

Module 2: Automating IP Address Assignment by Using DHCP

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Instructor Notes

Presentation:
120 Minutes

Labs:
45 Minutes

This module provides students with the knowledge and skills necessary to configure automatic Internet Protocol (IP) addressing in a Microsoft® Windows® 2000 network by using Dynamic Host Configuration Protocol (DHCP).

At the end of this module, students will be able to:

- Define DHCP and describe how to use it on a network.
- Install the DHCP service.
- Authorize the DHCP service.
- Create and configure a scope.
- Customize DHCP functionality.
- Configure DHCP in a routed network.
- Support DHCP on a network.

Materials and Preparation

This section provides you with the required materials and preparation tasks that are needed to teach this module.

Required Materials

To teach this module, you need the Microsoft PowerPoint® file 2153a_02.ppt.

Preparation Tasks

To prepare for this module, you should:

- Read all of the materials for this module.
- Complete the labs.
- Read the white paper *Dynamic Host Configuration Protocol for Windows 2000 Server*, under **Additional Reading** on the Web page on the Student Materials compact disc.

- Read the entire “Dynamic Host Configuration Protocol” section in the Windows 2000 Server Resource Kit.
- Read the following RFCs under **Additional Reading** on the Web page on the Student Materials compact disc:
 - RFC 951 *Bootstrap Protocol (BOOTP)*
 - RFC 1112 *Host Extensions for IP Multicasting*
 - RFC 1534 *Interoperation Between DHCP and BOOTP*
 - RFC 1542 *Clarifications and Extensions for the Bootstrap Protocol*
 - RFC 2131 *Dynamic Host Configuration Protocol*
 - RFC 2132 *DHCP Options and BOOTP Vendor Extensions*
 - RFC 2236 *Internet Group Management Protocol, Version 2*
 - RFC 2730 *Multicast Address Dynamic Client Allocation Protocol (MADCAP)*

Module Strategy

Use the following strategy to present this module:

- Overview of DHCP

This section is designed to provide an overview of DHCP and how it works to automatically assign IP addresses to client computers. Start by explaining the difference between automatic and manual IP address assignment. Next, explain how DHCP operates. Keep this description basic and easy to understand. Do not present too much detail yet, because detailed operations are covered later in this module.

Next, describe the IP lease generation process and the lease renewal process. Describe the message types that are used during lease generation and renewal. Then explain the requirements for DHCP server and client computers.

- Installing the DHCP Service

This section is designed to explain the installation process for DHCP. Explain the steps for installing the DHCP service. Be sure to point out the importance of assigning a static IP address to the DHCP server.

- Authorizing the DHCP Service

This section is designed to explain the authorization process for a DHCP server. Explain to students why they need to authorize a new DHCP server, and what happens to a DHCP server that is not authorized. Then describe the process for authorizing a DHCP server. Use the animated slide to help explain this content.

- Creating and Configuring a Scope

This section is designed to explain how to create and configure DHCP scopes. Start by defining a scope. Explain the components of a scope and why they are important. Next, explain how to create a scope by using the New Scope wizard. Then explain how to configure a scope with options. Explain the common scope options and the ones that are supported by DHCP.

Next, explain how to customize the use of scope options to apply to specific types of computers. Do not spend too much time defining vendor classes because these are covered later in the module.

Finally, explain how to reserve IP addresses for client computers. Explain when it is appropriate to do this, and conversely, when it is not a good idea.

- Customizing DHCP Functionality

This section is designed to explain how to customize DHCP functionality to fit a particular client environment or function. Start by explaining how to use option classes. Define vendor classes in more detail as compared with the previous topic, and then describe user classes. Explain how to configure both vendor and user classes.

Next, explain how to use superscopes. Explain what superscopes are and when to use them, and then explain how to create them.

Next, explain how to use multicast scopes. Explain what multicast scopes are, and then explain how to create them.

- Configuring DHCP In a Routed Network

This section is designed to explain how to configure DHCP in a routed network. First, explain the options for configuring DHCP in a routed environment. Explain the options, the application for each option, and the benefits and drawbacks of each option. Next, provide more detail on using a DHCP relay agent. Explain the messages that a DHCP relay agent uses and how it works to forward lease requests across subnets. Then explain how to install a DHCP relay agent, and how to configure a DHCP relay agent.

- Supporting DHCP

This section is designed to explain how to support DHCP. Start by explaining how to monitor the DHCP service and the reasons for doing this. Explain how to enable logging, and the information that it provides. Next, explain how to troubleshoot the DHCP database when problems arise. Explain where the database is stored, and what students need to do to troubleshoot the database. Next, explain the steps and guidelines to remove a DHCP server from the network. Explain the conditions under which students must perform this task, and explain the requirements so that other network servers can resume the work of the server being removed from the network.

Customization Information

This section identifies the lab setup requirements for a module and the configuration changes that occur on student computers during the labs. This information is provided to assist you in replicating or customizing Microsoft Official Curriculum (MOC) courseware.

Important The lab in this module is also dependent on the classroom configuration that is specified in the Customization Information section at the end of the Classroom Setup Guide for course 2153, *Implementing a Microsoft Windows 2000 Network Infrastructure*.

Lab Setup

There are no lab setup requirements that affect replication or customization.

Lab Results

There are no configuration changes on student computers that affect replication or customization.

Overview

Topic Objective

To provide an overview of the module topics and objectives.

Lead-in

In this module, you will learn how to use DHCP to automate the assignment of IP addresses.

- Overview of DHCP
- Installing the DHCP Service
- Authorizing the DHCP Service
- Creating and Configuring a Scope
- Customizing DHCP Functionality
- Configuring DHCP in a Routed Network
- Supporting DHCP

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Depending on the size of your network, the management and assignment of Internet Protocol (IP) addresses to client computers can require a significant amount of time and effort. But with a Microsoft® Windows® 2000 network, you can enable dynamic IP addressing by using the Dynamic Host Configuration Protocol (DHCP) on a DHCP server to automate the assignment and management of network IP addresses.

At the end of this module, you will be able to:

- Define DHCP and describe how to use it on a network.
- Install the DHCP service.
- Authorize the DHCP service.
- Create and configure a scope.
- Customize DHCP functionality.
- Configure DHCP in a routed network.
- Support DHCP on a network.

◆ Overview of DHCP

Topic Objective

To introduce topics related to DHCP functionality.

Lead-in

To implement DHCP effectively, you need to understand how DHCP works, including the lease generation and renewal processes.

- Manual vs. Automatic TCP/IP Configuration
- DHCP Operation
- The DHCP Lease Generation Process
- The DHCP Lease Renewal Process
- Requirements for DHCP Servers and Clients

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A DHCP Server uses a lease generation process to assign IP addresses to client computers for a specific period of time. IP address leases are normally temporary, so DHCP clients must periodically attempt to renew their leases with the DHCP server. Understanding the details of the DHCP lease generation and renewal process provides a foundation for effectively implementing dynamic IP addressing in your network environment.

Manual vs. Automatic TCP/IP Configuration

Topic Objective

To compare manual TCP/IP configuration with automatic configuration using DHCP.

Lead-in

Let's compare the process for manually configuring IP addresses with DHCP.

Manual TCP/IP Configuration	Automatic TCP/IP Configuration
Disadvantages	Advantages
IP addresses entered manually on each client computer	IP addresses are supplied automatically to client computers
Possibility of entering incorrect or invalid IP address	Ensures that clients always use correct configuration information
Incorrect configuration can lead to communication and network problems	Elimination of common source of network problems
Administrative overload on networks where computers are frequently moved	Client configuration updated automatically to reflect changes in network structure

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To understand why DHCP is useful for configuring Transmission Control Protocol/Internet Protocol (TCP/IP) on client computers, it helps to compare manual TCP/IP configuration with automatic configuration by using DHCP.

Manual TCP/IP Configuration

When you configure TCP/IP manually on your network, you must enter an IP address on each client computer. This means that users can enter an incorrect or invalid IP address instead of using a valid IP address from the network administrator. Using an incorrect address can lead to network problems that can be very difficult to trace to the source.

Also, manually typing the IP address, subnet mask, or default gateway can lead to typographical errors, causing communication problems due to an incorrect default gateway or subnet mask, or problems associated with duplicate IP addresses. Moreover, there is administrative overhead on networks where computers frequently move from one subnet to another.

Automatic TCP/IP Configuration

Using DHCP to configure TCP/IP automatically means that users no longer need to acquire IP address from an administrator. Instead, the DHCP server automatically supplies all of the necessary configuration information to DHCP clients. It also ensures that network clients use correct configuration information, thereby eliminating a common source of network problems. Finally, DHCP automatically updates client configuration information to reflect changes in network structure and the relocation of users to other physical networks, without the need to manually reconfigure client IP addresses.

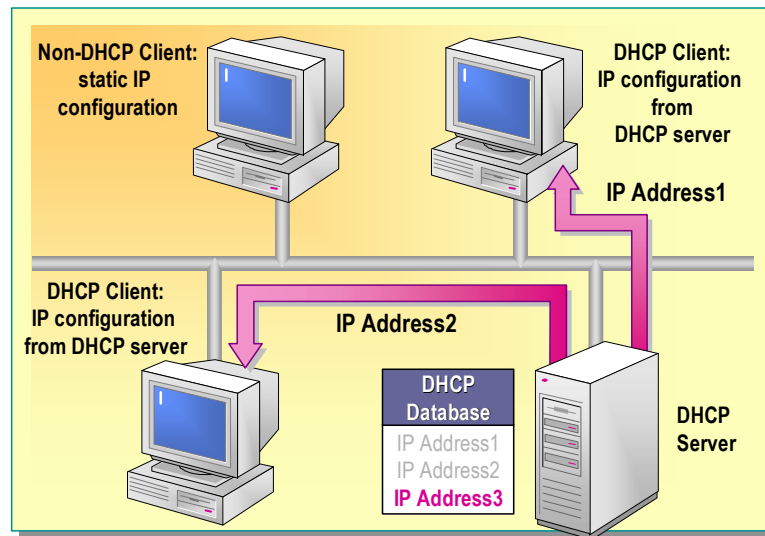
DHCP Operation

Topic Objective

To introduce the functionality of DHCP.

Lead-in

Each time that a DHCP client starts, it requests IP addressing information from a DHCP server.



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Each time that a DHCP client starts, it requests an IP address from a DHCP server. When the DHCP server receives the request, it selects an IP address from a range of addresses defined in its database. The DHCP server offers this address to the DHCP client.

If the client accepts the offer, the DHCP server leases the IP address to the client for a specified period of time. The default duration of an IP address lease is eight days, but this duration is configurable. The client then uses the IP address to access the network.

The IP addressing information sent by the DHCP server to the DHCP client can contain several elements, including:

- An IP address.
- A subnet mask.
- Optional values, such as:
 - A default gateway address.
 - The IP addresses of Domain Name System (DNS) servers.
 - The IP addresses of Windows Internet Name Service (WINS) servers.

Note For more information about DHCP, see RFCs 2131 and 2132 under **Additional Reading** on the Student Materials compact disc.

For more information about the Bootstrap Protocol (BOOTP) and how it interacts with DHCP, see RFCs 951, 1534, and 1542 under **Additional Reading** on the Student Materials compact disc.

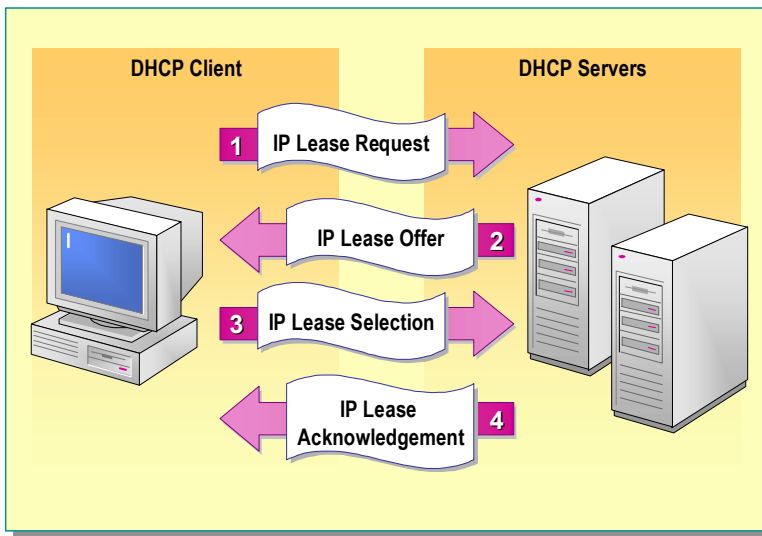
The DHCP Lease Generation Process

Topic Objective

To introduce the four phases in the DHCP lease generation process.

Lead-in

The process that DHCP uses to automatically configure clients occurs in four phases.



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Delivery Tip

Use the slide to briefly describe the four steps.

DHCP uses a four-step process to lease IP addressing information to DHCP clients:

1. IP lease request
2. IP lease offer
3. IP lease selection
4. IP lease acknowledgement

Note If a computer has multiple network adapters that are bound to TCP/IP, the DHCP process occurs separately over each adapter. The DHCP server assigns a unique IP address to each adapter that is bound to TCP/IP.

IP Lease Request

The lease generation process begins when a client computer either starts up or initializes TCP/IP for the first time. The lease process also begins when a client computer attempts to renew its lease and is denied (such as when you move a client computer to another subnet).

The process starts when the client initializes a limited version of TCP/IP and broadcasts a DHCPDISCOVER message for IP addressing information. The client does not yet have an IP address, so it uses 0.0.0.0 as the source address. And because the client does not know the IP address of a DHCP server, it uses 255.255.255.255 as the destination address. This broadcasts the message to the entire subnet.

The request message also contains the media access control (MAC) address, which is the hardware address of the client's network adapter. The message also contains the client's computer name so that DHCP servers can determine which client sent the request.

IP Lease Offer

All DHCP servers that have an IP address that is valid for the network segment to which the client is connected respond with a DHCPOFFER message, which includes the following information:

- The client's hardware address
- An offered IP address
- A subnet mask
- The length of the lease
- A server identifier, which is the IP address of the offering DHCP server

Each responding DHCP server reserves the offered IP address so that it does not offer it to another DHCP client prior to the requesting client's acceptance.

The DHCP client waits one second for an offer. If it does not receive an offer, it rebroadcasts the request four times at 2-, 4-, 8-, and 16-second intervals, plus a random length of time between 0 and 1,000 milliseconds.

If the client does not receive an offer after four requests, it uses an IP address in the reserved range from 169.254.0.1 to 169.254.255.254. The use of one of these autoconfigured IP addresses ensures that clients on a subnet without a DHCP server are able to communicate with each other. The DHCP client continues in an attempt to find a DHCP server every five minutes.

When a DHCP server becomes available, clients receive valid IP addresses, allowing them to communicate with hosts both on and off their subnet.

IP Lease Selection

The DHCP client responds to the first offer that it receives by broadcasting a DHCPREQUEST message to accept the offer. The DHCPREQUEST message includes the server identification of the server whose offer it accepted. All other DHCP servers then retract their offers and retain their IP addresses for other IP lease requests.

IP Lease Acknowledgement

The DHCP server issuing the accepted offer broadcasts a DHCP acknowledgement message (DHCPACK) to acknowledge the successful lease. This message contains a valid lease for the IP address and other configuration information.

When the DHCP client receives the acknowledgment, TCP/IP initializes by using the configuration information that the DHCP server provides. The client also binds the TCP/IP protocol to the network services and network adapter, permitting the client to communicate on the network.

Important All communication between a DHCP server and a DHCP client occurs using User Datagram Protocol (UDP) ports 67 and 68. Some switches do not properly forward DHCP broadcasts by default. For DHCP to function correctly, you may need to configure these switches to forward broadcasts over these ports.

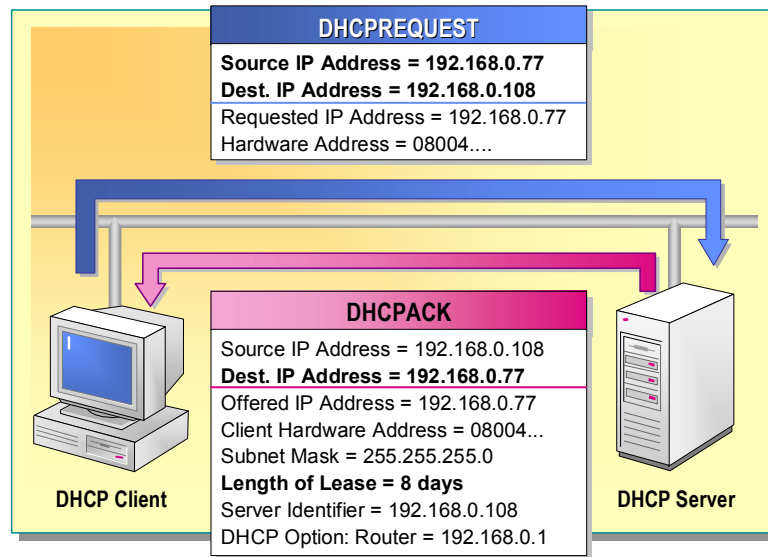
The DHCP Lease Renewal Process

Topic Objective

To illustrate how a DHCP client renews a lease from a DHCP server.

Lead-in

All DHCP clients attempt to renew their lease when 50 percent of the lease duration has expired.



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Delivery Tip

Use the illustration to explain the IP lease renewal process.

Emphasize that the lease renewal process involves the latter two phases of the lease generation process.

At specific intervals, a DHCP client attempts to renew its lease to ensure that it has up-to-date configuration information.

Automatic Lease Renewal

A DHCP client automatically attempts to renew its lease when 50 percent of the lease duration expires. To attempt a lease renewal, the DHCP client sends a DHCPREQUEST message directly to the DHCP server from which it obtained the lease.

If the DHCP server is available, it renews the lease and sends the client a DHCPACK message with the new lease duration and any updated configuration parameters. The client updates its configuration when it receives the acknowledgment. If the DHCP server is unavailable, the client continues to use its current configuration parameters.

If a DHCP client cannot renew its lease at the 50 percent interval, the client continues to use its current configuration parameters. It then broadcasts a DHCPDISCOVER message to update its address lease when 87.5 percent of the current lease duration expires. At this stage, the DHCP client accepts a lease that is issued by any DHCP server.

Note If a client requests an invalid or duplicate address for the network, a DHCP server can respond with a DHCP denial message (DHCPNACK). This forces the client to release its IP address and obtain a new, valid address.

If a DHCP server responds with a DHCPOFFER message to update the client's current lease, the client can renew its lease based on the server that offered the message and continue operation.

If the lease expires, the client must immediately discontinue its use of the current IP address. The DHCP client then begins the DHCP lease process in an attempt to lease a new IP address.

Note When you restart a DHCP client, it automatically attempts to renew the IP address lease that it had when it shut down. If the lease request is unsuccessful, the client attempts to contact the configured default gateway. If the default gateway responds and lease time is still available, the DHCP client uses the same IP address until its next lease renewal attempt. If the DHCP client cannot renew the lease or contact the default gateway, it stops using the current IP address. The client then uses an IP address in the reserved range from 169.254.0.1 to 169.254.255.254 and tries to contact a DHCP server every five minutes.

Manual Lease Renewal

You can renew an IP lease manually if you need to update DHCP configuration information immediately. For example, if you want DHCP clients to immediately obtain the address of a newly installed router from a DHCP server, renew the lease from the client to change this configuration.

To renew the lease manually, use the **ipconfig** command with the **/renew** switch. This sends a DHCPREQUEST message to the DHCP server to update configuration options and to renew the lease time.

Delivery Tip

Provide examples of when you might want to release a lease, such as when you move a client to a different network.

Note You can use the **ipconfig** command with the **/release** switch to release a lease (for example, if you are relocating a client from one subnet to another). This sends a DHCPRELEASE message to the DHCP server to release a client lease. After you issue this command, the client can no longer communicate on the network by using TCP/IP.

Requirements for DHCP Servers and Clients

Topic Objective

To describe the requirements for DHCP servers and clients.

Lead-in

Before you implement DHCP, you must ensure that the servers and clients meet certain requirements.

■ DHCP Server Requirements (Windows 2000 Server)

- The DHCP service
- Static IP address, subnet mask, default gateway
- Range of valid IP addresses

■ DHCP Clients

- Windows 2000 Professional or Windows 2000 Server
- Windows NT Server or Workstation 3.51 or later
- Windows 95 or Windows 98
- Windows for Workgroups 3.11, running TCP/IP-32
- Microsoft Network Client 3.0 for MS-DOS
- LAN Manager 2.2c
- Non-Microsoft operating systems

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The Windows 2000 DHCP service has specific software requirements for the server and client computers.

Delivery Tip

Mention that the DHCP server does not need to be a domain controller.

Also mention that a DHCP server cannot also be a DHCP client.

DHCP Server Requirements

All products in the Windows 2000 Server family include the DHCP service. Consequently, a server running any of the Windows 2000 Server family of operating systems can serve as a DHCP server.

A computer running Windows 2000 Server and acting as a DHCP server requires:

- Installation of the DHCP service.
- A static IP address, subnet mask, and default gateway.
- A range of valid IP addresses for lease or assignment to clients.

DHCP Clients

You must configure client computers to automatically obtain IP addresses from a DHCP server. Client computers running any of the following operating systems can be DHCP clients:

- Windows 2000 Professional or Windows 2000 Server
- Microsoft Windows NT® Server version 3.51 or later, or Windows NT Workstation version 3.51 or later
- Microsoft Windows 95 or Microsoft Windows 98
- Microsoft Windows for Workgroups version 3.11 with TCP/IP-32 installed
- Microsoft MS-DOS® with the Microsoft Network Client version 3.0 for MS-DOS installed, and using the real-mode TCP/IP driver
- Microsoft LAN Manager version 2.2c (LAN Manager 2.2c for OS/2 is not supported)
- Many non-Microsoft operating systems

Enabling DHCP Clients

To enable DHCP support on a client computer that is running Windows 2000, you must configure the TCP/IP properties on that computer so that the computer obtains an IP address automatically.

To configure Windows 2000 clients to obtain IP addresses automatically:

1. Open the **Properties** dialog box for the network connection that you are configuring.
2. Click **Internet Protocol (TCP/IP)**, and then click **Properties**.
3. In the **Internet Protocol (TCP/IP) Properties** dialog box, on the **General** tab, click **Obtain an IP address automatically**.
4. If you assign DNS server addresses by using DHCP, click **Obtain DNS server address automatically**.
5. Click **OK** twice.

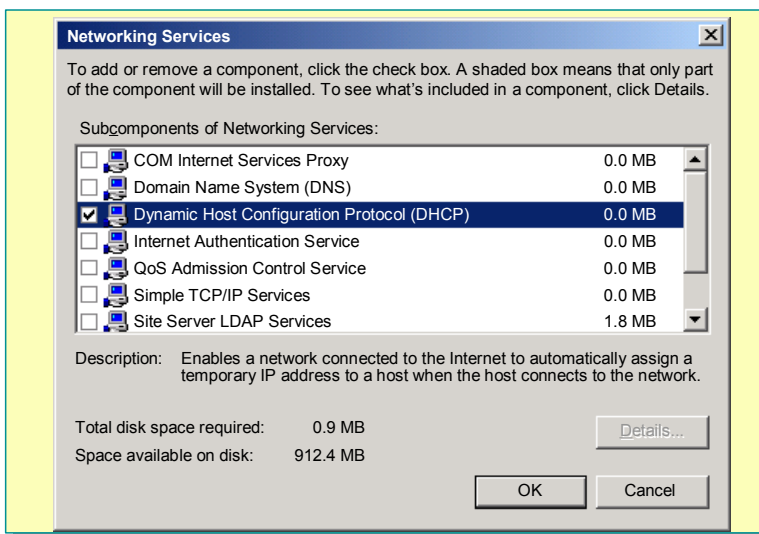
Installing the DHCP Service

Topic Objective

To introduce the interface for installing the DHCP service.

Lead-in

You install the DHCP service on a computer running Windows 2000 Server to create a DHCP server.



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To create a DHCP server, you must install the DHCP service on a computer running Windows 2000 Server.

Delivery Tip

Emphasize the need for providing a static TCP/IP configuration for a DHCP server.

Important Before you can install the DHCP service on the computer that you want to designate as the DHCP server, you must specify a static IP address, subnet mask, and default gateway address for the network adapter that is bound to TCP/IP.

For more information about configuring these parameters, see “Configure TCP/IP for Static Addressing” in Windows 2000 Help.

To install the DHCP service:

1. In Control Panel, double-click **Add/Remove Programs**.
2. In **Add/Remove Programs**, click **Add/Remove Windows Components**.
3. In the Windows Components wizard, on the **Windows Components** page, under **Components**, click **Networking Services**, and then click **Details**.
4. In the **Networking Services** dialog box, under **Subcomponents of Networking Services**, select the **Dynamic Host Configuration Protocol (DHCP)** check box, and then click **OK**.
5. Click **Next**.

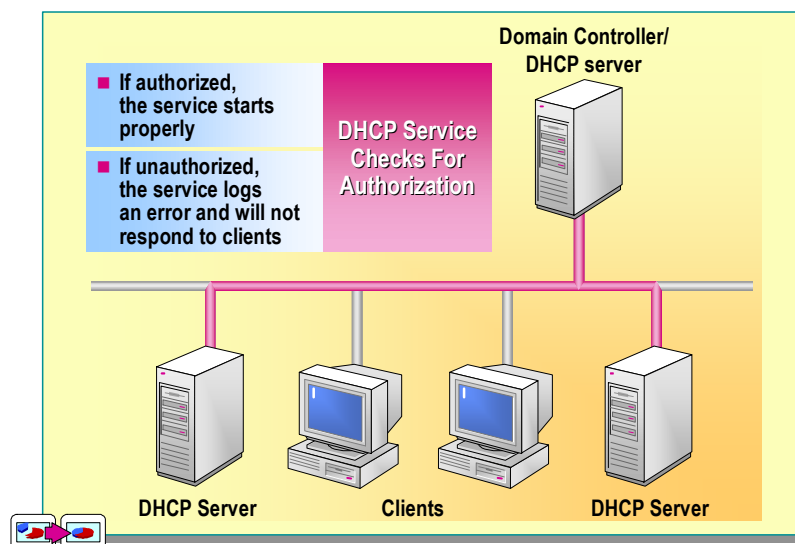
Authorizing the DHCP Service

Topic Objective

To illustrate DHCP server authorization in a domain.

Lead-in

In Windows 2000, you must authorize a DHCP server before the server can issue leases to DHCP clients.



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Delivery Tip

The slide for this topic includes animation. Click or press the SPACEBAR to advance the animation.

You must authorize a DHCP server before the server can issue leases to DHCP clients. Requiring authorization of the DHCP servers prevents unauthorized DHCP servers from offering potentially invalid IP addresses to clients. This requirement provides a network administrator with a great degree of control over IP lease assignments in a Windows 2000 network.

Note Only DHCP servers running Windows 2000 Server check for authorization. Other DHCP servers can still operate even though they are not authorized.

Detection of Unauthorized DHCP Servers

For DHCP authorization to work correctly, you must configure your network so that when the DHCP service starts, it sends out a DHCP informational message (DHCPINFORM) to the local broadcast address (255.255.255.255). When this occurs, other DHCP servers reply with DHCP acknowledgement messages (DHCPACK), which contain information about any Active Directory™ directory service root domain identified by each DHCP server.

The server that is attempting to initialize the DHCP service then contacts a domain controller in each of the domains that it identifies. It queries Active Directory for a list of DHCP servers that are currently authorized to operate on the network. If the DHCP server is authorized, the DHCP service on that computer starts properly. If the DHCP server is not authorized, the DHCP service logs an error in the system log and ignores all client requests.

Note A DHCP server broadcasts a DHCPINFORM message every five minutes in an attempt to detect other DHCP servers on the network. This allows it to determine changes in its authorization status and update its status accordingly.

Delivery Tip

Demonstrate the process for authorizing a DHCP server.

Authorizing a DHCP Server

To authorize a DHCP server:

1. Open DHCP from the **Administrative Tools** menu.
2. In the console tree, right-click **DHCP**, and then click **Manage authorized servers**.
3. In the **Manage Authorized Servers** dialog box, click **Authorize**.
4. In the **Authorize DHCP Server** dialog box, type the name or IP address of the DHCP server to authorize, and then click **OK**.
5. In the **DHCP** message box, click **Yes** to confirm the authorization.

Important To authorize a DHCP server, you must be a member of the Enterprise Admins group. This group has network-wide administrative privileges. For more information about delegating the ability to authorize DHCP servers to a user who is not a member of the Enterprise Admins group, see “To Delegate Ability to Authorize DHCP Servers to a Non-Enterprise Administrator” in Windows 2000 Help.

Note Authorization problems can exist if there are multiple forests on the same network infrastructure. Authorization is not recognized between forests, and the DHCP server from the other forest will continue to issue IP addresses.

Lab A: Creating and Authorizing a DHCP Server

Topic Objective

To introduce the lab.

Lead-in

In this lab, you will install the DHCP service to create a DHCP server. You will also authorize the DHCP server.



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Explain the lab objectives.

Objectives

After completing this lab, you will be able to:

- Install the DHCP Server service.
- Authorize a DHCP server.

Prerequisite

Before working on this lab, you must have knowledge of the concepts and function of DHCP.

Lab Setup

To complete this lab, you need the following:

- A computer running Windows 2000 Advanced Server that is configured as a domain controller in a child domain of the nwtraders.msft domain, has a static IP address, and uses the instructor computer for DNS name resolution.
- A partner with a similarly configured computer.
- The Eadmin user account in the nwtraders.msft domain. The instructor created this account for use in classroom labs, and the account is a member of the Enterprise Admins group in the domain nwtraders.msft. You will use this user account to authorize a DHCP server.

Key Points

The lab does not reflect the real-world environment. It is recommended that you always use complex passwords for any administrator accounts, and never create accounts without a password.

Outside of the classroom environment, it is strongly advised that you use the most recent software updates that are necessary. Because this is a classroom environment, we may use software that does not include the latest updates.

Important The lab does not reflect the real-world environment. It is recommended that you always use complex passwords for any administrator accounts, and never create accounts without a password.

Important Outside of the classroom environment, it is strongly advised that you use the most recent software updates that are necessary. Because this is a classroom environment, we may use software that does not include the latest updates.

Scenario

To simplify network administration, your organization has decided to implement automatic IP addressing by using DHCP. Before configuring client computers to obtain IP addresses automatically, you need to create a DHCP server by installing the DHCP Server service on a computer running Windows 2000 Server. You also need to authorize the server to assign IP addresses before clients can obtain IP addresses from it.

Estimated time to complete this lab: 15 minutes

Exercise 1

Installing and Authorizing the DHCP Server Service

Scenario

You want client computers to receive IP configuration information automatically from a DHCP server.

Goal

Install the DHCP Server service, and then add the DHCP server to the list of authorized servers for the network.

Tasks	Detailed Steps
1. Install the DHCP Server service.	- Log on as administrator@domain.nwtraders.msft (where <i>domain</i> is the name of your domain) with a password of password. - In Control Panel, double-click Add/Remove Programs. - In Add/Remove Programs, click Add/Remove Windows Components.
i Note: In the next detailed step, click the text Networking Services rather than the check box to avoid selecting all options under Networking Services .	
1. (continued)	- In the Windows Components wizard, on the Windows Components page, click Networking Services, and then click Details. - In the Networking Services dialog box, select the Dynamic Host Configuration Protocol (DHCP) check box, and then click OK. - On the Windows Components page, click Next. - If the Files Needed dialog box appears, type \\London\Setup\Winsrc and then click OK. - When the configuration is complete, click Finish, and then close all open windows.

(continued)

Tasks	Detailed Steps
2. Add the DHCP server to the list of authorized servers for the network.	a. Click Start, point to Programs, point to Administrative Tools, right-click DHCP, and then click Run as. b. In the Run As Other User dialog box, in the User name box, type eadmin@nwtraders.msft c. In the Password box, type password d. Delete the contents of the Domain box, and then click OK.
 Why must you authorize the service by using an account other than the administrator account for your domain? To authorize a DHCP server, you must use a user account that is a member of the Enterprise Admins group in the root domain for your forest. By using the Run as command and specifying the Eadmin user account to start the DHCP console, you specified an account that was in this group.	
2. <i>(continued)</i>	e. In the console tree of DHCP, right-click DHCP, and then click Manage authorized servers. f. In the Manage Authorized Servers dialog box, click Authorize. g. In the Authorize DHCP Server dialog box, type the IP address of your Classroom network connection, and then click OK. h. In the DHCP message box, verify the name and address of the server that you want to add to the authorized list, and then click Yes. i. Click Close to close the Manage Authorized Servers dialog box.
 Note: The authorization may take a few minutes, depending on the speed at which information replicates across the network. When authorization is complete, the server icon in the console tree will appear with a green arrow when you click it. You do not need to wait for the authorization to complete this lab.	
2. <i>(continued)</i>	j. Close all windows, and then log off.

◆ Creating and Configuring a Scope

Topic Objective

To introduce topics related to creating and configuring a DHCP scope.

Lead-in

Before you can use DHCP to issue IP addresses to client computers, you must create a scope.

- Overview of Scopes
- Using The New Scope Wizard
- Configuring a Scope with Options
- Customizing the Use of Scope Options
- Reserving IP Addresses for Client Computers

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Delivery Tip

Emphasize that a scope is a range of valid IP addresses for lease or assignment to client computers.

Provide examples of the types of information that you can configure a DHCP server to provide in addition to IP address leases.

To enable dynamic IP addressing, you must enter a range of valid IP addresses that the DHCP server can use to issue leases to clients. You perform this task after you install the DHCP service and authorize the DHCP server on the network.

Understanding how to create and configure this IP address pool allows you to configure DHCP clients automatically with IP addressing information and to minimize the administrative overhead associated with maintaining that information.

Note You can use the **netsh** command to configure DHCP from a command prompt or to script DHCP commands for automatic DHCP configuration.

For more information about how to use the **netsh** command for DHCP administration, see “Use DHCP Command-line Tools” in Windows 2000 Help.

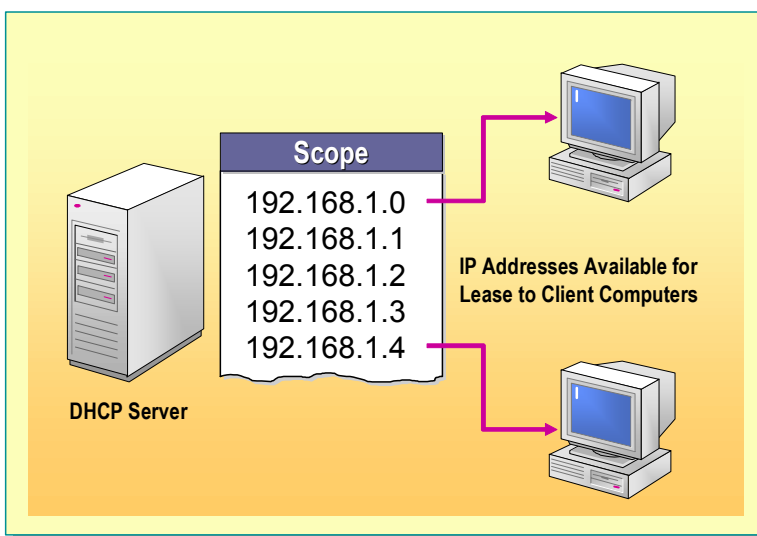
Overview of Scopes

Topic Objective

To introduce a DHCP Scope and to explain what it is used for.

Lead-in

A scope is a range of valid IP addresses available for lease to clients.



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Delivery Tip

Emphasize that a scope is a range of valid IP addresses for lease or assignment to client computers.

Provide examples of the types of information that you can configure a DHCP server to provide in addition to IP address leases.

A *scope* is a range of valid IP addresses that are available for lease or assignment to client computers on a particular subnet. You configure a scope on the DHCP server to determine the pool of IP addresses that the server can assign to DHCP clients.

Scope Options

You also configure a scope with options so that the DHCP server can provide additional information with an IP address lease. For example, you can configure a scope to provide the default gateway to client computers. This variable information is called a *scope option*.

DHCP applies scope options to client computers in a specific order. As a result, you can define DHCP-assigned options with varying levels of authority so that certain options take precedence over other options.

Client Reservations

You can also configure a scope so that the DHCP server always provides the same IP address to a particular computer. For example, you can reserve an IP address for a computer that requires a permanent IP address, such as a DNS server, because other computers are configured to connect to it by using its IP address. These permanent IP address assignments are called *client reservations*.

Using the New Scope Wizard

Topic Objective

To introduce the information that you specify to create a scope by using the New Scope wizard.

Lead-in

In Windows 2000, you create new scopes by using the New Scope wizard.

You use the New Scope Wizard to:

- Configure scope parameters
- Change the default lease duration
- Activate a scope

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In Windows 2000, you create a scope by using the New Scope wizard. To start the New Scope wizard, open DHCP from the **Administrative Tools** menu, right-click the name of the DHCP server on which you want to create the new scope, and then click **New Scope**.

Scope Parameters

The following table describes the parameters that you specify when creating a new scope by using the New Scope wizard.

Parameter	Description
Name	The name of the scope.
Description	An optional description of the scope to help you keep track of the purpose of the scope.
Start IP address and End IP address	Specify the range of addresses that the DHCP server can assign from this scope. To prevent problems with duplicate IP addressing, do not use the same IP addresses in more than one scope.
Length or Subnet mask	The subnet mask to assign to DHCP clients. To configure this parameter, enter the number of bits that make up the subnet mask, or type the four octets of the subnet mask.

(continued)

Parameter	Description
Exclusion address range <i>(optional)</i>	You can specify one or more ranges to exclude from the scope. Excluded addresses are not assigned to DHCP clients. To avoid duplicate IP addressing, exclude any statically assigned IP addresses on your network, such as computers acting as print servers.
Lease duration	The length of the IP address lease, in number of days, hours, and minutes. The default duration is eight days. To set the lease duration to unlimited, you must configure the scope properties after you create the scope. The wizard does not provide the option to configure an unlimited scope.

Important After you create a scope, you cannot change the subnet mask that the scope assigns. To change this scope information, you must delete the scope and create a new scope with the correct information.

Changing The Default Lease Duration

There are benefits and drawbacks to changing the default lease duration.

Decreasing Lease Duration

When you decrease lease durations, clients obtain leases even if only a few IP addresses are available. In addition, leases expire shortly after computers are turned off or removed from the network, allowing their IP addresses to be assigned to other computers. Clients also obtain newly assigned settings quickly. However, this short lease duration generates more network traffic due to lease renewals, and leases can expire if a DHCP server is temporarily unavailable.

Increasing Lease Duration

Increasing lease durations reduces network traffic caused by lease renewals. In addition, clients tend to retain IP addresses even if a DHCP server is temporarily unavailable. However, if only a few IP addresses are available, client computers may not be able to obtain a lease. In addition, it can take longer for client computers to receive newly assigned settings.

Unlimited Lease Duration

With an unlimited lease duration, DHCP only generates network traffic when a computer is started. Clients retain IP addresses even if a DHCP server is unavailable for extended periods. However, if only a few IP addresses are available, client computers may not be able to obtain a lease. IP addresses used by computers that you have removed from the network do not become available to other clients unless you manually remove the lease. Finally, clients only receive newly assigned settings when you restart the client computers or manually renew the lease.

Activating A Scope

After you create a scope, you must activate it to make it available for lease assignments. To activate a scope, in DHCP, right-click the entry for the scope, and then click **Activate**.

Important To ensure that all client computers receive complete configuration information, make sure that before you activate the scope, you set the scope options that you want.

Configuring a Scope with Options

Topic Objective

To introduce the scope options that you can configure for DHCP clients.

Lead-in

The DHCP server can send out a variety of additional information with an IP address.

Scope Options Supported by DHCP Include:

- IP Address of a Router
- IP Address of a DNS Server
- DNS Domain Name
- IP Address of a WINS Server
- Type of NetBIOS over TCP/IP Name Resolution

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You can configure a scope to provide a variety of information along with a DHCP lease. For example, you can configure the DHCP server to issue the address of a router to allow clients to communicate across subnets.

Important The networking software running on the client computer determines whether a client computer recognizes an option that a DHCP server supplies.

Common Scope Options

The New Scope wizard allows you to configure common scope options to provide additional IP addressing configuration information with the client lease. The following table describes the options that you can configure:

Option	Description
Router (Default Gateway)	The addresses of any default gateway, or router, for the scope
Domain name	The DNS domain to which the client computer belongs
DNS and WINS servers	The addresses of any DNS and WINS servers for clients to use for network communication

Scope Options Supported by DHCP

The following list describes the additional scope options supported by DHCP clients running Microsoft operating systems. You can use any of these options if clients require additional information for proper network operations.

Delivery Tip

In DHCP, expand the entry for the DHCP server, right-click **Server Options**, and then click **Configure Options** to display the list of options.

- *The IP address of a router.* To issue this information, configure the **003 Router** option with the IP address of a default router. This router is commonly referred to as the default gateway.
- *The IP address of one or more DNS name servers available to clients.* To issue this information, configure the **006 DNS Servers** option with the IP address of one or more DNS servers.
- *The DNS domain name.* A DNS domain name defines the domain to which a client computer belongs. The client computer can use this information to update a DNS server so that other computers can locate the client. To issue this information, configure the **015 DNS Domain Name** option with the proper DNS domain name.
- *The IP address of one or more WINS servers available to clients.* The client uses a WINS server for network basic input/output system (NetBIOS) name resolution. To issue this parameter, configure the **044 WINS/NBNS Servers** option with the IP address of one or more WINS servers.
- *The type of NetBIOS over TCP/IP name resolution.* To issue this information, configure the **046 WINS/NBT node type** option with the appropriate NetBIOS node type. The type of name resolution determines the order in which a client uses NetBIOS name servers and broadcasts to resolve NetBIOS names to IP addresses.

Note For information about NetBIOS node types, see RFCs 1001 and 1002 under **Additional Reading** on the Student Materials compact disc.

A complete list of the standard options that DHCP supports is currently defined in RFC 2132 on the Student Materials compact disc. However, most DHCP clients can accept only a few of the full set of standard, defined option types.

Configuring Additional Scope Options

To configure a scope with additional options:

1. Open DHCP from the **Administrative Tools** menu.
2. In the console tree, click the name of the DHCP server on which you want to configure additional scope options, and then wait for the server status to update.
3. In the console tree, expand the DHCP server, expand the scope entry, click **Scope Options**, right-click **Scope Options**, and then click **Configure Options**.
4. In the **Scope Options** dialog box, on the **General** tab, in the **Available Options** box, select the check box to the left of the option that you want.
5. In the **Data entry** box, specify the appropriate configuration information for the option.

Delivery Tip

Demonstrate how to configure a scope with additional options.

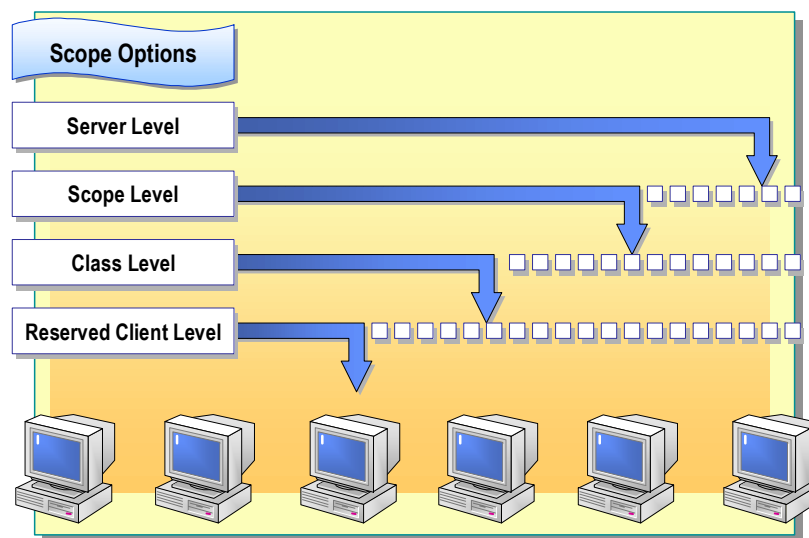
Customizing the Use of Scope Options

Topic Objective

To introduce the levels at which you can configure scope options.

Lead-in

You can configure scope options so that selected options apply to all DHCP clients, whereas other options apply only to a group of clients or even to a single client.



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You can configure scope options so that they apply to all DHCP clients, to a group of clients, or to a single client. You can configure scope options at four levels: server, scope, class, and reserved client.

Note TCP/IP properties that are specified on the client computer take precedence over any information that a DHCP server provides.

Server Level

Server-level options apply to all DHCP clients that lease an IP address from the DHCP server. You should configure options at the server level if all clients on all subnets require the same configuration information. For example, you might want to configure all clients to use the same DNS server or WINS server. To configure options at the server level, in DHCP, expand the server that you are configuring, right-click **Server Options**, and then click **Configure Options**.

Scope Level

Scope-level options are available only to clients that lease an address from that scope. For example, each subnet requires a different scope, and you can define a unique default gateway address for each scope. Options that you configure at the scope level take precedence over options that are configured at the server level. To configure options at the scope level, in DHCP, expand the scope that you are configuring, right-click **Scope Options**, and then click **Configure Options**.

Class Level

Options that you configure at the class level are available only to clients that identify themselves to the DHCP server as belonging to a particular class. For example, client computers running Windows 2000 can receive different options than all other clients on a network. Options that you configure at the class level take precedence over options that you configure at either the scope or server level. To configure options at the class level, in the **Server Options** or **Scope Options** dialog box, on the **Advanced** tab, select the vendor class or user class, and then under **Available Options**, configure the appropriate options.

Reserved Client Level

Options that you configure at the reserved client level apply to specific clients. For example, you can configure an option at the reserved client level so that a particular DHCP client uses a specific router to access resources outside its subnet. Options that you configure at the reserved client level take precedence over options that you configure at any other level. To configure options at the reserved client level, in DHCP, expand the scope that contains the client's address, click **Reservations**, right-click the entry for the client, and then click **Configure Options**.

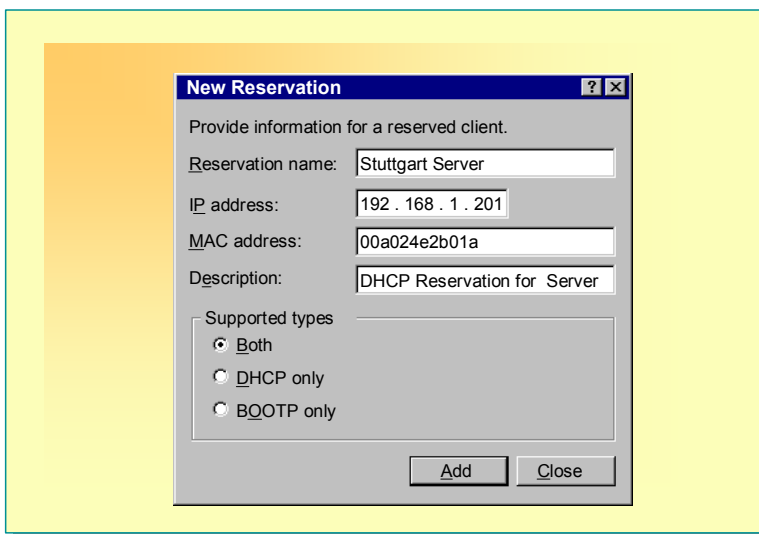
Reserving IP Addresses for Client Computers

Topic Objective

To introduce the interface for reserving an IP address for a client.

Lead-in

You can configure a DHCP server so that it always assigns the same IP address to the same client.



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Delivery Tip

Demonstrate how to verify a client's hardware address.

Demonstrate the steps to configure a client reservation.

You configure a client reservation to reserve a specific IP address for use by a DHCP client computer so that the client computer always has the same address. For example, the ability to configure a client reservation is useful if you have an application that authenticates a user by IP address.

Note If your network structure allows a client to receive an IP address from multiple DHCP servers, you must configure a client reservation at each of the servers. This prevents the client from obtaining different IP addressing information, depending on which DHCP server responds to the lease request.

To configure a client reservation:

1. Open DHCP from the **Administrative Tools** menu.
2. In the console tree, expand the server that you are configuring, expand the scope where you want to add a reservation, and then click **Reservations**.
3. Right-click **Reservations**, and then click **New Reservation**.
4. In the **New Reservation** dialog box, in the **Reservation name** box, type a name to identify the client.
The name associates the hardware address of the network adapter to a client.
5. In the **IP address** box, type the IP address that you want to reserve for a specific client.

Key Points

Clarify that MAC addresses and physical addresses are the same.

6. In the **MAC address** box, type the hardware address (MAC address) of the host's network adapter. Do not use dashes in the hardware address.

Important Type the hardware address carefully. If you type a value in the **MAC Address** box incorrectly, it will not match the value that the DHCP client sends, and the DHCP server will assign to the client any available IP address instead of the IP address that is reserved for that client.

7. In the **Comment** box, type an optional comment for the client.
8. Under **Supported types**, click which method the client uses, and then click **Add**. Some older client computers that are running a non-Microsoft operating system may use the older BOOTP instead of DHCP. Also, Windows 2000 Remote Installation Services (RIS) clients use the BOOTP protocol when they initialize. Click **Both**, unless you want the client computers to be able to use only a specific protocol to receive an IP address.

Lab B: Configuring a DHCP Scope

Topic Objective

To introduce the lab.

Lead-in

In this lab, you will create and configure a DHCP scope.



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Explain the lab objectives.

Objectives

After completing this lab, you will be able to:

- Create a DHCP scope.
- Configure DHCP scope options.
- Configure a DHCP reservation.

Prerequisites

Before working on this lab, you must have:

- Knowledge about DHCP scope options.
- Knowledge about DHCP reservations.
- Experience configuring network properties.

Lab Setup

To complete this lab, you need the following:

- A computer running Windows 2000 Advanced Server that is configured as a domain controller in a child domain of the nwtraders.msft domain, has a static IP address, and uses the instructor computer for DNS name resolution.
- A partner with a similarly configured computer.

Important One computer will be the DHCP server and the other will be the DHCP client. The computer of the student with the lower student number will act as the DHCP server; the computer of the student with the higher student number will act as the DHCP client. Determine the role that your computer will perform before starting the lab.

Scenario

You have installed and authorized a DHCP server on your network. Next, you want to configure a scope to test the service and to make sure that it is operating properly before putting the server into production.

Estimated time to complete this lab: 30 minutes

Exercise 1

Creating, Configuring, and Assigning a Scope

Scenario

You must configure a DHCP scope that has addresses that are valid for the network segment to which the DHCP server is attached. You must configure this scope to provide network configuration information to DHCP client computers.

Goal

The partner on the DHCP server will create a scope; exclude some of the addresses in the scope; and then configure the scope to provide a gateway, the IP address of a DNS server, and the IP address of a WINS server.

The partner on the DHCP client will record the hardware address of his or her network adapter, and then configure his or her TCP/IP properties to receive an IP address from a DHCP server.

Tasks	Detailed Steps
 Perform the following procedure only on the computer designated as the DHCP server.	
1. Create a scope for the IP address range 192.168.x.1 to 192.168.x.254 (where <i>x</i> is the third octet of the partner network's IP address). Use the scope name <i>server</i> (where <i>server</i> is the name of your computer). Exclude the first 50 and last two IP addresses of the scope, and configure the following optional information: Gateway: 192.168.x.254 DNS server: 192.168.x.254 WINS server: 192.168.x.254 (where <i>x</i> is the third octet of the partner network's IP address)	a. Log on as administrator@domain.nwtraders.msft (where <i>domain</i> is the name of your domain) with a password of password. b. Open DHCP from the Administrative Tools menu. c. In the console tree, click <i>server</i> (where <i>server</i> is the name of your computer), right-click <i>server</i>, and then click New Scope. d. In the New Scope wizard, click Next. e. On the Scope Name page, in the Name box, type <i>server</i> (where <i>server</i> is the name of your computer), and then click Next. f. On the IP Address Range page, in the Start IP address box, type 192.168.x.1 (where <i>x</i> is the third octet of the IP address of the PartnerNet connection). g. In the End IP address box, type 192.168.x.254 (where <i>x</i> is the third octet of the IP address of the PartnerNet connection).  <i>The wizard automatically fills in the correct length of the subnet mask and the IP address of the subnet mask.</i> h. Click Next. i. On the Add Exclusions page, in the Start IP address box, type 192.168.x.1 and in the End IP address box, type 192.168.x.50 (where <i>x</i> is the third octet of the IP address of the PartnerNet connection), and then click Add. j. Repeat the preceding step to exclude the address range 192.168.x.253 to 192.168.x.254 (where <i>x</i> is the third octet of the IP address of the PartnerNet connection), click Add, and then click Next. k. On the Lease Duration page, read the description of the lease duration, and then click Next.

Tasks	Detailed Steps
1. <i>(continued)</i>	l. On the Configure DHCP Options page, verify that Yes, I want to configure these options now is selected, and then click Next. m. On the Router (Default Gateway) page, in the IP address box, type 192.168.x.254 (where <i>x</i> is the third octet of the IP address of the PartnerNet connection), click Add, and then click Next. n. On the Domain Name and DNS Servers page, in the IP address box, type 192.168.x.254 (where <i>x</i> is the third octet of the IP address of the PartnerNet connection), click Add, and then click Next. o. On the WINS Servers page, in the IP address box, type 192.168.x.254 (where <i>x</i> is the third octet of the IP address of the PartnerNet connection), click Add, and then click Next. p. On the Activate Scope page, verify that Yes, I want to activate this scope now is selected, and then click Next. q. On the Completing the Create Scope Wizard page, click Finish.  <i>DHCP displays the scope that you created.</i>
	Note: If the DHCP server authorization information has been replicated to your computer, the server icon in the console tree appears with a green arrow when you click it. You do not need to wait for the authorization information to display correctly to complete this lab.
	Perform the following procedure only on the computer designated as the DHCP server.
2. Confirm that the wizard created the scope options correctly, and then add 192.168.x.255 (where <i>x</i> is the third octet of the partner network's IP address) as a secondary DNS server.	a. In the console tree, expand the scope that you created, and then click Scope Options. b. In the details pane, right-click 006 DNS Servers, and then click Properties. c. In the Scope Options dialog box, in the IP address box, type 192.168.x.255 (where <i>x</i> is the third octet of the IP address of the PartnerNet connection), and then click Add. d. Click OK to close the Scope Options dialog box.
	Perform the following procedure only on the computer that is designated as the DHCP client.

(continued)

Tasks	Detailed Steps
3. Configure your computer to obtain an IP address automatically.	a. Log on as administrator@domain.nwtraders.msft (where <i>domain</i> is the name of your domain) with a password of password. b. At a command prompt, type ipconfig /all and then press ENTER.  <i>Ipconfig displays the IP address settings for all network adapters in your computer. Notice that one local area connection is named Classroom, and that the other local area connection is named PartnerNet.</i> c. Record the IP address of the PartnerNet connection. d. Record the DNS server address of the PartnerNet connection. e. Minimize the command prompt window. f. Right-click My Network Places, and then click Properties. g. Open the Properties dialog box for the PartnerNet connection. h. In the PartnerNet Properties dialog box, click Internet Protocol (TCP/IP), but do not clear the check mark next to the option. i. Click Properties. j. In the Internet Protocol (TCP/IP) dialog box, click Obtain an IP address automatically. k. Click Obtain DNS server address automatically, and then click OK. l. Click OK to close the Properties dialog box for the PartnerNet connection. m. Restore the command prompt window. n. At the command prompt, type ipconfig /release and then press ENTER. o. Type ipconfig /renew and then press ENTER. p. Verify that Windows 2000 assigned an address from your partner's DHCP scope to the network adapter that you configured to automatically obtain an IP address. Also confirm that Windows 2000 assigned all of the scope options that your partner configured in the preceding exercise.

Exercise 2

Creating and Testing a Client Reservation

Scenario

One of the servers on your network runs an application that authenticates connections by using the IP address of the computer from which the connection originates. A client computer that connects to this server receives its TCP/IP configuration information from a DHCP server. You must configure a client reservation so that this client computer receives the same IP address each time that it requests an address from the DHCP server.

Goal

In this exercise, you will create a client reservation for a client computer that requires a specific IP address and then test the address assignment.

Tasks	Detailed Steps
 Perform the following procedure only on the computer that is designated as the DHCP client.	
1. Record the MAC address of your computer.	a. At a command prompt, type ipconfig /all and then press ENTER. b. Record the physical address for the Ethernet adapter PartnerNet .
 Perform the following procedure only on the computer designated as the DHCP server.	
2. Configure DHCP to assign the IP address 192.168.x.200 to your partner's computer (where <i>x</i> is the third octet of the IP address of the PartnerNet connection).	a. In DHCP, in the console tree, under the scope that you created in the preceding exercise, click Reservations . b. Right-click Reservations , and then click New Reservation . c. In the New Reservation dialog box, in the Reservation name box, type <i>partner_server</i> (where <i>partner_server</i> is the name of your partner's computer). d. In the IP address box, type 192.168.x.200 (where <i>x</i> is the third octet of the IP address of the PartnerNet connection). e. In the MAC address box, type the address of your partner's network adapter (which your partner recorded in the previous task), without the dashes. For example, for the physical address 00-aa-00-4b-ad-14, type 00aa004bad14 . f. Click Add , and then click Close . g. Close DHCP.
 Perform the following procedure on only the computer that is designated as the DHCP client.	

(continued)

Tasks	Detailed Steps
3. Obtain a new IP address and confirm that the DHCP server assigned the IP address 192.168.x.200 to your computer.	a. At a command prompt, type ipconfig /release and then press ENTER. b. Type ipconfig /renew and then press ENTER. c. Confirm that Windows 2000 assigned the IP address 192.168.x.200 to your computer. d. Close the command prompt window.
4. Configure your computer to use the static IP address that you recorded in the first exercise.	a. Right-click My Network Places, and then click Properties. b. In Network and Dial-up Connections, right-click PartnerNet, and then click Properties. c. In the PartnerNet Properties dialog box, click Internet Protocol (TCP/IP), and then click Properties. d. In the Internet Protocol (TCP/IP) dialog box, click Use the following IP address. e. In the IP address box, type the IP address that you recorded in Exercise 1. f. In the Subnet mask box, type 255.255.255.0. g. Verify that Use the following DNS server addresses is selected, and in the Preferred DNS server box, type the DNS server address that you recorded in Exercise 1, and then click OK. h. Click OK to close the PartnerNet Properties dialog box. i. Close all open windows.

Exercise 3

Removing DHCP

Scenario

After you have tested a DHCP configuration for your organization, you must restore your original configuration.

Goal

In this exercise, you will restore the original computer configuration.

Tasks	Detailed Steps
	Perform the following procedure on both computers. If you intend to complete the “If Time Permits” exercise, perform this procedure after you complete the “If Time Permits” exercise.
1. Remove the DHCP service.	- In Control Panel, double-click Add/Remove Programs. - In Add/Remove Programs, click Add/Remove Windows Components.
	Note: In the next detailed step, click the text Networking Services rather than the check box to avoid selecting all options under Networking Services .
1. <i>(continued)</i>	- In the Windows Components wizard, on the Windows Components page, click Networking Services, and then click Details. - In the Networking Services dialog box, clear the Dynamic Host Configuration Protocol (DHCP) check box, and then click OK. - On the Windows Components page, click Next. - When the configuration process is complete, click Finish. - Close all open windows, and then log off.

If Time Permits

Configuring a Second DHCP Server

Reverse roles with your partner and repeat all of the steps in exercise 1, “Creating, Configuring, and Assigning a Scope,” and exercise 2, “Creating and Testing a Client Reservation,” so that the computer that you configured as a DHCP client the first time that you completed the exercise is now configured as a DHCP server. Complete exercise 3, “Removing DHCP,” after you have completed exercises 1 and 2.

◆ Customizing DHCP Functionality

Objective

To introduce topics associated with customizing DHCP functionality.

Lead-in

By customizing DHCP functionality, you can reduce administrative overhead, automate configuration for select groups of clients, and minimize the number of DHCP servers that are required in a routed network environment.

- **Using Option Classes**
- **Combining Scopes by Using Superscopes**
- **Issuing Multicast Addresses by Using Multicast Scopes**

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By creating option classes, you can customize a DHCP server to issue configuration information to a specific client computer or to a group of client computers. You can also customize DHCP to function in a routed network without having to configure a DHCP server on each physical segment. The Windows 2000 implementation of DHCP also supports superscopes, which combine two or more scopes, and multicast scopes, which issue multicast addresses to DHCP clients.

By customizing DHCP functionality, you can reduce administrative overhead, automate configuration for select groups of clients, and minimize the number of DHCP servers that are required in a routed network environment.

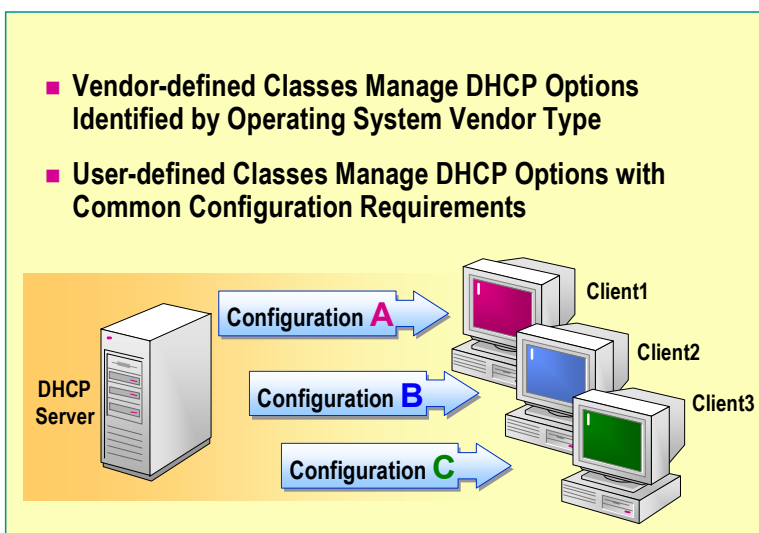
Using Option Classes

Topic Objective

To introduce vendor-defined and user-defined classes.

Lead-in

In Windows 2000, DHCP supports option classes, which you can use to provide unique configurations to client computers.



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You use option classes to provide unique configurations to specific types of client computers. The Windows 2000 implementation of DHCP supports two types of option classes: vendor-defined classes and user-defined classes.

Vendor-defined classes

Vendor-defined classes identify a DHCP client's operating system vendor type and configuration. You can configure vendor-defined classes to manage DHCP options that you want to assign to clients based on the operating system. For example, you can configure a vendor-defined class to provide a custom configuration for computers that are running a specific operating system, such as Windows 98 or Windows 2000 Professional.

DHCP servers and clients use the identifier in the TCP/IP networking software to take advantage of vendor-defined classes. The DHCP server automatically recognizes the identifiers sent by computers running Windows 2000 and Windows 98. You can also define additional vendor identifiers on the DHCP server. Before you configure additional vendor options, you must determine which identifier, if any, a specific vendor uses by contacting the vendor of the client operating system or network software.

User-defined classes

User-defined classes identify a DHCP client by its type. A client *type* refers to characteristics such as a dial-up connection or portable computer. You configure user-defined classes to manage DHCP options that you want to assign to clients that require a common configuration. For example, you can configure a user-defined class to provide a configuration for computers that require Internet access.

User-Defined Identifiers

You assign user-defined options to a client based on an identifier. The client sends this identifier to the DHCP server to identify itself. You need to configure a client computer with a user-defined class identifier before it will send this identifier to a DHCP server.

Note For a comparison of vendor-defined classes and user-defined classes, see the topic “Understanding User and Vendor Classes” in Windows 2000 Help.

Configuring Clients to Use the User Class

To configure a client computer that is running Windows 2000 to identify itself to a DHCP server by using a user class:

1. At a command prompt, type **ipconfig /setclassid class** (where *class* is the unique identifier of the user class).
2. Type **ipconfig /showclassid** to confirm that the user class was configured correctly.

Note You can type **ipconfig /?** at a command prompt to learn more about how to configure user-defined identifier options.

Creating a New Vendor or User Class

To create a new vendor or user class:

1. Open DHCP from the **Administrative Tools** menu.
2. In the console tree, right-click the DHCP server on which you want to create a new class, and then, to create a new vendor class, click **Define Vendor Classes**. To create a new user class, click **Define User Classes**.
3. In the **DHCP Vendor Classes** or **DHCP User Classes** dialog box, click **Add**.
4. In the **New Class** dialog box, type a display name, an optional description and an identifier that uniquely identifies the class.

After you have created a new vendor or user class, you can assign DHCP options to the class. These options are sent to clients that identify themselves by using the class ID.

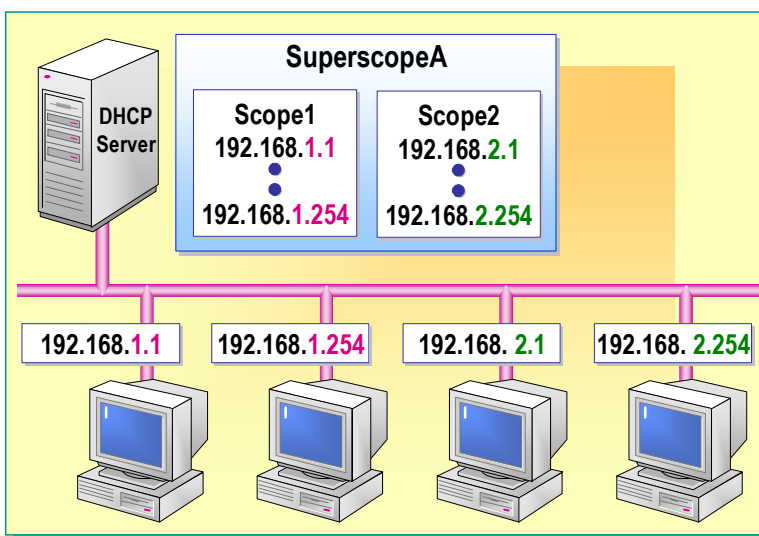
Combining Scopes by Using Superscopes

Topic Objective

To illustrate the function of a superscope.

Lead-in

You use superscopes to provide IP addresses from multiple logical subnets to DHCP clients on a single physical subnet.



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A *superscope* is a group of two or more scopes that are combined so that you can manage them as a single unit. When you configure a superscope on a DHCP server, that server can issue addresses from any participating scope to clients on the same physical subnet.

Superscopes are helpful in a variety of situations, such as when:

- You need to add more hosts than were originally planned on a subnet.
- You replace existing address ranges with new address ranges.
- The IP addresses that your organization owns are not in a contiguous range.

In each case, configuring a superscope eliminates the need to delete and re-create the existing scopes.

Note A DHCP server treats all included addresses as belonging to the same scope when it assigns addresses. You cannot ensure that certain clients receive an address from one of the included address ranges and not from another.

Delivery Tip

Demonstrate how to configure a superscope.

To create a superscope:

1. Open DHCP from the **Administrative Tools** menu.
2. In the console tree, click the name of the DHCP server for which you want to create a superscope, right-click the name of the DHCP server, and then click **New Superscope**.
3. In the New Superscope wizard, type the superscope name, and then specify two or more existing scopes to include in the superscope.

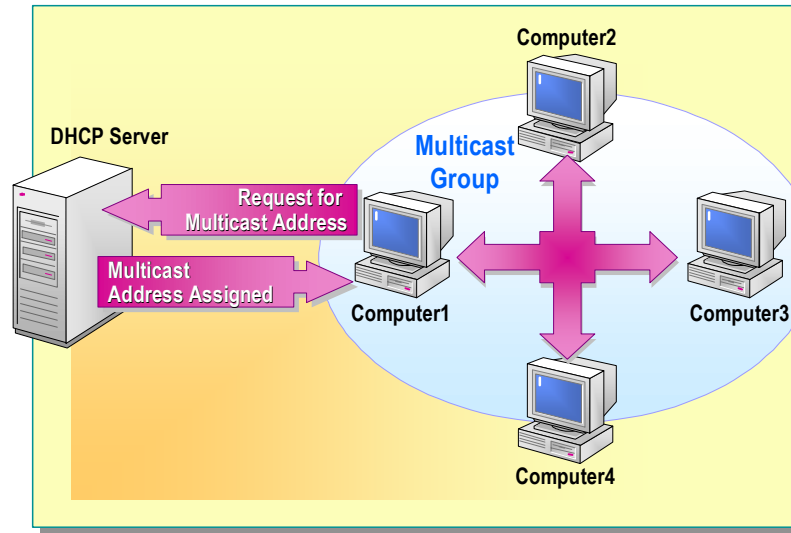
Issuing Multicast Addresses by Using Multicast Scopes

Topic Objective

To illustrate the function of a multicast scope.

Lead-in

DHCP in Windows 2000 supports multicast address assignment, which allows you to take advantage of the existing infrastructure of your network more effectively.



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You use a multicast scope to issue a multicast address to selected computers on a network. When you use DHCP to configure client computers with a multicast address, those clients can participate in collaborative application sessions. Typically, audio and conferencing applications, such as Microsoft Windows Media™, use multicasting technology for deploying information from a single point to multiple computers at one time.

You can configure several computers with the same multicast address in addition to each computer's individual IP address. All computers configured with the same multicast address receive IP packets that are sent to that address. For multicasting to work correctly, all routers between the server that is sending packets to the multicast address and the receiving client computers must be configured to recognize the multicast address.

Configuring a multicast scope to issue a multicast address eliminates the need for users to specify the address manually. To take advantage of dynamic multicast IP addressing, you must configure a multicast scope on a DHCP server, and multicast applications on client computers must be able to use the Multicast Address Dynamic Client Allocation Protocol (MADCAP).

Note For more information about multicast addresses, see RFCs 1112, 2236, and 2730 under **Additional Reading** on the Student Materials compact disc.

Delivery Tip

Demonstrate how to configure a multicast scope. Make sure that students understand that a host can be configured with a multicast address in addition to its regular IP address, and that client applications must be configured to take advantage of dynamically assigned multicast addresses.

To create a multicast scope:

1. Open DHCP from the **Administrative Tools** menu.
2. In the console tree, right-click the name of the DHCP server on which you want to create a multicast scope, and then click **New Multicast Scope**.
3. In the New Multicast Scope wizard, on the **Multicast Scope Name** page, type the name and an optional description of the multicast scope, and then click **Next**.

4. On the **IP Address Range** page, type the start IP address and the end IP address, and then click **Next**.

The range of multicast addresses that you select must be in the range of valid multicast addresses, 224.0.0.0 to 239.255.255.255.

5. Select a Time to Live (TTL), which is the number of routers through which multicast traffic can pass, and then click **Next**.
6. On the **Add Exclusions** page, specify any excluded IP addresses, and then click **Next**.
7. On the **Lease Duration** page, specify the lease duration.
8. On the **Activate Multicast Scope** page, click **Yes**, and then click **Next**.
9. On the **Completing the New Multicast Scope Wizard** page, click **Finish**.

Configuring DHCP in a Routed Network

Topic Objective

To introduce the topics related to configuring DHCP in a routed network.

Lead-in

DHCP is a broadcast service, so you need to configure DHCP to function in an environment with multiple subnets.

- Routed Network Configuration Options
- Using a DHCP Relay Agent

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Routers separate subnets in large network environments. One of the functions of a router is to contain broadcast traffic to a given subnet. As a result, routers are typically configured to not forward broadcast messages to other subnets.

However, DHCP is a broadcast-based service. As a result, DHCP communication is limited to a single subnet unless you configure it to work in a routed network environment.

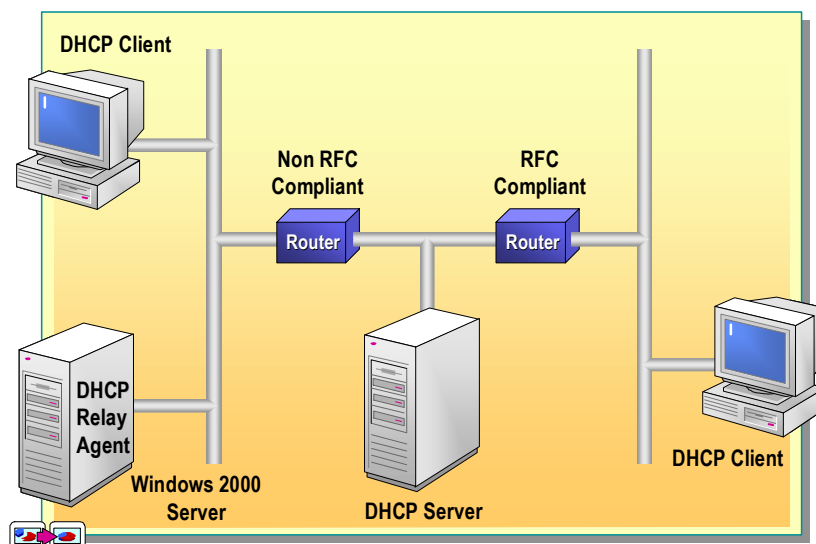
Routed Network Configuration Options

Topic Objective

To define a DHCP relay agent and describe how to enable a computer running Windows 2000 as a DHCP relay agent.

Lead-in

A DHCP relay agent relays DHCP messages between DHCP clients and servers on different IP networks.



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The slide shows two different processes. The left portion of the illustration shows the use of a DHCP relay agent. The right portion of the illustration shows a client contacting a DHCP server through an RFC-compliant router. Be sure to explain each of these examples separately.

You configure DHCP functionality in a routed network in one of three ways:

- *Include at least one DHCP server on each subnet.* This method supplies DHCP functionality to each subnet. However, it requires significant administrative overhead because of the additional equipment and the need to configure scopes on each DHCP server. In addition, you should configure at least two DHCP servers per subnet for fault tolerance. Placing two DHCP servers on each subnet is often too expensive.
- *Configure an RFC 1542-compliant router to forward DHCP messages between subnets.* An RFC 1542-compliant router that is configured for BOOTP forwarding selectively forwards DHCP broadcasts to another subnet, but it does not forward other broadcast messages. Although this option is preferable to using DHCP servers on each subnet, it can complicate router configuration, and DHCP communication across multiple subnets is slow.
- *Configure a DHCP relay agent on each subnet to forward DHCP messages between subnets.* Configuring a DHCP relay agent on each subnet has several advantages over the other options. Configuring a DHCP relay agent is generally easier than configuring other options, and using a DHCP relay agent limits broadcasts to the subnet in which they originate. By adding DHCP relay agent to multiple subnets, a single DHCP server can provide IP addresses to multiple subnets more efficiently than when using RFC 1542-compliant routers. Configuring a DHCP relay agent can also provide fault tolerance.

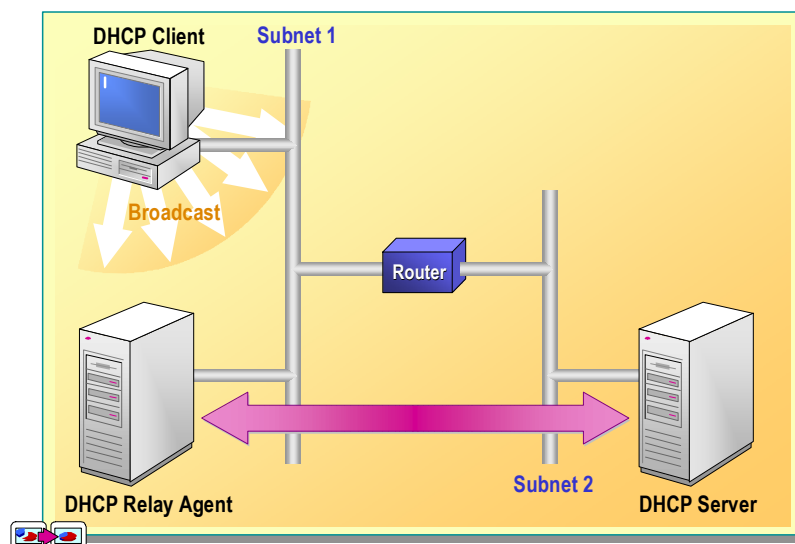
Using a DHCP Relay Agent

Topic Objective

To show how a DHCP relay agent works on a network.

Lead-in

A DHCP relay agent intercepts DHCP client address requests and forwards them to a DHCP server on another subnet.



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On a local subnet, a DHCP relay agent intercepts DHCP client address request broadcast messages and forwards them to a DHCP server on another subnet. The DHCP server responds to the relay agent by using a directed packet. The relay agent then broadcasts the response on the local subnet for use by the requesting client.

Installing a DHCP Relay Agent

To install a DHCP relay agent:

1. Open Routing and Remote Access from the **Administrative Tools** menu.
2. In the console tree, expand the server icon, and then click **IP Routing**.
3. In the details pane, right-click **General**, and then click **New Routing Protocol**.
4. In the **New Routing Protocol** dialog box, click **DHCP Relay Agent**, and then click **OK**.
5. Open the **Properties** dialog box for the DHCP relay agent, in the **Server Address** box, type the IP address of a DHCP server, and then click **Add**.

Configuring a DHCP Relay Agent

Before a DHCP relay agent forwards DHCP requests from clients on any of its network interfaces, you must configure the relay agent to respond to these requests. When enabling relay agent functionality, you can also specify time-out values for a hop count threshold and a boot threshold.

The *hop count threshold* determines the number of subnets on which the packet can exist as a broadcast before being discarded. Setting this number too high can result in excess network traffic when relay agents are incorrectly configured.

The *boot threshold* determines how long the DHCP relay agent will wait for a local DHCP server to respond to client requests before forwarding the request. If you have a DHCP server on the local subnet, this number should be high enough so that the local DHCP server responds to client broadcasts before the DHCP relay agent forwards client requests. Then the DHCP relay agent only contacts a remote DHCP server if the local DHCP server is not available. This mechanism provides for fault tolerance because a correctly configured DHCP relay agent on a network segment with a DHCP server only contacts a DHCP server on a remote network when the local DHCP server does not respond. If you notice that the DHCP relay agent forwards client requests even though there is a DHCP server on the local network, increase the boot threshold.

Important When you configure a DHCP relay agent to provide fault tolerance, the DHCP on the remote network must configure a scope that is valid for the subnet on which the DHCP clients are located. For more information about configuring DHCP for fault tolerance, see “Planning for DHCP” and “DHCP Scenarios” in the Windows 2000 Server Resource Kit.

To configure a DHCP relay agent:

1. Open Routing and Remote Access from the **Administrative Tools** menu.
2. In the console tree, expand the server icon, expand **IP Routing**, and then expand **General**.
3. Right-click **DHCP Relay Agent**, and then click **New Interface**.
4. Click the interface that you want to add, and then click **OK**.
5. In the **DHCP Relay Properties** dialog box, on the **General** tab, verify that the **Relay DHCP packets** check box is selected.
6. If needed, in **Hop-count threshold** and **Boot threshold (seconds)**, click the arrows to modify the thresholds, and then click **OK**.

Note Routing and Remote Access must be enabled to configure a DHCP relay agent. For more information on enabling Routing and Remote Access, see module 7, “Configuring Remote Access,” in course 2153, *Implementing a Microsoft Windows 2000 Network Infrastructure*.

◆ Supporting DHCP

Topic Objective

To introduce topics associated with supporting DHCP.

Lead-in

The DHCP service can be configured to log events, which can then be monitored for errors or potential problems.

- **Monitoring the DHCP Server Service**
- **Troubleshooting DHCP Database Problems**
- **Removing a DHCP Server from Service**

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The DHCP service can be configured to log events on the server. You can then monitor these event logs to look for errors or potential problems. Understanding how to use these event logs will help you support DHCP on your network.

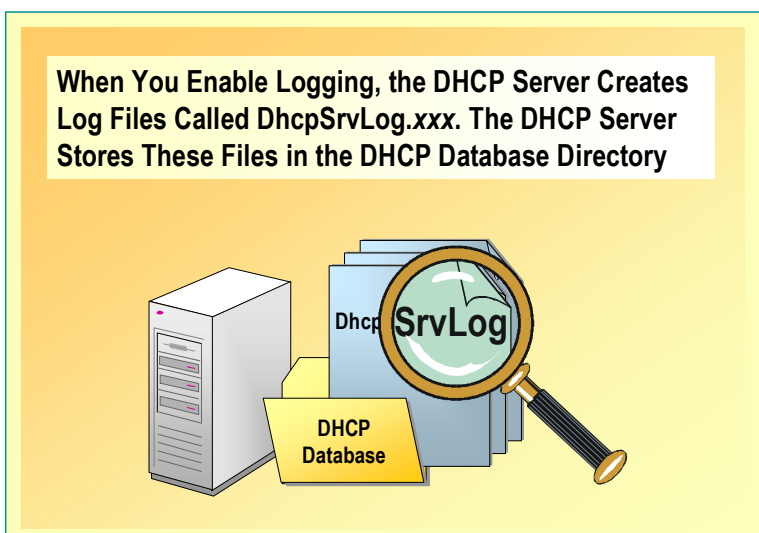
Monitoring the DHCP Service

Topic Objective

To describe the process of monitoring the DHCP service.

Lead-in

It is important to monitor the DHCP service on a regular basis to ensure its smooth operation.



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The DHCP service records service startup and shutdown events in addition to critical errors in the Windows system log. You can monitor the details of DHCP operations by enabling detailed event logging.

When you enable logging, DHCP server creates detailed log files of its activity in files called DhcpSrvLog.xxx (where xxx are the first three letters of the day of the week), which it places in the DHCP database directory. You can review these files to view errors that DHCP server may have encountered.

Important Because of the system overhead of detailed logging, enable this setting only to troubleshoot DHCP.

To enable logging in DHCP:

1. Right-click the server that you are configuring, and then click **Properties**.
2. In the **DHCP Properties** dialog box, on the **General** tab, click **Enable DHCP audit logging**.

Note For more information about DHCP audit logging, see “Audit Logging” in Windows 2000 Help.

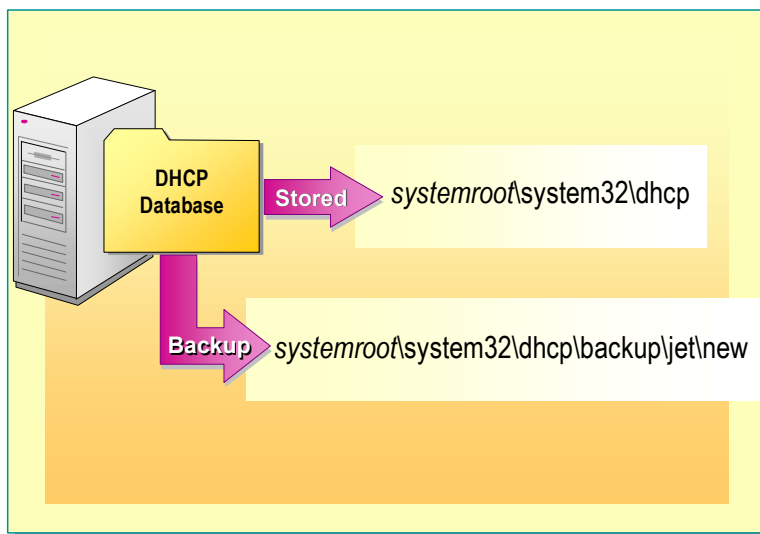
Troubleshooting DHCP Database Problems

Topic Objective

To describe the various methods of repairing and restoring the DHCP database.

Lead-in

If the DHCP database is corrupted, an error message is logged into the Event Log.



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Windows stores the DHCP database in the directory `systemroot\system32\dhcp`. By default, the database is automatically backed up to the `backup\jet\new` directory, which is located in the database directory. When the DHCP service starts, and periodically thereafter, DHCP performs a consistency check of its database and attempts to fix any errors that it encounters.

If the event log contains Jet database messages that indicate a corruption of the DHCP database, you can repair the database by using the Jetpack program that is included with Windows 2000 Server. On busy DHCP servers with large databases, you should also perform this procedure once per month to compact the database thoroughly.

To run the Jetpack program:

1. Stop the DHCP service.
2. At a command prompt, change to the directory where the DHCP database is located (by default `systemroot\system32\dhcp`).
3. Type **jetpack dhcp.mdb temp** (where *temp* is a file name for a temporary database location that is used during repair), and then press ENTER.
4. Start the DHCP service.

Important Before running the Jetpack program, rule out other sources for the errors, such as disk problems, and back up the DHCP database files to a separate location.

If the Jetpack program does not repair the database, you can restore the database from the backup directory. If restoring the DHCP database from these backup files is unsuccessful, you must restore the files from a recent backup tape.

Note For more information about how to force the DHCP server to load the database from the backup directory, see “Restoring Server Data” in Windows 2000 Help.

Removing a DHCP Server from Service

Topic Objective

To describe the method of removing the DHCP server from service.

Lead-in

When you remove a DHCP scope from a server or remove a DHCP server from service, you need to take steps to ensure that clients continue to be able to connect to network resources.

Before Removing a DHCP Server from Service

- Set short lease durations for clients
- Ensure new lease for clients
- Record any reserved addresses
- Large address pool in other DHCP servers
- Transfer IP address to the new scope

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When you remove a DHCP scope from a server or remove a DHCP server from service, you need to take the following steps to ensure that clients continue to be able to connect to network resources:

- *Short lease duration for clients.* To prepare for removing a DHCP scope, set the lease duration for the scope to a short period. This ensures that clients receive only a short lease, which expires soon after the scope is removed.
- *New lease for clients.* Ensure that all clients have received a lease with the new period by waiting until the previous lease period has expired.
- *Record any reserved addresses.* Record any reserved addresses so that you can re-create them on another DHCP server that will assign addresses for the subnet.
- *Sufficiently large address pool on the new DHCP server.* Ensure that another DHCP server that assigns addresses for the subnet has a large enough address pool to assign IP addresses to all clients on the subnet.
- *Transfer IP address to the new scope.* Before allocating any IP addresses of the current scope to another scope, wait until the lease period has expired. This ensures that no DHCP server assigns addresses that are still used by clients that received the address from the scope that you are removing.

Review

Topic Objective

To reinforce module objectives by reviewing key points.

Lead-in

The review questions cover some of the key concepts taught in the module.

- Overview of DHCP
- Requirements for DHCP Servers and Clients
- Installing the DHCP Service
- Authorizing the DHCP Service
- Creating and Configuring a Scope
- Customizing DHCP Functionality
- Supporting DHCP

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1. What are the steps in the DHCP lease process?
 1. A DHCP-enabled client broadcasts a DHCPDISCOVER message to lease an IP address.
 2. All DHCP services respond with a DHCPOFFER message.
 3. The DHCP-enabled client selects an offer from the first DHCP service and sends a DHCPREQUEST message.
 4. The DHCP server responds with a DHCPACK message.

2. What must you configure on a computer running Windows 2000 Server before you can install the DHCP service?

Before you install the DHCP service, you must specify a static IP address, subnet mask address, and if the DHCP server will be assigning IP addresses to clients on multiple subnets; you must also specify a default gateway for the network adapter that is bound to TCP/IP on the computer that is designated as the DHCP server.

3. How does a DHCP server in a Windows 2000 network determine its authorization status and what are the possible results of that determination?

When a DHCP server starts, it queries other DHCP servers for a list of Active Directory root domains in the network. It then queries Active Directory to determine whether it is currently authorized to operate on the network.

If it is authorized, the DHCP service starts properly.

If it is not authorized, the DHCP service logs an error in the system log and will not respond to any client requests.

4. After you create a scope, how can you modify the subnet mask in the scope?

After you create a scope, you cannot change the subnet mask in the scope. To change this information, you must delete and re-create the scope.

5. What types of option classes does Windows 2000 support and how are they different?

Windows 2000 supports two types of option classes: vendor-defined and user-defined. You configure vendor-defined classes to manage DHCP options that are assigned to clients that are identified by vendor type. You configure user-defined classes to manage DHCP options that are assigned to clients that require a common configuration that is not based on vendor type.

6. Your network consists of multiple network segments that are connected by routers. How should you configure the network so that all client computers can receive IP addresses by using DHCP?

Your options are to add a DHCP server to each network segment, to configure your routers to forward DHCP broadcasts, or to configure DHCP relay agents. Configuring DHCP relay agents is often the most efficient solution.