Chapter 10: DHCP

Objectives

- Know how to configure router or L3 switch as DHCP server
- Troubleshooting DHCP Configuration
- Know how to configure DHCP Helper Address
- Know how to configure DHCP Client on a Ethernet Interface

1. Overview

Dynamic Host Configuration Protocol, DHCP provides configuration parameters to Internet hosts. DHCP consists of two components: a protocol for delivering host-specific configuration parameters from a DHCP Server to a host and a mechanism for allocating network addresses to hosts. DHCP is built on a client/server model, where designated DHCP Server hosts allocate network addresses and deliver configuration parameters to dynamically configured hosts. By default, Cisco routers running Cisco IOS software include DHCP server and relay agent software.

DHCP three mechanisms for IP address allocation:

- Automatic allocation—DHCP assigns a permanent IP address to a client.

- Dynamic allocation—DHCP assigns an IP address to a client for a limited period of time (or until the client explicitly relinquishes the address).

- Manual allocation—The network administrator assigns an IP address to a client and DHCP is used simply to convey the assigned address to the client.

The format of DHCP messages is based on the format of Bootstrap Protocol (BOOTP) messages, which ensures support for BOOTP relay agent functionality and interoperability between BOOTP clients and DHCP Servers. BOOTP relay agents eliminate the need for deploying a DHCP Server on each physical network segment. BOOTP is explained in RFC 951, *Bootstrap Protocol (BOOTP)*, and RFC 1542, *Clarifications and Extensions for the Bootstrap Protocol*.

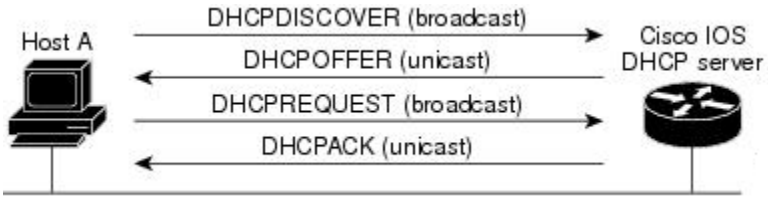
To identify the hardware platform or software image information associated with a feature, use the Feature Navigator on Cisco.com to search for information about the feature or refer to the software release notes for a specific release. For more information, see the "Identifying Supported Platforms" section in the "Using Cisco IOS Software" chapter in this book.

DHCP Server Overview

The Cisco IOS DHCP Server feature is a full DHCP Server implementation that assigns and manages IP addresses from specified address pools within the router to DHCP clients. If the Cisco IOS DHCP Server cannot satisfy a DHCP request from its own database, it can forward the request to one or more secondary DHCP Servers defined by the network administrator.

Figure 14 shows the basic steps that occur when a DHCP client requests an IP address from a DHCP Server. The client, Host A, sends a DHCPDISCOVER broadcast message to locate a Cisco IOS DHCP Server. A DHCP Server offers configuration parameters (such as an IP address, a MAC address, a domain name, and a lease for the IP address) to the client in a DHCPOFFER unicast message.

Figure 14 DHCP Request for an IP Address from a DHCP Server



Note A DHCP client may receive offers from multiple DHCP Servers and can accept any one of the offers; however, the client usually accepts the first offer it receives. Additionally, the offer from the DHCP Server is not a guarantee that the IP address will be allocated to the client; however, the server usually reserves the address until the client has had a chance to formally request the address.

The client returns a formal request for the offered IP address to the DHCP Server in a DHCPREQUEST broadcast message. The DHCP Server confirms that the IP address has been allocated to the client by returning a DHCPACK unicast message to the client.

Note The formal request for the offered IP address (the DHCPREQUEST message) that is sent by the client is broadcast so that all other DHCP Servers that received the DHCPDISCOVER broadcast message from the client can reclaim the IP addresses that they offered to the client.

If the configuration parameters sent to the client in the DHCPOFFER unicast message by the DHCP Server are invalid (a misconfiguration error exists), the client returns a DHCPDECLINE broadcast message to the DHCP Server.

The DHCP Server will send to the client a DHCPNAK denial broadcast message, which means the offered configuration parameters have not been assigned, if an error has occurred during the negotiation of the parameters or the client has been slow in responding to the DHCPOFFER message (the DHCP Server assigned the parameters to another client) of the DHCP Server.

DHCP defines a process by which the DHCP Server knows the IP subnet in which the DHCP client resides, and it can assign an IP address from a pool of valid IP addresses in that subnet.

The DHCP Server identifies which DHCP address pool to use to service a client request as follows:

- If the client is not directly connected (the giaddr field of the DHCPDISCOVER broadcast message is non-zero), the DHCP Server matches the DHCPDISCOVER with a DHCP pool that has the subnet that contains the IP address in the giaddr field.

- If the client is directly connected (the giaddr field is zero), the DHCP Server matches the DHCPDISCOVER with DHCP pool(s) that contain the subnet(s) configured on the receiving interface. If the interface has secondary IP addresses, the subnets associated with the secondary IP addresses are examined for possible allocation only after the subnet associated with the primary IP address (on the interface) is exhausted.

The Cisco IOS DHCP Server feature offers the following benefits:

- Reduced Internet access costs

Using automatic IP address assignment at each remote site substantially reduces Internet access costs. Static IP addresses are considerably more expensive to purchase than are automatically allocated IP addresses.

- Reduced client configuration tasks and cost**s**

Because DHCP is easy to configure, it minimizes operational overhead and costs associated with device configuration tasks and eases deployment by nontechnical users.

- Centralized management

Because the DHCP Server maintains configurations for several subnets, an administrator only needs to update a single, central server when configuration parameters change.

Before you configure the Cisco IOS DHCP Server feature, complete the following tasks:

- Identify an external File Transport Protocol (FTP), Trivial File Transfer Protocol (TFTP), or remote copy protocol (rcp) server that you will use to store the DHCP bindings database.

- Identify the IP addresses that you will enable the DHCP Server to assign, and the IP addresses that you will exclude.

- Identify DHCP options for devices where necessary, including the following:

– Default boot image name

– Default routers

– Domain Name System (DNS) servers

– NetBIOS name server

• Decide on a NetBIOS node type (b, p, m, or h).

• Decide on a DNS domain name.

DHCP Client Overview

The Cisco IOS DHCP client now enables you to obtain an IP address from a DHCP Server dynamically using the DHCP protocol as specified in RFC 2131. In Cisco IOS Release 12.2, only Ethernet interfaces are supported; work is in progress to support all interface types. The Cisco IOS DHCP client offers the following benefits:

• Reduces time to configure and deploy

• Reduces the number of configuration errors

• Enables customers to centrally control the IP address assigned to a Cisco IOS router

DHCP Relay Agent Overview

A DHCP relay agent is any host that forwards DHCP packets between clients and servers. Relay agents are used to forward requests and replies between clients and servers when they are not on the same physical subnet. Relay agent forwarding is distinct from the normal forwarding of an IP router, where IP datagrams are switched between networks somewhat transparently. Relay agents receive DHCP messages and then generate a new DHCP message to send out on another interface.

The Cisco IOS DHCP relay agent supports the use of unnumbered interfaces. The DHCP relay agent automatically adds a static host route specifying the unnumbered interface as the outbound interface.

DHCP Configuration Task List

The DHCP Server database is organized as a tree. The root of the tree is the address pool for natural networks, branches are subnetwork address pools, and leaves are manual bindings to clients. Subnetworks inherit network parameters and clients inherit subnetwork parameters. Therefore, common parameters, for example the domain name, should be configured at the highest (network or subnetwork) level of the tree.

Note Inherited parameters can be overridden. For example, if a parameter is defined in both the natural network and a subnetwork, the definition of the subnetwork is used.

Address leases are not inherited. If a lease is not specified for an IP address, by default, the DHCP Server assigns a one-day lease for the address.

To configure the Cisco IOS DHCP Server feature, perform the tasks described in the following sections. First configure a database agent or disable conflict logging, then specify IP addresses that the DHCP Server should not assign (excluded addresses) and should assign (a pool of available IP addresses) to requesting clients. The tasks in the first three sections are required.

- Configuring a DHCP Database Agent or Disabling DHCP Conflict Logging (Required)
- Excluding IP Addresses (Required)
- Configuring a DHCP Address Pool (Required)

If you want to configure Dynamic Host Configuration Protocol (DHCP) on PC clients, you currently have multiple options to choose for your DHCP server. One of the more common ways to accomplish this is by using a Windows or Linux server. However, most home networks get DHCP from their DSL or cable router.

Many administrators forget—or don't even realize—that DHCP is also available on Cisco IOS routers and switches. Keep in mind that DHCP is only available on newer IOS-based switches. For example, Catalyst 3550 and 3750 offer DHCP.

2. Deciding if this is right for your organization

Using a router as a DHCP server has its pros and cons. For example, let's say you have a multisite network, and you've decided to use your routers as DHCP servers for each network.

One benefit of running DHCP on a routers is that it doesn't require any extra hardware (like a Windows server does). In addition, running DHCP on a router can save your organization the cost of a dedicated DHCP server. It also provides DHCP locally at each site—regardless of whether the WAN is operational.

But there are some drawbacks. For example, some administrators might not be too comfortable monitoring and troubleshooting DHCP from a router; they may prefer to use Windows DHCP Manager rather than Cisco IOS commands to check the status of client leases, manually terminate a DHCP lease, or assign a static reservation.

In addition, some administrators might prefer implementing a centralized DHCP server in order to have one place to monitor and troubleshoot DHCP.

Of course, every IT shop is different, with varying skill sets, comfort levels, and budgets. Depending on your organization's needs, Cisco IOS DHCP could be the perfect fit for your network.

3. Configuring Router or an L3 Switch as DHCP Server

Let's look at how to configure basic DHCP on an IOS-based router. For this example, we'll start off with the default configuration on a Cisco 2611 router. (The configuration should be the same—or very similar—on all IOS-based routers).

To begin, connect the router's Ethernet port to a switch, and connect the switch to a laptop, which will serve as the DHCP client.

To configure Cisco IOS DHCP, follow these steps, which include sample commands:

1. Configure an IP address on the router's Ethernet port, and bring up the interface. (On an existing router, you would have already done this.)

```
Router(config)# interface ethernet0/0

Router(config-if)#ip address 1.1.1.1 255.0.0.0

Router(config-if)# no shutdown
```

2. Create a DHCP IP address pool for the IP addresses you want to use.

```
Router(config)# ip dhcp pool mypool
```

3. Specify the network and subnet for the addresses you want to use from the pool.

```
Router(dhcp-config)# network 1.1.1.0 /8
```

4. Specify the DNS domain name for the clients.

```
Router(dhcp-config)#domain-name mydomain.com
```

5. Specify the primary and secondary DNS servers.

```
Router(dhcp-config)#dns-server 1.1.1.10 1.1.1.11
```

6. Specify the default router (i.e., default gateway).

```
Router(dhcp-config)#default-router 1.1.1.1
```

7. Specify the lease duration for the addresses you're using from the pool.

```
Router(dhcp-config)#lease 7
```

8. Exit Pool Configuration Mode.

```
Router(dhcp-config)#exit
```

This takes you back to the global configuration prompt. Next, exclude any addresses in the pool range that you don't want to hand out.

For example, let's say that you've decided that all IP addresses up to .100 will be for static IP devices such as servers and printers. All IP addresses above .100 will be available in the pool for DHCP clients.

Here's an example of how to exclude IP addresses .100 and below:

```
Router(config)#ip dhcp excluded-address 1.1.1.0 1.1.1.100
```

Next, enter the *ipconfig /renew* command on the laptop to receive an IP address. After you have the IP address, enter the *ipconfig /all* command.

4. Verifying and Troubleshooting DHCP Configuration

`Router#show ip dhcp binding`	Displays a list of all bindings created.
`Router#show ip dhcp binding` *w . x . y . z*	Displays the bindings for a specific DHCP client with an IP address of *w.x.y.z*.
`Router#clear ip dhcp binding` *a . b . c . d*	Clears an automatic address binding from the DHCP server database.
`Router#clear ip dhcp binding *`	Clears all automatic DHCP bindings.
`Router#show ip dhcp conflict`	Displays a list of all address conflicts recorded by the DHCP server.
`Router#clear ip dhcp conflict` *a.b.c.d*	Clears address conflict from the database.
`Router#clear ip dhcp conflict *`	Clears conflicts for all addresses.
`Router#show ip dhcp database`	Displays recent activity on the DHCP database.
`Router#show ip dhcp server statistics`	Displays a list of the number of messages sent and received by the DHCP server.
`Router#clear ip dhcp server statistics`	Resets all DHCP server counters to 0.
`Router#debug ip dhcp server {events | packets | linkage | class }`	Displays the DHCP process of addresses being leased and returned.

5. Configuring a DHCP Helper Address

For the SVI line state to be up, at least one port in the VLAN must be up and forwarding. The **switchport auto-state exclude** command excludes a port from the SVI interface line-state up-or-down calculation.

Router

`Router(config)#interface fastethernet 0/0`	Moves to interface configuration mode.
`Router(config-if)#ip helper-address 172.16.20.2`	DHCP broadcasts will be forwarded as a unicast to this specific address rather than be dropped by the router.

Layer 3 Switch

`Switch(config)#interface vlan 10`	Moves to SVI configuration mode.
`Switch(config-if)#ip helper-address 172.16.20.2`	DHCP broadcasts will be forwarded as a unicast to this specific address rather than be dropped by the router.

The **ip helper-address** command forwards broadcast packets as a unicast to eight different UDP ports by default:

- TFTP (port 69)
- DNS (port 53)

- Time service (port 37)
- NetBIOS name server (port 137)
- NetBIOS datagram server (port 138)
- Boot Protocol (BOOTP) client and server datagrams (ports 67 and 68)
- TACACS service (port 49)
- Host Name Service (port 42)

To close some of these ports, use the **no ip forward-protocol udp** *x* command at the global configuration prompt, where *x* is the port number you want to close. The following command stops the forwarding of broadcasts to port 49:

```
Router(config)#no ip forward-protocol udp 49
```

To open other UDP ports, use the **ip forward-helper udp** *x* command, where *x* is the port number you want to open:

```
Router(config)#ip forward-protocol udp 517
```

6. DHCP Client on a Cisco IOS Software Ethernet Interface

`Router(config)#interface fastethernet 0/0`	Moves to interface configuration mode.
`Router(config-if)#ip address dhcp`	Specifies that the interface acquire an IP address through DHCP. **NOTE:** The **ip address dhcp** command can also be applied on an L3 switch at the SVI as well as any port where the **no switchport** command has been used.

References:

Data Communications and Networking 2 (Cisco 2)

- http://www.ciscopress.com/articles/article.asp?p=1574301&seqNum=5