interface works, the script disconnects from the
'   the object and reconnects and attempts to set the options to retrieve
'   the SACL. If it fails, throw an error.
'****************************************************************************
Set objObject = Nothing
Set objObject = GetObject(strLDAPPath)
objObject.SetOption ADS_OPTION_SECURITY_MASK, ADS_SECURITY_INFO_OWNER _
                                           Or ADS_SECURITY_INFO_GROUP _
                                           Or ADS_SECURITY_INFO_DACL _
                                           Or ADS_SECURITY_INFO_SACL

On Error Resume Next
Set objSD = objObject.Get("nTSecurityDescriptor")
If Err = E_ADS_PROPERTY_NOT_FOUND Then
  Out ""
  Out "You do not have access to the SACL..."
  WScript.Quit
End If
On Error Goto 0
```

```
'****************************************************************************
'Write out the SACL general information
'****************************************************************************
Set objSACL = objSD.SystemAcl
Out "System ACL"
Out "  SACL revision : " & objSACL.AclRevision
Out "  SACL ACE Count: " & objSACL.AceCount
Out "------------------------------------------------------------------"

'****************************************************************************
'Loop through ACEs
'****************************************************************************
EnumACEs(objSACL)
Out "------------------------------------------------------------------"

'****************************************************************************
'Main Script Logic End
'****************************************************************************
'****************************************************************************

'****************************************************************************
'****************************************************************************
'Subroutines
'****************************************************************************

'****************************************************************************
'Output Routine, change this routine to redirect output
'****************************************************************************
Sub Out(str)
  WScript.Echo str
End Sub

'****************************************************************************
'Convert a binary GUID to a string GUID
'   Convert GUID octet string to Hex characters then arrange in proper order
'   and add brackets {}
'****************************************************************************
Function GuidToStr(Guid)
  Dim i, str
  str = " "
  For i = 1 To Lenb(Guid)
    str = str & Right("0" & Hex(Ascb(Midb(Guid, i, 1))), 2)
  Next

  GuidToStr = "{"
  For i = 1 to 4
    GuidToStr = GuidToStr & Mid(str,10-(i*2),2)
  Next
  GuidToStr = GuidToStr & "-"
  For i = 1 to 2
    GuidToStr = GuidToStr & Mid(str,14-(i*2),2)
  Next
  GuidToStr = GuidToStr & "-"
  For i = 1 to 2
     GuidToStr = GuidToStr & Mid(str,18-(i*2),2)
  Next
  GuidToStr = GuidToStr & "-"
  For i = 1 to 2
     GuidToStr = GuidToStr & Mid(str,16+(i*2),2)
  Next
  GuidToStr = GuidToStr & "-"
  For i = 1 to 6
     GuidToStr = GuidToStr & Mid(str,20+(i*2),2)
  Next
  GuidToStr = GuidToStr & "}"
End Function

'*****************************************************************************
'Convert integer to Hexidecimal string for output - format (0xnnnn)
'*****************************************************************************
Function HexStr(val)
  HexStr = "(0x" & Hex(val) & ")"
End Function

'*****************************************************************************
'Get list of Flag strings for given bit flag value and Dictionary
'  Loops through the keys of a dictionary object and executes a bitwise-AND
'  against value and each key. If there is a match, adds key's matching item
'*****************************************************************************
Function GetFlagStrs(val,ByRef dict)
  Dim keys, keycnt, i, ar(  ), flgcnt
  flgcnt=0
  keys = dict.Keys
  keycnt = UBound(keys)
  For i = 0 To keycnt
    If ((val and keys(i)) = keys(i)) Then
      Redim Preserve ar(flgcnt)
      ar(flgcnt) = dict(keys(i)) & "  " & HexStr(keys(i))
      flgcnt = flgcnt + 1
    End If
  Next
  GetFlagStrs=ar
End Function

'*****************************************************************************
'Loop through Array and display strings with fill padding

'*****************************************************************************
Sub DisplayFlags(ar,fill)
  Dim str
  For Each str In ar
    Out fill & str
  Next
End Sub
```

```
'*****************************************************************************
'Convert ACETYPE value to string
'   ACETYPE is NOT a bitflag attribute.
'*****************************************************************************
Function AceTypeToStr(acetype)
  Select Case acetype
    Case ADS_ACETYPE_SYSTEM_AUDIT_OBJECT
      AceTypeToStr = "ADS_ACETYPE_SYSTEM_AUDIT_OBJECT"
    Case ADS_ACETYPE_ACCESS_DENIED_OBJECT
      AceTypeToStr = "ADS_ACETYPE_ACCESS_DENIED_OBJECT"
    Case ADS_ACETYPE_ACCESS_ALLOWED_OBJECT
      AceTypeToStr = "ADS_ACETYPE_ACCESS_ALLOWED_OBJECT"
    Case ADS_ACETYPE_SYSTEM_AUDIT
      AceTypeToStr = "ADS_ACETYPE_SYSTEM_AUDIT"
    Case ADS_ACETYPE_ACCESS_DENIED
      AceTypeToStr = "ADS_ACETYPE_ACCESS_DENIED"
    Case ADS_ACETYPE_ACCESS_ALLOWED
      AceTypeToStr = "ADS_ACETYPE_ACCESS_ALLOWED"
    Case Else
      AceTypeToStr = "Unknown"
  End Select
  AceTypeToStr = AceTypeToStr & " " & HexStr(acetype)
End Function

'*****************************************************************************
'Resolves a GUID to a schema objects or a Control Access Right object
'*****************************************************************************
Function GuidToObj(guid, access)
  Dim str
  guid = UCase(guid)
  If (guid <> "") Then
    If (SchemaGuids.Exists(guid)) Then
      str = SchemaGuids(guid)
    End If
    If (str = "") Then
      If (access and ADS_RIGHT_DS_SELF) Then
        guid = "VWRITE - " & guid
      End If
      If (CARGuids.Exists(guid)) Then
        str = CARGuids(guid)
      End If
    End If
    If (str = "") Then str = "_  _UNKNOWN_  _"
    GuidToObj = str & " (" & guid & ")"

  Else
    GuidToObj = "_  _NONE_  _"
  End If
End Function

'*****************************************************************************
```

```
'Loop through ACES from ACL and display information about each ACE
'****************************************************************************
Sub EnumACEs(ByRef objACL)
  dim intACECount
  intACECount = 1
  For Each objACE In objACL
    Out "  ACE #" & intACECount
    Out "     Trustee               : " & objACE.Trustee
    Out "     AceType               : " & AceTypeToStr(objACE.AceType)
    Out "     AceFlags " & HexStr(objACE.AceFlags)
    DisplayFlags GetFlagStrs(objACE.AceFlags,ACEFlagsD), "        "
    Out "     Access Mask Flags " & HexStr(objACE.AccessMask)
    DisplayFlags GetFlagStrs(objACE.AccessMask,AccMaskD), "        "
    Out "     Flags " & HexStr(objACE.Flags)
    DisplayFlags GetFlagStrs(objACE.Flags,FlagsD), "        "
    Out "     Object Type           : " _
                & GuidToObj(objACE.ObjectType,objACE.AccessMask)
    Out "     Inherited Object Type : " _
       & GuidToObj(objACE.InheritedObjectType,objACE.AccessMask)
    Out ""
    intAceCount = intACECount + 1
  Next
End Sub
```

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26.6. Summary

This chapter took a detailed look at the four main interfaces that you can use to manipulate and iterate over permissions and auditing entries for objects and attributes in your organization:

- IADsAccessControlEntry
- IADsAccessControlList
- IADsSecurityDescriptor
- IADsSecurityUtility

You should now have the tools in your programming belt necessary to modify the permissions in Active Directory as needed.

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Chapter 27. Extending the Schema and the Active Directory Snap-ins

This chapter takes a look at two different areas: programmatically extending the schema and customizing the functionality of the Active Directory administrative MMC snap-ins. Although these topics may seem very different, they share the common thread of storing and presenting information beyond what Active Directory is configured to do by default. They are also related because you will often want to include new schema extensions in the Active Directory snap-ins.

In the first half of the chapter, we take a look at how you can manipulate the schema to include new attributes and classes. In the second half, we describe how to modify the various components of the Active Directory Users and Computers (ADUC) snap-in to include customized display names and menus. While we will focus on ADUC, the techniques presented in this chapter can be used to modify any of the Active Directory administrative snap-ins.

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27.1. Modifying the Schema with ADSI

We've shown you how the schema works in Chapter 4, and how to design extensions in Chapter 12. Now let's take a look at how to query and manipulate the schema using ADSI.

27.1.1. IADsClass and IADsProperty

In addition to being able to query and update schema objects as you can any other type of object with the `IADs` interface, there are two main schema-specific interfaces available: `IADsClass` and `IADsProperty`. Each of these interfaces has a variety of useful methods and property methods to allow you to set mandatory properties for classes, optional properties for classes, maximum values for attributes, and so on.

First, let's compare accessing and modifying the schema by directly using the attributes we are interested in versus using the `IADsClass` and `IADsProperty` methods. This first code section uses attributes directly:

```
objAttribute.Put "isSingleValued", False
 objAttribute.Put "attributeId", "1.3.6.1.4.1.999999.1.1.28"

arrMustContain = objSchemaClass.Get("mustContain")
arrMayContain = objSchemaClass.Get("mayContain")
```

Now we will use the ADSI schema interfaces to do the same thing:

```
objAttribute.MultiValued = True
 objAttribute.OID = "1.3.6.1.4.1.999999.1.1.28"

arrMustContain = objSchemaClass.MandatoryProperties
arrMayContain = objSchemaClass.OptionalProperties
```

This makes use of `IADsProperty::MultiValued`, `IADsProperty::OID`, `IADsClass::MandatoryProperties`, and `IADsClass::OptionalProperties`. As you can see, it's not hard to convert the code. However, we feel that including code that directly modifies the properties themselves gives you some idea of what you are actually changing and helps you to refer back to the definitions presented in Chapter 4.

More details on these three interfaces can be found in the MSDN Library at:

http://msdn.microsoft.com/library/default.asp?url=/library/en-us/adsi/adsi/schema_interfaces.asp

27.1.2. Creating the Mycorp-LanguagesSpoken Attribute

We will create an example attribute called `Mycorp-LanguagesSpoken`. It is to be a multivalued, indexed attribute that can hold an array of case-sensitive strings of between 1 and 50 characters. The name is prefixed with *Mycorp* so it is obvious that *Mycorp* created the attribute.

Mycorp's Schema Manager has decided that the OID for this attribute is to be 1.3.6.1.4.1.999999.1.1.28. This is worked out as follows:

- Mycorp's root OID namespace is 1.3.6.1.4.1.999999.
- Mycorp's new attributes use 1.3.6.1.4.1.999999.1.1.*xxxx* (where *xxxx* increments from 1).
- Mycorp's new classes use 1.3.6.1.4.1.999999.1.2.*xxxx* (where *xxxx* increments from 1).
- The attribute is to be the 28th new attribute created by Mycorp.

The code to create such an attribute is included in Example 27-1.

Example 27-1. Creating the MyCorp-LanguagesSpoken attribute

```
Dim objAttribute
Dim objSchemaContainer

Set objSchemaContainer = _
  GetObject("LDAP://cn=Schema,cn=Configuration,dc=mycorp,dc=com")

Set objAttribute = objSchemaContainer.Create("attributeSchema", _
                                       "cn=Mycorp-LanguagesSpoken")

'Write out mandatory attributes
objAttribute.Put  "attributeId",  "1.3.6.1.4.1.999999.1.1.28"
objAttribute.Put  "oMSyntax",  27
objAttribute.Put  "attributeSyntax",  "2.5.5.3"
objAttribute.Put "isSingleValued", False
objAttribute.Put "lDAPDisplayName", "myCorp-LanguagesSpoken"

'Create the attribute
objAttribute.SetInfo

'Write out optional attributes
objAttribute.GetInfo
objAttribute.Description = "Indicates the languages that " & _
                           "a user speaks"
```

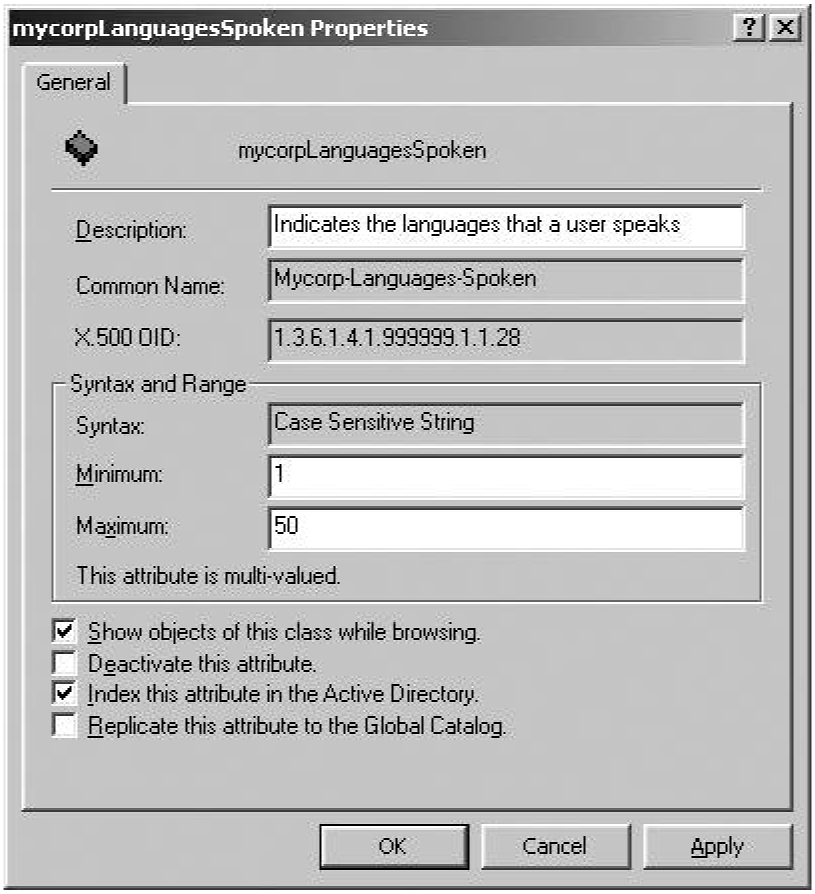
```
objAttribute.Put "rangeLower", 1
objAttribute.Put "rangeUpper", 50
objAttribute.Put "searchFlags", 1
objAttribute.SetInfo
```

Here is the corresponding LDIF file:

```
dn:
 CN=Mycorp-LanguagesSpoken,CN=Schema,CN=Configuration,DC=mycorp,DC=com
changetype: add
objectClass: attributeSchema
description: Indicates the languages that a user speaks
attributeID: 1.3.6.1.4.1.999999.1.1.28
attributeSyntax: 2.5.5.3
oMSyntax: 27
isSingleValued: FALSE
rangeLower: 1
rangeUpper: 50
adminDisplayName: Mycorp-LanguagesSpoken
searchFlags: 1
lDAPDisplayName: myCorp-LanguagesSpoken
```

That was fairly straightforward. Remember to change the `attributeID` attribute to correspond to your own OID namespace if you use the code. Figure 27-1 shows the newly created attribute using the Schema Manager snap-in.

Figure 27-1. The Mycorp-LanguagesSpoken attribute viewed using the Schema Manager snap-in



Description: Indicates the languages that a user speaks

Common Name: Mycorp-Languages-Spoken

X.500 OID: 1.3.6.1.4.1.999999.1.1.28

Syntax and Range

Syntax: Case Sensitive String

Minimum: 1

Maximum: 50

This attribute is multi-valued.

☑ Show objects of this class while browsing.

☐ Deactivate this attribute.

☑ Index this attribute in the Active Directory.

☐ Replicate this attribute to the Global Catalog.

27.1.3. Creating the FinanceUser class

We will now create a new class called `Mycorp-FinanceUser`. It is to be a structural class so that others can create instances of it within containers. It will have the new `Mycorp-LanguagesSpoken` as an attribute, as well as inheriting from the User class. The OID for the class will be 1.3.6.1.4.1.999999.1.2.4, representing the fourth class we've created under our base OID. Example 27-2 contains the code to create the class.

Example 27-2. Creating the Mycorp-FinanceUser class

```
Const ADS_PROPERTY_APPEND = 3

Dim objAttribute
Dim objSchemaContainer

Set objSchemaContainer = _
  GetObject("LDAP://cn=Schema,cn=Configuration,dc=mycorp,dc=com")

Set objClass = objSchemaContainer.Create("classSchema", _
                                          "cn=Mycorp-FinanceUser")

'Write out mandatory attributes
objClass.Put  "governsId",  "1.3.6.1.4.1.999999.1.2.4"
objClass.Put "objectClassCategory", 1 'Structural Class
objClass.Put "subClassOf", "user"
objClass.Put "lDAPDisplayName", "mycorp-FinanceUser"

'Create the class
objClass.SetInfo

'Write out optional attributes
objClass.GetInfo
objClass.Description = "Indicates a Financial User"
objClass.Put "mustContain", "myCorp-LanguagesSpoken"
objClass.SetInfo
```

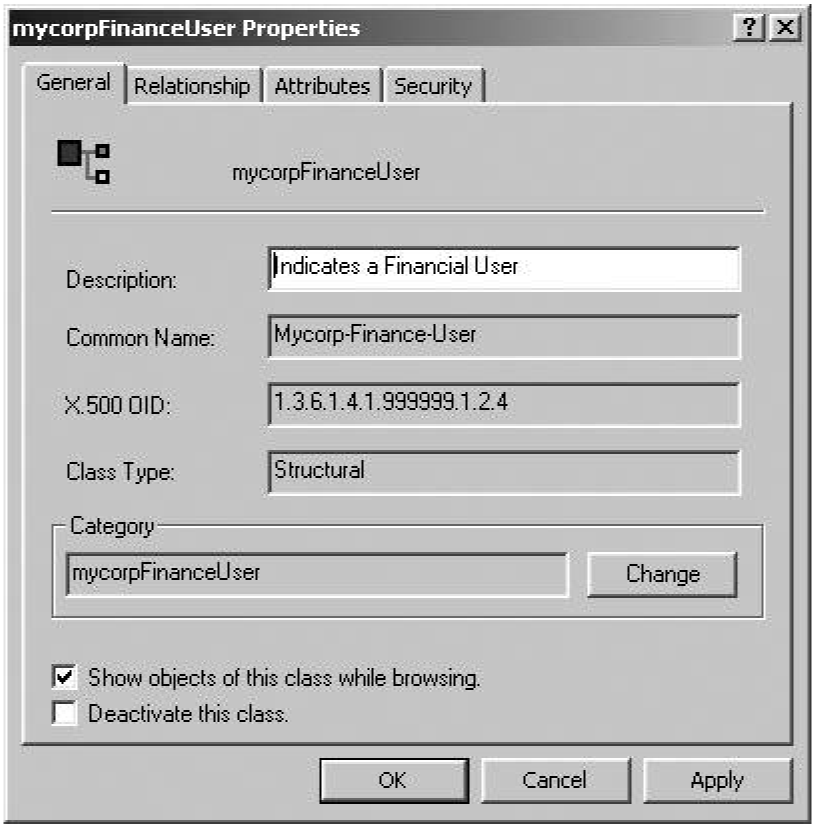
Here is the corresponding LDIF file:

```
dn:
 CN=Mycorp-FinanceUser,CN=Schema,CN=Configuration,DC=mycorp,DC=com
changetype: add
objectClass: classSchema
description: Indicates a Financial User
subClassOf: user
 governsID: 1.3.6.1.4.1.999999.1.2.4
mustContain: myCorp-LanguagesSpoken
adminDisplayName: Mycorp-FinanceUser
 objectClassCategory: 1
lDAPDisplayName: mycorp-FinanceUser
```

Figure 27-2 is the Schema Manager view of the newly created Mycorp-FinanceUser class.

27.1.3.1. Creating instances of the new class

Finally, we want to create a new Mycorp-FinanceUser object. First, we have to get a reference to the Schema Container and create the object with all the mandatory attributes. Example 27-3 shows what this would look like.



mycorpFinanceUser

Description: Indicates a Financial User

Common Name: Mycorp-Finance-User

X.500 OID: 1.3.6.1.4.1.999999.1.2.4

Class Type: Structural

Category: mycorpFinanceUser

☑ Show objects of this class while browsing.

☐ Deactivate this class.

Figure 27-2. The Mycorp-FinanceUser class viewed using the Schema Manager snap-in

Example 27-3. Creating an instance mycorp-FinanceUser

```
Dim objContainer
Dim objMycorpFinanceUser

Set objContainer = _
  GetObject("LDAP://ou=Finance Users,dc=Mycorp,dc=com")

'Create the new Mycorp-FinanceUser object
Set objMycorpFinanceUser = objContainer.Create("Mycorp-FinanceUser", _
  "cn=SimonWilliams")

'Set the mandatory properties
objMycorpFinanceUser.Put "sAMAccountName", "SimonWilliams"
objMycorpFinanceUser.Put "Mycorp-LanguagesSpoken", _
  Array("English", "French", "German")

'Write the object to the AD
objMycorpFinanceUser.SetInfo
```

Note that the mandatory properties include Mycorp-LanguagesSpoken from the Mycorp-FinanceUser class and sAMAccountName from the User class, which the Mycorp-FinanceUser class inherits from.

> sAMAccountName is not required for Windows Server 2003 AD and ADAM.

27.1.4. Finding the Schema Container and Schema FSMO

In your scripts or applications, it is good practice to locate the Schema Container and Schema FSMO dynamically instead of hard coding those values. By finding those values programmatically, your scripts become much more forest-independent, which makes it much easier to transport to other forests in the future.

The solution to find the Schema Container is an easy one. The DN of the Schema Container for a forest can be found by querying the schemaNamingContext value of the RootDSE on any domain controller in the forest. The following code shows how to do that:

```
Dim objRootDSE
Dim objSchemaContainer
Dim strSchemaPath

'Get the Root DSE from a random DC
Set objRootDSE = GetObject("LDAP://RootDSE")
```

```
'Get the Schema NC path for the domain
strSchemaPath = objRootDSE.Get("schemaNamingContext")

'Connect to the schema container on a random DC
Set objSchemaContainer = GetObject("LDAP://" & strSchemaPath)
```

The first `GetObject` call retrieves the RootDSE. Next we simply get the `schemaNaming-Context` attribute and pass that to another `GetObject` call (or the `IADsOpenDSObject::OpenDSObject` method if you prefer to authenticate), which will return a reference to the Schema Container on a random domain controller. If you want to make changes without forcing the FSMO role to your currently connected server, you need to change the last line to connect to the server currently holding the Schema FSMO. This can be done in several additional steps:

```
Dim objNTDS, objServer
Set objNTDS = GetObject("LDAP://" & _
         objSchemaContainer.Get("fSMORoleOwner"))
Set objServer = GetObject( objNTDS.Parent )
strFSMORoleOwner = objServer.Get("dNSHostName")

'Connect to the schema container on the server holding the
' FSMO Schema Master role
Set objSchemaContainer = _
  GetObject("LDAP://" & strFSMORoleOwner & "/" & strSchemaPath)
```

The `fSMORoleOwner` attribute of the Schema Container actually contains the NTDS Settings DN of the domain controller holding the Schema FSMO. For example:

```
cn=NTDS Settings,cn=MOOSE,cn=Servers,cn=Main-Headquarters-
Site,cn=Sites,cn=Configuration,dc=mycorp,dc=com
```

From this, you can retrieve the `ADsPath` of the parent container that holds an attribute called `dNSHostName` that contains the DNS host name of the domain controller that object represents.

27.1.5. Transferring the Schema FSMO Role

If you want to transfer the Schema FSMO role to a specific server, just set the `becomeSchemaMaster` attribute to 1 on the RootDSE for that server. The script will need to either run under the credentials of someone in the Schema Admins group to perform this transfer or use `IADsOpenDSObject::OpenDSObject` and authenticate as someone in Schema Admins. The moment we write out the property cache, the proposed master contacts the current master and requests the role and any updates to the Schema NC that it has yet to see. Here is the code to do the transfer:

```
Const DC_TO_TRANSFER_FSMO_TO = "niles.mycorp.com"

Dim objRootDSE
Dim objSchemaContainer
Dim strSchemaPath

'Get the Root DSE
Set objRootDSE = GetObject("LDAP://" & DC_TO_TRANSFER_FSMO_TO & _
                          "/RootDSE")

'Request a Schema Master transfer
objRootDSE.Put "becomeSchemaMaster", 1
objRootDSE.SetInfo
```

At this point, the transfer has been requested. We now need to connect to the Schema NC and wait until the `fSMORoleOwner` attribute points to our new server:

```
'Get the Schema NC path for the domain
strSchemaPath = objRootDSE.Get("schemaNamingContext")

'Connect to the schema container on my DC
Set objSchemaContainer = GetObject("LDAP://" & DC_TO_TRANSFER_TO _
  & "/" & strSchemaPath)

'Initialize the while loop by indicating that the server is not the one
'we are looking for
strServerName = ""

'While the Server Name is not the one we are looking for, keep searching
While Not strServerName = DC_TO_TRANSFER_FSMO_TO
  'Get the FSMO Role Owner attribute
  strFSMORoleOwner =  objSchemaContainer.Get("fSMORoleOwner")

  Set objNTDS = GetObject("LDAP://" &  strFSMORoleOwner )
  Set objServer = GetObject( objNTDS.Parent )
  strServerName = objServer.Get("dNSHostName")

  objNTDS = Nothing
  objServer = Nothing
  ' Sleep 2 seconds
  WScript.Sleep 2000
Wend

'At this point in the code, the role has been
'  transferred, so we can continue
```

You should not use the code exactly as written here because there is no error checking. Without error checking, there is no guarantee that the original writing of the becomeSchemaMaster attribute actually worked. There is also no guarantee that the attachment to the DC_TO_TRANSFER_FSMO_TO server actually worked, either. So if either of these or anything else went wrong, we may never exit the while loop. Even if both of these conditions worked, we may set the value, and the DC may attempt to contact the current Schema FSMO to find that it is unavailable. Again, we go into an infinite loop and the code never terminates. You certainly should include a timeout value as a second condition to the while loop to trap an occurrence of this problem.

27.1.6. Forcing a Reload of the Schema Cache

If you need to reload the schema cache, Microsoft recommends that you do so once you've finished all your writes. While the cache is being reloaded, any new queries are served from the old cache and will continue to be served by the old cache until the new one comes online. Microsoft specifically states that working threads that are referencing the old cache once a reload is finished will continue to reference the old cache. Only new threads will reference the new cache.

Reloading the cache using ADSI is very simple. All you have to do is set the schemaUpdateNow attribute to 1 on the RootDSE of a DC. The following code shows how to do this with vbscript:

```
Dim objRootDSE
Dim strDC

strDC = "dc01"

'Get the Root DSE
Set objRootDSE = GetObject("LDAP://" & strDC & "RootDSE")

'Reload the cache on that DC
 objRootDSE.Put "schemaUpdateNow", 1
```

It can also be done in LDIF with the following file:

```
dn:
changetype: modify
add: schemaUpdateNow
schemaUpdateNow: 1
-
```

27.1.7. Finding Which Attributes Are in the GC for an Object

In Chapter 4, we described a desire to programmatically query all attributes directly defined on an object class in the schema to find out which ones are in the GC. It should now be possible to see how simple it is to write this code. We need two categories of information, all of the attributes that are valid for a class of object and all of the attributes that are listed in the global catalog.

For the first piece of information, there is a constructed attribute called allowedAt-tributes, which is a list of every attribute that is available for a given object. For the second piece of information, we need to query the schema and ask for all attributes that have a value of TRUE for isMemberOfPartialAttributeSet or have bit 1 (value 2) set on the systemFlags attribute. Example 27-4 contains the code.

Example 27-4. Checking for user object attributes included in the GC

```
Option Explicit

'Check the User class, via the administrator user
Const OBJECT_TO_CHECK = _
  "LDAP://cn=administrator,cn=Users,dc=Mycorp,dc=com"

Dim objObject, arrObjAttrs, strListOfAttributesinGC
Dim objConn, objRS, GCAttribs, strAttribute

'Connect to object and retrieve list of attributes
Set objObject = GetObject(OBJECT_TO_CHECK)
objObject.GetInfoEx  Array("allowedAttributes"),0
arrObjAttrs = objObject.GetEx("allowedAttributes")


'Connect to schema and retrieve GC attributes
Set GCAttribs=CreateObject("Scripting.Dictionary")
Set objConn = CreateObject("ADODB.Connection")
objConn.Provider = "ADSDSOObject"
objConn.Open

Set objRS = objConn.Execute _
  ("<LDAP://cn=schema,cn=configuration,dc=mycorp,dc=com>;" _
   & "(&(objectCategory=attributeSchema)(|" _
   & "(isMemberOfPartialAttributeSet=TRUE)" _
    & "(systemFlags:1.2.840.113556.1.4.803:=2)));" _
   & "lDAPDisplayName;SubTree")
While Not objRS.EOF
   GCAttribs.add  objRS.Fields.Item("lDAPDisplayName").Value,"1"
  objRS.MoveNext
Wend
objConn.Close
Set objRS = Nothing

'Initialize the output string
strListOfAttributesinGC = "The list of attributes for the class: " & vbCrLf _
  & vbCrLf & vbTab & objObject.Schema & vbCrLf & vbCrLf & "is:"_
  & vbCrLf & vbCrLf

'Loop through object attributes and compare to GC
 attributes
For Each strAttribute In arrObjAttrs
  If (GCAttribs.Exists(strAttribute)) Then
    strListOfAttributesinGC = strListOfAttributesinGC & _
                              strAttribute & vbCrLf
  End If
Next
Wscript.Echo strListOfAttributesinGC
```

27.1.8. Adding an Attribute to the GC

If you identify an attribute that you would like to be part of the GC, but it is not, it is straightforward to add it. Typically, an attribute that is part of the GC should be "globally interesting," meaning more than one application would find use for it. The data for the attribute also should not be very volatile or very large since it will be replicated to every GC server in the forest. To add an attribute, the `isMemberOfPartialAttributeSet` attribute for the `attributeSchema` object must be set to true. Example 27-5 shows how to enable the `myCorp-SpokenLanguages` attribute in the GC.

Example 27-5. GC-Enabling the myCorp-SpokenLanguages attribute

```
Option Explicit
Const ATTR_TO_GC = "myCorp-LanguagesSpoken"

Dim objRootDSE, objSchemaContainer
Dim strFSMORoleOwner, strSchemaPath

'Get the Root DSE from a random DC
Set objRootDSE = GetObject("LDAP://RootDSE")

'Get the Schema NC path for the domain
strSchemaPath = objRootDSE.Get("schemaNamingContext")

'Connect to the schema container on a random DC
Set objSchemaContainer = GetObject("LDAP://" & strSchemaPath)

'Get the Schema FSMO DNS name
Dim objNTDS, objServer
Set objNTDS = GetObject("LDAP://" & objSchemaContainer.Get("fSMORoleOwner") )
Set objServer = GetObject( objNTDS.Parent )
strFSMORoleOwner = objServer.Get("dNSHostName")

'Connect to Schema FSMO and Get the attribute
```

```
Dim objAttr
Set objAttr = GetObject("LDAP://" & strFSMORoleOwner & "/" & _
                  "cn=" & ATTR_TO_GC & "," & strSchemaPath)

'Set the property to true
objAttr.Put "isMemberOfPartialAttributeSet", True
objAttr.SetInfo
```

Under Windows 2000, anytime an attribute is added to the GC, a full sync of the GC contents is initiated to all GC servers in the forest. Because this can have a significant impact on replication and network performance, it should be done with caution. This limitation was removed in Windows Server 2003.

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27.2. Customizing the Active Directory Administrative Snap-ins

For those who have worked with Windows NT domains, you are undoubtedly familiar with two GUI tools: User Manager (*usrmgr.exe*) and Server Manager (*srvmgr.exe*). User Manager allows administrators to manipulate the properties of users and groups, while Server Manager can manipulate computer accounts. In Active Directory, a Microsoft Management Console (MMC) snap-in called Active Directory Users and Computers (ADUC) has taken the place of both these tools.

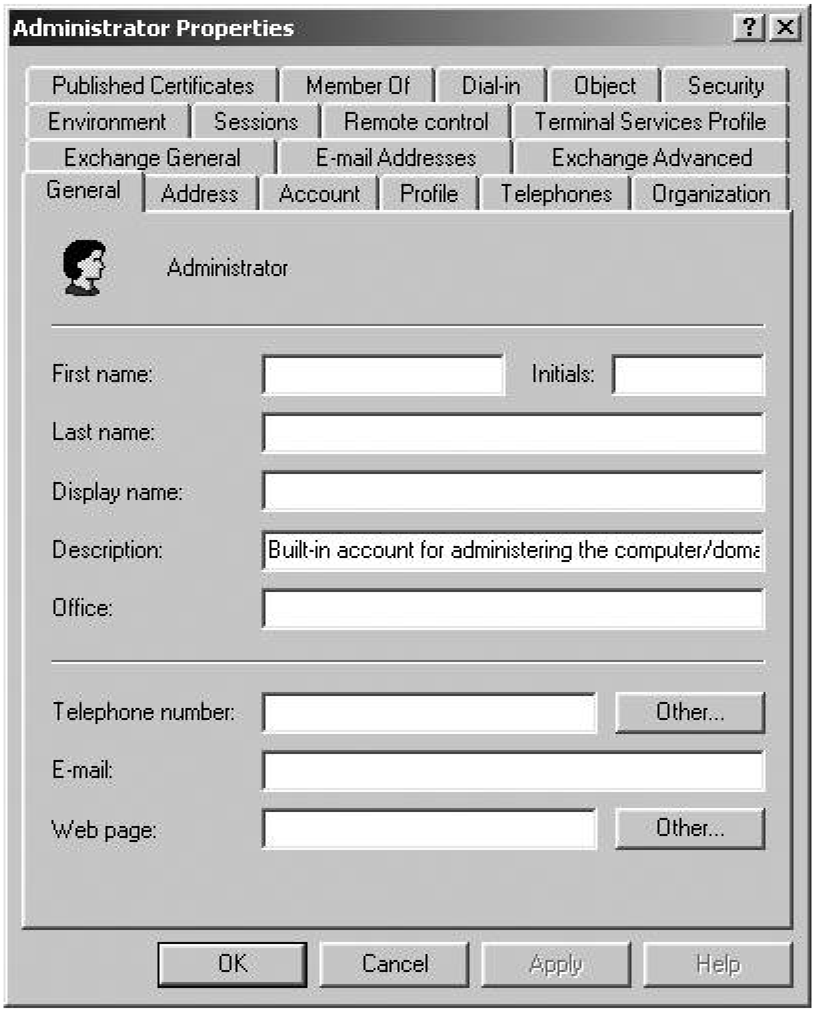
While ADUC is built primarily to manage users, groups, and computers as the previous User Manager and Server Manager did, you can actually use it to manage nearly any type of object within a Domain Naming Context. You can create an entire hierarchy of Organizational Units, user accounts, computer accounts, groups, printers, and so on and manage them with ADUC. The tool, however, is limited in what it provides "out of the box." While ADUC can display a lot of attributes for objects, you cannot view every attribute, as you can with *ADSIEdit*. Figure 27-3 shows the various groupings of attributes (e.g., Organization) that can be viewed by clicking the appropriate tab. Each tab represents a property page, which contains a logical grouping of attributes to display.

Now compare Figure 27-3 with Figure 27-4, which shows the property pages for a computer object.

Figure 27-4 contains considerably fewer property pages. A computer object inherits from the user class and contains a few additional attributes of its own. So a computer could potentially have more information set on it than even a user object, but those attributes could not be viewed with the default ADUC.

In many cases, you may want to modify ADUC to display additional attributes, perhaps even ones you've created. Continuing the schema extension example from the beginning of the chapter, let's say that you decide you want the `myCorp-LanguagesSpoken` attribute to be displayed in ADUC so others can view the languages

Figure 27-3. Numerous property pages for a user object



Administrator

First name:

Initials:

Last name:

Display name:

Description: Built-in account for administering the computer/doma

Office:

Telephone number:

E-mail:

Web page:

a user speaks. Fortunately, the Active Directory snap-ins are largely customizable by modifying one or more attributes in Active Directory. You can also extend the functionality of a snap-in using WSH, VB, or any other COM-based language.

The rest of the chapter is devoted to reviewing the components behind the Active Directory administrative snap-ins and how you can modify them to meet your needs. These components include:

Display specifiers

Objects in Active Directory that contain localized user interface information

Property ages

Tabbed dialog box that displays information

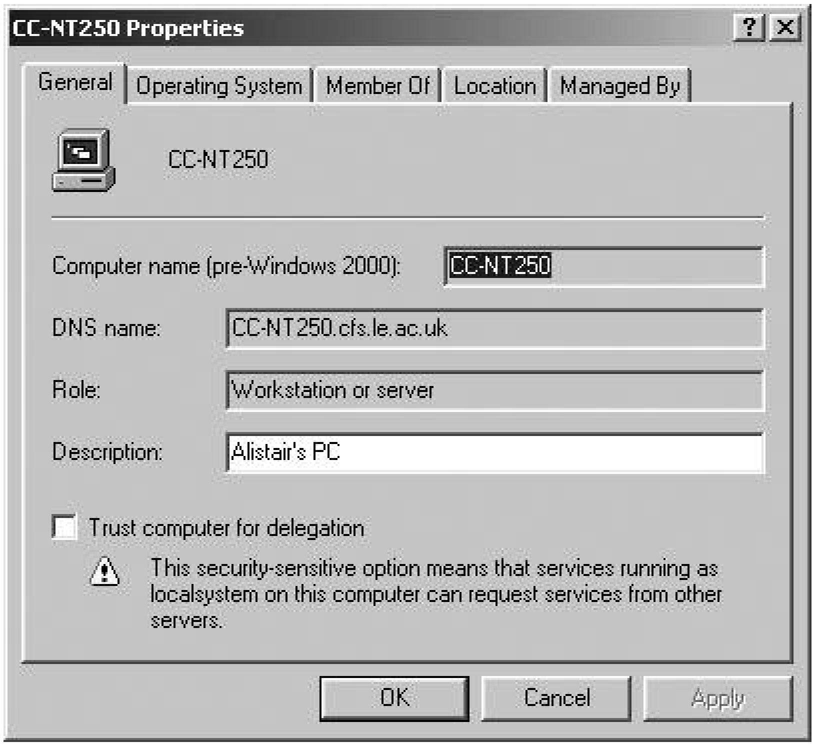
Context menus

Menu displayed after right-clicking an object (e.g., user)

Icons

Image displayed when viewing a particular class

Figure 27-4. Significantly fewer property pages for a computer objec



CC-NT250

Computer name (pre-Windows 2000): CC-NT250

DNS name: CC-NT250.cfs.le.ac.uk

Role: Workstation or server

Description: Alistair's PC

□ Trust computer for delegation

This security-sensitive option means that services running as localsystem on this computer can request services from other servers.

Display names

User-friendly names displayed for attributes and classes (e.g., Last Name)

Creation wizard

Wizard interface used to create an object

27.2.1. Display Specifiers

Display specifiers are objects stored in Active Directory that contain information on how to display and manage objects for a specific object class through the Active Directory snap-ins. These display specifiers are held in the Configuration Naming Context under the DisplaySpecifiers container. Within the DisplaySpecifiers container, there is a container for each supported locale, in a path similar to this:

```
LDAP://cn=409,cn=DisplaySpecifiers,cn=Configuration,dc=mycorp,dc=com
```

The preceding container contains the display specifiers for the U.S./English locale of 409. If you wanted to create or manage display specifiers for a different locale, you just create a new container with the relevant hexadecimal code for the locale and populate it with the relevant display specifier objects. For example, 409 in hex represents 1,033 in decimal, and 1,033 is the U.S./English locale. If we created 809 (2,057 in decimal), we would get the U.K./English locale, and if we created 40C (1,036 in decimal), we would get the French locale. The currently installed locale values can be found in the registry at HKLM\SYSTEM\CurrentControlSet\Control\ContentIndex\Lang-uage. Having display specifiers per locale enables you to support a wide variety of languages for a geographically disperse client base.

Each of the locale-specific containers contains a series of objects of the displaySpecifier class. The object names are in the form of *ObjectClass-Display*. The user class has one called *User-Display*, the computer class has one called *Computer-Display*, and so on. To extend the interface for a specific object class for a particular language, you just need to modify the appropriate attributes on the displaySpecifier object that represents the class in that container.

Here's a simple example. The classDisplayNameattribute exists on all displaySpecifier objects. Let's say we use the ADSI Edit tool from the Support Tools to open up the *Group-Display* object and change this attribute from Group to *Moose*. If we right-click on any container in the ADUC tool, a context menu normally appears, allowing us to create a new user, group, or Organizational Unit (among other things). After making the edit and reopening ADUC, it allows us to create a new User, *Moose*, or Organizational Unit. The way that the group class was displayed in the interface has been changed. If we wanted to change the display specifier for the French locale as well as or instead of the U.S./English locale, we would go to (or create) the 40C container and apply the change to the *Group-Display* object.

Let's now review some of the other customizations you can make.

27.2.2. Property Pages

You can see the array of property pages that exist for two objects in Figures 27-3 and 27-4. You can add property pages to these and display your own here. For this to work, though, the property page has to exist as a Component Object Model (COM) object that supports the IShellExitInit and IShellPropSheetExt interfaces. This means that the property page has to be created first in Visual Basic, Visual C++, or something similar.

Creating the object is the hardest part. Actually telling the system to use it is easy. Once the property page COM object exists, it will have a Universally Unique Identifier (UUID) . You then use ADSI Edit to go to the display specifier object representing the class that you wish to modify and alter the adminPropertyPages or shellPropertyPages attributes. These attributes are multivalued and store data in the following form:

```
    2, {AB4909C2-6BEA-11D2-B1B6-00C04F9914BD}
    1, {AB123CDE-ABCD-1124-ABAB-00CC4DD11223}
```

The first item represents the order number in which the sheets should appear. The second represents the UUID. A third optional parameter can be used to store extended information, such as data passed to the property page as it is displayed.

To add your own property page to a class, you edit either the `Shell` or `Admin` property page attribute, depending on whether you want the default (shell) or administrator UI to be modified, and add in a line like the preceding form. It really is that simple. You can even modify the existing pages, if any exist, and resequence them to your liking.

27.2.3. Context Menus

When you right-click an object in the ADUC tool, a context menu pops up. You can add your own entries to this context menu. Context menu items are held in the `shellContextMenu` attribute for the default UI and `adminContextMenu` attribute for the admin UI in each `displaySpecifier` object. Items that should appear in both go into the `contextMenu` attribute.

The items that you add to the context menus can launch an application or create an instance of a COM object. The data takes the following form in the relevant attributes:

```
    1,Extra &Data..., E:\MYPROG.EXE
     2,&Extended Attributes...,C:\MYSCRIPT.VBS
      3,{DB4909C2-6BEA-11D2-B1B6-00C04F9914BD}
```

Notice that the last item is a COM object. It is denoted by its UUID. The COM object must have been created to support the `IShellExtInit` and `IContextMenu` interfaces. Extra data can be passed to the COM object by including it as a third parameter on the line. The former two items are much more important to administrators. Here you can see that we added two extra items to the menu. These items are an executable program and a VBScript script. Any type of application is valid. The second parameter is the string you want to appear on the context menu. Use of an ampersand (&) character before a letter denotes that letter as the menu selector. Thus, when the menu is being displayed using the previous code example, typing "d" selects the first option, and "e" selects the second.

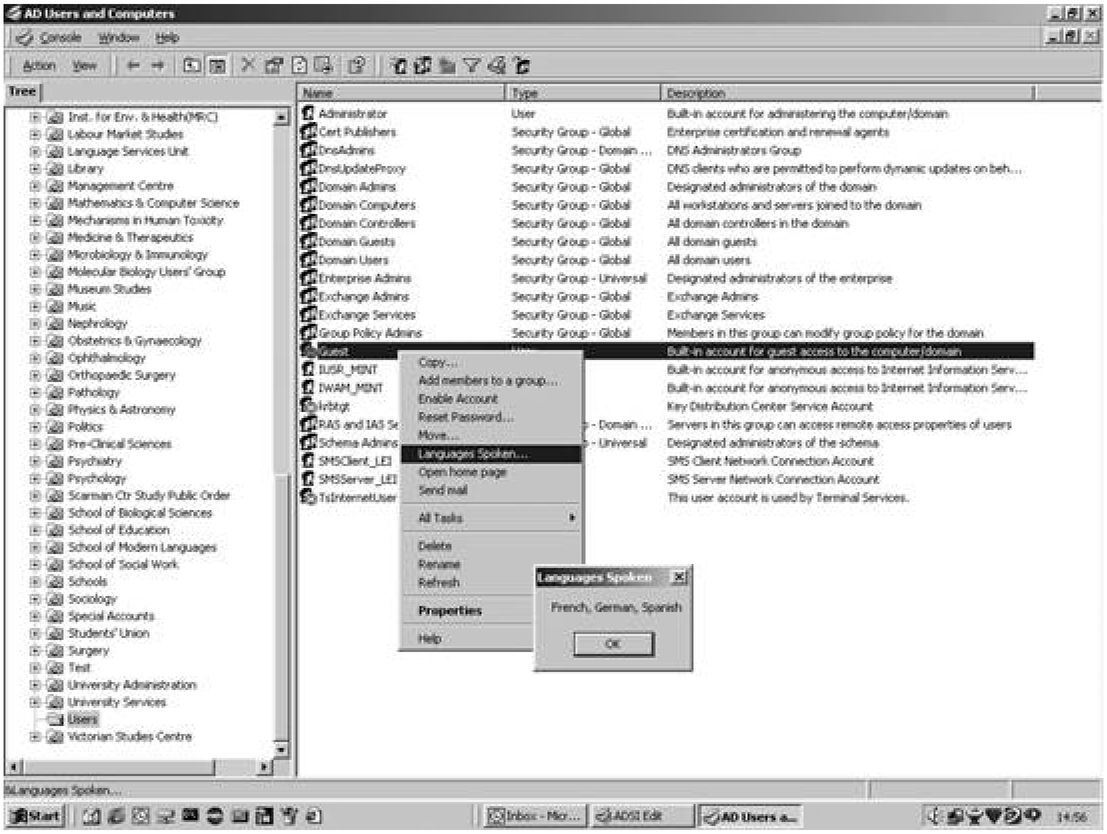
Being able to add scripts and programs to a context menu is a very powerful capability. Couple these scripts and programs with ADSI, and you have a way of extending the snap-ins Microsoft provides to deliver completely customized functionality based on your business or organizational needs. For example, let's say that you want to extend the schema and include a new, optional `myCorp-LanguagesSpoken` attribute for the User class. You can go to the *User-Display* object for the appropriate locale and modify the `contextMenu` attribute (so it is available to both users and administrators) to include an ADSI script that displays that attribute in a message box. The following code is all that is needed:

```
Set wshArgs = WScript.Arguments

 Set objUser = GetObject(wshArgs(0))
MsgBox objUser.Get("myCorp-LanguagesSpoken"),,"Languages Spoken"
```

The script does nothing more than bind to the object's ADsPath that is passed in as an argument to the program, and print out the attribute in a MsgBox with an appropriate title, as shown in Figure 27-5.

Figure 27-5. Looking at the languages spoken for a user



Name	Type	Description
Administrator	User	Built-in account for administering the computer/domain
Cert Publishers	Security Group - Global	Enterprise certification and renewal agents
DnsAdmins	Security Group - Domain ...	DNS Administrators Group
DnsUpdateProxy	Security Group - Global	DNS clients who are permitted to perform dynamic updates on beh...
Domain Admins	Security Group - Global	Designated administrators of the domain
Domain Computers	Security Group - Global	All workstations and servers joined to the domain
Domain Controllers	Security Group - Global	All domain controllers in the domain
Domain Guests	Security Group - Global	All domain guests
Domain Users	Security Group - Global	All domain users
Enterprise Admins	Security Group - Universal	Designated administrators of the enterprise
Exchange Admins	Security Group - Global	Exchange Admins
Exchange Services	Security Group - Global	Exchange Services
Group Policy Admins	Security Group - Global	Members in this group can modify group policy for the domain
Guest	User	Built-in account for guest access to the computer/domain
IUSR_MINT		Built-in account for anonymous access to Internet Information Serv...
IWAM_MINT		Built-in account for anonymous access to Internet Information Serv...
krbtgt		Key Distribution Center Service Account
RAS and IAS Se	- Domain ...	Servers in this group can access remote access properties of users
Schema Admins	- Universal	Designated administrators of the schema
SMSClient_LEI		SMS Client Network Connection Account
SMSServer_LEI		SMS Server Network Connection Account
TsInternetUser		This user account is used by Terminal Services.

Languages Spoken

French, German, Spanish

OK

The Guest user object was right-clicked, which popped up a context menu that includes Languages Spoken. You can see that it is actually the string "&Languages Spoken..." being displayed if you look at the text in the bottom-left corner of the window. When we click the item or press the L key, a dialog box generated by the script is displayed on the screen. Normally the dialog box and the context menu would not be displayed together, but we have done so in this screen to show you the process.

You could also write a script or program that allowed you to modify the LanguagesSpoken attribute and have it appear only on the administrator's context menus. Then you can use the ADUC tool to manage your users and this extra attribute, without ever needing to actually develop an entirely new interface if you don't want to.

27.2.4. Icons

When you look at a container of objects in ADUC, it shows you an icon for each object that is appropriate to the specific object class for that object. The icons for Organizational Units look different than those for containers, users, and printers, for example. The icon can actually be used to represent different states of that object. For example, if you disable a user or computer object, the icon is changed to indicate that the object is disabled. All in all, 16 different state icons can be defined for any object class. The first three represent the states closed (the default state), open, and disabled; the last 13 are currently undefined and left for your own use.

To modify the icon for an object class, simply use the iconPath attribute to store multivalued data of the following form:

```
0, c:\windows\system32\myicon.ico
1, c:\windows\system32\myicons.dll, 0
2, c:\windows\system32\myicons.dll, 2
3, c:\windows\system32\myicons.dll, 7
```

This sets the first four icon values. Remember that 0 is closed, 1 is open, and 2 is disabled; 3 through 15 are undefined. The first one uses a proper icon file with an ICO extension and so doesn't need a third parameter. The last three use the first (0), third (2), and eighth (7) icons from *MYICONS.DLL*, using an index for the set of icons held in the DLL, starting at 0. The icon path has to exist on the local machine for any client to properly display the icon. Remember to take that into account, since you may need to deploy the icon files to all clients in an enterprise if they are to display the icons properly.

27.2.5. Display Names

As shown earlier, you can alter the way that both class and attribute names appear within a GUI. If you want to change the class name, change the text in the classDisplayName property of the relevant displaySpecifier object. If you want to change what attributes names appear as, then you need to modify the multivalued attribute attributeDisplayNames. Attribute values take the form of a comma-delimited string as follows:

```
mobile,Mobile Number
physicalDeliveryOfficeName,Office Location
extensionAttribute1,My First Extended Attribute
```

The first value is the LDAP name corresponding to the attribute in the schema, and the second is the name that it is to be displayed as. Note that you shouldn't insert a space between the comma and the second value unless you want the name to be preceded by a space.

27.2.6. Leaf or Container

When you view objects in the ADUC, some display as containers and some display as leaf objects. Most objects that you are concerned with actually act as containers, even if you see them displayed as leaf objects. Take a printer on a computer, for example. If that printer is published as a printQueue object to Active Directory, the object is located as a leaf object within the computer object that it is published on. The computer object acts as a container for any print queues that it publishes. User, computer, and group objects by default do not display themselves as containers. ADUC in fact has an option on the View menu to change this, called "View users, groups, and computers as containers." However, all objects get treated in this fashion, and you can modify any object's default setting by going to the displaySpecifier and changing the Boolean value of treatAsLeaf to true or false as required.

27.2.7. Object Creation Wizard

When you create a user, group, or Organizational Unit, ADUC presents a simple wizard to allow you to specify the relevant data for that object. It is possible for administrators to modify the default behavior in one of two ways. Administrators can replace the existing wizard entirely, if one exists, or they can just add extra pages to the wizard. Only one wizard can ever exist, so you either create a new one or modify the existing one. Let's say that you want to have the wizard ask for the value for the myCorp-LanguagesSpoken attribute for the User class. As the existing User creation wizard does not allow data to be input for this attribute, you can replace the entire wizard with a new one of your own, or you can place a new page into the wizard to receive data on this attribute. With property pages, we need to create new wizards or creation wizard extensions (extra pages to existing wizards) as COM objects that support the IDsAdminNewObjExt interface. New wizards that replace the default wizards in use by the system are known as primary extensions, and they replace the core set of pages that would be used to create the object. Primary extensions support creation wizard extensions; you can define a primary extension for all users, for example, and later add a couple of extra pages using a creation wizard extension if you require.

If you are replacing the wizard entirely with a primary extension, modify the creationWizard attribute of the relevant displaySpecifier object to hold the UUID of the COM object. If you are just providing creation wizard extensions, you specify the order that the pages should appear, followed by the UUID in the createWizardExt multivalued attribute. The format is the same as for property pages.

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27.3. Summary

In this chapter, we covered how to query and manipulate the Active Directory Schema, including how to locate and transfer the Schema FSMO. The schema cache and its importance was also briefly touched on, along with information on how to determine which attributes of an object are in the GC and how to add an attribute to the GC if necessary.

The second part of the chapter focused on how to customize the Active Directory administrative MMC snap-ins by modifying `displaySpecifier` objects. We described how to manipulate each of the major snap-in components, including property pages, context menus, icons, display names and the object creation wizard. For more information about customizing snap-ins, check out the following locations in the MSDN Library:

- http://msdn.microsoft.com/library/default.asp?url=/library/en-us/ad/ad/extending_the_user_interface_for_directory_objects.asp
- http://msdn.microsoft.com/library/default.asp?url=/library/en-us/ad/ad/active_directory_admin_interfaces.asp
- http://msdn.microsoft.com/library/default.asp?url=/library/en-us/shellcc/platform/shell/programmersguide/shell_intro.asp

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Chapter 28. Using ADSI and ADO from ASP or VB

Two important features of Active Directory require administrators to create their own tools:

- The ability to extend the Active Directory schema with your own classes and attributes, which allows you to store additional data with objects
- The ability to delegate control of administration of Active Directory in a very detailed manner

If you take advantage of these, there is a large chance that you will want to provide customized tools for administration.

For example, you might decide that a group of users is to manage only certain properties of certain objects; for example, which users can go into a group. There is no point in giving them Active Directory Users and Computers snap-in; that's like using a sledgehammer to crack a nut. Why not create a tool of your own that only allows them to manipulate the values that they have permission to? If you then incorporate logging into a file or database within this application, you have a customized audit trail as well.

Tools of this nature do not lend themselves to VBScript because they tend to require a much more enhanced GUI interface. Consequently, you are left with three choices:

- Write code in a compiled language like Visual Basic or VB.NET that supports complex GUI routines.
- Write code for a web-based interface using HTML and Active Server Pages (ASPs) or using ASP.NET.
- Write code in another scripting language such as Perl that supports complex graphical controls.

We will concentrate on the first two in this chapter.

28.1. VBScript Limitations and Solutions

Using ADSI from within WSH is very useful, but it does have certain limitations . For one thing, you cannot natively display output on screen in anything other than a MsgBox or request information from users without using the InputBox. It is easy to show how these are lacking. Consider that we wish to write a general script that adds a user to a single group selected from a list. If we wrote this under WSH, we would have to list all the groups to the screen in a large MsgBox (or via a file using Notepad) with incremental numbers so that each group could be identified. Then the person running the script would have to remember the number and type it into an InputBox later so that the request could be serviced. If there were more than a few dozen groups in Active Directory, the person running the script would have to go through a number of screens of groups before being able to see them all. It would be much simpler just to display a drop-down list box of all groups and have the user select one. This is not possible under WSH using VBScript , but it is possible under VB and Active Server Pages (ASP).

VB provides a full programming environment for your ADSI applications. ASP provides VBScript with the user-interface facilities that HTML allows, effectively making your scripts more user friendly. ASP pages are useful for two important reasons. First, there is a single copy maintained in the organization. Hence, if the single copy is updated, everyone gets the latest copy on the next use. This also saves you from version hellhaving multiple versions of a program floating around. Second, no runtime or design-time licenses are required in the development of such pages, as is the case when you develop VB applications.

Also, if we publish the web pages on an Internet server rather than an intranet server, we can make the scripts available to anyone who has the correct privilege to the script whether he is on our local network or not. At present, you may find it hard to see a need for being able to manipulate Active Directory from outside the organization. But as Active Directory becomes a larger store for complex objects, you may find yourself writing pages to interrogate company databases as well as Active Directory, bringing both sets of information forward to the user. Web pages also allow you to prototype or identify a need for a future application. If you find that your users are making heavy use of the web interface, perhaps it is time to consider rolling out a proper application. It all depends on what sort of mechanism you prefer to develop and maintain to let your users access your Active Directory.

This chapter will describe in detail how to create ASP pages using HTML and ADSI and how to migrate VBScript scripts to simple VB applications.

While incorporating ADSI scripts into ASP pages via HTML is fairly easy, anyone who is considering using VBScript with HTML pages needs to do some background reading on ASP programming. This chapter alone barely scratches the surface and in no way covers HTML in any real depth.

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28.2. How to Avoid Problems When Using ADSI and ASP

There is one very large pitfall with ADSI scripts under ASP that is very easy to fall into. ADSI scripts running under ASP work only when served from IIS. So whenever you want to test-run an ASP page, make sure that you are obtaining it from the server. This problem tends to occur in two main ways:

- When developing scripts on the machine that IIS is running on
- When developing scripts on a machine that has a drive mapped to the directory on IIS where you are storing the scripts

In both of these cases, it is just as easy to open a file called *C:\INETPUB\WWWROOT\MYTEST.ASP* as it is to open http://www.mycorp.com/mytest.asp from within IE. Both files will open correctly, but only the IIS-served page will correctly work with ADSI. If you start getting unexplained errors with code that you know should be working, just check the URL of the ASP that you are opening.

The second annoying pitfall occurs when you are constantly updating pages, testing them with a browser, and then updating them again. If you are developing in this cycle, remember to keep refreshing the page. It becomes really annoying to find that the bug you have been trying to solve is due to the fact that your browser thoughtfully cached a page 15 minutes ago, and you have been forgetting to press the Shift key when clicking the Refresh button.[*]

[*] Another option if you are using Internet Explorer is to open up the Internet Options from the Tools menu and set the Temporary Internet Files to check for newer versions of stored pages on every visit to the page.

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28.3. Combining VBScript and HTML

HTML pages are written as text files in the same way as VBScripts. HTML pages display information according to a series of tags, which you use to turn certain formatting on and off. The tags you normally use to construct a basic page look like this:

```
<HTML>

<HEAD>
<TITLE>Hello World Page</TITLE>
</HEAD>

<BODY>
Hello World
<P>Hello again
</BODY>

</HTML>
```

The <HTML> tag denotes it as an HTML document. The <HEAD> and </HEAD> pair denote everything within those tags as belonging to the header description part of the document. The <TITLE> tag denotes the start of the page title and </TITLE> turns it off again. The <BODY> tag denotes the main part of the page, which contains a simple text string, a newline or paragraph marker <P>, and then another line of text. This is the bare bones of writing HTML documents. You can create lists, set colors, make and populate tables, display images, and so on. However, you do not need to go into all of that to demonstrate incorporating ADSI VBScripts into HTML pages. You only need to be aware of the following major sets of tags: <FORM>...</FORM>, <OBJECT>...</OBJECT>, <%...%>, and <SCRIPT> ...</SCRIPT>.

28.3.1. Incorporating Scripts into Active Server Pages

Two sorts of scripts can be created within ASPs: client-side scripts and server-side scripts. Client-side scripting is used to access all the objects in a web page (e.g., text, images, tags), browser objects (e.g., frames, windows), and local ActiveX components. Server-side scripting is used to create a web page dynamically via parameters, forms, and code that is then passed to a browser.

Because the two types of scripts are executed at different locations, each has a separate set of interfaces. We'll go through the major differences now so that you will be less likely to make annoying mistakes.

28.3.1.1. Client-side scripting

Assuming you are using Internet Explorer (IE), you can use the <SCRIPT> tags to add client-side VBScript code to an HTML page. Whenever the browser encounters the tags, the enclosed script is executed as if it were being issued from the client. You can use blocks of scripting in both the BODY and HEAD sections of a web page if you want to. If you put your code in the HEAD section, it will be read and executed before any item in the BODY section is accessed. As an example, here is a procedure to display a line of text:

```
<SCRIPT LANGUAGE
="VBScript">

  Document.Write "This is a line of text<P>"

</SCRIPT>
```

The LANGUAGE attribute indicates that this is VBScript rather than one of the other languages. As this is not running under the WSH, you do not have a VBS or JS extension to denote the language. The Document::Write method writes the line to the web page. It is only one of a number of properties and methods from interfaces available to you as an ASP developer. You also can use MsgBox and InputBox within client-side scripts.

The important thing about client-side scripts from this chapter's point of view is that ADSI functions and methods cannot be included in these scripts. This is an important limitation, one that we will show you how to get around later.

28.3.1.2. Server-side scripting

You also can use the SCRIPT tags to denote server-side scripting in ASP pages; this type of scripting does not place a dependency on the browser version because all dynamic content is generated on the server. To distinguish server-side SCRIPT tags from client-side tags, you use the RUNAT attribute as follows:

```
<SCRIPT LANGUAGE="VBScript" RUNAT="SERVER">
Set objGroup = GetObject("LDAP://cn=Managers,ou=Sales," _
  & "dc=mycorp,dc=com")

  Response.Write objGroup.Description
</SCRIPT>
```

The RUNAT="SERVER" tag is used as is. It does not require you to substitute an actual server name.

Server-side scripting can also go in either the BODY or HEAD sections. As you can see from the example, server-side scripting can include ADSI calls without any problem. The Response::Write method is used to write lines of text out to a page by code that is processed on the web server. You cannot use Document::Write in server-side scripts as the Document interface is unavailable to the server; it is available only to the browser.

There is also another and more common short form to denote server-side scripting, the <%...%> tags. Any code between this set of tags is automatically treated as server-side scripting code. Here is the previous example again, using these tags:

```
<%
  Set objGroup = GetObject("LDAP://cn=Managers,ou=Sales," _
    & "dc=mycorp,dc=com")

  Response.Write objGroup.Description
%>
```

Throughout the rest of the chapter, we will use the <%...%> tags to indicate server- side scripting and the SCRIPT tag to indicate client-side scripting. The <%...%> tags allow you to create quite complex scripts that switch back and forth between script code and HTML on every line if you like. For example, here is a simple server-side script:

```
<%
  If myCondition = True Then
    Response.Write "The Condition is TRUE<P>"
  Else
    Response.Write "The Condition is FALSE<P>"
  End If
%>
```

Here is the same script again using the <%...%> tags more heavily so that we can make use of HTML without using Response::Write whenever we want to:

```
<% If myCondition = True Then %>
     The Condition is TRUE<P>
<% Else %>
     The Condition is FALSE<P>
<% End If %>
```

Setting the Default Language

If you choose to use the <%...%> tags, you can change the primary scripting language for a single page by adding a command line to the beginning of your ASP page. The syntax for this command is the following if you are using JScript, VBScript, or any other language that supports Object.Method syntax:

```
<%@ LANGUAGE="VBSCRIPT" %>

<%@ LANGUAGE="JSCRIPT" %>
```

You should make this line the first line of the ASP page and make sure that you have a blank space between the @ character and the LANGUAGE keyword.

If you are writing ASP pages using VBScript as your language, you can omit this line from all of your pages, as VBScript is set as the default language anyway.

28.3.2. ActiveX Controls and ASPs

Anyone who has developed ASPs before or who reads any ASP book will find out about embedding ActiveX controls into web pages. This is another technology that is dependent upon using Internet Explorer for the browser.

The OBJECT tag is used to add extra functionality to an HTML document by allowing the insertion of various ActiveX controls onto web pages. Included in these are items such as buttons you can press, drop-down list boxes from which you can select items, text entry and display fields, and so on. When you insert an object into your web page using the OBJECT tag, you can specify its initial contents, its position, its caption, its color, and so on. Most people who create web pages using ActiveX controls do not type all this data in by hand. Instead, developers normally use a tool to select from the available options when creating the tag.

If you want to buy a tool, you could use Microsoft FrontPage, which was designed for people who are not used to scripting and would prefer an Office-type interface. Alternatively, you could use Microsoft InterDev, which was designed to have the same interface as all of Microsoft's other development products, such as VB. Various other free web-development tools also exist that will insert these tags. Here is the code for a clickable command button in a web page:

```
<HTML>
<HEAD>
<TITLE>Simple Command Button</TITLE>
</HEAD>
<BODY>
```

```
<OBJECT ID="CommandButton1" WIDTH=93 HEIGHT=33
   CLASSID="CLSID:D7053240-CE69-11CD-A777-00DD01143C57">
     <PARAM NAME="ForeColor" VALUE="2147483670">
     <PARAM NAME="BackColor" VALUE="2147483668">
     <PARAM NAME="VariousPropertyBits" VALUE="23">
    <PARAM NAME="Caption" VALUE="Click me!">
     <PARAM NAME="Size" VALUE="2469;882">
     <PARAM NAME="MousePointer" VALUE="1">
     <PARAM NAME="FontCharSet" VALUE="0">
     <PARAM NAME="FontPitchAndFamily" VALUE="2">
     <PARAM NAME="ParagraphAlign" VALUE="3">
     <PARAM NAME="FontWeight" VALUE="0">
</OBJECT>

</BODY>
</HTML>
```

ActiveX controls are very useful, but they do have their limits with respect to ADSI. For example, the object specified in the preceding script is a client-side ActiveX control. If you wanted to attach an event to it, say a procedure that is executed when the button is pressed, you couldn't use ADSI code within that procedure. For example, while this looks like great code, *it will not work*:

```
<SCRIPT LANGUAGE="VBScript">
Sub CommandButton1_Click(   )
  Set objGroup = GetObject("LDAP://cn=Managers,ou=Sales," _
    & "dc=mycorp,dc=com")

  Document.Write objGroup.Description
</SCRIPT>
```

You can, however, easily populate list boxes and other controls with the results of ADSI calls. This is great for display purposes, but you can't manipulate the contents. Let's lay out an example to show you the problem.

Let's say that we have an ASP page with two list box ActiveX controls. When the page is loaded, we can trigger the population of the first list box with all the users in Active Directory. We can do the same for the second list box with all the groups in Active Directory. We now can click and select values from each of the list boxes, although nothing happens when we do so. Now we need to add a command button ActiveX control to the ASP page. We wish to attach an event to that button so that an ADSI call is made that attempts to add the user to the group and print out the result. Unfortunately, we can't do that, since the ActiveX control event procedure is client-side and ADSI code must be server-side.

While ActiveX controls may be very powerful, they can't incorporate ADSI directly from triggered events.

28.3.3. Forms

If ActiveX control events are not available, you can use HTML forms to create simple ASP pages. Here is an example:

```
<FORM ACTION = "simple_form_demo.asp" METHOD = "POST">
  <P>A simple input field: <INPUT NAME = "myfield1" SIZE = 48>
  <P>Here is a list of all the users in the default Users container:
  <SELECT
 NAME = "user">
    <% Set objUsers = GetObject("LDAP://cn=Users,dc=mycorp,dc=com")
       For Each objObject in objUsers
         If objObject.Class = "user" Then %>
           <OPTION
><% = objObject.Name %></OPTION>
    <%   End If
       Next %>
  </SELECT>
  <P><INPUT TYPE = SUBMIT>
</FORM>
```

This form incorporates an alphanumeric input field, a list box populated by users from the default Users container, and a button labeled Submit Query. The list box is populated via the `OPTION` tag between a `<SELECT>...</SELECT>` tag pair. Clever use of server-side scripts here between the `SELECT` tag pair means that you can populate the list box using ADSI calls.

More importantly, once the form is submitted, server-side scripts can retrieve the values typed into the input fields by passing the name of the form to the `Request::Form` method. If the previous form were submitted, you could retrieve the value selected in the list box by using the following code:

```
Request.Form("user")
```

One important point needs noting here. It is possible to attach scripts to form-field events, such as clicking a button or tabbing out of a field. Unfortunately, as the form is client-side, the script attached to the event has to be client-side. That precludes the use of ADSI in these sorts of scripts. Here is an example:

```
<HTML>
<HEAD>
<TITLE>Display Description</TITLE>
</HEAD>
<BODY>
<FORM NAME="Form1">
  <INPUT TYPE="Button" NAME="Button1" VALUE="Click me for Description!">
  <SCRIPT FOR="Button1" EVENT="onClick" LANGUAGE="VBScript">
    MsgBox "Clicked!"
  </SCRIPT>
</FORM>
</BODY>
</HTML>
```

Because the scripts are only client-side, we will not be using these types of scripts within this chapter.

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28.4. Binding to Objects via Authentication

Whenever we need to access the properties of an object in Active Directory, we bind to it using VBScript's GetObject function or the ADSI method IADsOpenDSOb-ject::OpenDSObject. The circumstances in which each method should be used to access Active Directory are very clear-cut but deserve to be outlined here, as it will be important whenever you construct ASPs.

28.4.1. When to Use VBScript's GetObject Function

By default, many of the objects and properties within Active Directory can be read by any authenticated user of the forest. As an example, here is some code to connect to an Organizational Unit called Sales under the root of the domain. This code works under the WSH:

```
Set objSalesOU = GetObject("LDAP://ou=Sales,dc=mycorp,dc=com")
Wscript.Echo objSalesOU.Description
```

Here is the same script incorporated into an ASP:

```
<HTML>
<HEAD>
<TITLE>Binding to an existing Organizational Unit</TITLE>
</HEAD>

<BODY>
<%
  Set objSalesOU = GetObject("LDAP://ou=Sales,dc=mycorp,dc=com")
  Response.Write "The Sales OU description is: " & objSalesOU.Description
%>
</BODY>
</HTML>
```

This mechanism works perfectly when you wish to have read-only access to properties of objects that can be read without special privileges. Using GetObject is not appropriate in the following cases:

- You want to write properties of an object.
- The object you are attempting to bind to requires elevated privileges to access.

While it may make little sense, it is perfectly feasible to restrict read access to the description of the Sales Organizational Unit, or more commonly the Sales Organizational Unit itself. If the Sales Organizational Unit is restricted, a `GetObject` will fail to bind to it. If only the description is restricted, a `GetObject` will successfully bind to the Sales Organizational Unit, but access to the description property will be denied.

To gain access to a restricted object or impersonate another user, you must authenticate using `IADsOpenDSObject::OpenDSObject`.

28.4.2. When to Use IADsOpenDSObject::OpenDSObject

Here is a simple Organizational Unit creation script that works under the WSH when an administrator is logged in:

```
Set objRoot=GetObject("LDAP://dc=mycorp,dc=com")

Set objSalesOU = objRoot.Create("organizationalUnit","ou=Sales")
objSalesOU.Description = "My new description!"
objSalesOU.SetInfo
```

However, we cannot transfer the script to an ASP page as it stands. To make the script work, we must use the `IADsOpenDSObject::OpenDSObject` method, which does allow authentication. Here is the same example using authentication within an ASP:

```
<HTML>
<HEAD>
<TITLE>Successful Organizational Unit Creation</TITLE>
</HEAD>

<BODY>
<%
  strPath = "LDAP://dc=mycorp,dc=com"
  strUsername = "mycorp\administrator"
  strPassword = "My-admin-password!"

  Set objNamespace = GetObject("LDAP:")
  Set objRoot = objNamespace.OpenDSObject(strPath, strUsername, strPassword, 0)

  Set objSalesOU = objRoot.Create("organizationalUnit","ou=Sales")
  objSalesOU.Description = "My new description!"
  objSalesOU.SetInfo

  Response.Write "The Sales OU has been created in the " & strPath & " domain."
%>
</BODY>
</HTML>
```

> It may seem obvious, but there are serious security considerations you need to keep in mind when using `OpenDSObject`. One of the more serious is risking accidental exposure of the userid/password of the admin account. Another issue is maintainability; every time the admin password is changed, you have to change your ASP pages.

If we wanted to manipulate any of the properties of the new Sales Organizational Unit during that script, we could continue to use the `objSalesOU` variable to do so. If we write a new script that needs to access that Organizational Unit and to print the description, we now can use either `GetObject` or authenticate directly to that Organizational Unit in the same way as we did to the root of the tree:

```
<HTML>
<HEAD>
<TITLE>Binding to an existing Organizational Unit</TITLE>
</HEAD>

<BODY>
<%
  adsOUPath = "LDAP://ou=Sales,dc=mycorp,dc=com"
  strUsername = "mycorp\administrator"
  strPassword = "My-admin-password!"

  Set objNamespace = GetObject("LDAP:")
  Set objSalesOU = objNamespace.OpenDSObject(adsOUPath,strUsername,strPassword,0)

  Response.Write "The Sales OU description is: " & objSalesOU.Description
%>
</BODY>
</HTML>
```

What may seem strange is that you can authenticate to the root of the tree and access objects there, but you still need to authenticate again to other areas of the tree if you need to bind to them. Authenticating to one point in the tree does not allow you to use `GetObject` happily throughout the rest of the script for all objects and containers that exist below that point. If you need authentication, for whatever reason, to access objects in disparate areas of the tree, you need to authenticate each binding separately. As an example, this next script creates the Organizational Unit again and then sets the description for a user named Ian Harcombe in the Users container. In this example, both need authentication because we wish to update properties in both cases:

```
<HTML>
<HEAD>
<TITLE>Example use of Complex Authentication</TITLE>
</HEAD>
```

```
<BODY>
<%
  strRootPath = "LDAP://dc=mycorp,dc=com"
  strUserPath  = "LDAP://cn=Ian Harcombe,cn=Users,dc=mycorp,dc=com"
  strUsername = "mycorp\administrator"
  strPassword = "My-admin-password!"

  Set objNamespace = GetObject("LDAP:")
   Set  objRoot  =  objNamespace.OpenDSObject(strRootPath,strUsername,strPassword,0)

  Set objSalesOU = objRoot.Create("organizationalUnit","ou=Sales")
  objSalesOU.Description = "My new description!"
  objSalesOU.SetInfo

   Set  objUser  =  objNamespace.OpenDSObject(strUserPath,strUsername,strPassword,0)
  objUser.Description = "My new description!"
  objUser.SetInfo
%>
</BODY>
</HTML>
```

28.4.3. When to Use IADsContainer::GetObject

We've shown that we cannot use the VBScript `GetObject` function to authenticate a connection to objects in Active Directory from an ASP. However, there is a method called `IADsContainer::GetObject` that can be used to bind to objects from a container using the preexisting authenticated connection for the container. While both `GetObject` methods have identical names and similar functions, to save confusion, we will use the fully qualified `IADsContainer::GetObject` when talking about the method and `GetObject` when talking about VBScript's function.

The `IADsContainer::GetObject` method is used to retrieve items from a container. It takes two parameters, the class of the object to retrieve and the object's RDN. The fact that `IADsContainer::GetObject` retrieves objects using the RDN means that you do not have to bind to individual objects below a container. This saves authenticating a connection to each object if you need to work on multiple objects in a container. If the Sales Organizational Unit now has three users below it, we can authenticate to the container and then use the `IADsContainer::GetObject` method to manipulate the three users. Here is an example:

```
<HTML>
<HEAD>
<TITLE>Use of IADsContainer::GetObject</TITLE>
</HEAD>

<BODY>
<%
  adsOUPath = "LDAP://ou=Sales,dc=mycorp,dc=com"
  strUsername = "mycorp\administrator"
  strPassword = "My-admin-password!"

  Set objNamespace = GetObject("LDAP:")
  Set objSalesOU = objNamespace.OpenDSObject(adsOUPath,strUsername,strPassword,0)

  Set objUser1 = objSalesOU.GetObject("User","cn=Simon Williams")
  Set objUser2 = objSalesOU.GetObject("User","cn=Markie Newell")
  Set objUser3 = objSalesOU.GetObject("User","cn=Jason Norton")

  Response.Write "Simon Williams' description is: " & objUser1.Description
  Response.Write "<BR>Markie Newell's description is: " & objUser2.Description
  Response.Write "<BR>Jason Norton's description is: " & objUser3.Description
%>
</BODY>
</HTML>
```

This works under WSH in exactly the same way as it does here. However, it is something that you may make much more use of in an ASP to save you from a lot of unnecessary authentication. If the class is null with `IADsContainer::GetObject`, the first item matching the RDN of any class is returned.

28.4.4. Authenticating from Passwords Input via Forms

When you need to force authentication in a script, the last thing you want to do is hardcode a password into the script. That's not to say that the ASP page isn't secure; it is. Assuming the web site is properly configured, the script is visible only to users of the computer in which IIS is running and not to web client users, because it is parsed before being displayed. Also, if the permissions are secured, even this is not visible. However, you have to keep in mind that you will have to change the embedded password in all the ASP files every time the account password is changed. The simplest solution is to use an HTML form with a field for the password in your ASP and prompt for a password from the user. An example would look like this:

```
<HTML>
<HEAD>
<TITLE>Authentication Request</TITLE>
</HEAD>

<BODY>
<FORM ACTION="restricted.asp" METHOD=POST>

  <P>Name <BR><INPUT
    NAME="Name"
    TYPE=TEXT
    VALUE="mycorp\administrator"
    SIZE="60">

  <P>Password<BR><INPUT
```

```
    TYPE="PASSWORD"
    NAME="Password">

  <P><INPUT TYPE="SUBMIT" VALUE="OK"><INPUT TYPE="RESET" VALUE="Reset">
</FORM>

</BODY>
</HTML>
```

This eliminates the problem of having to embed the username and password in a script. The `<INPUT TYPE="PASSWORD">` tag places asterisk (*) characters in the field whenever a character is entered. In this instance, the username and password are passed from this authentication page to your page entitled *restricted.asp*, which will use the credentials to perform the authentication and continue on.

> When sending passwords or other critical data between the client and the web server with forms, you should use SSL to protect the transfer of information to avoid the data being transmitted "in the clear."

28.4.5. A Simple Password Changer

A simple ASP example to show both server-side ADSI scripts and the use of the password attribute of the `FORM` tag is a password changer. Users load the page, type their usernames along with their old and new passwords into a form, and click the Submit button. Submitting the form triggers an authentication access to the user object supplied, using the user object itself with the old password. Provided that the user successfully authenticated to the user's own object, the password is then changed using the `IADsUser::ChangePassword` method.

This script consists of two parts: the form itself, which sits in the body of the page, and the code that interprets the submission of the form, which is located in the header. Let's start with the makeup of the form, which needs six fields:

- A text input field for the name
- A password input field for the current password
- A password input field for the new password
- A password input field to confirm the new password
- A Submit button
- A Reset button that sets all the input fields back to their default values

Here is the form:

```
<FORM  ACTION="psw_changer1.asp"  METHOD=POST>

  <P>Name <BR><INPUT
    NAME="Name"
    TYPE=TEXT
    VALUE="cn=xxxxx,cn=Users,dc=mycorp,dc=com"
    SIZE="60">

  <P>Old Password<BR><INPUT
    TYPE="PASSWORD"
    NAME="OldPassword">

  <P>New Password<BR><INPUT
    TYPE="PASSWORD"
     NAME="NewPassword1">
  <P>Confirm Password<BR><INPUT
    TYPE="PASSWORD"
     NAME="NewPassword2">

  <P><INPUT TYPE="SUBMIT" NAME="SetPass" VALUE="Change Password!">
  <INPUT TYPE="RESET" VALUE="Reset">
</FORM>
```

The username field has been given a default value that will appear in the entry box to save typing. Obviously this would be much improved if the user could just type his username and an ADO search was initiated.

Whenever the Submit button is clicked, the page is reloaded according to the value associated with the ACTION parameter. In addition, the form's fields have been set. This differs from the normal loading of a page when the fields will be empty. In the server-side code, we need to make sure that the code is triggered only when the page is loaded via the submission of the form. To do this, we can surround the code with the following section:

```
<%
  On Error Resume Next
  If Request.Form("SetPass") = "Change Password!" Then
    'Code goes here
  End If
%>
```

Once the form is submitted, the value of the SetPass button will be the button's label. Until that happens, the value is blank. This is a good way to check for the submission of a form.

Assuming that this code is being executed properly after submission, we need to check that the new passwords match. We will be using only one of the values to set the new password, so we have to make sure that both passwords are as the user intended. To do that, we can use Request::Form again to check both passwords:

```
<%
  On Error Resume Next
  If Request.Form("SetPass") = "Change Password!" Then
     If Request.Form("NewPassword1") = Request.Form("NewPassword2") Then
      'code goes here
    Else
      Response.Write "The two new passwords do not match. Please try again."
    End If
  End If
%>
```

We are now ready to fill in the rest of the code, which is fairly straightforward. First, we need to authenticate to the user, and if that is successful, attempt to change the password. Example 28-1 lists the completed ASP code incorporating the ADSI calls, which have been highlighted.

Example 28-1. ASP code incorporating the ADSI calls

```
<HTML>
<HEAD>
<TITLE>Simple Password Changer</TITLE>
</HEAD>

<BODY>
<%
  On Error Resume Next
  If Request.Form("SetPass") = "Change Password!" Then
     If Request.Form("NewPassword1") = Request.Form("NewPassword2") Then

       strUsername = "LDAP:// " & Request.Form("Name")
      Set objNamespace = GetObject("LDAP: ")
      'Attempt to authenticate to the user object in the tree using
      'the username and the current password
      Set objUser = objNamespace.OpenDSObject(strUsername, _
         Request.Form("Name"), Request.Form("OldPassword"), 0)
       If Err=0 Then

        'Attempt to change the password
        objUser.ChangePassword _
          CStr(Request.Form("OldPassword")), _
          CStr(Request.Form("NewPassword1"))
        If Err=0 Then
          Response.Write "Password has been changed."
        Else
          Response.Write "Error: the Password has not been changed."
        End If
      Else
```

```
        Response.Write "Unable to authenticate. Password or Username incorrect."
      End If
    Else
      Response.Write "The two new passwords do not match. Please try again."
    End If
  End If
%>
<FORM  ACTION="psw_changer1.asp"  METHOD=POST>

  <P>Name <BR><INPUT
    NAME="Name"
    TYPE=TEXT
    VALUE="cn=xxxxx,cn=Users,dc=mycorp,dc=com"
    SIZE="60">

  <P>Old Password<BR><INPUT
    TYPE="PASSWORD"
    NAME="OldPassword">

  <P>New Password<BR><INPUT
    TYPE="PASSWORD"
     NAME="NewPassword1">
  <P>Confirm Password<BR><INPUT
    TYPE="PASSWORD"
     NAME="NewPassword2">

  <P><INPUT TYPE="SUBMIT" NAME="SetPass" VALUE="Change Password!">
  <INPUT TYPE="RESET" VALUE="Reset">
</FORM>
</BODY>
</HTML>
```

As you can see, this is not particularly difficult. You also could add an `Else` clause and print out `Hex(Err.Number)` and `Err.Description` if you wished.

28.4.6. Adding Users to Groups

A password changer is a good example for a simple form, but more complex forms can sometimes be necessary. In this example, we want to populate two list boxes with users and groups from the default Users container. If we select a user and a group from the two list boxes and enter a username/password that has permissions, we should be able to click the Submit button to add the user to the group.

Once again, like most ADSI ASPs that use forms, this page is split into two parts: the form itself and the server-side script. The form is a fairly simple extension of the one that we outlined earlier, and it is listed in Example 28-2. Population of the list boxes is done using two sets of server-side scripts that enumerate all values in the Users container and add any items to the list box of the appropriate class. The important population code is emphasized.

Example 28-2. Adding a user to a group

```
<FORM ACTION = "userlist2.asp" METHOD = "POST">
  <P>Users:
  <SELECT NAME = "user">
<% Set objUsersContainer = _
       GetObject("LDAP://cn=Users,dc=mycorp,dc=com")
    For Each objObject in objUsersContainer
       If objObject.Class ="user"Then %>
         <OPTION><% = objObject.Name %>
<%    End If
   Next %>
  </SELECT>
  Groups:
  <SELECT NAME = "group">
<%  For Each objObject in objUsersContainer
       If objObject.Class ="group"Then %>
         <OPTION><% = objObject.Name %>
<%    End If
Next %>
  </SELECT></P>

  <P>Username: <INPUT
    NAME="Name"
    TYPE=TEXT
    VALUE="mycorp\administrator"
    SIZE="60">

  <P>Password<INPUT
    TYPE="PASSWORD"
    NAME="Password">

  <P><INPUT TYPE=SUBMIT NAME="Submit" VALUE="Add User To Group!">
</FORM>
```

The server-side script that interprets the results needs to make sure that the script is executed only when the form has been submitted. Once that condition is true, the script has to attempt to authenticate to the selected group using the username and password supplied in the form. Example 28-3 lists the whole script with the major ADSI calls in the server-side script emphasized.

Example 28-3. Authenticating the new user to the selected group

```
<HTML>
<HEAD>
<TITLE>Adding Users to Groups from the default Users Container</TITLE>

</HEAD>

<BODY>
<%
  On Error Resume Next
  If Request.Form("Submit") <> "" Then
    strGroupPath = "LDAP://" & Request.Form("group") _
      & ",cn=Users,dc=mycorp,dc=com"
    strUserPath = "LDAP://" & Request.Form("user") _
      & ",cn=Users,dc=mycorp,dc=com"

Set objNamespace = GetObject("LDAP: ")
    Err.Clear
Set objGroup = objNamespace.OpenDSObject(strGroupPath, _
CStr(Request.Form("Name")), _
CStr(Request.Form("Password")),0)
    If Err=0 Then
If objGroup.IsMember(strUserPath) Then
        Response.Write "User is already a member of the group"
      Else
        Err.Clear
objGroup.Add(strUserPath)
        If Err=0 Then
          Response.Write "User is now a member of the group"
        Else
          Response.Write "An error occurred when adding the user to the group."
        End If
      End If
    Else
      Response.Write "Authentication failed."
    End If
  End If
%>
<P>
<FORM ACTION = "userlist2.asp" METHOD = "POST">
  <P>Users:
  <SELECT NAME = "user">
<%  Set objUsersContainer = _
      GetObject("LDAP://cn=Users,dc=mycorp,dc=com")
    For Each objObject in objUsersContainer
      If objObject.Class = "user" Then %>
        <OPTION><% = objObject.Name %>
<%    End If
    Next %>
  </SELECT>
  Groups:
  <SELECT NAME = "group">
<%  For Each objObject in objUsersContainer
```

```
      If objObject.Class = "group" Then %>
        <OPTION><% = objObject.Name %>
<%    End If
    Next %>
  </SELECT></P>

  <P>Username: <INPUT
    NAME="Name"
    TYPE=TEXT
    VALUE="mycorp\administrator"
    SIZE="60">

  <P>Password<INPUT
    TYPE="PASSWORD"
    NAME="Password">

  <P><INPUT TYPE=SUBMIT NAME="Submit" VALUE="Add User To Group!">
</FORM>
</BODY>
</HTML>
```

We checked to see if the user was a member just so that the script is more user-friendly. You also can see in this script that we use the `GetObject` function to populate the initial list boxes, but we then switch to `IADsOpenDSObject::OpenDSObject` as soon as we need to update Active Directory.

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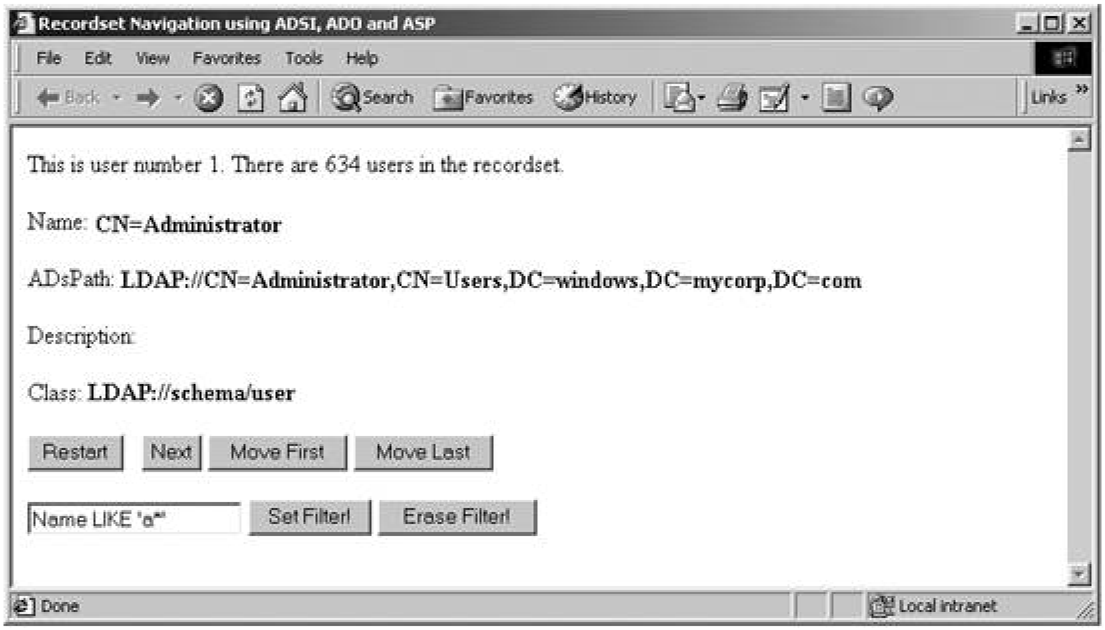
28.5. Incorporating Searches into ASP

ADO searches can be easily incorporated into ASPs using the information in this chapter and Chapter 22. In this first example, we will navigate through a resultset using server-side scripts in order to populate a table that gets created dynamically. To make it easier to understand, Figure 28-1 is what the final result should look like for a new server with very few users.

Figure 28-1. A navigable table on a web page populated by ADO


Recordset Navigation using ADSI, ADO and ASP
File Edit View Favorites Tools Help
Back Search Favorites History
Links
Done
Local intranet

This is user number 1. There are 634 users in the recordset.

Name: **CN=Administrator**

ADsPath: **LDAP://CN=Administrator,CN=Users,DC=windows,DC=mycorp,DC=com**

Description:

Class: **LDAP://schema/user**

Restart | Next | Move First | Move Last

Name LIKE 'a*' | Set Filter! | Erase Filter!

This ASP page includes all its code in the body of the web page. To begin with, we must retrieve the resultset:

```
<%
  Set objConn = CreateObject("ADODB.Connection")
  objConn.Provider = "ADSDSOObject"
  objConn.Open "", _
    "mycorp\administrator", "My-admin-password!"

  Set objRS = objConn.Execute _
    ("<LDAP://dc=mycorp,dc=com>;" _
      & "(&(objectCategory=person)(objectClass=user));Name,ADsPath;SubTree")
```

```
%>
```

Having done this, we can now begin to create the table. The table definition can include the number of columns. Even though we know that we are retrieving two columns, we will include the value returned from the query rather than hardcoding a value of 2 into the table so that we can extend the page later. The table definition then looks like this:

```
<TABLE BORDER=1 COLS=<% = objRS.Fields.Count%>>
```

Now we need to include column headings. Again, if we take these directly from the query, then we can expand the query much more easily later:

```
  <TR>
    <% For Each adoField In objRS.Fields %>
         <TH> <% = adoField.Name %> </TH>
    <% Next %>
  </TR>
```

Now we can navigate through the actual resultset and populate the table. Each row is created via the `<TR>...</TR>` pair of tags by navigating through the resultset using a `Do While...Loop` construct. As soon as we go past the end of the loop, the table closing tag is sent. Each individual row is populated using a `For...Each` loop:

```
  <% Do While Not objRS.EOF %>
    <TR>
      <% For Each adoField In objRS.Fields %>
         ' Populate the cells here
      <% Next
      objRS.MoveNext %>
    </TR>
  <% Loop %>
</TABLE>
```

Each cell within each column of that row is created using the `<TD>` tag within that For loop, like so:

```
<TD ALIGN=LEFT>
<% If IsNull(adoField) Then
     Response.Write ""
   Else
     Response.Write adoField.Value
   End If %>
</TD>
```

The whole section of code comes together in Example 28-4. Ignore the first line for now; we'll come back to it in a minute.

Example 28-4. Incorporating searches into ASP

```
<!--#include file="adovbs.inc" -->
<HTML>
<HEAD>
<TITLE>Navigating a simple resultset using ADSI, ADO and ASP</TITLE>
</HEAD>

<BODY>
<%
  On Error Resume Next

  Set objConn = CreateObject("ADODB.Connection")
  objConn.Provider = "ADSDSOObject"
  objConn.Open "", "mycorp\administrator", "My-admin-password!"

  Set objRS = objConn.Execute _
    ("<LDAP://dc=mycorp,dc=com>;" _
      & "(&(objectCategory=person)(objectClass=user));Name,ADsPath;SubTree")
%>

<TABLE BORDER=1 COLS=<% = objRS.Fields.Count%>>
  <TR>
    <% For Each oField In objRS.Fields %>
         <TH> <% = oField.Name %> </TH>
    <% Next %>
  </TR>
  <% Do While Not objRS.EOF %>
    <TR>
      <% For Each oField In objRS.Fields %>
           <TD ALIGN=LEFT>
           <% If IsNull(oField) Then
                Response.Write "&nbsp;"
              Else
                Response.Write oField.Value
              End If %>
           </TD>

      <% Next
      objRS.MoveNext %>
    </TR>
  <% Loop %>
</TABLE>

<%
  objConn.Close
  Set objRS = Nothing
%>

</BODY>
</HTML>
```

28.5.1. ASP Searches Allowing User Navigation of a Resultset

We'll now go through a rather more complex example so that you can see how to allow users to navigate through a resultset. This example came from a need to be able to display the name, description, and ADsPath of every object in the tree in a simple fashion on a web page. The most obvious solution was to use an ADO resultset with Move First, Move Last, Previous, and Next buttons to step through it. Once the simple example is assembled, we will expand it to include a demonstration of filters.

The ASP is split up as usual between the server-side script and the HTML of the web page itself. The resultset is retrieved as part of the server-side script and looks identical to those we considered earlier:

```
<%
  Set objConn = CreateObject("ADODB.Connection")
  objConn.Provider = "ADSDSOObject"
  objConn.Open "", "mycorp\administrator", " My-admin-password!"

  Set objRS = objConn.Execute _
 ("<LDAP://dc=mycorp,dc=com>;(&(objectCategory=person)(objectClass=User))" _
                                                & ";ADsPath;SubTree")
%>
```

> You may need to add either Microsoft Data Access Components (MDAC) or ADO components to your installation of IIS before IIS will accept ADO on web pages. If you find that you are getting continual errors with simple ADO queries, you may have forgotten to install the relevant components so that IIS can interpret ADO code.

We'll leave the server-side script for now and concentrate on the HTML elements. The web page needs to display the `name`, `description`, and `ADsPath` of the user. To do that, we need to bind to the user via the `ADsPath` of the current record of the resultset. We will use

IADsOpenDSObject::OpenDSObject here, although GetObject would do just as well:

```
<%
  strUsername = "mycorp\administrator"
  strPassword = "My-admin-password!"

  Set objNamespace = GetObject("LDAP:")
  Set objUser = objNamespace.OpenDSObject(objRS("ADsPath"), _
     strUsername,strPassword,0)

  Response.Write "Name: <B>" & objUser.Name & "</B><P>"
  Response.Write "ADsPath: <B>" & objUser.ADsPath & "</B><P>"
  Response.Write "Description: <B>" & objUser.Description & "</B><P>"
%>
```

For the form itself, we've made sure that the Previous button is not displayed at the first resultset record and that the Next button is not displayed at the final resultset record. This prevents the resultset from going out of range, and is simple to do using server-side scripting within the HTML code by checking the Recordset::AbsolutePosition and Recordset::RecordCount properties:

```
<FORM METHOD="POST" ACTION="rs_demo.asp">
  <% If objRS.AbsolutePosition = objRS.RecordCount Then %>
    <INPUT TYPE="SUBMIT" NAME="Previous" VALUE="Previous">
  <% ElseIf objRS.AbsolutePosition = 1 Then %>
    <INPUT TYPE="SUBMIT" NAME="Next" VALUE="Next">
  <% Else %>
    <INPUT TYPE="SUBMIT" NAME="Previous" VALUE="Previous">
    <INPUT TYPE="SUBMIT" NAME="Next" VALUE="Next">
  <% End If %>

  <INPUT TYPE="SUBMIT" NAME="First" VALUE="Move First">
  <INPUT TYPE="SUBMIT" NAME="Last" VALUE="Move Last">
</FORM>
```

This is essentially it for the client HTML code. Before looking at the server-side code, there is one HTML line we have to add for ADO prior to anything else on the page:

```
<!--#include file="adovbs.inc" -->
```

This line is known as a Server-side Include (SSI) and is used to include all the ADO constants you may wish to use in your ASP without having to declare them yourself. This file is installed with the ADO component of IIS in the *\ProgramFiles\Common Files\System\ado* directory as a text file, so you can easily open it and look through the constants that are available to you. If you are using JScript, you need to use *adojavas.inc* instead.

After including the code to retrieve the resultset, we now need to include the code to navigate that resultset according to which buttons are clicked on the form. However, at this point, we have a problem. Because the page reloads the resultset every time, the current record will always be the first no matter what button is selected. For this web page to properly navigate a resultset, we will have to maintain some sort of indicator to the current record between refreshes of each page. This is very easy to do using the `HIDDEN` attribute of fields on the existing form. All we need to do is set up an extra entry anywhere on the form that includes a reference to the current record. We can do this using the `Recordset::AbsolutePosition` of the resultset:

```
<INPUT TYPE="HIDDEN" NAME="AbsPosition"
  VALUE="<% = objRS.AbsolutePosition %>">
```

If we do this, whenever the form is submitted, the current record's position is transmitted with the form.

> There is one problem with using `Recordset::AbsolutePosition` in this example: the resultset may not be static throughout every query. If users are being created and deleted while the page is being accessed, there is a chance, however small, that the current record may disappear between page refreshes or that a navigation moves to a new record that did not previously exist. Solutions to this problem are discussed later in the chapter.

Assuming that we do this, we can navigate through the new resultset using the following code:

```
<%
  If Request.Form("Next") <> "" Then
     objRS.AbsolutePosition = Request.Form("AbsPosition") + 1
  ElseIf Request.Form("Previous") <> "" Then
     objRS.AbsolutePosition = Request.Form("AbsPosition") - 1
  ElseIf Request.Form("First") <> "" Then
    objRS.MoveFirst
  ElseIf Request.Form("Last") <> "" Then
    objRS.MoveLast
  End If
%>
```

At this point, the code is essentially complete. Example 28-5 shows it in its entirety.

Example 28-5. Navigating through a resultset

```
<!--#include file="adovbs.inc" -->
<%
  Set objConn = CreateObject("ADODB.Connection")
  objConn.Provider = "ADSDSOObject"
  objConn.Open "", "mycorp\administrator", "My-admin-password!"

  Set objRS = objConn.Execute _
    ("<LDAP://dc=mycorp,dc=com>;(&(objectCategory=person)(objectClass=User))" _
                                                & ";ADsPath;SubTree")

  If Request.Form("Next") <> "" Then
     objRS.AbsolutePosition = Request.Form("AbsPosition") + 1
  ElseIf Request.Form("Previous") <> "" Then
     objRS.AbsolutePosition = Request.Form("AbsPosition") - 1
  ElseIf Request.Form("First") <> "" Then
    objRS.MoveFirst
  ElseIf Request.Form("Last") <> "" Then
    objRS.MoveLast
  End If
%>

<! Start the main page>
<HTML>
<HEAD>
<TITLE>Recordset Navigation using ADSI, ADO and ASP</TITLE>
</HEAD>

<BODY>
<%
  strUsername = "mycorp\administrator"
  strPassword = "My-admin-password!"

  Set objNamespace = GetObject("LDAP:")
  Set objUser = objNamespace.OpenDSObject(objRS("ADsPath"), _
     strUsername,strPassword,0)

  Response.Write "Name: <B>" & objUser.Name & "</B><P>"
  Response.Write "ADsPath: <B>" & objUser.ADsPath & "</B><P>"
  Response.Write "Description: <B>" & objUser.Description & "</B><P>"
%>
<FORM METHOD="POST" ACTION="rs_demo.asp">
  <INPUT TYPE="HIDDEN" NAME="AbsPosition"
    VALUE="<% = objRS.AbsolutePosition %>">
  <% If objRS.AbsolutePosition = objRS.RecordCount Then %>
    <INPUT TYPE="SUBMIT" NAME="Previous" VALUE="Previous">
  <% ElseIf objRS.AbsolutePosition = 1 Then %>
    <INPUT TYPE="SUBMIT" NAME="Next" VALUE="Next">
  <% Else %>
    <INPUT TYPE="SUBMIT" NAME="Previous" VALUE="Previous">
    <INPUT TYPE="SUBMIT" NAME="Next" VALUE="Next">
  <% End If %>
  <INPUT TYPE="SUBMIT" NAME="First" VALUE="Move First">
  <INPUT TYPE="SUBMIT" NAME="Last" VALUE="Move Last">
</FORM>

</BODY>
</HTML>
```

28.5.2. Enhancing the User Navigation ASP

There are a number of enhancements that you can make to the code, not only to make it more user-friendly but also to demonstrate the use of filtering an existing resultset. We'll deal with these enhancements individually and then combine them all at the end into an expanded ASP incorporating all of the enhancements.

28.5.2.1. Empty resultsets

Occasionally, you will write an ASP that generates an empty resultset. If that is the case, we should make sure that the page handles this properly. We could print a simple message and stop processing the page any further. In addition, we could provide a Restart button that could reload the page from scratch if desired. Here is the section of code to accomplish this:

```
<%
  If objRS.EOF Then
    Response.Write("No users found!")
%>
    <FORM METHOD="POST" ACTION="rs_demo.asp">
      <INPUT TYPE="SUBMIT" NAME="Restart" VALUE="Restart">
    </FORM>
<%
    objConn.Close
    Set objRS = Nothing
    Set objConn = Nothing
    Response.End
  End If
%>
```

28.5.2.2. Starting from scratch

Occasionally, it would be nice to wipe the resultset clean and start again from scratch at the first item. This is easy to achieve using another button on the form:

```
<INPUT TYPE="SUBMIT" NAME="Restart
" VALUE="Restart">
```

If the page is opened using the Restart button , we reload the page from scratch by using the trick of redirecting the browser to the page. This triggers the browser to get a new copy of the page, clearing all the values set by the form on previous pages. The server-side code looks like this:

```
<%
  If Request.Form("Restart") = "Restart" Then
    Response.Redirect("rs_demo.asp")
    Response.End
  End If
%>
```

28.5.2.3. Filters

To include filters on an existing resultset, we need to monitor two extra values when the form is submitted. First, we need to know that a filter is being applied to the resultset, so that we can reapply it when the page is refreshed after the submission of a form. Second, we need to keep a copy of the actual filter itself. The first is easily taken care of by another hidden field in the form:

```
<INPUT TYPE="HIDDEN" NAME="IsFilterOn" VALUE="<% = bolFilter %>">
```

To set this value, we need to include some server-side code to cope with the fact that the value will not be set for the first-ever access to the page. We can do it like this:

```
<%
  If Request.Form("IsFilterOn") = "FALSE" Then
    bolFilter = "FALSE"
  ElseIf Request.Form("IsFilterOn") = "TRUE" Then
    bolFilter = "TRUE"
  Else
    bolFilter = "FALSE"
  End If
%>
```

We could just as easily use an `INPUT` field of type `CHECKBOX` here if desired. This is a Boolean input and would work just as well.

The second requirement can be taken care of by an INPUT field on the form:

```
<INPUT TYPE="TEXT" NAME="FilterText" VALUE= "<% = strFilter %>">
```

We would also like to include a default value for this filter, so strFilter needs to be set somewhere prior to the form itself. After the page has been accessed once, the value of this field entry will have been set. From then on, we should be able to use the existing value of this field as the base for the input field. Here is the code:

```
<%
  If CStr(Request.Form("FilterText")) = "" Then
    strFilter = "Name LIKE 'a*'"
  Else
    strFilter = CStr(Request.Form("FilterText"))
  End If
%>
```

We also need some way of being able to set and remove the filter on the resultset. As there will always be a value in the filter field, we cannot use this to trigger the addition of a filter to the resultset. Once again, the simplest solution is to use two more buttons on the form:

```
<INPUT TYPE="SUBMIT" NAME="SetFilter" VALUE="Set Filter!">
<INPUT TYPE="SUBMIT" NAME="EraseFilter" VALUE="Erase Filter!">
```

We now can write the code that actually applies and removes the filter using these two buttons:

```
ElseIf Request.Form("SetFilter") <> "" Then
  objRS.Filter = CStr(Request.Form("FilterText"))
  bolFilter = "TRUE"
ElseIf Request.Form("EraseFilter") <> "" Then
  objRS.Filter = adFilterNone
  bolFilter = "FALSE"
```

There is still one small piece of code missing. Although we can set a filter using the appropriate button, as soon as we begin to navigate the filtered resultset, we will be clicking other buttons. We need to make sure that the filter is applied while the IsFilterOn field is true. To do this, we add an extra line to the code that sets *bolFilter*, which we laid out earlier. The code should now look like this:

```
If Request.Form("IsFilterOn") = "FALSE" Then
```

```
  bolFilter = "FALSE"
ElseIf Request.Form("IsFilterOn") = "TRUE" Then
  objRS.Filter = CStr(Request.Form("FilterText"))
  bolFilter = "TRUE"
Else
  bolFilter = "FALSE"
End If
```

This makes sure that the filter is always applied after it has been initially set.

28.5.2.4. Displaying the location of individual records

We will add two other lines of code to the ASP page. While they are not strictly necessary, these two lines serve to demonstrate how resultsets work:

```
This is user number <% = objRS.AbsolutePosition %>.
There are <% = objRS.RecordCount %> users in the recordset.<P>
```

The last line will always tell you how many records you can currently navigate through in the resultset. If there are 12 records and you have no filter, the result will be 12. If you have 12 records but have a filter that limits it to 4, the result will be 4. However, the first line always refers to the record number out of the entire recordset total, regardless of whether a filter has been set.

This means that including the following code can lead to undesired results:

```
<P>This is user <% = objRS.AbsolutePosition %> out of a total of
<% = objRS.RecordCount %> users in the recordset.</P>
```

If a filter were applied to a resultset that limited the resultset to the entries 1, 3, 8, and 9, when you navigated between the four results, you would receive the following responses:

```
This is user 1 out of a total of 4 users in the recordset.
This is user 3 out of a total of 4 users in the recordset.
This is user 8 out of a total of 4 users in the recordset.
This is user 9 out of a total of 4 users in the recordset.
```

It is important to understand this distinction.

28.5.2.5. The enhanced ASP search

Example 28-6 lists the code for the enhanced version of the ASP ADO search.

Example 28-6. The enhanced version of the ASP ADO search

```
<!--#include file="adovbs.inc" -->
<HTML>
<HEAD>
<TITLE>Recordset Navigation using ADSI, ADO and ASP</TITLE>
</HEAD>

<BODY>
<%
  ' If the page is opened using the Restart button then reload the page
  ' from scratch by redirecting to the page itself
  If Request.Form("Restart") = "Restart" Then
    Response.Redirect("rs_demo.asp")
    Response.End
  End If

  ' Retrieve the Resultset
  Set objConn = CreateObject("ADODB.Connection")
  objConn.Provider = "ADSDSOObject"
  objConn.Open "", "mycorp\administrator", "My-admin-password!"

  Set objRS = objConn.Execute _
    ("<LDAP://dc=mycorp,dc=com>;(&(objectCategory=person)(objectClass=User))" _
                                                      & ";ADsPath;SubTree")

  If Request.Form("IsFilterOn") = "FALSE" Then
    bolFilter = "FALSE"
  ElseIf Request.Form("IsFilterOn") = "TRUE" Then
    objRS.Filter = CStr(Request.Form("FilterText"))
    bolFilter = "TRUE"
  Else
    bolFilter = "FALSE"
  End If

  If Request.Form("Next") <> "" Then
     objRS.AbsolutePosition = Request.Form("AbsPosition") + 1
  ElseIf Request.Form("Previous") <> "" Then
     objRS.AbsolutePosition = Request.Form("AbsPosition") - 1
  ElseIf Request.Form("First") <> "" Then
    objRS.MoveFirst
  ElseIf Request.Form("Last") <> "" Then
    objRS.MoveLast
  ElseIf Request.Form("SetFilter") <> "" Then
    objRS.Filter = CStr(Request.Form("FilterText"))
    bolFilter = "TRUE"
  ElseIf Request.Form("EraseFilter") <> "" Then
    objRS.Filter = adFilterNone
    bolFilter = "FALSE"
  End If

  ' If no results were returned, then end the session
  ' but provide a restart button
  If objRS.EOF Then
    Response.Write("No users found!")
%>
    <FORM METHOD="POST" ACTION="rs_demo.asp">
      <INPUT TYPE="SUBMIT" NAME="Restart" VALUE="Restart">
    </FORM>
<%
    objConn.Close
    Set objRS = Nothing
    Set objConn = Nothing
    Response.End
  End If
%>

<! Start the main page>
This is user number <% = objRS.AbsolutePosition %>.
There are <% = objRS.RecordCount %> users in the recordset.<P>

<%
  If CStr(Request.Form("FilterText")) = "" Then
    strFilter = "Name LIKE 'a*'"
  Else
    strFilter = CStr(Request.Form("FilterText"))
  End If
  strUsername = "mycorp\administrator"
  strPassword = "My-admin-password!"

  Set objNamespace = GetObject("LDAP:")
  Set objUser = objNamespace.OpenDSObject(objRS("ADsPath"), _
     strUsername,strPassword,0)

  Response.Write "Name: <B>" & objUser.Name & "</B><P>"
  Response.Write "ADsPath: <B>" & objUser.ADsPath & "</B><P>"
  Response.Write "Description: <B>" & objUser.Description & "</B><P>"
  Response.Write "Class: <B>" & objUser.Schema & "</B><P>"
%>

<FORM METHOD="POST" ACTION="rs_demo.asp">
  <INPUT TYPE="SUBMIT" NAME="Restart" VALUE="Restart">
  <INPUT TYPE="HIDDEN" NAME="AbsPosition"
    VALUE="<% = objRS.AbsolutePosition %>">
  <INPUT TYPE="HIDDEN" NAME="IsFilterOn" VALUE="<% = bolFilter %>">

  <% If objRS.AbsolutePosition = objRS.RecordCount Then %>
```

```
    <INPUT TYPE="SUBMIT" NAME="Previous" VALUE="Previous">
  <% ElseIf objRS.AbsolutePosition = 1 Then %>
    <INPUT TYPE="SUBMIT" NAME="Next" VALUE="Next">
  <% Else %>
    <INPUT TYPE="SUBMIT" NAME="Previous" VALUE="Previous">
    <INPUT TYPE="SUBMIT" NAME="Next" VALUE="Next">
  <% End If %>

  <INPUT TYPE="SUBMIT" NAME="First" VALUE="Move First">
  <INPUT TYPE="SUBMIT" NAME="Last" VALUE="Move Last">
  <P>
  <INPUT TYPE="TEXT" NAME="FilterText" VALUE= "<% = strFilter %>">
  <INPUT TYPE="SUBMIT" NAME="SetFilter" VALUE="Set Filter!">
  <INPUT TYPE="SUBMIT" NAME="EraseFilter" VALUE="Erase Filter!">
</FORM>

</BODY>
</HTML>
```

28.5.2.6. Problems with this example

As mentioned earlier, there is the problem that the resultset may not be static throughout every query. One way around this is to pass the `ADsPath` of the user back in a hidden field, and once the query is executed, confirm that the current record of the new query is the same current record of the old query prior to performing any actions from the buttons. If there were a problem, you could pop up a `MsgBox` or write some text to the screen to that effect.

We have not integrated the use of bookmarks into this code, since Microsoft specifically warns against moving to a record in a resultset using a bookmark from another query. Because the query is executed again each time the page is loaded, the use of bookmarks is not appropriate. While the bookmarks for the ADSI OLE DB provider are currently only a copy of the `Recordset::AbsolutePosition` field, it would be wise to follow Microsoft's advice in case they change the format in the future.

28.5.3. Other Ideas for Expansion

There are many other ways that you could extend the look and functionality of the existing code. For example, you could place Previous and Next buttons on each page even if you were at the first or last record. If you did this, you could use the following section of code to cycle around the resultset. If you click Next from the last record, you will go to the first; if you click Previous from the first, you will get to the last:

```
If Request.Form("Next") <> "" Then
  objRS.AbsolutePosition = Request.Form("AbsPosition") + 1
  If objRS.EOF Then
```

```
    objRS.MoveFirst
  End If
ElseIf Request.Form("Previous") <> "" Then
  If Request.Form("AbsPosition") = 1 Then
    objRS.MoveLast

  Else
    objRS.AbsolutePosition = Request.Form("AbsPosition") - 1   End If
End If
```

You can actually modify the descriptions on the buttons themselves using a script if you wish. For example, while you were on Record 3, you could replace Next and Previous with Move to Record 2 and Move to Record 4.

While we bound to Active Directory using the administrator username and password embedded in a plain text in the ASP source file, you could easily adapt the examples so that the web page had fields for both of these. That removes the authentication details from the ASP page. In addition, as we have authenticated to Active Directory, you could use this fact to extend this page to manipulate the existing Active Directory information. For example, instead of displaying the description for a user as text, you could make the current description the default value for a text `INPUT` field in the existing form. Then you could modify this description and click another button that you included, which would write that new description back to Active Directory.

If you wanted to use the ASP page to display every attribute for every mandatory and optional property that user objects have, you could walk the property list based on the schema class definition and write the results to a web page rather than a file (see Chapter 21). This can be achieved using the `IADs::Schema` property (i.e., `objUser.Schema`).

You could modify what happens when you get an empty resultset due to an incorrect filter. Instead of just providing a Restart button and ending the session, you could put up the three filter fields and allow people to see and correct their mistakes.

Obviously, you also could expand and extend the search so that it could search for any classes of objects, possibly via a list box within a form.

Even though the HTML code on the ASP pages is dynamically generated and sent to the client by server-side scripts, the HTML is static once it has been generated. This means that for a new set of data to be sent to the client, a new page has to be opened. The data on the page returned to the client has to change each time a button is pressed, so the web page is therefore reloaded with every button click. This means that the query is executed again and the resultset is retrieved afresh with every click of the button. The only way to alter the HTML code that exists on the client after it has been generated is to use Dynamic HTML or DHTML. This update to HTML does exactly what it says: it allows HTML to be updated dynamically on the client. While you could use DHTML here, it lies outside the scope of this book. The point is that there are quite a few things that you can do with ADO searches of Active Directory within Active Server Pages.

PREV NEXT

28.6. Migrating Your ADSI Scripts from VBScript to VB

If you decide you need a GUI-based application instead of a web-based application, it is time to start thinking about coding in a different language. VB is an easy language with the capabilities of great complexity. The VB language itself is very similar to VBScript, so you can port code quickly from your existing scripts. However, there is so much that you can do with VB that the bewildering array of interfaces and methods can easily get confusing. The simplest solution to this is to get a book on VB. There are many dozens of books that already exist on the complexities of writing in VB, and we do not intend to provide an introduction here. If you are seriously considering writing in VB, your best option is to pick up a book on it.

This section covers what you need to do to write ADSI code with VB after having written ADSI code in VBScript. This includes a brief look at the major differences between VBScript and VB, the options that need to be set, and the Platform SDK, which you will need to compile your code. We also briefly cover a series of examples that are available from the O'Reilly web site. The notes that we present in this section are with respect to Microsoft Visual Basic Professional Version 6.0. However, these examples should also work with future versions of VB as well.

28.6.1. Platform Software Development Kit

To access the ADSI interfaces and libraries, you need to be able to reference the appropriate component of the Microsoft Platform Software Development Kit (SDK) in your code. You can either download the appropriate component or obtain the full SDK, which includes all components.

The full SDK provides developers with a single, easy-to-use location from which to download current and emerging Microsoft technologies; it includes tools, headers, libraries, and sample code. The Platform SDK is the successor to the individual SDKs, such as the Win32, BackOffice, ActiveX/Internet Client, WMI, ADSI, and DirectX SDKs.

You can get the full SDK build environment or just the ADSI component in a number of ways:

- If you purchase an MSDN Professional-level subscription, you will be shipped all of the SDKs that you require.
- If you purchase an MSDN Universal-level subscription, you will be shipped all of the SDKs and all of the Visual Studio products, which includes Microsoft Visual Basic Enterprise Edition as well.
- If you purchase Visual Basic, you receive the full MSDN Library set of CDs and the SDK build environment.

You can download the parts of the platform SDK by going to http://www.microsoft.com/downloads/details.aspx?FamilyId=A55B6B43-E24F-4EA3-A93E-40C0EC4F68E5.

> If you wish to make use of ADO from the next chapter, you need Microsoft Data Access Components (MDAC) as well. You can download these from the Downloads section of the Universal Data Access site: http://www.microsoft.com/data/download.htm.

Once the SDK has been downloaded and installed, start VB and in any new project that you write, make sure that you go to Project → References and check items according to Table 28-1.

Table 28-1. When to use relevant references in VB

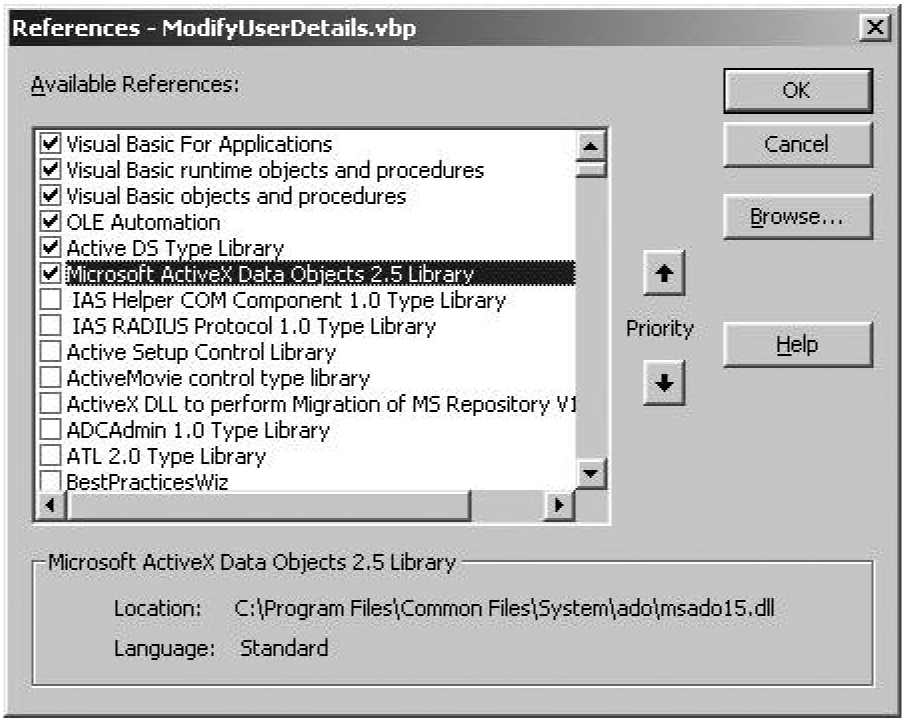
Reference	Use
Active DS Type Library	ADSI
Microsoft ActiveX Data Objects 2.5 Library	ADO

You can see the References window in Figure 28-2, with both items checked.

28.6.2. The Differences Between VB and VBScript

There are many differences between VBScript and VB, but the three major ones that you will come into contact with when porting your scripts can be quickly explained.

Figure 28-2. Visual Basic references



References - ModifyUserDetails.vbp

Available References:

- ☑ Visual Basic For Applications
- ☑ Visual Basic runtime objects and procedures
- ☑ Visual Basic objects and procedures
- ☑ OLE Automation
- ☑ Active DS Type Library
- ☑ Microsoft ActiveX Data Objects 2.5 Library
- □ IAS Helper COM Component 1.0 Type Library
- □ IAS RADIUS Protocol 1.0 Type Library
- □ Active Setup Control Library
- □ ActiveMovie control type library
- □ ActiveX DLL to perform Migration of MS Repository V1
- □ ADCAdmin 1.0 Type Library
- □ ATL 2.0 Type Library
- □ BestPracticesWiz

Microsoft ActiveX Data Objects 2.5 Library

Location: C:\Program Files\Common Files\System\ado\msado15.dll

Language: Standard

28.6.2.1. Screen functions

The code will not be executing under the WSH any more so `Wscript.Echo` is not appropriate. While `MsgBox` still works, these lines should be replaced either by `Debug.Print` or by directly passing results into `TextBox` controls.

28.6.2.2. Variables

In VBScript, every variable is of the type Variant and does not have to be declared. In VB , every variable must be declared at the beginning, just as if you were using `Option Explicit` in VBScript. In addition, each variable must be declared to be of a particular type. Here are some examples for VB:

```
'VB code
Dim objUser as IADsUser
Dim objRoot as IADsContainer
Dim objMember as IADsMember
```

In addition, `CreateObject` is not needed. Instead, you use the `New` keyword and declare the object created prior to the main code. The following VBScript code:

```
'VBScript code
```

```
Set objConn = CreateObject("ADODB.Connection")
```

is replaced with the following code in VB:

```
'VB code
Dim objConn as New ADODB.Connection
```

For another important point, look at these declarations:

```
'VB
 code
Dim objUser as IADsUser
Dim objUser2 as IADs
```

If we want to use the `IADsUser` methods and properties, we have to use the variable `objUser`. If we want to use the `IADs` methods and properties, we have to use `objUser2`. This is how it works:

```
'VB code
Dim objUser as IADsUser
Dim objUser2 as IADs

Set objUser = GetObject("LDAP://cn=Administrator,cn=Users,dc=mycorp,dc=com")
Set objUser2 = objUser
Debug.Print objUser.Description
Debug.Print  objUser2.Class
```

The first `Debug::Print` statement prints the `IADsUser::Description` property, and the second prints the `IADs::Class` property. We have to include the second Set command to make sure that `objUser2` points to the same object as `objUser`.

28.6.2.3. Loop constructs

The syntax for loops changes slightly. Here, for example, are two loops in VBScipt:

```
'VBScript code
While (condition)
  'Do something
Wend
```

```
For Each objMember In objGroup.Members
  WScript.Echo objMember.Name & vbCrLf & objMember.ADsPath
Next
```

Here they are again in VB:

```
'VB code
While (condition) Do
  'Do something
Wend

For Each objMember In objGroup.Members
  Debug.Print objMember.Name & vbCrLf & objMember.ADsPath
Next objMember
```

We now can move on to some proper VB coding.

28.6.3. Getting Help from VB When Coding in ADSI

When you begin to code in VB, the interface tries to help you code by providing you with the appropriate methods and properties for the object you are manipulating.

For example, if we started declaring a variable in VB, then as soon as we had stated something like this:

```
'Declare use variable
Dim objUser As
```

the interface would pop up a dialog displaying all the variable types so we could pick one. We'll say that we chose `IADsUser` from the list at this point. Now in my code we wish to use a method on the object, so we start typing:

```
'Declare use variable
Dim objUser As IADsUser

'Use IADsUser method
objUser.
```

As soon as we have typed the dot, VB knows we want to use a method, so it pops up all the possible methods that we could use at this point. This is a great help, so that you do not have to remember the names of the methods and properties all the time.

You also can use View ⟶ Object Browser (or use the F2 key), which shows you all the possible methods and properties available in any SDKs that are currently included as references to your project.

28.6.4. A Simple Password Changer in VB

This is a variation on the password changer we introduced earlier. This changer is for use by a help desk to set a user's password and automatically unlock the account if it is locked. All the users are presumed to be in the Users container for this simple project, which makes use of one form, shown in Figure 28-3.

> This entire project can be downloaded from the O'Reilly web site.

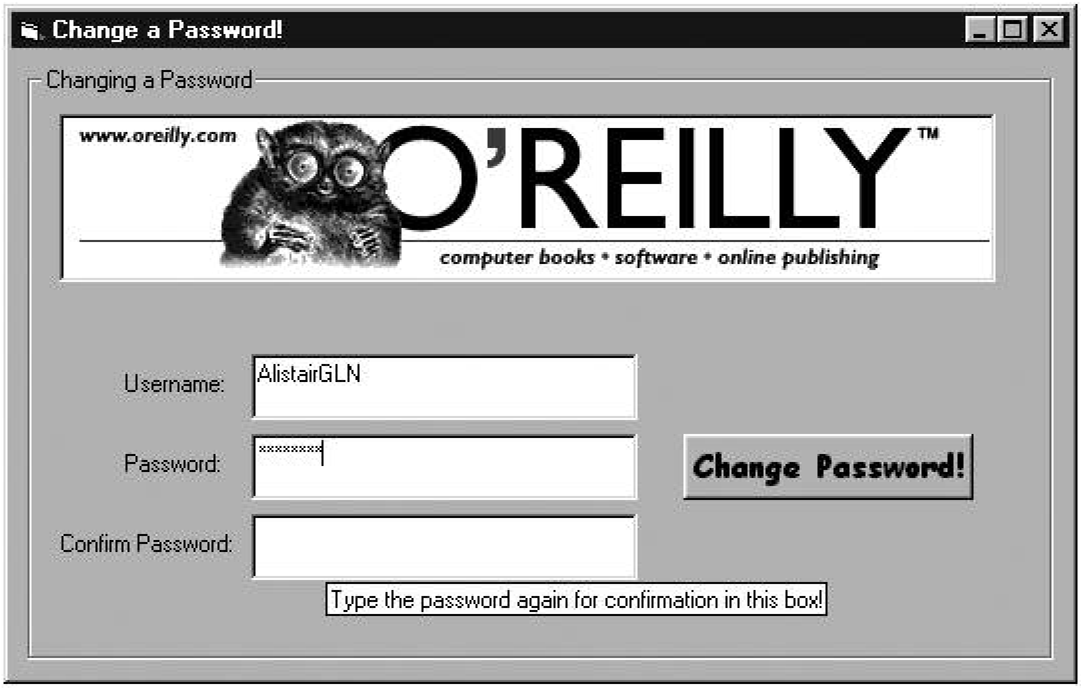
The form (the window) contains the following controls (objects that sit on the window):

- One PictureBox control, the O'Reilly logo
- Three Label controls, the text fields that cannot be edited
- Three TextBox controls (`txtUsername`, `txtPass1`, and `txtPass2`), the three data entry fields
- One CommandButton control (`cmdChangePassword`), the Change Password button

Some of the properties for fields have been set as follows:

- To make sure that using the Tab key cycles properly through the three TextBox controls and the CommandButton control, the `TabIndex` property is set for each control in the order that the Tab key is to cycle through; e.g., `txtUsername=1`, `txtPass1=2`, `txtPass2=3`, `cmdChangePassword=4`.

Figure 28-3. The change password script result



Username: AlistairGLN

Password: ********

Confirm Password:

Type the password again for confirmation in this box!

- The two password boxes have the PasswordChar property set to "*" so that the password is not displayed in plain text on the form.
- The ToolTipText property specifies the text that will appear when the cursor hovers over each TextBox and CommandButton. The text for the second password field is displayed in Figure 28-3.

The command button needs some code to tell it what to do when the button is clicked. This is known as an event procedure, as it is triggered when an event (clicking the button) occurs. No code is attached to anything other than the command button. The code that sits behind the command button looks like this:

```
Private Sub cmdChangePassword_Click(  )

Dim objUser As IADsUser

If txtUsername.Text <> "" Then
  If txtPass1.Text = txtPass2.Text Then
    Set objUser = GetObject("LDAP://cn=" + txtUsername.Text _
      + ",cn=Users,dc=mycorp,dc=com")

    objUser.SetPassword txtPass1.Text
    objUser.pwdLastSet = 0
    objUser.lockoutTime = 0
    objUser.SetInfo


    'Reset everything
    txtUsername.Text = ""
```

```
      txtPass1.Text = ""
      txtPass2.Text = ""

      MsgBox "Password changed!"
    Else
      MsgBox "Passwords are not the same, please try again!"
    End If
Else
    MsgBox "A username must be specified!"
End If
```

You can see that we are using the text typed into the `TextBox ::Text` property for each TextBox control as necessary. We don't declare these controls as we do with variables, as the very fact that they're on the form is enough to declare them.

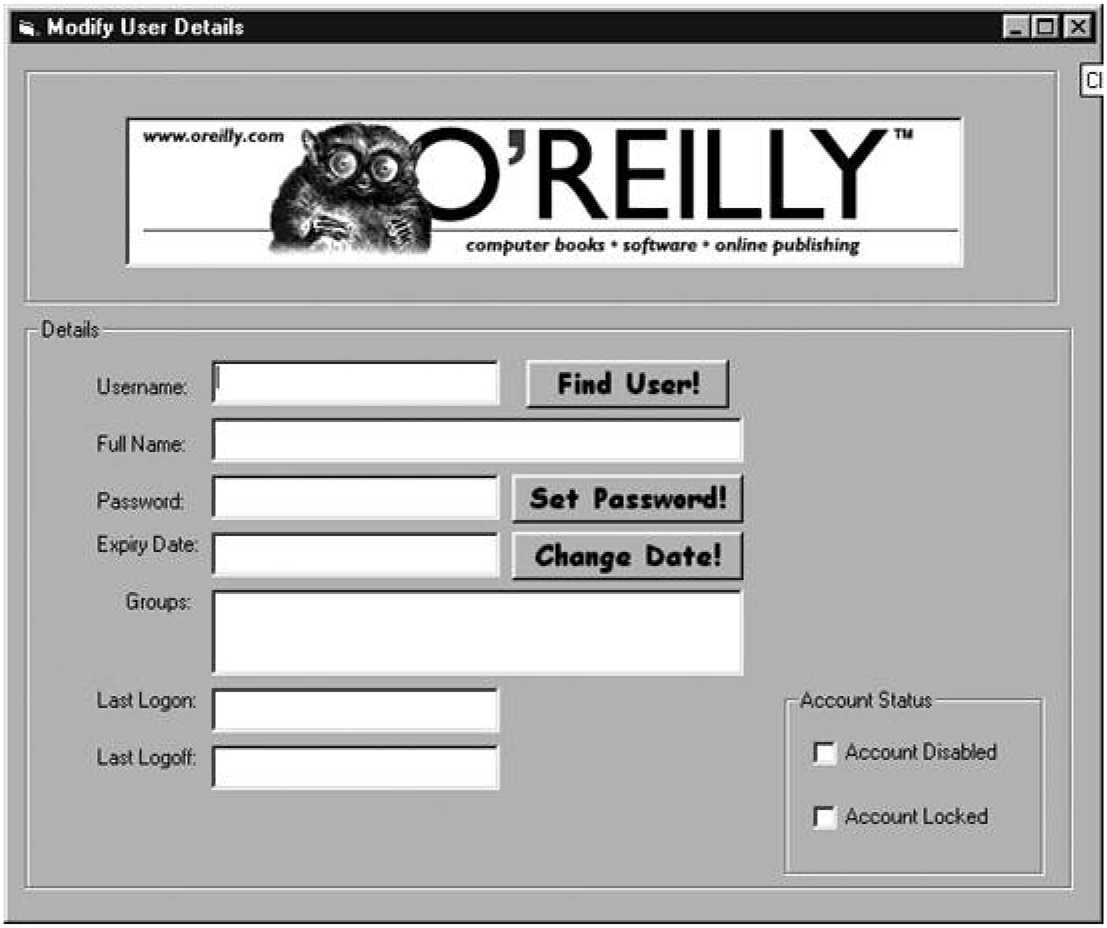
There is a procedure that is attached to the CommandButton called `cmdChangePassword`, and it is executed when a single-click event occurs on that button. When that button is clicked, we check that the `txtUsername` field has had a username typed in, and if it has, then we check that the two passwords are the same. If they are, we concatenate the username with the domain string and get a handle to the user object. We then use the `IADsUser::SetPassword` method with one of the two passwords as the parameter and also set the `pwdLastSet` property to 0 to indicate that the password is expired. This means the user has to change it when he next logs on. We set the `lockoutTime` property to 0 as this will unlock the account if it was locked. This is necessary because a user can't use a locked account even if the password is changed. We then write out the property cache. You can also see that we are not checking that the password was set properly or later that the other properties were set. It would be simple to put in if desired.

28.6.5. The ModifyUserDetails Program in VB

Let's take one more example by extending the previous one to modify a variety of user details. Take a look at Figure 28-4.

Figure 28-4 is another simple user querying and modification tool. This one has a number of different features. To start with, the username is typed into the top TextBox. When the user clicks on the Find User! command button, an ADO search function retrieves the full ADsPath of the user. This ADsPath then is used to bind to the user and to retrieve the full name, the expiry date, the group memberships, the last logon and last logoff times, and whether the account is disabled or locked. The group membership's TextBox automatically displays vertical scrollbars if the results cannot be displayed in the space available.

Figure 28-4. The Modify User Details screen



☐ Account Disabled

☐ Account Locked

The administrator then can use the Set Password! button to set the password. This time, no confirmation is requested; the password is just accepted as is. The Change Date! button can set the expiration date. The two account status checkboxes in the bottom right can enable/disable the account or unlock it if it gets locked.

Actually, the unlock checkbox should never give the option to lock an account; instead, it should be grayed out (disabled) by default. Then it can be enabled only when an account is locked. Clicking the checkbox on a locked account would unlock the account and then disable the checkbox again immediately. Obviously this means that a user could never change his mind and relock an account, which is fairly nonsensical, but in that case it can simply be disabled instead.

While the code is not particularly complex, it is quite long, and for that reason, we've made it available for download from the companion O'Reilly web site for this book.

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28.7. Summary

Being able to customize the Active Directory schema means that you may end up using a number of new classes and attributes that you create. As these classes and attributes can be manipulated using the same ADSI interfaces that you have seen in the previous chapters, you can easily create your own customized tools to operate on these new objects. This allows you free rein in developing solutions that are perfectly tailored for your requirements, whether from a web-based or GUI-based interface.

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Chapter 29. Scripting with WMI

The Windows Management Instrumentation (WMI) API was developed by Microsoft in 1998 in response to the ever-growing need for developers and system administrators to have a common, scriptable API to manage the components of the Windows operating systems. Before WMI, if you wanted to manage some component of the operating system, you had to resort to using one of the component-specific Win32 API's, such as the Registry API or Event Log API. Each API typically had its own implementation quirks and required way too much work to do simple tasks. The other big problem with the Win32 APIs was that Microsoft's scripting languages such as VBScript could not use them. This really limited how much an inexperienced programmer or system administrator could do to programmatically manage systems. WMI changes all this by providing a single API that can be used to query and manage the Event Log, the Registry, processes, the filesystem, or any other operating system component.

So you may be wondering at this point: this is a book on Active Directory, so why do I need to care about a system management API? Even if your sole job in life is to manage Active Directory, WMI can benefit you in at least two ways. First, Active Directory runs on top of Windows 2000 or Windows Server 2003. These servers need to be managed (i.e., Event Log settings configured, Registry modified, applications installed, etc.) and monitored (i.e., filesystem space, services running, etc.). You can choose to do all of those tasks manually, or you can use WMI to automate them. For each task you automate, the total cost of ownership to support Active Directory is reduced, and you help ensure your servers stay consistent. The other reason why WMI is important to Active Directory is the direction Microsoft is taking WMI with respect to monitoring and managing any system or application under the Microsoft umbrella. That's right, not only does Microsoft want WMI to be the primary interface to manage and monitor Windows systems, but also any other Windows application, including Active Directory. Currently, ADSI provides the primary management interface into Active Directory, but in the Windows Server 2003 release, there are several new WMI hooks into Active Directory to monitor things such as trusts and replication.

In this chapter, we will give a brief introduction to the concepts and terminology behind WMI and then delve into several sample scripts showing how to make use of it. We will cover some system-specific tasks, such as managing services, the Event Log, and the Registry, which should give you a good grounding in some of the fundamentals of WMI. In the second half of the chapter, we will review how WMI can be used to access and monitor Active Directory.

In a single chapter, we can go into only so much detail about the internals of WMI; we won't be covering some of the more advanced topics. If you are interested in more information than what this chapter provides, we recommend checking out the MSDN Library or one of the WMI books available on the market. At the time this book was published, you could access the WMI SDK documentation by going to the MSDN Library web page:

http://msdn.microsoft.com/library/en-us/wmisdk/wmi/wmi_start_page.asp

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29.1. Origins of WMI

There have been several industry initiatives over the years to develop a model for managing systems and devices that would be robust enough to meet the needs of most vendors. Several protocols and frameworks have been developed to address the problem. The Simple Network Management Protocol (SNMP) is probably the most notable, but is pretty simple in its implementation and does not provide many features most vendors need for a single management framework.

The Distributed Management Task Force (DMTF) was created in the early 1990s to address the management framework problem. They developed the Web Based Enterprise Management (WBEM) standard, which attempts to unify the management frameworks utilizing web technologies. As part of the WBEM standard, they also created the Common Information Model (CIM) , which is the language used for describing management data in an object-oriented way. The WBEM/CIM standards have garnered a lot of industry support in recent years and provide the basis for WMI.

For more information on WBEM/CIM, check out the DMTF web site:

> http://www.dmtf.org

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29.2. WMI Architecture

The WMI architecture is composed of two primary layers: the CIM infrastructure, which includes the CIMOM and CIM Repository, and the WMI providers. Although the concepts Microsoft uses are very similar to the WBEM/CIM standards, they did not implement one very important component: the use of web technologies for the transport mechanism. Instead of using HTTP to transport messages between the WMI infrastructure and clients, Microsoft uses COM and DCOM, two Microsoft-specific technologies. This limits the use of WMI to only Microsoft platforms.

That being said, the capabilities to manage Microsoft-based platforms with WMI are nearly unlimited. More and more vendors are utilizing WMI not only to manage components of the Microsoft OS, but also to manage their own applications. Microsoft has also become heavily invested in WMI by providing WMI providers for nearly all of its major applications, including Active Directory, Exchange 2000/2003, DNS, and even Microsoft Office.

29.2.1. CIMOM and CIM Repository

The CIM Repository is the primary warehouse for management data. It contains the static data that does not change very frequently, such as memory or disk size. The CIMOM or CIM Object Manager handles requests from clients, retrieves data from the CIM Repository, and returns it to the client. The CIMOM also provides an event service, so that clients can register for events and be notified dynamically when they occur. For dynamic data, such as performance monitor counters, the CIMOM will interact directly with a WMI provider instead of retrieving the data directly from the CIM Repository. The CIM Repository cannot store all possible data that is needed by the various WMI providers. The storage requirements would be significant, not to mention that a lot of the data would become out-of-date almost immediately after it was stored.

29.2.2. WMI Providers

The WMI providers contain much of the intelligence behind WMI. Typically a provider will be implemented for each individual managed component, such as the Event Log or Active Directory Trusts. Each provider is responsible for interacting with its managed component and can perform certain functions implemented by methods on classes representing that component. Also, as described earlier, some providers interact with the CIMOM to provide dynamic data that cannot be held in the CIM Repository.

Each WMI provider is also associated with a namespace. The namespace is used to segregate where WMI providers store their data and class definitions. Think of it as a file system. You could store all of your files in a single directory, but it would be hard to manage. By storing data and class definitions for providers under different namespaces, you don't have to worry about confusing the EventLog provider with the Active Directory Trust provider. Table 29-1 contains the more commonly used and AD-related WMI providers and the associated namespace.

Table 29-1. Some of the commonly used and AD-related WMI providers

Provider	Namespace
Win32 provider	*root\cimv2*
EventLog provider	*root\cimv2*
Registry provider	*root\default*
Active Directory provider	*root\directory\LDAP*
Replication provider	*root\MicrosoftActiveDirectory*
Trustmon provider	*root\MicrosoftActiveDirectory*
DNS provider	*root\MicrosoftDNS*

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29.3. Getting Started with WMI Scripting

Once you have a basic understanding of the WMI architecture, scripting with WMI is easy. In fact, once you understand how to reference, enumerate, and query objects of a particular class with WMI, it is straightforward to adapt the code to work with any managed component.

29.3.1. Referencing an Object

To reference objects in WMI, you use a UNC-style path name. An example of how to reference the C: drive on a computer looks like the following:

```
\\dc1\root\CIMv2:Win32_LogicalDisk.DeviceID="C:"
```

The format should be easy to follow. The first part of the path (\\dc1\) is a reference to the computer on which the object resides. To reference the computer on which the script is running, you can use a "." for the computer name. The second part (root\CIMv2) is the namespace the object resides in. The third part (Win32_LogicalDisk) is the class of the object to reference. The fourth part is the key/value pairs representing the object. Generically, the path can be shown as follows:

```
\\ComputerName\NameSpace:ClassName.KeyName="KeyValue"[,KeyName2="KeyValue2"...]
```

Now that we know how to reference WMI objects, let's go ahead and instantiate an object using VBScript's GetObject function. For GetObject to understand that we are referencing WMI objects, we have to include one additional piece of information: the moniker. Just as we've been using the LDAP: and WinNT: progIDs to reference Active Directory and SAM-based objects in ADSI, we need to use the winmgmts: moniker when we are dealing with WMI objects:

```
Set  objDisk  =  GetObject("winmgmts:\\dc1\root\CIMv2:Win32_LogicalDisk.DeviceID='C:'")
```

Note that if you want to reference the *C:* logical drive on the local computer, you can leave off the computer name and namespace path. The GetObject call would then look like this:

```
Set  objDisk  =  GetObject("winmgmts:Win32_LogicalDisk.DeviceID='C:'")
```

> We have left out the namespace path to show that a script can use a default namespace. *root\CIMv2* is the default namespace; however, this is configurable, and it is not advised to assume this will be the default on any systems you do not directly control. Also, when accessing a provider that uses any other namespace or when referencing a remote object you need to include the namespace path.

29.3.2. Enumerating Objects of a Particular Class

Now let's look at an example. We want to view all logical disks on a machine, not just a particular disk. To do so, we need to use the `InstancesOf` method on a WMI object pointing to the namespace of the provider that contains the class. This example shows `InstancesOf` in use:

```
strComputer = "."
Set objWMI = GetObject("winmgmts:\\" & strComputer & "\root\cimv2")
Set objDisks = objWMI.InstancesOf("Win32_LogicalDisk")
For Each objDisk In objDisks
    WScript.Echo "DeviceID: " &  objDisk.DeviceID
    WScript.Echo "FileSystem: " &  objDisk.FileSystem
    WScript.Echo "FreeSpace: " & objDisk.FreeSpace
    WScript.Echo "Name: " & objDisk.Name
    WScript.Echo "Size: " & objDisk.Size
    WScript.Echo ""
Next
WScript.Echo "The script has completed successfully."
```

Here we get a WMI object pointing to the root\CIMv2 namespace, after which we call the `InstancesOf` method and pass the `Win32_LogicalDisk` class. That method returns a collection of `Win32_LogicalDisk` objects, which we then iterate over with a `For Each` loop.

As you can imagine, this is very powerful and allows you to easily retrieve a list of all the logical disks, services, or processes on a computer. The only issue with the last example is that we needed to know which property methods of the `Win32_LogicalDisk` class we wanted to see. We can instead retrieve all properties of the `Win32_LogicalDisk` class using the `Properties_` method on each object:

```
strComputer = "."
strWMIClass = "Win32_LogicalDisk"

Set objWMI = GetObject("winmgmts:\\" & strComputer & "\root\cimv2")
Set objDisks = objWMI.InstancesOf(strWMIClass)
For Each objDisk In objDisks
   For Each objProp In objDisk.Properties_
      ' Print out NULL if the property is blank
      If IsNull(objProp.Value) Then
         WScript.Echo " " & objProp.Name & " : NULL"
      Else
      ' If the value is an array, we need to iterate through each element
      ' of the array
         If objProp.IsArray = TRUE Then
            For I = LBound(objProp.Value) To UBound(objProp.Value)
               WScript.echo " " & objProp.Name & " : " & objProp.Value(I)
            Next
         Else
       ' If the property was  not NULL or an array, we will print it
            WScript.echo " " & objProp.Name & " : " & objProp.Value
         End If
      End If
   Next
   WScript.Echo ""
Next
WScript.Echo "The script has completed successfully."
```

29.3.3. Searching with WQL

So far we've shown how to instantiate specific objects, such as a logical drive, and also how to enumerate all the objects of a particular class using the InstancesOf method. Knowing how to do both of these functions will take us a long way with WMI, but we are missing one other important capability: the ability to find objects that meet certain criteria.

The creators of WMI found an elegant way to handle this problem. They implemented a subset of the Structured Query Language (SQL) known as the WMI Query Language (WQL) . WQL greatly increases the power of WMI by giving the programmer ultimate control over locating objects.

With WQL, we can even perform the same function as the InstancesOf method we used earlier. The following query will retrieve all the Win32_LogicalDisk objects on the system:

```
"select * from Win32_LogicalDisk"
```

We can use any property available on Win32_LogicalDisk objects as criteria in our search. As an example, let's say we wanted to find all NTFS logical disks that have less than 100 MB of available space. The query would look like the following:

```
select * from Win32_LogicalDisk
where FreeSpace < 104857600
and   filesystem = 'NTFS'
```

Pretty easy, right? Now let's put WQL to use. We first need to get a WMI object to the namespace we want to query. After we've done that, we can call the ExecQuery method on that object and pass the

WQL query to use. The next example uses the "less than 100 MB" query we just described to print out all logical disks on the local computer that match that criterion:

```
strComputer = "."
Set objWMI = GetObject("winmgmts:\\" & strComputer & "\root\cimv2")
Set objDisks = objWMI.ExecQuery _
             ("select * from Win32_LogicalDisk " & _
              "where FreeSpace < 104857600 " & _
             "and filesystem = 'NTFS' ")
For Each objDisk In objDisks
    WScript.Echo "DeviceID: " & objDisk.DeviceID
    WScript.Echo "Description: " & objDisk.Description
    WScript.Echo "FileSystem: " & objDisk.FileSystem
    WScript.Echo "FreeSpace: " & objDisk.FreeSpace
Next
WScript.Echo "The script has completed successfully."
```

29.3.4. Authentication with WMI

So far, the examples we've shown assume that the caller of the script has the necessary rights to access the WMI information on the target machine. In many cases in which you are trying to automate a task, this may not be the case. Luckily, using alternate credentials in WMI is very straightforward.

Previously, to connect to a WMI namespace, we would have used the following:

```
strComputer = "dc1"
Set objWMI = GetObject("winmgmts:\\" & strComputer & "\root\cimv2")
```

But let's say that the person calling the script does not have any privileges on the *dc1* computer. We must now use the following:

```
strComputer  = "dc1.mycorp.com"
strUserName = "administrator"
strPassword = "password"

Set objLocator = CreateObject("WbemScripting.SWbemLocator")
Set objWMI = objLocator.ConnectServer(strComputer, "root\cimv2", _
                                      strUserName, strPassword)
```

We've replaced the single call to `GetObject` with a call to `CreateObject` to instantiate a `WbemScripting.SWbemLocator` object. The `SWbemLocator` object has a method called `ConnectServer` , which allows us to specify the target machine, username, and password to authenticate with. You can then use the object returned from ConnectServer to get the instances of a class, perform a WQL search, or any other function.

This was quick introduction to WMI scripting. We will be covering additional tasks, such as invoking an action or modifying properties of an object, as we walk through specific examples later in the chapter.

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29.4. WMI Tools

There are several tools available to query and browse WMI information. These tools can be very useful in situations in which you want to access WMI information but do not want to write a script to do it.

29.4.1. WMI from a Command Line

The WMI command-line tool (WMIC) is a powerful tool that can expose virtually any WMI information you want to access. It is available in Windows XP and Windows Server 2003. Unfortunately, WMIC does not run on Windows 2000, but it can still be used to query WMI on a Windows 2000 machine.

WMIC maps certain WMI classes to "aliases ." Aliases are used as shorthand so that you only need to type "logicaldisk" instead of "Win32_LogicalDisk." An easy way to get started with WMIC is to type the alias name of the class you are interested in. A list of all the objects that match that alias/class will be listed.

```
wmic:root\cli>logicaldisk list brief
DeviceID  DriveType  FreeSpace    ProviderName  Size         VolumeName
A:        2
C:        3           1540900864                 4296498688   W2K
D:        3           15499956224                15568003072
Z:        5           0                          576038912    NR1EFRE_EN
```

Most aliases have a `list brief` subcommand that will display a subset of the properties for each object. You can run similar queries for services, CPUs, processes, and so on. For a complete list of the aliases, type `alias` at the WMIC prompt.

The creators of WMIC didn't stop with simple lists. You can also utilize WQL to do more complex queries. This next example displays all logical disks with a drivetype of 3 (local hard drive):

```
wmic:root\cli>logicaldisk where (drivetype = '3') list brief
DeviceID  DriveType  FreeSpace    ProviderName  Size         VolumeName
C:        3           1540806144                 4296498688   W2K
D:        3           15499956224                15568003072
```

We have just touched the surface of the capabilities of WMIC. You can invoke actions, such as creating or killing a process or service, and modify WMI data through WMIC as well. For more information, check out the Support WebCast "WMIC: A New Approach to Managing Windows

Infrastructure from a Command Line," available at http://support.microsoft.com/default.aspx?scid=/webcasts/. Help information is also available on Windows XP and Windows Server 2003 computers by going to Start → Help, and search on WMIC.

29.4.2. WMI from the Web

Included as sample applications with the original WMI SDK, the WMI CIM Studio and WMI Object browser are web-based applications that provide much more benefit than just being example applications provided in the SDK. The following is a list of the tools and their purpose:

- The WMI CIM Studio is a generic WMI management tool that allows you to browse namespaces, instantiate objects, view the instances of a class, run methods, edit properties, and even perform WQL queries.
- The WMI Object Browser allows you to view the properties for a specific object, look at the class hierarchy, view any associations, run methods, and edit properties for an object.
- The WMI Event Registration allows you to create, view, and configure event consumers.
- The WMI Event Viewer displays events of configured event consumers.

The web-based WMI tools can be obtained separately from the WMI SDK at:

> http://www.microsoft.com/downloads/details.aspx?displaylang=en&FamilyID=6430F853-1120-48DB-8CC5-F2ABDC3ED314

29.4.3. WMI SDK

The WMI SDK provides the complete WMI reference documentation, along with numerous sample scripts and programs. It also includes the web-based WMI tools described in the previous section. The WMI SDK can be downloaded from the Platform SDK site located at:

> http://www.microsoft.com/msdownload/platformsdk/sdkupdate/default.htm

29.4.4. Scriptomatic Version 2.0; WMI Scripting Tool

The Microsoft "Scripting Guys" have made an extremely useful tool freely available for creating basic WMI scripts. It allows you to browse a machine's namespaces and classes to select the items you are interested in and then generates a basic script to display the associated properties. You have the option to create scripts in several scripting languages, including VBScript, Perl, JScript, and Python. This tool can be downloaded from the Microsoft web site and is located at:

> http://www.microsoft.com/downloads/details.aspx?FamilyID=09dfc342-648b-4119-b7eb-783b0f7d1178

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29.5. Manipulating Services

Querying services is simple to do with WMI. The Win32_Service class is the WMI representation of a service. The Win32_Service class contains a lot of property methods that provide information about the service; the most useful ones have been listed in Table 29-2.

Table 29-2. Useful Win32_Service properties

Property	Description
AcceptPause	Returns a Boolean indicating whether the service can be paused.
AcceptStop	Returns a Boolean indicating whether the service can be stopped.
Description	Description of the service.
DisplayName	Display name of the service.
Name	Unique string identifier for the service.
PathName	Fully qualified path to the service executable.
Started	Boolean indicating whether the service has been started.
StartMode	String specifying the start mode of the service. Will be one of Automatic, Manual, or Disabled.
StartName	Account under which the service runs.
State	Current state of the service. Will be one of Stopped, Start Pending, Stop Pending, Running, Continue Pending, Pause Pending, Paused, or Unknown.

The following script retrieves all the running services on a machine. All we need to do is use a WQL query that finds all Win32_Service objects that have a state of "Running":

```
strComputer = "."

Set objWMI  = GetObject("winmgmts:\\" & strComputer & "\root\cimv2")
Set objServices = objWMI.ExecQuery _
           ("SELECT * FROM Win32_Service WHERE State = 'Running'")
For Each objService In objServices
   WScript.Echo objService.DisplayName
   WScript.Echo " Name: " & objService.Name
   WScript.Echo " PathName: " & objService.PathName
   WScript.Echo " Started: " & objService.Started
   WScript.Echo " StartMode: " & objService.StartMode
   WScript.Echo " StartName: " & objService.StartName
   WScript.Echo " State: " & objService.State
   WScript.Echo ""
Next
WScript.Echo "The script has completed successfully."
```

Before you can start to manipulate the status of a service, you have to be able to find any dependent services. A dependent service requires the parent service to be running while it is running. If you try to stop the parent service without first stopping all dependent services, you will get an error. The following example shows how to find all dependent services for the IIS Admin service:

```
strService  = "IISADMIN"
strComputer = "."

Set objWMI = GetObject("winmgmts:\\" & strComputer & "\root\cimv2")
Set objServiceList = objWMI.ExecQuery( _
              "Associators of {Win32_Service.Name='" & strService & "'} " & _
              "Where AssocClass=Win32_DependentServiceRole=Antecedent" )
WScript.Echo "List of dependent services for " & strService & ":"
For Each objService In objServiceList
    WScript.Echo " " & objService.DisplayName
Next
WScript.Echo "The script has completed successfully."
```

You may have noticed the WQL query in this example is a little different than the ones we've used so far. We used something called the Associators for a class. One of the fundamental concepts within WMI is class association, which allows you to perform queries to retrieve objects that have dependencies or associations to a given object. Associators come into play in lot of situations, but a great example of them is with service dependencies. Some services are dependent on others in order to run. Using the `Associators of` clause within a WQL query allows you to find each dependent service.

Now that we can get a list of a service's dependent services, we can write scripts to stop, start, and restart a service. Table 29-3 lists the useful methods available to the `Win32_Service` class.

Table 29-3. Useful Win32_Service methods

Property	Description
`ChangeStartMode`	Changes the start mode for the service. Pass in Automatic, Manual, or Disabled.
`PauseService`	Pause a service.
`ResumeService`	Resume a service.
`StartService`	Start a service.

Property	Description
StopService	Stop a service.

Example 29-1 shows how to restart a service. Because there is no RestartService method available in WMI, you have to simulate a restart by stopping all dependent services, stopping the target service, and then starting the target service and any dependent services.

Example 29-1. Using Win32_Service methods to simulate a RestartService method

```
strService  = "IISADMIN"
strComputer = "."

WScript.Echo "Restarting " & strService & "..."

' Stop dependent services
Set objWMI = GetObject("winmgmts:\\" & strComputer & "\root\cimv2")
Set objServiceList = objWMI.ExecQuery("Associators of " _
                  & "{Win32_Service.Name='" & strService & "'} Where " _
                  & "AssocClass=Win32_DependentService " & "Role=Antecedent" )
For Each objService In objServiceList
    WScript.Echo " Stopping " & objService.Name
    objService.StopService(  )
Next
WScript.Sleep 10000    ' Pause to allow services to stop

' Stop target service
Set objService = objWMI.Get("Win32_Service.Name='" & strService & "'")
WScript.Echo " Stopping " & objService.Name
objService.StopService(  )
WScript.Sleep 10000    ' Pause to allow service to stop

' Start target service
Set objService = objWMI.Get("Win32_Service.Name='" & strService & "'")
WScript.Echo " Starting " & objService.Name
objService.StartService(  )
WScript.Sleep 10000    ' Pause to allow service to start

' Start dependent services
Set objServiceList = objWMI.ExecQuery("Associators of " _
                  & "{Win32_Service.Name='" & strService & "'} Where " _
                  & "AssocClass=Win32_DependentService " & "Role=Antecedent" )
For Each objService In objServiceList
    WScript.Echo " Starting " & objService.Name
    objService.StartService(  )
Next
WScript.Echo "The script has completed successfully."
```

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29.6. Querying the Event Logs

The Event Logs are typically a system administrator's first line of inquiry when trying to troubleshoot problems. Because they are so important, it is also important to see how we can make use of them with WMI. The two major components that we need to be concerned with are the Event Logs themselves and the events contained within each Event Log. We will first focus on properties of Event Logs.

The `Win32_NTEventLogFile` class represents an Event Log. Table 29-4 contains several `Win32_NTEventLogFile` properties that can be used to query or modify properties of an Event Log.

Table 29-4. Useful Win32_NTEventLogFile properties

Property	Description
`FileSize`	Size of the Event Log file in bytes.
`LogFileName`	Standard name used for describing the Event Log (e.g., Application).
`MaxFileSize`	Max size in bytes that the Event Log file can reach. This is a writeable property.
`Name`	Fully qualified path to the Event Log file.
`NumberOfRecords`	Total number of records in the Event Log.
`OverwriteOutDated`	Number of days after which events can be overwritten. This is a writeable property with 0 indicating to overwrite events as needed, 1-365 being the number of days to wait before overwriting, and 4294967295 indicating that events should never be overwritten.
`OverwritePolicy`	Text description of the overwrite policy (as specified by the `OverwriteOutDated` property). Can be one of WhenNeeded, OutDated, or Never.
`Sources`	Array of registered sources that may write entries to the Event Log.

Let's look at an example that displays all of the properties listed in Table 29-4 for each Event Log and sets the `MaxFileSize` and `OverwriteOutDated` properties if they have not already been set to the correct values. Since we want to iterate over all Event Logs, we will pass `Win32_NTEventLogFile` to the `InstancesOf` method. Example 29-2 shows how to accomplish this.

Example 29-2. Displaying properties of the Event Log using Win32_NTEventLogFile

```
strComputer = "."
intMaxFileSize = 10 * 1024 * 1024    ' << 10MB
intOverwriteOutDated = 180           ' << 6 months

Set objWMI = GetObject("winmgmts:\\" & strComputer & "\root\cimv2")
Set objELF = objWMI.InstancesOf("Win32_NTEventLogFile")
' Iterate over each Event Log
For Each objEL In objELF
   WScript.Echo objEL.LogFileName & " Log:"
   WScript.Echo " FileSize: " & objEL.FileSize

   ' If the size has not been set yet, set it
   If objEL.MaxFileSize <> intMaxFileSize Then
      WScript.Echo " ** Setting MaxFileSize: " & intMaxFileSize & " (new) " & _
                   objEL.MaxFileSize & " (current)"
      objEL.MaxFileSize = intMaxFileSize
      objEL.Put_
   Else
      WScript.Echo " MaxFileSize: " & objEL.MaxFileSize
   End If

   WScript.Echo " Name: " & objEL.Name
   WScript.Echo " NumberOfRecords: " & objEL.NumberOfRecords

   ' If the overwrite date has not been set, set it
   WScript.Echo " OverwritePolicy: " & objEL.OverwritePolicy
   If objEL.OverwriteOutDated <> intOverwriteOutDated Then
      WScript.Echo " ** Setting OverwriteOutDated: " & _
                   intOverwriteOutDated & " (new) " & _
                   objEL.OverwriteOutDated & " (current)"
      objEL.OverwriteOutDated = intOverwriteOutdated
      objEL.Put_
   Else
      WScript.Echo " OverwriteOutDated: " & objEL.OverwriteOutDated
   End If

   WScript.Echo ""
Next
WScript.Echo "The script has completed successfully."
```

Note that for the MaxFileSize and OverwriteOutDated properties, we set them only if they haven't been set already. To set properties, simply set the property method equal to the new value. To commit the change, you must use the Put_ method. Using Put_ is very similar to SetInfo in ADSI. WMI implements a caching mechanism very similar to the Property Cache described in Chapter 19. If we did not call Put_, the new values would never have been written back to the system.

The Event Logs contain a wealth of information about the health and status of the system and hosted applications. With WMI, system administrators can write simple to complex queries to find specific events in any of the Event Logs. The Win32_NTLogEvent class represents individual event entries in an Event Log. Table 29-5 contains several useful properties that are available for Win32_NTLogEvent objects.

Table 29-5. Useful Win32_NTLogEvent properties

Property	Description
CategoryString	Category name if present.
EventCode	The event number (or id) for the event.
EventType	Numeric value representing severity of the event. See Type for the string version.
LogFile	Event Log name the event is contained in. LogFile and RecordNumber are used as keys to uniquely identify an event.
Message	Event message text.
RecordNumber	The number associated with the event. RecordNumber is unique within an Event Log.
SourceName	Name of source that generated the error.
Type	String representing the severity of the event. Will be one of Error, Warning, Informational, Security audit success, or Security audit failure.
User	User that was logged on when event was generated.

In the next example, we will retrieve all events that match certain criteria. Let's say that we want to find all Information events in the System Event Log that have an event code of 5778 and were generated after November 1, 2005. The WQL for this query works out to be:

```
    Select * from Win32_NTLogEvent
     Where Type = 'Information'
     And Logfile = 'System'
      and EventCode = 5778
      and TimeGenerated > '2005/11/01'
```

Once we have the WQL query, the rest of the code is very similar to many of the previous examples:

```
strComputer = "."

Set objWMI = GetObject("winmgmts:\\" & strComputer & "\root\cimv2")
Set objEvents = objWMI.ExecQuery _
         ("Select * from Win32_NTLogEvent Where Logfile = 'System' " & _
          "and EventCode = 5778 and Type = 'Information' " & _
          "and TimeGenerated > '2005/11/01' ")
```

```
WScript.Echo "Total events that match criteria: " & objEvents.Count
For Each objEvent In objEvents
   WScript.Echo " CategoryString: " & objEvent.CategoryString
   WScript.Echo " EventType: " & objEvent.EventType
   WScript.Echo " LogFile: " & objEvent.LogFile
   WScript.Echo " Message: " & objEvent.Message
   WScript.Echo " RecordNumber: " & objEvent.RecordNumber
   WScript.Echo " SourceName: " & objEvent.SourceName
   WScript.Echo " TimeGenerated: " & objEvent.TimeGenerated
   WScript.Echo " Type: " & objEvent.Type
   WScript.Echo " User: " & objEvent.User
   WScript.Echo ""
Next
WScript.Echo "The script has completed successfully."
```

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29.7. Querying AD with WMI

Up to now, we've shown how WMI can be a powerful resource to aid in managing components of individual computers. You may be wondering what impact WMI will have on Active Directory? It can, in fact, play as big a role in automating the management of Active Directory as you want. Also, over time, WMI's importance with respect to monitoring Active Directory will continue to grow as Microsoft develops new providers.

First we are going to review how you can use WMI and the Active Directory provider to access and query objects in Active Directory. We will then cover some specific WMI providers that Microsoft has made available in Windows Server 2003; these providers help you monitor certain aspects of Active Directory, such as trusts and replication. In the next chapter, we will cover the WMI DNS provider and how you can manage Microsoft DNS servers with it. To start with, let's look at the Active Directory provider.

The Active Directory provider uses the root\directory\ldap namespace. Within that namespace, every Active Directory schema class and attribute is mapped to corresponding WMI classes or properties. Each abstract class (e.g., `top`) is mapped to a WMI class with "ds_" prefixed on the name. Each nonabstract class (e.g., structural and auxiliary) is mapped to two classes. One has "ads_" prefixed, and the other has "ds_" prefixed. The "ads_" classes conform to the class hierarchy defined by the `subClassOf` attribute for each class. The "ds_" classes for nonabstract (e.g., structural) classes are descendants of their corresponding "ads_" class. Perhaps an example would help illustrate this hierarchy:

```
ds_top
   ads_person
       ads_organizationalperson
           ads_user
               ads_computer
                    ds_computer
```

In this example, we showed the class hierarchy for the Active Directory "computer" object class as it is mapped to WMI. The attribute mappings are more straightforward. Each Active Directory attribute has a corresponding property in WMI with "ds_" prefixed. So the `description` attribute would map to the `ds_description` property in WMI. An additional property was added called `ADSIPath` , which is the `ADsPath` , and is the key for each Active Directory object in WMI. We highly recommend installing and using the WMI CIM Studio to browse the root\directory\ldap namespace. The organization of classes and objects will become apparent.

We can use the techniques shown so far to query and manipulate Active Directory objects. We can retrieve all the instances of a particular Active Directory class (via `InstancesOf`) or perform a WQL query based on certain criteria. In the following example, we search for all user objects that have a last name equal to "Allen:"

```
strComputer = "."

Set objWMI = GetObject("winmgmts:\\" & strComputer & "\root\directory\LDAP")
Set objUsers = objWMI.ExecQuery("SELECT * FROM ds_user where ds_sn = 'Allen' ")

If objUsers.Count = 0 Then
   WScript.Echo "No matching objects found"
Else
   For Each objUser in objUsers
      WScript.Echo "First Name: " & objUser.ds_givenName
      WScript.Echo "Last Name: " & objUser.ds_sn
      WScript.Echo ""
   Next
End If
WScript.Echo "The script has completed successfully."
```

Since WMI is typically used to manage computers, we can leverage Active Directory as a repository of computer objects and perform certain functions on a set of computers that match our criteria. In the next code sample, we do a WQL query for all computers that are running "Windows Server 2003," connect to each one, and print the date each machine was last rebooted:

```
on error resume next

strComputer = "."

Set objWMI = GetObject("winmgmts:\\" & strComputer & "\root\directory\LDAP")
Set objComps = objWMI.ExecQuery("SELECT * FROM ds_computer " & _
                              "where ds_OperatingSystem = 'Windows Server 2003' ")

If objComps.Count = 0 Then
   WScript.Echo "No matching objects found"
Else
   For Each objComp In objComps
      WScript.Echo objComp.ds_name
       Set objRemoteWMI = GetObject("winmgmts:\\" & objComp.ds_name & "\root\cimv2")
      If Err <> 0 Then
         WScript.Echo "  Could not connect"
         Err.Clear
      Else
         ' Perform whatever functions necessary on objRemoteWMI
          Set objOSes = objRemoteWMI.InstancesOf("Win32_OperatingSystem")

         For Each objOS In objOSes
            strTime = objOS.LastBootUpTime
             strYear = Left(strTime, 4)
             strMon = Mid(strTime, 5, 2)
             strDay = Mid(strTime, 7, 2)

            WScript.Echo "  Last Reboot: " & strYear & "/" & strMon & "/" & strDay
         Next
      End If
      WScript.Echo ""

      Set objRemoteWMI = Nothing
   Next
End If
WScript.Echo "The script has completed successfully."
```

In the code, we retrieve each matching computer object and then construct a WMI moniker to connect to that machine. From there, we enumerate the `Win32_OperatingSystem` object and print out the `LastBootUpTime` property. Note that we could perform essentially any function we want, including querying disks and the event log, modifying the registry, and so on. Also, we could instantiate a `WbemScripting .SWbemLocator` object if we need to log on to the computers with alternate credentials other than those the script is running under.

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29.8. Monitoring Trusts

New to Windows Server 2003 is the Trustmon WMI provider. The Trustmon provider allows you to query the list of trusts supported on a domain controller and determine if they are working correctly. The Trustmon provider consists of three classes, but the primary one is the `Microsoft_DomainTrustStatus` class, which represents each trust the domain controller knows about. The Trustmon provider is contained under the root\MicrosoftActiveDirectory namespace. Note that this namespace is different than for the Active Directory provider, which is contained under root\directory\ldap.

Table 29-6 provides a list of the property methods available to this class.

Table 29-6. Microsoft_DomainTrustStatus properties

Property	Description
`Flatname`	NetBIOS name for the domain.
`SID`	SID for the domain.
`TRustAttributes`	Flag indicating special properties of the trust. Can be any combination of the following: • 0x1 (nontransitive) • 0x2 (uplevel clients only) • 0x40000 (tree parent) • 0x80000 (tree root)
`TRustDCName`	Name of the domain controller the trust is set up with.
`trustDirection`	Integer representing direction of the trust. Valid values include: • 1 (inbound) • 2 (outbound) • 3 (bidirectional)
`trustedDomain`	Naming of trusted domain.
`trustIsOK`	Boolean indicating whether the trust is functioning properly.
`TRustStatus`	Integer representing the status for the trust. 0 indicates no failure.

Property	Description
trustStatusString	Textual description of status for the trust.
trustType	Integer representing the type of trust. Valid values include: - 1 (downlevel) - 2 (uplevel) - 3 (Kerberos realm) - 4 (DCE)

As you can see from Table 29-6, the Microsoft_DomainTrustStatus class provides just about all the information you'd want to know concerning a trust. The following example shows how easy it is to enumerate all the trusts using this class:

```
strComputer = "."

Set objWMI = GetObject("winmgmts:\\" & strComputer & _
                       "\root\MicrosoftActiveDirectory")
Set objTrusts = objWMI.ExecQuery("Select * from Microsoft_DomainTrustStatus")

For Each objTrust In objTrusts
    WScript.Echo objTrust.TrustedDomain
    WScript.Echo " TrustedAttributes: " & objTrust.TrustAttributes
    WScript.Echo " TrustedDCName: "     & objTrust.TrustedDCName
    WScript.Echo " TrustedDirection: "  & objTrust.TrustDirection
    WScript.Echo " TrustIsOk: "         & objTrust.TrustIsOK
    WScript.Echo " TrustStatus: "       & objTrust.TrustStatus
    WScript.Echo " TrustStatusString: " & objTrust.TrustStatusString
    WScript.Echo " TrustType: "         & objTrust.TrustType
    WScript.Echo ""
Next
WScript.Echo "The script has completed successfully."
```

Next, let's illustrate a script that finds any trust that has some kind of failure. All we need to do is modify the WQL query in the previous example to include a whereTrustIsOk = False clause. We then print out the trustStatusString property, which will return a description of the failure:

```
strComputer = "."

Set objWMI = GetObject("winmgmts:\\" & strComputer & _
                       "\root\MicrosoftActiveDirectory")
Set objTrusts = objWMI.ExecQuery("Select * from Microsoft_DomainTrustStatus " & _
                                 "where TrustIsOk = False ")
```

```
If objTrusts.Count = 0 Then
   WScript.Echo "There are no trust failures"
Else
    For Each objTrust In objTrusts
       WScript.Echo objTrust.TrustedDomain & " - " & objTrust.TrustStatusString
       WScript.Echo ""
   Next
End If
WScript.Echo "The script has completed successfully."
```

One of the neat features of the Trustmon provider is that it is configurable. Through WMI, you can modify what type of checks it does to determine trust failures and also how long to cache information it retrieves. All of this is done with the `Microsoft_TrustProvider` class. Table 29-7 contains a list of all property methods for this class.

Table 29-7. Microsoft_TrustProvider properties

Property	Description
`trustListLifetime`	Number of minutes to cache the last trust enumeration (20 is the default).
`trustStatusLifetime`	Number of minutes to cache the last trust status request (3 is the default).
`TRustCheckLevel`	Number representing the type of check to perform against each trust during enumeration (2 is the default). Valid values include: • 0 (enumerate only) • 1 (enumerate with SC_QUERY) • 2 (enumerate with password check) • 3 (enumerate with SC_RESET)
`ReturnAll`	Boolean indicating whether both trusting and trusted domains are enumerated. True is the default, which indicates to check both trusting and trusted domains.

Now we will show a simple script that changes the default settings for the Trustmon provider. In the following example, we set the `trustListLifetime` to 15 minutes, the `trustStatusLifetime` to five minutes, and the `TRustCheckLevel` to 1:

```
strComputer = "."

Set objTrustProv = GetObject("winmgmts:\\" & strComputer & _
                       "\root\MicrosoftActiveDirectory:Microsoft_TrustProvider=@")
```

```
objTrustProv.TrustListLifetime   = 15    ` 15 minutes
objTrustProv.TrustStatusLifetime = 5     ` 5 minutes
objTrustProv.TrustCheckLevel     = 1     ` Enumerate with SC_QUERY
objTrustProv.Put_
WScript.Echo "The script has completed successfully."
```

The Trustmon provider is a great example of how to utilize WMI in the Active Directory space. What previously could only have been done with command-line utilities or MMC snap-ins can now be done programmatically very easily.

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29.9. Monitoring Replication

The WMI Replication provider is another good example of how Microsoft is leveraging WMI to help with monitoring Active Directory. Like the Trustmon provider, the Replication provider is only available with Windows Server 2003 and is contained under the root\MicrosoftActiveDirectory namespace. It provides classes to list the replication partners for a domain controller, view the supported Naming Contexts for a domain controller, and also see the pending replication operations.

Table 29-8 contains some of the more useful properties for the MSAD_ReplNeighbor class, which represents a replication partner (or neighbor) for a given domain controller.

Table 29-8. Useful MSAD_ReplNeighbor properties

Property	Description
IsDeletedSourceDsa	Boolean indicating whether the source DC has been deleted.
LastSyncResult	Number representing the result of the last sync operation with this neighbor. A value of 0 indicates success.
NamingContextDN	DN of the Naming Context for which the partners replicate.
NumConsecutiveSyncFailures	Number of consecutive sync failures between the two neighbors.
SourceDsaCN	CN of the replication neighbor.
SourceDsaSite	Site the replication neighbor is in.
TimeOfLastSyncAttempt	Time of the last sync attempt.
TimeOfLastSyncSuccess	Time of last successful sync attempt.

There are actually several property methods available other than what is shown in Table 29-8, so in the following example, we will enumerate all the replication neighbors and print out every property available to the MSAD_ReplNeighbor class:

```
strComputer = "."

Set objWMI = GetObject("winmgmts:\\" & strComputer & _
                       "\root\MicrosoftActiveDirectory")
Set objReplNeighbors = objWMI.ExecQuery("Select * from MSAD_ReplNeighbor")

For Each objReplNeighbor In objReplNeighbors

   WScript.Echo objReplNeighbor.SourceDsaCN & "/" & _
```

```
                objReplNeighbor.NamingContextDN & ":"

   For Each objProp In objReplNeighbor.Properties_
      If IsNull(objProp.Value) Then
         WScript.Echo " " & objProp.Name & " : NULL"
      Else
         WScript.Echo " " & objProp.Name & " : " & objProp.Value
      End If
   Next

   WScript.Echo ""
Next
WScript.Echo "The script has completed successfully."
```

Now that we can find all of the replication neighbors for a given domain controller, we will take a look at any outstanding replication operations. The `MSAD_ReplPendingOp` class represents a pending replication operation. The class has several property methods, and some of the more useful ones are listed in Table 29-9.

Table 29-9. Useful MSAD_ReplPendingOp properties

Property	Description
`DsaDN`	DN of replication neighbor
`NamingContextDN`	DN of Naming Context that holds the object being synced
`PositionInQ`	Number representing the position in the replication queue
`TimeEnqueued`	Date representing when operation was put in the queue

The next example is not much different from most of our others. We simply query all `MSAD_ReplPendingOp` objects for a particular host. If zero are returned, that signifies there are no pending replication operations on the host:

```
strComputer = "."

Set objWMI = GetObject("winmgmts:\\" & strComputer & _
                       "\root\MicrosoftActiveDirectory")
Set objRepOps = objWMI.ExecQuery("Select * from MSAD_ReplPendingOp")

If objRepOps.Count = 0 Then
    WScript.Echo "There are no pending replication operations"
Else
    For Each objRepOp in objRepOps
        WScript.Echo objRepOp.DsaDN
        WScript.Echo objRepOp.NamingContextDN
        WScript.Echo objRepOp.PositionInQ
        WScript.Echo objRepOp.TimeEnqueued
    Next
End If
WScript.Echo "The script has completed successfully."
```

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29.10. Summary

In this chapter, we gave a quick introduction into the WMI architecture and the concepts behind it. We then covered some of the tools available for querying and modifying WMI data. Next, we went through several examples for querying and manipulating services and the Event Logs. The last part of the chapter covered the WMI hooks into Active Directory, including the WMI providers for Trustmon and Replication monitoring.

In the next chapter, we will put our WMI knowledge to use as we work with the WMI DNS Provider. We will use WMI to configure Microsoft DNS server settings programmatically and manipulate zones and resource records.

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Chapter 30. Manipulating DNS

DNS is a core technology of Active Directory that cannot be overlooked. Although features such as Active Directory Integrated DNS can take a lot of the hassle of managing DNS servers and zones out of your hands, you still have to set up the initial zone configurations. Unfortunately, lack of a good DNS API has always been a big gap for managing a Microsoft DNS server environment. The only way to automate maintenance and management of Microsoft DNS has been by executing `Dnscmd` commands from within a batch, VBScript, or Perl script. Over time, Microsoft has continued to improve `Dnscmd`, and as of Windows 2000, it provides just about every option you need to manage DNS server configuration, zones, and resource records using a command line. In Windows Server 2003, it even allows you to manage Application Partitions! Microsoft also provides the DNS MMC snap-in for those who want to manage DNS via a GUI, although it is not very suitable for managing large environments or making bulk modifications.

Microsoft's answer to the DNS API issue is WMI. As explained in Chapter 29, WMI is Microsoft's API of choice for managing and monitoring systems and services. With the WMI DNS provider, you have complete programmatic control over a Microsoft DNS environment, much as you do with `Dnscmd` from a command line.

In this chapter, we will cover the WMI DNS provider at length, including the properties and methods available for the primary WMI DNS classes. Several sample scripts will be shown, which will give you a head start on developing scripts to manage your own DNS environment.

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30.1. DNS Provider Overview

The DNS WMI provider was first released as part of the Windows 2000 Resource Kit Supplement 1, but unfortunately it was not ready for prime time. That version was buggy, did not include all the documented features, and in several cases behaved differently than what the documentation described. Also, since the DNS provider was included as part of a Resource Kit, it was not fully supported by Microsoft, which means that if you encountered problems, you were largely on your own. That said, much of the functionality you probably need is present in the Windows 2000 version, so it may be suitable. You can download the Windows 2000 DNS provider separately from the Resource Kit via FTP from ftp://ftp.microsoft.com/reskit/win2000/dnsprov.zip.

With Windows Server 2003, the DNS provider is fully functional and supported. It is installed automatically whenever you install the DNS Server service. You can also install it separately as described in the next section. This may be necessary when doing development with the provider on a machine that does not have the DNS Server installed.

> For our purposes, all sample code has been tested using the Windows Server 2003 DNS provider.

30.1.1. Installing the DNS Provider

You do not need to manually install the provider if you are installing the DNS Server service on a Windows Server 2003 server because it gets installed with the service.

If you downloaded the DNS provider files for Windows 2000 (*dnsschema.mof* and *dnsprov.dll*), you will first need to copy them to the *%SystemRoot%\System32\wbem* directory. Next, you'll need to compile the DNS managed object format (MOF) file by executing `mofcomp`*`filename`* from a command line. With Windows 2000, the DNS MOF file is named *dnsschema.mof*, and with Windows Server 2003, it is called *dnsprov.mof*. The output of the command should look like the following:

```
C:\WINDOWS\system32\wbem>mofcomp  dnsprov.mof
Microsoft (R) 32-bit MOF Compiler Version 5.2.3628.0
Copyright (c) Microsoft Corp. 1997-2001. All rights reserved.
Parsing MOF file: dnsprov.mof
MOF file has been successfully parsed
Storing data in the repository...
Done!
```

The last step is to register the DNS provider DLL by executing *regsvr32 dnsprov.dll* from a command line. You should see a dialog box with the following:

```
DllRegisterServer in dnsprov.dll succeeded.
```

At this point, you will be able to use the DNS provider from your scripts.

30.1.2. Managing DNS with the DNS Provider

The three main areas of interest when it comes to managing DNS include server configuration, zone management, and creation and deletion of resource records. The DNS provider has several classes to manipulate each of these components. With the `MicrosoftDNS_Server` class, you can manipulate server configuration settings, start and stop the DNS service, and initiate scavenging. The `MicrosoftDNS_Zone` class allows you to create, delete, and modify zone configuration. The `MicrosoftDNS_ResourceRecord` class and its child classes provide methods for manipulating the various resource record types. Each of these will be explained in more detail in the next few sections.

Several additional classes are also supported by the DNS provider to manage other aspects of DNS, including the root hints (`MicrosoftDNS_RootHints`), DNS cache (`MicrosoftDNS_Cache`), and server statistics (`MicrosoftDNS_Statistics`). For more information on these classes, including sample scripts in VBScript and Perl, check out the following section in the MSDN Library: http://msdn.microsoft.com/library/default.asp?url=/library/en-us/dns/dns/dns_wmi_provider.asp.

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30.2. Manipulating DNS Server Configuration

There are close to 50 different settings that can be configured on a Microsoft DNS server. They range from default scavenging and logging settings to settings that customize the DNS server behavior, such as how zone transfers will be sent to secondaries and whether to round-robin multiple A record responses.

The DNS provider is mapped to the root\MicrosoftDNS namespace. A DNS server is represented by an instance of a `MicrosoftDNS_Server` class, which is derived from the `CIM_Service` class. Table 30-1 contains all the property methods available in the `MicrosoftDNS_Server` class.

Table 30-1. MicrosoftDNS_Server class properties

Property name	Property description
`AddressAnswerLimit`	Max number of records to return for address requests (e.g., A records).
`AllowUpdate`	Determines whether DDNS updates are allowed.
`AutoCacheUpdate`	Indicates whether the DNS server will dynamically attempt to update its root hints (also known as cache) file.
`AutoConfigFileZones`	Indicates which standard primary zones that are authoritative for the name of the DNS server must be updated when the name server changes.
`BindSecondaries`	Determines the format zone transfers (AXFR) will be sent as to non-Microsoft DNS servers.
`BootMethod`	Determines where the server will read its zone information.
`DefaultAgingState`	For AD-integrated zones, the default scavenging interval in hours.
`DefaultNoRefreshInterval`	For AD-integrated zones, the default no-refresh interval in hours.
`DefaultRefreshInterval`	For AD-integrated zones, the default refresh interval in hours.
`DisableAutoReverseZones`	Determines whether the server automatically creates reverse zones.
`DisjointsNets`	Indicates whether the default port binding for a socket used to send queries to remote DNS servers can be overridden.
`DsAvailable`	Indicates whether Active Directory is available on the server.

Property name	Property description
DsPollingInterval	For AD-integrated zones, the interval in seconds to poll Active Directory for updates.
DsTombstoneInterval	For AD-integrated zones, the length of time in seconds that tombstoned records (i.e., deleted) records should remain in Active Directory.
EdnsCacheTimeout	Length of time, in seconds, the cached EDNS version information is cached.
EnableDirectoryPartitionSupport	Flag indicating whether application partition support has been enabled.
EnableDnsSec	Flag indicating whether DNSSEC resource records are returned if queried.
EnableEDnsProbes	When TRUE, the DNS server always responds with OPT resource records according to RFC 2671, unless the remote server has indicated it does not support EDNS in a prior exchange. When FALSE, the DNS server responds to queries with OPTs only if OPTs are sent in the original query.
EventLogLevel	Determines the type of events (e.g., errors or warnings) that will be logged to the DNS Event Log.
ForwardDelegations	Determines whether queries to delegated subzones are forwarded.
Forwarders	List of IPs the server forwards queries to.
ForwardingTimeout	Time in seconds to wait for a response from a forwarded query.
IsSlave	Indicates whether the DNS server is a slave.
ListenAddresses	List of addresses the DNS server can receive queries on.
LocalNetPriority	If TRUE, records for IPs on the same net are given a higher priority.
LogFileMaxSize	Max size in bytes of the DNS server log.
LogFilePath	Filename and path to DNS server log.
LogIPFilterList	List of IPs used to filter entries written to the DNS server log.
LogLevel	Determines what events should be written to the system log.
LooseWildcarding	Indicates whether the server supports wildcarding (e.g., * MX records).
MaxCacheTTL	Max time in seconds to leave a recursive query in the local cache.
MaxNegativeCacheTTL	Max time in seconds to leave a recursive query that resulted in an error in the local cache.
Name	FQDN or IP of server.
NameCheckFlag	Indicates the set of eligible characters to be used in DNS names.

Property name	Property description
NoRecursion	Flag indicating whether the server will perform recursive lookups.
RecursionRetry	Time in seconds before retrying a recursive lookup.
RecursionTimeout	Time in seconds before the DNS server gives up recursive query.
RoundRobin	Flag indicating whether the server will round-robin addresses returned from a query that returns multiple A records.
RpcProtocol	Protocol to run administrative RPC over.
ScavengingInterval	Interval in hours between initiating scavenges.
SecureResponses	Indicates whether the DNS server exclusively saves records of names in the same subtree as the server that provided them.
SendPort	Port on which the DNS server sends UDP queries to other servers.
ServerAddresses	List of IP addresses for the server.
StrictFileParsing	Indicates whether the DNS server parses zone file strictly, which means if bad data is encountered, the zone will fail to load.
UpdateOptions	Flag that restricts the type of records that can be updated via DDNS.
Version	DNS server version.
WriteAuthorityNS	Flag indicating whether the server includes NS and SOA records in the authority section on successful response.
XfrConnectTimeout	Number of seconds server waits for a successful TCP connection to a remote server when attempting a zone transfer.

The MicrosoftDNS_Server class also provides a few methods to initiate certain actions on the DNS server. Perhaps two of the most useful are StartService and StopService, which allow you to start and stop the DNS service. Table 30-2 contains the list of methods available to the MicrosoftDNS_Server class.

Table 30-2. MicrosoftDNS_Server class methods

Method name	Method description
GetdistinguishedName	For AD-integrated zones, gets the DN of the zone
StartScavenging	Starts the scavenging process for zones that have scavenging enabled
StartService	Starts the DNS service
StopService	Stops the DNS service

30.2.1. Listing a DNS Server's Properties

The first step in programmatically managing your DNS server configuration is to see what settings you currently have and determine whether any need to be modified. With WMI, it is really easy to list all properties for the server. The following example shows how to do it:

```
Set objDNS = GetObject("winMgmts:root\MicrosoftDNS")
Set objDNSServer = objDNS.Get("MicrosoftDNS_Server.Name="".""")

WScript.Echo objDNSServer.Properties_.Item("Name") & ":"
For Each objProp In objDNSServer.Properties_
   If IsNull(objProp.Value) Then
      WScript.Echo " " & objProp.Name & " : NULL"
   Else
      If objProp.IsArray = TRUE Then
         For I = LBound(objProp.Value) To UBound(objProp.Value)
             WScript.Echo " " & objProp.Name & " : " & objProp.Value(I)
         Next
      Else
         WScript.Echo " " & objProp.Name & " : " & objProp.Value
      End If
   End If
Next
WScript.Echo "The script has completed successfully."
```

After getting a WMI object for the DNS provider (root\MicrosoftDNS), we get a `MicrosoftDNS_Server` object by looking for the "." instance. Because there can only be one instance of `MicrosoftDNS_Server` running on any given computer, we do not need to worry about multiple objects. After getting a `MicrosoftDNS_Server` object, we iterate through all the properties of the object and print each one out. Note that we have added special checks for values that contain arrays to print each element of the array. In that case, we use `Lbound` and `Ubound` to iterate over all the values for the array.

30.2.2. Configuring a DNS server

Now that we can see what values have been set on our DNS server, we may want to change some of them. To do so is very straightforward. We simply need to set the property method (e.g., `EventLogLevel`) to the correct value. This example shows how it can be done:

```
On Error Resume Next

Set objDNS = GetObject("winMgmts:root\MicrosoftDNS")
Set objDNSServer = objDNS.Get("MicrosoftDNS_Server.Name="".""")

WScript.Echo objDNSServer.Name & ":"
objDNSServer.EventLogLevel = 4
objDNSServer.LooseWildcarding = True
objDNSServer.MaxCacheTTL  =  900
objDNSServer.MaxNegativeCacheTTL  =  60
objDNSServer.AllowUpdate  =  3
objDNSServer.Put_

If Err Then
   WScript.Echo " Error occurred: " & Err.Description
Else
   WScript.Echo " Change successful"
End If
WScript.Echo "The script has completed successfully."
```

Note that we had to call `Put_` at the end. If we didn't, none of the changes would have been committed.

30.2.3. Restarting the DNS Service

After making changes to DNS settings, you typically will need to restart the DNS service for them to take effect. We can utilize the `StopService` and `StartService` methods as shown in the following example to do this:

```
On Error Resume Next

Set objDNS = GetObject("winMgmts:root\MicrosoftDNS")
Set objDNSServer = objDNS.Get("MicrosoftDNS_Server.Name="".""")

objDNSServer.StopService
If Err Then
  WScript.Echo "StopService failed: " & Err.Description
  WScript.Quit
End If

objDNSServer.StartService
If Err Then
  WScript.Echo "StartService failed: " & Err.Description
  WScript.Quit
End If

WScript.Echo "Restart successful"
```

30.2.4. DNS Server Configuration Check Script

Building on the examples we've used so far in this chapter, we can now move forward with writing a robust DNS server configuration check script. A configuration check script can be very important, especially in large environments where you may have many DNS servers. Unless you have a script that routinely checks the configuration on all of your DNS servers, it is very likely that those servers will not have an identical configuration. If this is true, when problems pop up over time, you may end up spending considerably more time troubleshooting because of the discrepancies between the servers.

To accomplish the configuration checking, we will store each setting in a VBScript `Dictionary` object. For those coming from other languages such as Perl, a `Dictionary` object is the VBScript analog of a hash or associative array. It is not extremely flexible but works well in situations such as what we need. Another option would be to store the settings in a text file and read them into a `Dictionary` object when the script starts up. Example 30-1 contains the configuration check code.

Example 30-1. DNS Server configuration check script

```
Option Explicit
On Error Resume Next

Dim arrServers
Dim strUsername, strPassword
Dim dicDNSConfig

` Array of DNS servers to check
arrServers  =  Array("dns1.mycorp.com","dns2.mycorp.com")

` User and password that can modify the config on the DNS servers
strUsername = "dnsadmin"
strPassword = "Securednspwd!"

` This dictionary object will contain the key value pairs for all the settings
` that you want to check and configure on the DNS servers
Set dicDNSConfig = CreateObject("Scripting.Dictionary")
dicDNSConfig.Add "AllowUpdate",              1
dicDNSConfig.Add "LooseWildCarding",        True
dicDNSConfig.Add "MaxCacheTTL",              900
dicDNSConfig.Add "MaxNegativeCacheTTL",      60
dicDNSConfig.Add "EventLogLevel",            0
dicDNSConfig.Add "StrictFileParsing",       True
dicDNSConfig.Add "DisableAutoReverseZones", True

Dim arrDNSConfigKeys
arrDNSConfigKeys = dicDNSConfig.keys

Dim objLocator
Set objLocator = CreateObject("WbemScripting.SWbemLocator")

Dim x, y, boolRestart
For x = LBound(arrServers) To UBound(arrServers)
```

```
   boolRestart = False

   WScript.Echo arrServers(x)

   Dim objDNS, objDNSServer
   Set objDNS = objLocator.ConnectServer(arrServers(x), "root\MicrosoftDNS", _
                                         strUserName, strPassword)
   Set objDNSServer = objDNS.Get("MicrosoftDNS_Server.Name="".""")

   For y = 0 To dicDNSConfig.Count - 1
      Dim strKey
      strKey = arrDNSConfigKeys(y)

      WScript.Echo "  Checking " & strKey
      If dicDNSConfig.Item(strKey) <> objDNSServer.Properties_.Item(strKey) Then
         objDNSServer.Properties_.Item(strKey).value = dicDNSConfig(strKey)
         objDNSServer.Put_
         boolRestart = True
         If Err Then
            WScript.Echo "    Error setting " & strKey & " : " & Err.Description
            WScript.Quit
         Else
            WScript.Echo "    " & strKey & " updated"
         End If
      End If
   Next

   If boolRestart Then
      objDNSServer.StopService
      If Err Then
         WScript.Echo "StopService failed: " & Err.Description
         WScript.Quit
      End If

      objDNSServer.StartService
      If Err Then
         WScript.Echo "StartService failed: " & Err.Description
         WScript.Quit
      End If
      WScript.Echo "Restarted"
   End If

   WScript.Echo ""
Next
WScript.Echo "The script has completed successfully."
```

Besides the use of the Dictionary object, most of the script is a combination of the other three examples shown so far in this chapter. We added a server array so that you can check multiple servers at once. Then for each server, the script simply checks each key in the Dictionary object to see whether the value for it matches that on the DNS server. If not, it modifies the server and commits the change via `Put_`. After it's done looping through all the settings, it restarts the DNS service if a change has been made to its configuration. If a change has not been made, it proceeds to the next server.

One enhancement that would make the process even more automated would be to dynamically query the list of DNS servers instead of hard coding them in an array. You would simply need to query the NS record for one or more zones that your DNS servers are authoritative for. As long as an NS record is added for each new name server, the script would automatically pick it up in subsequent runs. Later in the chapter, we will show how to query DNS with the DNS provider.

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30.3. Creating and Manipulating Zones

The MicrosoftDNS_Zone class provides a plethora of properties and methods to aid in managing your zones. Even if you are using AD-integrated zones, which help reduce the amount of work it takes to maintain DNS, you will inevitably need to configure settings on a zone or create additional zones. In Tables 30-3 and 30-4, the list of available properties and methods for the MicrosoftDNS_Zone class are presented.

Table 30-3. MicrosoftDNS_Zone class properties

Property name	Property description
Aging	Specifies aging and scavenging behavior. Zero indicates scavenging is disabled.
AllowUpdate	Flag indicating whether dynamic updates are allowed.
AutoCreated	Flag indicating whether the zone was auto-created.
AvailForScavengeTime	Specifies the time when the server may attempt scavenging the zone.
DataFile	Name of zone file.
DisableWINSRecordReplication	If TRUE, WINS record replication is disabled.
DsIntegrated	Specified if zone is AD integrated.
ForwarderSlave	Indicates whether the DNS server acts as a slave when resolving the names for the specified forward zone. Applicable to Forward zones only.
ForwarderTimeout	Indicates the time, in seconds, a DNS server forwarding a query for the name under the forward zone waits for resolution from the forwarder before attempting to resolve the query itself. This parameter is applicable to the Forward zones only.
LastSuccessfulSoaCheck	Number of seconds since the beginning of January 1, 1970 GMT, since the SOA serial number for the zone was last checked.
LastSuccessfulXfr	Number of seconds since the beginning of January 1, 1970 GMT, since the zone was last transferred from a master server.
LocalMasterServers	Local IP addresses of the master DNS servers for this zone. If set, these masters over-ride the MasterServers found in Active Directory.
MasterServers	IP addresses of the master DNS servers for this zone.

Property name	Property description
NoRefreshInterval	Specifies the time interval between the last update of a record's timestamp and the earliest moment when the timestamp can be refreshed.
Notify	If set to 1, the master server will notify secondaries of zone updates.
NotifyServers	
Paused	Flag indicating whether the zone is paused and therefore not responding to requests.
RefreshInterval	
Reverse	If TRUE, zone is a reverse (in-addr.arpa) zone. If FALSE, zone is a forward zone.
ScavengeServers	Array of strings that enumerates the list of IP addresses of DNS servers that are allowed to perform scavenging of stale records of this zone. If the list is not specified, any primary DNS server authoritative for the zone is allowed to scavenge the zone when other prerequisites are met.
SecondaryServers	Array of strings enumerating IP addresses of DNS servers allowed to receive this zone through zone replication.
SecureSecondaries	Flag indicating whether zone transfers are allowed only to servers specified in SecondariesIPAddressesArray.
Shutdown	If TRUE, zone has expired (or shutdown).
UseWins	Flag indicating whether zone uses WINS lookups.
ZoneType	Type of zone. It will be either DS Integrated, Primary, or Secondary.

Table 30-4. MicrosoftDNS_Zone class methods

Method name	Method description
AgeAllRecords	Age part or all of a zone.
ChangeZoneType	Convert zone to one of the following types: DS integrated, Primary, Secondary, Stub, Stub-DS integrated, or Forward.
CreateZone	Create a new zone.
ForceRefresh	Forces secondary to update its zone from master.
GetdistinguishedName	Get distinguished name of the zone.
PauseZone	Causes the DNS server to not respond to queries for the zone.

Method name	Method description
ReloadZone	Reload the contents of the zone. This may be necessary after making changes to a zone that you want to take effect immediately.
ResetSecondaries	Specify list of secondaries.
ResumeZone	Causes the DNS server to start responding to queries for the zone again.
UpdateFromDS	Reloads the zone information from Active Directory. This is only valid for AD-integrated zones.
WriteBackZone	Save zone data to a file.

30.3.1. Creating a Zone

Creating a zone with the DNS provider is a straightforward operation. You simply need to get a WMI object for the DNS namespace, instantiate an object from the MicrosoftDNS_Zone class, and call CreateZone on that object. The next example shows how to do this:

```
On Error Resume Next

strNewZone = "mycorp.com."

Set objDNS = GetObject("winMgmts:root\MicrosoftDNS")
Set objDNSZone = objDNS.Get("MicrosoftDNS_Zone")
strNull  =  objDNSZone.CreateZone(strNewZone,0,True)

If Err Then
   WScript.Echo "Error occurred creating zone: " & Err.Description
Else
   WScript.Echo "Zone created..."
End If
```

The three parameters we passed into CreateZone( ) include the zone name, zone type flag, and DS-integrated flag. A zone type of 0 means to create a primary zone. When the DS-integrated flag is set to true, the primary zone will be AD-integrated; if it is false, it will be a standard primary. At the time of this writing, Microsoft had conflicting documentation about these parameters and their valid values.

30.3.2. Configuring a Zone

Configuring a zone is not too different from configuring a server. The primary difference is how you instantiate a MicrosoftDNS_Zone object. To use the Get( ) method on a WMI (SWbemServices) object, you have to specify the keys for the class you want to instantiate. For the MicrosoftDNS_Zone class, the keys include ContainerName, DnsServerName, and Name. In this case, ContainerName and

Name are the name of the zone. The DnsServerName we retrieve by getting a `MicrosoftDNS_Server` object as we've done earlier in the chapter.

Example 30-2 first lists all of the properties of the *mycorp.com*. zone before it modifies the "AllowUpdate" property and commits the change.

Example 30-2. Configuring a zone

```
On Error Resume Next

strZone = "mycorp.com."

Set objDNS = GetObject("winMgmts:root\MicrosoftDNS")
Set objDNSServer = objDNS.Get("MicrosoftDNS_Server.Name="".""")
Set objDNSZone = objDNS.Get("MicrosoftDNS_Zone.ContainerName=""" & strZone & _
                            """,DnsServerName=""" & objDNSServer.Name & _
                            """,Name=""" & strZone & """")

' List all of the properties of the zone
WScript.Echo objDNSZone.Name
For Each objProp In objDNSZone.Properties_
   If IsNull(objProp.Value) Then
      WScript.Echo " " & objProp.Name & " : NULL"
   Else
      If objProp.IsArray = TRUE Then
         For I = LBound(objProp.Value) To UBound(objProp.Value)
             WScript.Echo " " & objProp.Name & " : " & objProp.Value(I)
         Next
      Else
         WScript.Echo " " & objProp.Name & " : " & objProp.Value
      End If
   End If
Next

' Modify the zone
objDNSZone.AllowUpdate = 1
objDNSZone.Put_

WScript.Echo ""
If Err Then
   WScript.Echo "Error occurred: " & Err.Description
Else
   WScript.Echo "Change successful"
End If
```

30.3.3. Listing the Zones on a Server

The last zone example we will show lists the configured zones on a specific DNS server. To make the following example a little more robust, we've added logic to make the script configurable so it can be run against any DNS server. That is accomplished by using the ConnectServer method on the SWbemLocator object.

```
strServer  = "dns1.mycorp.com"
strUsername = "dnsadmin"
strPassword = "Securednspwd!"

Set objLocator = CreateObject("WbemScripting.SWbemLocator")
Set objDNS = objLocator.ConnectServer(strServer, "root\MicrosoftDNS", _
                                      strUsername, strPassword)
Set objDNSServer = objDNS.Get("MicrosoftDNS_Server.Name="".""")
Set objZones = objDNS.ExecQuery("Select * from MicrosoftDNS_Zone " & _
                                "Where DnsServerName = '" & _
                                objDNSServer.Name & "'")
WScript.Echo objDNSServer.Name
For Each objZone In objZones
   WScript.Echo " " & objZOne.Name
Next
WScript.Echo "The script has completed successfully."
```

To retrieve the list of zones, we used a WQL query with ExecQuery to find all MicrosoftDNS_Zone objects that had a DnsServerName equal to the name of the server we are connecting to.

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30.4. Creating and Manipulating Resource Records

Resource records are the basic unit of information in DNS. A DNS server's primary job is to respond to queries for resource records . Most people don't realize they are generating resource record queries with nearly every network-based operation they do, including accessing a website, pinging a host via its Fully Qualified Domain Name (FQDN), or logging into Active Directory.

Resource records come in many different flavors or types. Each type corresponds to a certain type of name or address lookup. Each record type also has additional information encoded with the record that represents things such as the time to live of the record. The following is a textual example of what a CNAME record looks like:

```
www.mycorp.com.   1800   IN   CNAME   www1.mycorp.com.
```

Or, more generically:

```
Owner   TTL   Class   Type   RR-Data
```

Now let's break down the record into its individual parts:

`Owner`

The owner of the resource record. This field is typically what is specified during a query for the particular type.

`TTL`

The time to live, or length of time a nonauthoritative DNS server should cache the record. After the TTL expires, a nonauthoritative server should requery for an authoritative answer.

`Class`

Resource record classification. In nearly all cases, this will be "IN" for Internet.

`Type`

Name of the resource record type. Each type has a standard name that is used in zones (e.g., CNAME, A, PTR, SRV).

RR-Data

Resource record specific data. When you perform a query, you are typically looking for the information returned as part of the RR-Data.

The WMI DNS provider fully supports querying and manipulating resource records. In Tables 30-5 and 30-6, the supported properties and methods are listed for the MicrosoftDNS_ResourceRecord class, which implements a generic interface for resource records.

Table 30-5. MicrosoftDNS_ResourceRecord class properties

Property name	Property description
ContainerName	Name of container (e.g., zone name) that holds the RR
DnsServerName	FQDN of the server that contains the RR
DomainName	FQDN of the domain that contains the RR
OwnerName	Owner of the RR
RecordClass	Class of the RR; 1 represents IN
RecordData	Resource record data
Textrepresentation	Textual representation of the RRe.g., www.mycorp.com. 1800 IN CNAME www1.mycorp.com
Timestamp	Time RR was last refreshed
TTL	Time to live or maximum time a DNS server is supposed to cache the RR

Table 30-6. MicrosoftDNS_ResourceRecord class methods

Method name	Method description
CreateInstanceFromTextRepresentation	Creates a new instance of a MicrosoftDNS_ResourceRecord subclass based on the textual representation of the resource record, server name, and container or zone name. A reference to the new object is returned as an out parameter.
GetObjectByTextRepresentation	Gets an instance of the appropriate MicrosoftDNS_ResourceRecord subclass as specified by the textual representation of the resource record, server name, and container or zone name.

The `MicrosoftDNS_ResourceRecord` class by itself is not enough. There are over two dozen different types of resource records with many having additional fields that would not have corresponding methods in the generic interface. To solve this problem, subclasses of `MicrosoftDNS_ResourceRecord` were created for each supported record type. Each subclass provides specific methods to access any field supported by the resource record type. Each supported resource record has a subclass with a name in the format of `MicrosoftDNS_<RR Type>Type`.

To show just how different resource records can be, let's take a look at an A record:

```
www.mycorp.com.   1800   IN   A   192.10.4.5
```

Now let's compare that with an SRV record:

```
_ldap._tcp.dc._msdcs.mycorp.com 1800   IN   SRV   0 100 389 dc1.mycorp.com.
```

As you can see, the SRV record has several additional fields. By using the `Microsoft-DNS_SRVType` subclass, we can access each field with methods provided by the class.

The complete list of supported resource record types is provided in Table 30-7.

Table 30-7. DNS provider supported resource records

Resource record type	DNS provider class	RFC	Description
A	MicrosoftDNS_Atype	RFC1035	Name-to-IPv4 address mapping
AAAA	MicrosoftDNS_AAAAType	RFC1886	Name-to-IPv6 address mapping
AFSDB	MicrosoftDNS_AFSDBType	RFC1183	Andrew File System (AFS) Database Server record
ATMA	MicrosoftDNS_ATMAType	N/A	ATM-address-to-name mapping
CNAME	MicrosoftDNS_CNAMEType	RFC1035	Canonical (alias) name
HINFO	MicrosoftDNS_HINFOType	RFC1035	Host information
ISDN	MicrosoftDNS_ISDNType	RFC1183	Integrated services digital network (ISDN) record
KEY	MicrosoftDNS_KEYType	RFC2535	KEY record
MB	MicrosoftDNS_MBType	RFC1035	Mailbox record
MD	MicrosoftDNS_MDType	RFC1035	Mail agent
MF	MicrosoftDNS_MFType	RFC1035	Mail forwarding agent

Resource record type	DNS provider class	RFC	Description
MG	MicrosoftDNS_MGType	RFC1035	Mail group record
MINFO	MicrosoftDNS_MINFOType	RFC1035	Mail information record
MR	MicrosoftDNS_MRType	RFC1035	Mailbox rename record
MX	MicrosoftDNS_MXType	RFC1035	Mail exchanger
NS	MicrosoftDNS_NSType	RFC1035	Name server
NXT	MicrosoftDNS_NXTType	RFC2535	Next record
PTR	MicrosoftDNS_PTRType	RFC1035	Address-to-name mapping record
RP	MicrosoftDNS_RPTType	RFC1183	Responsible person
RT	MicrosoftDNS_RTType	RFC1183	Route through record
SIG	MicrosoftDNS_SIGType	RFC2535	Signature record
SOA	MicrosoftDNS_SOAType	RFC1035	Start of authority
SRV	MicrosoftDNS_SRVType	RFC2052	Service record
TXT	MicrosoftDNS_TXTType	RFC1035	Text record
WINS	MicrosoftDNS_WINSType	N/A	WINS server
WINSR	MicrosoftDNS_WINSRType	N/A	WINS reverse-lookup
WKS	MicrosoftDNS_WKSType	RFC1035	Well-known services
X25	MicrosoftDNS_X25Type	RFC1183	X.121 Address-to-name mapping

30.4.1. Finding Resource Records in a Zone

With the marriage of DNS and WMI, querying DNS has never been so easy. By using WQL, you can write complex query routines that would not have been possible previously. To list all of the resource records on a server, you simply need to execute the WQL query `select * from MicrosoftDNS_ResourceRecord` against the target server. The following example shows what this would look like if the script is run on a DNS server:

```
Set objDNS = GetObject("winMgmts:root\MicrosoftDNS")
Set objRR = objDNS.ExecQuery("Select * from MicrosoftDNS_ResourceRecord ")

For Each objInst In objRR
   WScript.Echo objInst.TextRepresentation

Next
WScript.Echo "The script has completed successfully."
```

The TextRepresentation method is available to all resource record types since it is defined in MicrosoftDNS_ResourceRecord. It will return a text string representing the resource record, such as the following:

```
www.mycorp.com. IN  A  192.10.4.5
```

If you want to limit the query to only a specific zone, change the WQL query to include criteria for ContainerName, such as the following:

```
Select * from MicrosoftDNS_ResourceRecord Where ContainerName = 'ZoneName'
```

Since Active Directory uses DNS to store all of the Global Catalog servers in a forest and domain controllers in a domain, you can write scripts to utilize DNS to access this information and integrate it into your applications. The following example does exactly this by selecting all SRV records with a particular OwnerName. To find all Global Catalog servers in a forest, you can simply query *_ldap._tcp.gc._msdcs.<ForestDNSName>*, and to find all domain controllers in a domain, query *_ldap._tcp.dc._msdcs.<DomainDNSName>*.

```
Option Explicit

Dim strDomain
strDomain = "mycorp.com"

Dim objDNS, objRRs, objRR
Set objDNS = GetObject("winMgmts:root\MicrosoftDNS")
Set objRRs = objDNS.ExecQuery("Select * from MicrosoftDNS_SRVType " & _
                             " Where OwnerName = '_ldap._tcp.gc._msdcs." & _
                             strDomain & "'")
WScript.Echo "Global Catalogs for " & strDomain
For Each objRR In objRRs
   WScript.Echo " " & objRR.DomainName
Next

WScript.Echo

Set objRRs = objDNS.ExecQuery("Select * from MicrosoftDNS_SRVType " & _
                             " Where OwnerName = '_ldap._tcp.dc._msdcs." & _
                             strDomain & "'")
WScript.Echo "Domain Controllers for " & strDomain
For Each objRR In objRRs
   WScript.Echo " " & objRR.DomainName
Next
WScript.Echo "The script has completed successfully."
```

30.4.2. Creating Resource Records

With the DNS provider, creating resource records is also very easy to do. The MicrosoftDNS_ResourceRecord::CreateInstanceFromTextRepresentation method takes the server name to create the record on, the domain name, and the text representation of the resource record as in parameters. It also provides an out parameter, which will be an object representing the newly created record.

Example 30-3 goes through the process of creating both A and PTR records. Both records are typically necessary when adding a new host to DNS.

Example 30-3. Creating A and PTR resource records

```
Option Explicit

Dim strRR, strReverseRR, strDomain, strReverseDomain

' A record to add
strRR = "testb.mycorp.com. IN A 192.32.64.13"
strDomain = "mycorp.com"

' PTR record to add
strReverseRR = "13.64.32.192.in-addr.arpa IN PTR testb.mycorp.com"
strReverseDomain = "192.in-addr.arpa."

Dim objDNS, objRR, objDNSServer, objRR2, objOutParam
Set objDNS = GetObject("winMgmts:root\MicrosoftDNS")
Set objRR = objDNS.Get("MicrosoftDNS_ResourceRecord")
Set objDNSServer = objDNS.Get("MicrosoftDNS_Server.Name="".""")

' Create the A record
Dim strNull
strNull = objRR.CreateInstanceFromTextRepresentation( _
                  objDNSServer.Name, _
                  strDomain, _
                  strRR, _
                  objOutParam)

Set objRR2 = objDNS.Get(objOutParam)
WScript.Echo "Created Record: " & objRR2.TextRepresentation
Set objOutParam = Nothing

' Create the PTR record
strNull = objRR.CreateInstanceFromTextRepresentation( _
                  objDNSServer.Name, _
                  strReverseDomain, _
                  strReverseRR, _
                  objOutParam)
```

```
Set objRR2 = objDNS.Get(objOutParam)
WScript.Echo "Created Record: " & objRR2.TextRepresentation
```

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30.5. Summary

The WMI DNS provider fills a much-needed gap for programmatic management of a Microsoft DNS environment. In this chapter, we reviewed how to install the DNS provider, including some of the caveats for using it on Windows 2000. We then covered the classes used for managing server configuration along with each of the available server settings. Next, we showed how to create and manipulate zones with the DNS provider. Finally, we covered the various resource record types and their associated WMI classes.

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Chapter 31. Getting Started with VB.NET and System.Directory Services

Unless you've been hiding in a cave in recent years, you've undoubtedly heard of Microsoft's latest initiative, called .NET. At a low level, .NET is the basis for a new programming platform, including a completely new set of APIs to manage Microsoft-based products and develop Windows applications. Microsoft even released a new programming language in conjunction with .NET called C# (C-sharp). At a higher level, Microsoft has morphed the concept of .NET to the point where it is hard to define its true boundaries. Here is the definition provided on Microsoft's website: "Microsoft .NET is a set of software technologies designed to connect your world of information, people, systems, and devices."

As far as Active Directory goes, the impact of .NET has been pretty minimal so far. Windows Server 2003 Active Directory was an evolutionary step, not revolutionary; perhaps the biggest .NET-influenced change is with the new APIs called `System.DirectoryServices` that were developed for Active Directory. In this chapter, we will discuss the `System.DirectoryServices` interfaces and cover numerous examples of how they can be used to query and manipulate data in Active Directory. Before getting into that, we first need to talk a bit about the .NET Framework .

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31.1. The .NET Framework

The .NET Framework is a new set of interfaces intended to replace the old Win32 and COM APIs. A couple of the major design goals for the .NET Framework were to make programming in a Windows environment much simpler and more consistent. The .NET Framework has two major components: the common language runtime (CLR) and the .NET Framework class library.

The CLR is the sandbox from which all .NET-based code, called managed code, is executed. The CLR is in charge of things such as memory management, security management, thread management, and other code management functions. One of the great benefits of the CLR is that different programming languages can develop code that runs in the CLR and can be used by other programming languages. That means you can develop managed Perl code that can be easily used by a C# application.

The other major component of the .NET Framework is the class library, which is a comprehensive set of object-oriented interfaces that replace the traditional Win32 API. The class library is divided up into namespaces. You can think of a namespace as a grouping of classes, properties, and methods that are targeted for a specific function. For example, the `System.Text` namespace contains classes for representing strings in ASCII, Unicode, and other character encoding systems. The namespace that is of the most interest to us is the `System.DirectoryServices` namespace, which contains all the classes necessary to query and manipulate a directory, such as Active Directory, using the .NET Framework.

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31.2. Using VB.NET

Because the majority of the code we've demonstrated so far in this book has been written in VBScript, you may be wondering why we are going to talk about Visual Basic.NET (VB.NET). Unfortunately, one of the drawbacks with the .NET Framework is that it currently does not provide native support for VBScript. It does support JScript, but since Visual Basic is a much more powerful language than JScript, we will use VB.NET in our examples.

As we mentioned earlier, one of the design goals for the .NET Framework was simplicity. With the .NET Framework class library, Microsoft has made developing Windows-based applications significantly easier. As far as Active Directory goes, it will not take long at all to map your ADSI knowledge to the classes, properties, and methods in the `System.DirectoryServices` namespace.

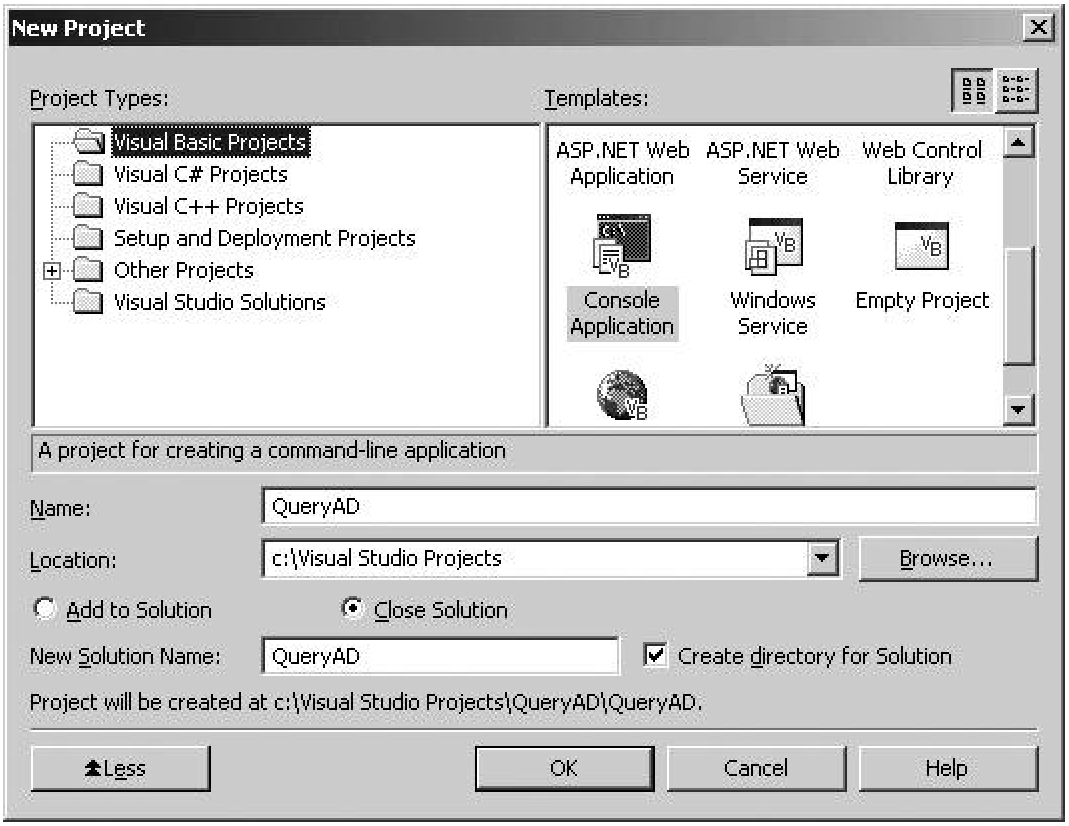
To get started using VB.NET, you'll need to get an integrated development environment (IDE) such as Visual Studio.NET (VS.NET), which is available from http://msdn.microsoft.com/vstudio/. Once you have VS.NET, you should download the latest .NET Framework SDK, which is available from http://msdn.microsoft.com/netframework/. Once you have both of those installed, you are ready to start programming with the .NET Framework.

To start a new project in VS.NET, select File → New → Project from the menu. At that point, you'll see a screen similar to the one in Figure 31-1.

Click on Visual Basic Projects and select Console Application from the Templates window. Now you have started a new project and are ready to start writing code in a file called *Module1.vb*, which contains the following code by default:

```
Module Module1
    Sub Main(  )
    End Sub
End Module
```

Figure 31-1. Creating a new VB.NET project



A project for creating a command-line application

Name: QueryAD

Location: c:\Visual Studio Projects

○ Add to Solution ● Close Solution

New Solution Name: QueryAD ☑ Create directory for Solution

Project will be created at c:\Visual Studio Projects\QueryAD\QueryAD.

If you are inexperienced with VB, you can create usable programs simply by adding code to the `Main( )` subroutine. Once you become more experienced, you can start creating your own classes, subroutines, and functions, and then reference them within `Main( )`.

To start using the `System.DirectoryServices` classes to query and manipulate Active Directory, you must add a reference to it in your project. From the menu, select Project ⟶ Add Reference, then under Component Name, click on System.DirectoryServices. Click the Select button and click OK. Figure 31-2 shows what this window looks like in VS.NET.

You are now ready to start writing Active Directory applications with the .NET Framework, so let's take a look at the `System.DirectoryServices` namespace.

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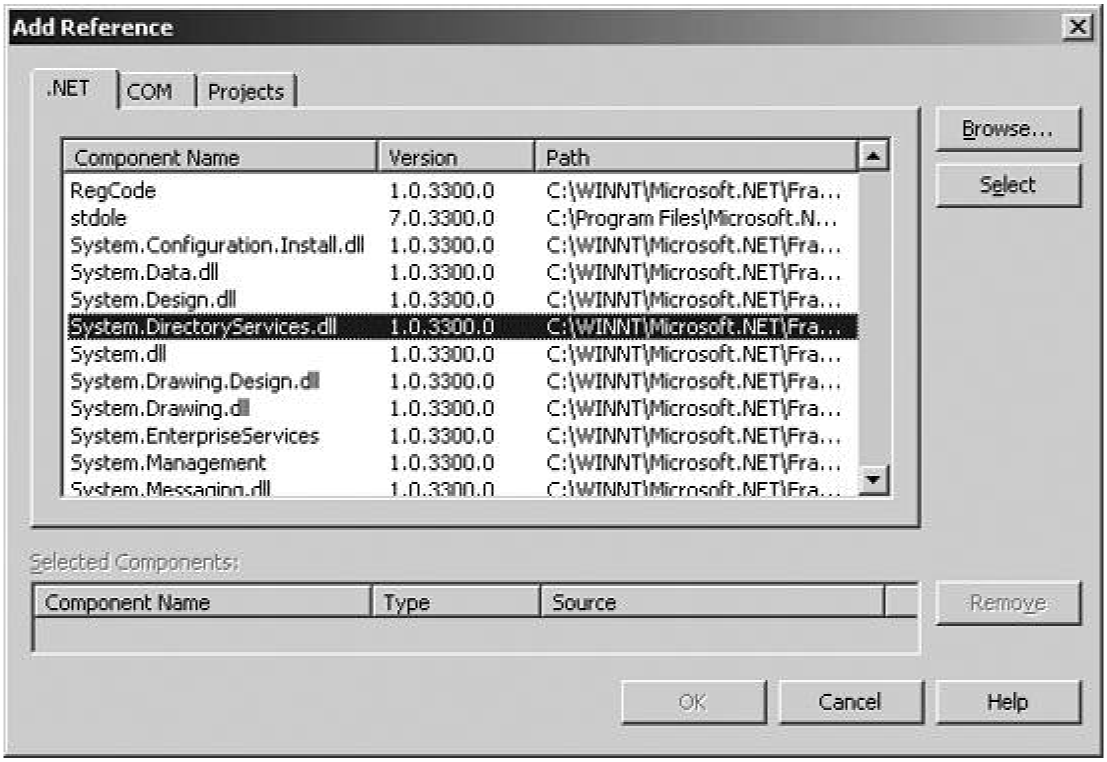
31.3. Overview of System.DirectoryServices

The System.DirectoryServices namespace contains several classes, many of which were built on top of ADSI. If you are already familiar with ADSI, the learning curve for the System.DirectoryServices classes should be pretty minimal. Table 31-1 contains the base classes contained within the System.DirectoryServices namespace.

Figure 31-2. Adding a reference to System.DirectoryServices



Component Name	Version	Path
RegCode	1.0.3300.0	C:\WINNT\Microsoft.NET\Fra...
stdole	7.0.3300.0	C:\Program Files\Microsoft.N...
System.Configuration.Install.dll	1.0.3300.0	C:\WINNT\Microsoft.NET\Fra...
System.Data.dll	1.0.3300.0	C:\WINNT\Microsoft.NET\Fra...
System.Design.dll	1.0.3300.0	C:\WINNT\Microsoft.NET\Fra...
System.DirectoryServices.dll	1.0.3300.0	C:\WINNT\Microsoft.NET\Fra...
System.dll	1.0.3300.0	C:\WINNT\Microsoft.NET\Fra...
System.Drawing.Design.dll	1.0.3300.0	C:\WINNT\Microsoft.NET\Fra...
System.Drawing.dll	1.0.3300.0	C:\WINNT\Microsoft.NET\Fra...
System.EnterpriseServices	1.0.3300.0	C:\WINNT\Microsoft.NET\Fra...
System.Management	1.0.3300.0	C:\WINNT\Microsoft.NET\Fra...
System.Messaging.dll	1.0.3300.0	C:\WINNT\Microsoft.NET\Fra...

Component Name	Type	Source

Table 31-1. System.DirectoryServices classes

Class name	Description
DirectoryEntries	Contains the children (child entries) of an entry in Active Directory.

Class name	Description
DirectoryEntry	Encapsulates a node or object in the Active Directory hierarchy.
DirectorySearcher	Performs queries against Active Directory.
DirectoryServicesPermission	Allows control of code access security permissions for System.DirectoryServices.
DirectoryServicesPermissionAttribute	Allows declarative System.DirectoryServices permission checks.
DirectoryServicesPermissionEntry	Defines the smallest unit of a code access security permission set for System.DirectoryServices.
DirectoryServicesPermissionEntryCollection	Contains a strongly typed collection of DirectoryServicesPermissionEntry objects.
PropertyCollection	Contains the properties of a DirectoryEntry.
PropertyValueCollection	Contains the values of a DirectoryEntry property.
ResultPropertyCollection	Contains the properties of a SearchResult instance.
ResultPropertyValueCollection	Contains the values of a SearchResult property.
SchemaNameCollection	Contains a list of the schema names that the SchemaFilter property of a DirectoryEntries object can use.
SearchResult	Encapsulates a node in the Active Directory hierarchy that is returned during a search through DirectorySearcher.
SearchResultCollection	Contains the SearchResult instances that the Active Directory hierarchy returned during a DirectorySearcher query.
SortOption	Specifies how to sort the results of a search.

The list of classes in Table 31-1 was taken from the Microsoft Developer Network (http://msdn.microsoft.com). For more information on System.DirectoryServices and the .NET Framework, check out the .NET web site: http://msdn.microsoft.com/netframework/.

The two main classes within System.DirectoryServices are DirectoryEntry and DirectorySearcher. The DirectoryEntry class represents an object in Active Directory. You can create new objects and manage existing ones with DirectoryEntry. The DirectorySearcher class is the primary interface for searching Active Directory. It is an easy-to-use interface that contains properties for all the typical options you need to set when performing LDAP-based queries. We will be touching on some of the other classes as we go along, but these two are the main ones to become familiar with.

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31.4. DirectoryEntry Basics

The DirectoryEntry class contains several properties to access the attributes of Active Directory objects. The following code shows how to display the currentTime attribute of the RootDSE:

```
Dim objRootDSE As New DirectoryEntry("LDAP://RootDSE")
Console.WriteLine(objRootDSE.Properties("currentTime")(0))
```

In the code, once we instantiated the DirectoryEntry object, we can access the currentTime attribute by passing it to the Properties property. The Properties property actually returns a collection of values for the attribute in the form of a PropertyCollection class, which is why we needed to specify an index of 0 to get at a specific value. If the currentTime attribute was multi-valued, we could get at the other values by incrementing the index to 1 and so on.

> In object-oriented parlance, a property allows you to get or set an attribute of an object. A method typically results in some kind of action being taken on the object.

Now let's look at how to display all the values for all the attributes of an object in Active Directory. Again we will use RootDSE as the object we want to display:

```
Dim objRootDSE As New DirectoryEntry("LDAP://RootDSE")
Dim strAttrName As String
Dim objValue As Object
For Each strAttrName In objRootDSE.Properties.PropertyNames
    For Each objValue In objRootDSE.Properties(strAttrName)
        Console.WriteLine(strAttrName & " : " & objValue.ToString)
    Next objValue
Next strAttrName
```

As you can see, the Properties property, which returns a PropertyCollection, has a PropertyNames property that returns a collection of attribute names for the Active Directory object. We loop over each attribute name and then loop over each value for that attribute to ensure we print out values for all single- and multi-valued attributes. The ToString property converts whatever value is stored in the attribute to a printable string.

There are several properties available in the DirectoryEntry class. Table 31-2 contains a list of them.

Table 31-2. DirectoryEntry properties

Property name	Description
AuthenticationType	Gets or sets the type of authentication to use when accessing the directory
Children	Gets a DirectoryEntries class that contains the child objects of this object
Guid	Gets the GUID for the object (e.g., in Active Directory the objectGUID attribute)
Name	Gets the relative distinguished name of the object
NativeGuid	Gets the GUID of the object as returned by the provider
NativeObject	Gets the native ADSI object
Parent	Gets the object's parent in Active Directory
Password	Gets or sets the password to use when authenticating
Path	Gets or sets the ADsPath for the object
Properties	Gets a PropertyCollection class ccontaining the attributes on the object
SchemaClassName	Gets the objectClass of the object
SchemaEntry	Gets the DirectoryEntry class of the object's objectClass
UsePropertyCache	Gets or sets the flag indicating whether the property cache should be committed after each operation
Username	Gets or sets the username to use when authenticating

One interesting property to note is Children, which returns a DirectoryEntries collection containing each child object. Using the Children property, you can quickly traverse a directory tree. The following code prints out the entire directory tree rooted at dc=mycorp,dc=com:

```
Sub Main(  )
    Dim objADObject As New DirectoryEntry("LDAP://dc=mycorp,dc=com")
    DisplayChildren(objADObject, " ")
End Sub
Sub DisplayChildren(ByVal objADObject As DirectoryEntry, _
                    ByVal strSpaces As String)
    Console.WriteLine(strSpaces & objADObject.Name)
    Dim objChild As New DirectoryEntry(  )
    For Each objChild In objADObject.Children
        DisplayChildren(objChild, strSpaces & "  ")
    Next objChild
End Sub
```

The DisplayChildren( ) subroutine is recursive. For each child that is found, DisplayChildren( ) is called again, and so on until no child objects are found. The strSpaces variable is used to indent each child so that you can see the hierarchy when printed out.

Now let's say that we wanted to traverse the tree but print out only the Organizational Units. To do that, we can use the SchemaClassName property for each object and only print out the entry if its SchemaClassName equals organizationalUnit, which is the objectClass value for OUs:

```
Sub Main(  )
    Dim objADObject As New DirectoryEntry("LDAP://dc=mycorp,dc=com")
    DisplayChildren(objADObject, " ")
End Sub
Sub DisplayChildren(ByVal objADObject As DirectoryEntry, _
                    ByVal strSpaces As String)
    If objADObject.SchemaClassName = "organizationalUnit" Then
       Console.WriteLine(strSpaces & objADObject.Name)
    End If
    Dim objChild As New DirectoryEntry(  )
    For Each objChild In objADObject.Children
        DisplayChildren(objChild, strSpaces & "  ")
    Next objChild
End Sub
```

We are now going to take many of the concepts described so far and make a fully functional program. Let's expand on the first example we covered that printed the attributes and values for the RootDSE. We are going to turn it into a program that can accept a command-line argument, which should be the ADsPath of an object, and then display all of the attributes and values for that object. Example 31-1 contains the code.

Example 31-1. Making a fully functional program

```
Imports System
Imports System.DirectoryServices
Module Module1
    Sub Main(  )
        Dim cmd As String
       ' Read the commandline and get the number of arguments passed
        Dim intArgs As Integer
        Try
            intArgs = Environment.GetCommandLineArgs(  ).Length(  )
        Catch exp As Exception
            ' Set intArgs to 0 if no arguments were passed
            intArgs = 0
        End Try
        ' If an argument was specified on the commandline, set
       ' strADsPath to that, if not default to query the RootDSE
        Dim strADsPath As String
        If intArgs > 1 Then
            strADsPath = Environment.GetCommandLineArgs(  )(1)
        Else
            strADsPath = "LDAP://RootDSE"
        End If
        ' We need to see if the object in strADsPath exists
        ' and if not, print an error and return
        Dim objADObject As New DirectoryEntry(  )
        Try
            If objADObject.Exists(strADsPath) = False Then
                Throw (New Exception("Object does not exist"))
            End If
        Catch exp As Exception
            Console.WriteLine("Error retrieving object: " & strADsPath)
            Return
        End Try
        ' Iterate over each attribute of the object and print its values
        Dim strAttrName As String
        Dim objValue As Object
        Try
           objADObject.Path = strADsPath
           Console.WriteLine("Displaying " & objADObject.Path)
           For Each strAttrName In objADObject.Properties.PropertyNames
               For Each objValue In objADObject.Properties(strAttrName)
                   Console.WriteLine(strAttrName & " : " & objValue.ToString)
               Next objValue
           Next strAttrName
        Catch exp As Exception
            Console.WriteLine("Fatal error accessing: " & strADsPath)
            Return
        End Try
    End Sub
End Module
```

Error Handling in VB.NET

One of the important new features of VB.NET is robust error handling . VB.NET supports a new `try Catch` statement that allows you to easily catch exceptions as they happen and perform certain actions based on the type of exception that was thrown. Typically in .NET, if an error is encountered, an exception is thrown. Using a `try Catch` statement allows you to handle errors gracefully, much as you could with the `On Error` directive in Visual Basic 6.0. In fact, if you use `On Error` with VB.NET, the compiler actually translates it into `TRy Catch` statements.

Let's take a look at a code snippet we used earlier to print the `currentTime` attribute of the `RootDSE`:

```
Dim objRootDSE As New DirectoryEntry("LDAP://RootDSE")
Console.WriteLine(objRootDSE.Properties("currentTime")(0))
```

As you can see, there is no error handling. If there is a problem accessing the `RootDSE`, the program will return an error message and abort gracelessly. Using a `TRy Catch` statement, we can change the code to die gracefully or even continue execution of the rest of the program:

```
Try
  Dim objRootDSE As New DirectoryEntry("LDAP://RootDSE")
   Console.WriteLine(objRootDSE.Properties("currentTime")(0))
Catch objExp As Exception
  Console.WriteLine("Error retrieving RootDSE: " & _
                    objExp.Message)
End Try
```

One of the nice features of the `TRy Catch` statement is you can catch different types of errors. For example, let's pretend that we wanted to write to a file after we retrieved the `currentTime` from the `RootDSE`. Interacting with a file can generate certain I/O exceptions. We can insert an additional catch into the `TRy End Try` block to catch I/O exceptions as follows:

```
Try
  Dim objRootDSE As New DirectoryEntry("LDAP://RootDSE")
   Console.WriteLine(objRootDSE.Properties("currentTime")(0))
  ' write to a file
Catch objIOExp as IOException
  Console.WriteLine("File IO Error: " & objIOExp.Message)
Catch objExp As Exception
  Console.WriteLine("Error retrieving RootDSE: " & _
                    objExp.Message)
End Try
```

You can also generate your own exceptions with the `Throw` statement. Here is an example:

```
Try
    If objADObject.Exists(strADsPath) = False Then
       Throw (New Exception("Object does not exist"))
    End If
Catch exp As Exception
       Console.WriteLine("Error retrieving object: " & _
                         strADsPath)
End Try
```

The try Catch statement is very powerful and flexible. For more information on the properties and methods available to exception objects, check out the System.Exception namespace.

The first two lines, which use the Imports keyword, allow us to specify class names contained within those namespaces without fully qualifying them. For example, by using Imports, we can use the following code:

```
New DirectoryEntry(  )
```

instead of :

```
New System.DirectoryServices.DirectoryEntry(  )
```

For simplicity, we put the rest of the code directly in the Main( ) subroutine. The first part of the code attempts to read the command line using the System.Environment namespace to see if a parameter was specified. A try Catch statement was used because the call to Environment.GetCommandLineArgs( ).Length( ) will throw an exception if no parameters are passed on the command line. For more information on error handling, see the "Error Handling in VB.NET" sidebar. Note that the intArgs variable will contain the number of arguments passed to the script including the script name as the first argument. To see if the user actually passed the ADsPath, we have to check whether intArgs > 1. It is for this reason that we set the strADsPath variable to the value specified on the command line and if one wasn't, default to the RootDSE. Next, we use the Exists( ) method (not property) to determine if the object specified in strADsPath actually exists. The DirectoryEntry class contains a host of methods in addition to the properties we showed earlier. Table 31-3 contains a list of all the DirectoryEntry methods.

Table 31-3. DirectoryEntry methods

Method name	Description
Close	Closes the DirectoryEntry and releases any system resources associated with the component
CommitChanges	Saves any changes to the object in Active Directory (similar to SetInfo)
CopyTo	Creates a copy of the object

Method name	Description
`DeleteTree`	Deletes the object and any children
`Equals`	Determines whether two objects are the same
`Exists`	Determines whether the object exists in Active Directory
`Invoke`	Allows you to invoke a native ADSI method
`MoveTo`	Moves an object to a different location
`RefreshCache`	Refreshes the property cache for the object
`Rename`	Renames the relative distinguished name of the object
`ToString`	String representation of the object

If the `Exists( )` check fails, we generate an exception using `THRow( )`. If the object exists, we proceed to iterate over each attribute, printing the values for it. To turn the code into an executable, you can compile the program by selecting Build → Build Solution from the VS.NET menu. If any errors are found, they are displayed in the bottom pane. If none are found, you can then execute the program. If we named the project `EntryQuery`, an example command line would look like the following:

```
D:\Visual Studio Projects\EntryQuery\EntryQuery\bin> entryquery.exe LDAP://
dc=mycorp,dc=com
```

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31.5. Searching with DirectorySearcher

We've shown how easy it is to read individual objects from Active Directory with the `DirectoryEntry` class, so let's now look at how to search Active Directory with the `DirectorySearcher` class. The `DirectorySearcher` class works like many other LDAP-based search APIs. Table 31-4 contains all of the `DirectorySearcher` properties.

Table 31-4. DirectorySearcher properties

Property name	Description
`CacheResults`	Gets or sets the flag that determines whether results are cached on the client
`ClientTimeout`	Gets or sets the time period the client is willing to wait for the server to answer the search
`Filter`	Gets or sets the search filter string
`PageSize`	Gets or sets the page size for paged searching
`PropertiesToLoad`	Gets or sets the attributes to return from a search
`PropertyNamesOnly`	Gets or sets the flag indicating to only return attribute names from a search
`ReferralChasing`	Gets or sets whether referrals are chased
`SearchRoot`	Gets or sets the base from which the search should start
`SearchScope`	Gets or sets the scope of the search
`ServerPageTimeLimit`	Gets or sets the time the server will wait for an individual page to return from a search
`ServerTimeLimit`	Gets or sets the time the server will wait for a search to complete
`SizeLimit`	Gets or sets the maximum number of objects that can be returned by a search
`Sort`	Gets or sets the attribute that is used when returning sorted search results

Many of the properties, such as `SearchScope`, should look familiar. The following code shows how to search for all user objects in the *mycorp.com* domain.

```
Dim objSearch As New DirectorySearcher(   )
objSearch.SearchRoot = New DirectoryEntry("LDAP://dc=mycorp,dc=com")
objSearch.Filter = "(&(objectclass=user)(objectcategory=person))"
objSearch.SearchScope = SearchScope.Subtree
objSearch.PropertiesToLoad.Add("cn")
```

```
Dim colQueryResults As SearchResultCollection
colQueryResults = objSearch.FindAll(  )
Dim objResult As SearchResult
For Each objResult In colQueryResults
     Console.WriteLine(objResult.Properties("cn")(0))
Next
```

After a new `DirectorySearcher` class was instantiated, we set four properties before executing the search. The `SearchRoot` accepts a `DirectoryEntry` object representing the search base; the `Filter` property is the LDAP filter string; `SearchScope` is one of the values contained in the `System.DirectoryServices.SearchScope` enumeration; and `PropertiesToLoad.Add( )` builds the attribute list to return from the query. You can specify multiple attributes in a single statement by using `PropertiesToLoad.AddRange`:

```
objSearch.PropertiesToLoad.AddRange(New String(  ) {"cn", "sn", "givenname"})
```

After all of the search parameters have been set, we can use the `FindAll( )` method to invoke the search. A `System.DirectoryServices.SearchResultsCollection` is returned by the `FindAll( )` method, and you can iterate over each entry using a `For Each` loop. The `SearchResultsCollection` contains `System.DirectoryServices.SearchResult` objects, which are very similar to `DirectoryEntry` objects.

> If you want to retrieve only the first object in the search results, you can use the `FindOne( )` method, which returns a single `SearchResult` object.
>
> If you use a .NET Framework prior to 2.0, there is a resource cleanup issue with the `FindOne( )` method. Microsoft has not acknowledged this in any support articles, but Max Vaughn of Microsoft Developer Support posted the issue in the `microsoft.public.adsi.general` newsgroup. Use `FindAll( )` with a `SizeLimit( )` of 1 as an alternative.

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31.6. Manipulating Objects

Modifying objects with System.DirectoryServices can be accomplished a couple of different ways. To modify an attribute that currently has a value, you can set it using the Properties property. For example, the following code would modify the givenName attribute:

```
objADObject.Properties("givenName")(0)  =  "Robert"
```

If you want to set an attribute that was previously unset, you must use the Properties.Add method. The following code would set the previously unset sn attribute:

```
objADObject.Properties("sn").Add("Robert")
```

To determine whether an attribute has been set, you can use Properties("*attribute-name*").Count, which will return the number of values that have been set for the attribute. Just like with ADSI, all modifications are made initially to the local property cache and must be committed to the server. With ADSI, you would use the IADs::SetInfo( ) method, and with System.DirectoryServices, it is called CommitChanges( ), which is available from the DirectoryEntry class.

```
objADObject.CommitChanges(   )
```

Now that we covered how to set an attribute, we can modify the earlier code that printed all the values of an attribute to set an attribute instead. The code in Example 31-2 expects three command-line parameters: the first is the ADsPath of the object to modify, the second is the attribute name, and the third is the value to set the attribute to.

Example 31-2. Setting an attribute

```
Dim strADsPath As String
Dim strAttrName As String
Dim strAttrValue As String
Try
    Dim intArgs As Integer = Environment.GetCommandLineArgs(   ).Length(   )
    If intArgs <> 4 Then
```

```
        Throw (New Exception("All parameters are required"))
    Else
         strADsPath = Environment.GetCommandLineArgs(   )(1)
         strAttrName = Environment.GetCommandLineArgs(   )(2)
         strAttrValue = Environment.GetCommandLineArgs(   )(3)
    End If
Catch objExp As Exception
    Console.WriteLine("Error: " & objExp.Message)
     Console.WriteLine("Usage: " & Environment.GetCommandLineArgs(   )(0) & _
                      " ADsPath AttributeName Attribute Value")
    Console.WriteLine(   )
    Return
End Try
Dim objADObject As New DirectoryEntry(   )
Try
    If objADObject.Exists(strADsPath) = False Then
        Throw (New Exception("Object does not exist"))
    End If
Catch objExp As Exception
    Console.WriteLine("Error retrieving object: " & strADsPath)
    Console.WriteLine("Error: " + objExp.Message)
    Return
End Try
Dim strOldValue As String
Try
    objADObject.Path = strADsPath
     If objADObject.Properties(strAttrName).Count > 0 Then
         strOldvalue = objADObject.Properties(strAttrName)(0)
         objADObject.Properties(strAttrName)(0) = strAttrValue
    Else
        objADObject.Properties(strAttrName).Add(strAttrValue)
    End If
    objADObject.CommitChanges(   )
Catch objExp As Exception
    Console.WriteLine("Error setting object: " & strADsPath)
    Console.WriteLine("Error: " + objExp.Message)
    Return
End Try
Console.WriteLine(strADsPath)
Console.WriteLine("Attribute: " + strAttrName)
Console.WriteLine("Old value: " + strOldValue)
Console.WriteLine("New value: " + strAttrValue)
Console.WriteLine(   )
Console.WriteLine("Update Successful")
```

This code is not terribly different from Example 31-1. The main difference is the check for additional command-line parameters and the determination of whether the attribute that was specified on the command line was set previously.

Adding objects with System.DirectoryServices is similar in nature to ADSI. You must first get a reference to the parent object and then add a child. You can add a child by using the Children.Add( ) method of a DirectoryEntry object. The following example shows how to create a user object:

```
Dim objParent As New DirectoryEntry("LDAP://ou=sales,dc=mycorp,dc=com", _
                                    "administrator@mycorp.com", _
                                    "MyPassword", _
                                    AuthenticationTypes.Secure)
Dim objChild As DirectoryEntry = objParent.Children.Add("cn=jdoe", "user")
objChild.Properties("sAMAccountName").Add("jdoe")
objChild.CommitChanges(  )
objChild.NativeObject.AccountDisabled = False
objChild.CommitChanges(  )
Console.WriteLine("Added user")
```

You may have noticed several things. First, when we instantiated the DirectoryEntry object, we passed three additional parameters that we haven't used before. The second parameter is the user to authenticate with, the third is the password for the user, and the last is any authentication options from the AuthenticationTypes enumeration (ADS_AUTHENTICATION_ENUM in ADSI). After the first CommitChanges( ) call, the object is created in Active Directory. After that, we enable the account by calling ADSI's AccountDisabled method. System.DirectoryServices does not duplicate all of the functionality of ADSI. As we said earlier, it is primarily a wrapper around ADSI. One of the reasons System.DirectoryServices is so powerful is that you can still access native ADSI interfaces by using the NativeObject method. NativeObject will return the IADs interface of the specific type of object. In our previous example, NativeObject will return an IADsUser object, which we can then call the IADsUser::AccountDisabled method on. A final CommitChanges( ) call will update Active Directory and enable the account.

> To use the NativeObject method, you'll need to add a reference to the *ActiveDs.dll* library. From VS.NET, select Project ⟶ Add Reference from the menu. Click the COM tab, click Active DS Type Library under Component Name, and click the Select button. Click OK to close the window.

This concludes our introduction to the .NET Framework and the System.Directory-Services namespace. The information we covered should be sufficient to get you started writing Active Directory applications with .NET, but if you need additional information, check out MSDN, which contains detailed documentation on the .NET class library, including System.DirectoryServices.

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31.7. Summary

The .NET initiative is one of the biggest technology shifts at Microsoft since they embraced the Internet in the latter half of the 1990s. Microsoft is using .NET to refocus the company on new technologies such as XML web services and the .NET Framework. The .NET Framework is a completely new way to program in the Windows environment. The Common Language Runtime (CLR) helps applications share code more efficiently and securely. In addition, the .NET Framework class library is a new set of APIs that make the older Win32 APIs look antiquated. The object-oriented approach and better organization of classes make for a much more simplified programming environment.

The impact of .NET on Active Directory is pretty minimal so far. The biggest impact has been with the introduction of the `System.DirectoryServices` API, which builds on top of ADSI and is straightforward to use. In its current release, VBScript cannot be used natively with the .NET Framework, but due to the simplicity of .NET, using Visual Basic.NET is not much of a leap for experienced VBScript programmers. In this chapter, we covered the two main classes of `System.DirectoryServices`: the `DirectoryEntry` class and the `DirectorySearcher` class. By having a good understanding of these two classes, you'll be well on your way to writing robust Active Directory applications with the .NET Framework.

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About the Author

Joe Richards is a consultant, administrator, and tool writer who happens to have a secret identity as a Microsoft MVP for Windows Server Directory Services. His specialty is Directory Services, but he has "minors" in Security and Active Directory programming. By day he works for a large services/consulting/manufacturing company. He takes time to chat with people on listservs and newsgroups, write about stuff he knows, and whip up various fairly useful tools. He shares his home with a feisty black cat, two guinea pigs, a ferret, a chinchilla, and an extremely understanding fiancée.

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Colophon

The animals on the cover of *Active Directory*, Third Edition are a domestic cat (*felis silvetris*) and her kitten. The domestic cat is a descendant of the African wild cat, which first inhabited the planet almost one million years ago. Other early forerunners of the cat existed as many as 12 million years ago.

The domestic cat is one of the most popular house pets in the world. There are hundreds of breeds of domestic cats, which weigh anywhere from 5 to 30 pounds, with an average of 12 pounds. The cat is slightly longer than it is tall, with its body typically being longer than its tail. Domestic cats can be any of 80 different colors and patterns. They often live to be 15 to 20 years old; 10 years for a human life is about equal to 60 years for a cat.

The cat's gestation period is approximately two months, and each litter may contain three to seven kittens. Mother cats teach their kittens to eat and to use litter boxes. Kittens ideally should not leave their mother's side until the age of 12 weeks and are considered full-grown at the age of about three years.

The cover image is a 19th-century engraving from the Dover Pictorial Archive. The cover font is Adobe ITC Garamond. The text font is Linotype Birka; the heading font is Adobe Myriad Condensed; and the code font is LucasFont's TheSans Mono Condensed.

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