IP Addressing: DHCP Configuration Guide, Cisco IOS Release 15M&T

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CHAPTER 1

DHCP Overview

The Dynamic Host Configuration Protocol (DHCP) is based on the Bootstrap Protocol (BOOTP), which provides the framework for passing configuration information to hosts on a TCP/IP network. DHCP adds the capability to automatically allocate reusable network addresses and configuration options 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.

This module describes the concepts needed to understand Cisco IOS XE DHCP.

Information About DHCP

DHCP Overview

Cisco routers running Cisco IOS XE software include Dynamic Host Control Protocol (DHCP) server and relay agent software. The Cisco IOS XE DHCP server is a full DHCP server implementation that assigns and manages IP addresses from specified address pools within the router to DHCP clients. These address pools can also be configured to supply additional information to the requesting client such as the IP address of the DNS server, the default router, and other configuration parameters. If the Cisco IOS XE 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.

DHCP supports 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, which is called a lease (or until the client explicitly relinquishes the address). DHCP also supports on-demand address pools (ODAPs), which is a feature in which pools of IP addresses can be dynamically increased or

reduced in size depending on the address utilization level. ODAPs support address assignment for customers using private addresses.

- 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 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*.

The main advantage of DHCP compared to BOOTP is that DHCP does not require that the DHCP server be configured with all MAC addresses of all clients. 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. Most of the other information that DHCP might supply, such as the default router IP address, is the same for all hosts in the subnet so DHCP servers can usually configure information per subnet rather than per host. This functionality reduces network administration tasks compared to BOOTP.

Benefits of Using Cisco IOS DHCP

The Cisco IOS DHCP implementation 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 costs

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.

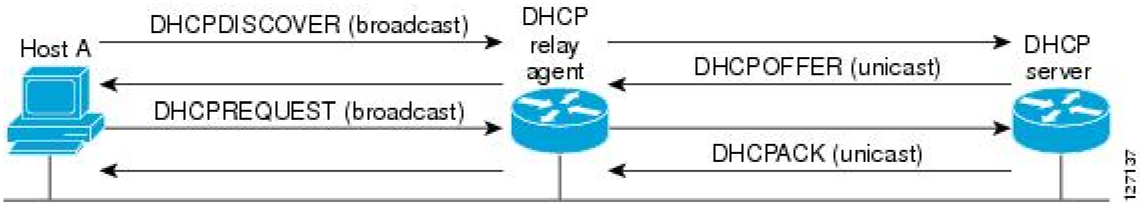
DHCP Server Relay Agent and Client Operation

Dynamic Host Control Protocol (DHCP) provides a framework for passing configuration information dynamically to hosts on a TCP/IP network. A DHCP client is a host that uses DHCP to obtain configuration parameters such as an IP address.

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. By contrast, relay agents receive DHCP messages and then generate a new DHCP message to send on another interface.

The figure below 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 DHCP server. A relay agent forwards the packets between the DHCP client and 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 1: DHCP Request for an IP Address from a DHCP Server



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.

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 Database

DHCP address pools are stored in non-volatile RAM (NVRAM). There is no limit on the number of address pools. An address binding is the mapping between the client’s IP and hardware addresses. The client’s IP address can be configured by the administrator (manual address allocation) or assigned from a pool by the DHCP server.

Manual bindings are stored in NVRAM. Manual bindings are just special address pools configured by a network administrator. There is no limit on the number of manual bindings.

Automatic bindings are IP addresses that have been automatically mapped to the MAC addresses of hosts that are found in the DHCP database. Automatic bindings are stored on a remote host called the database agent. A DHCP database agent is any host--for example, an FTP, TFTP, or RCP server--that stores the DHCP bindings database.The bindings are saved as text records for easy maintenance.

You can configure multiple DHCP database agents and you can configure the interval between database updates and transfers for each agent.

DHCP Attribute Inheritance

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.

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.

DHCP Options and Suboptions

Configuration parameters and other control information are carried in tagged data items that are stored in the options field of the DHCP message. Options provide a method of appending additional information. Vendors that want to provide additional information to their client not designed into the protocol can use options.

The Cisco IOS XE DHCP implementation also allows most DHCP server options to be customized. For example, the TFTP server, which stores the Cisco IOS XE image, can be customized with option 150 to support intelligent IP phones.

Virtual Private Networks (VPNs) allow the possibility that two pools in separate networks can have the same address space, with private network addresses, served by the same DHCP server. Cisco IOS XE software supports VPN-related options and suboptions such as the relay agent information option and VPN identification suboption. A relay agent can recognize these VPN-related options and suboptions and forward the client-originated DHCP packets to a DHCP server. The DHCP server can use this information to assign IP addresses and other parameters, distinguished by a VPN identifier, to help select the VPN to which the client belongs.

For more information on DHCP options and suboptions, see the “DHCP Options Reference” appendix in the *Network Registrar User’s Guide* , Release 6.3.

During lease negotiation, the DHCP server sends the options shown in the table below to the client.

Table 1: Default DHCP Server Options

DHCP Option Name	DHCP Option Code	Description
Subnet mask option	1	Specifies the client’s subnet mask per RFC 950.
Router option	3	Specifies a list of IP addresses for routers on the client’s subnet, usually listed in order of preference.
Domain name server option	6	Specifies a list of DNS name servers available to the client, usually listed in order of preference.

DHCP Option Name	DHCP Option Code	Description
Hostname option	12	Specifies the name of the client. The name may or may not be qualified with the local domain name.
Domain name option	15	Specifies the domain name that the client should use when resolving hostnames via the Domain Name System.
NetBIOS over TCP/IP name server option	44	Specifies a list of RFC 1001/1002 NetBIOS name servers listed in order or preference.
NetBIOS over TCP/IP node type option	46	Enables NetBIOS over TCP/IP clients that are configurable to be configured as described in RFC 1001/1002.
IP address lease time option	51	Allows the client to request a lease for the IP address.
DHCP message type option	53	Conveys the type of the DHCP message.
Server identifier option	54	Identifies the IP address of the selected DHCP server.
Renewal (T1) time option	58	Specifies the time interval from address assignment until the client transitions to the renewing state.
Rebinding (T2) time option	59	Specifies the time interval from address assignment until the client transitions to the rebinding state.

DHCP Server On-Demand Address Pool Management Overview

The Cisco IOS DHCP server on-demand address pool (ODAP) manager is used to centralize the management of large pools of addresses and simplify the configuration of large networks. ODAP provides a central management point for the allocation and assignment of IP addresses. When a router is configured as an ODAP manager, pools of IP addresses are dynamically increased or reduced in size depending on the address utilization level.

ODAPs support address assignment using DHCP for customers using private addresses. Each ODAP is configured and associated with a particular Multiprotocol Label Switching (MPLS) VPN. Cisco IOS software also provides ODAP support for non-MPLS VPN address pools by adding pool name support to the **peer default ip address dhcp-pool** *pool name*command.

DHCP server subnet allocation is a way of offering entire subnets (ranges of addresses) to relay agents so that remote access devices can provision IP addresses to DHCP clients. This functionality can occur along with or instead of managing individual client addresses. Subnet allocation can improve IP address provisioning, aggregation, characterization, and distribution by relying on the DHCP infrastructure to dynamically manage subnets.

This capability allows the DHCP server to be configured with a pool of subnets for lease to ODAP clients. Subnet pools can be configured for global ODAP clients or MPLS VPN ODAP clients on a per-client basis. The DHCP subnet allocation server creates bindings for the subnet leases and stores these leases in the DHCP database.

DHCP Services for Accounting and Security Overview

Cisco IOS software supports several new capabilities that enhance DHCP accounting, reliability, and security in Public Wireless LANs (PWLANs). This functionality can also be used in other network implementations.

DHCP accounting provides authentication, authorization, and accounting (AAA) and Remote Authentication Dial-In User Service (RADIUS) support for DHCP. The AAA and RADIUS support improves security by sending secure START and STOP accounting messages. The configuration of DHCP accounting adds a layer of security that allows DHCP lease assignment and termination to be triggered for the appropriate RADIUS START and STOP accounting records so that the session state is properly maintained by upstream devices such as a Service Selection Gateway (SSG). This additional security can help to prevent unauthorized clients or hackers from gaining illegal entry to the network by spoofing authorized DHCP leases.

Three other features have been designed and implemented to address the security concerns in PWLANs. The first feature secures ARP table entries to DHCP leases in the DHCP database. The secure ARP functionality prevents IP spoofing by synchronizing the database of the DHCP server with the ARP table to avoid address hijacking. Secure ARP adds an entry to the ARP table for a client when an address is allocated that can be deleted by the DHCP server only when a binding expires.

The second feature is DHCP authorized ARP. This functionality provides a complete solution by addressing the need for DHCP to explicitly know when a user logs out. Before the introduction of DHCP authorized ARP, there was no mechanism to inform the DHCP server if a user had left the system ungracefully, which could result in excessive billing for a customer that had logged out but the system had not detected the log out. To prevent this problem, DHCP authorized ARP sends periodic ARP messages on a per-minute basis to determine if a user is still logged in. Only authorized users can respond to the ARP request. ARP responses from unauthorized users are blocked at the DHCP server providing an extra level of security.

In addition, DHCP authorized ARP disables dynamic ARP learning on an interface. The address mapping can be installed only by the authorized component specified by the **arp authorized** interface configuration command. DHCP is the only authorized component currently allowed to install ARP entries.

The third feature is ARP autologoff, which adds finer control for probing when authorized users log out. The **arp probe interval** command specifies when to start a probe (the timeout), how frequent a peer is probed (the interval), and the maximum number of retries (the count).

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS Commands	Cisco IOS Master Command List, All Releases

Related Topic	Document Title
DHCP commands: complete command syntax, command mode, command history, defaults, usage guidelines, and examples	Cisco IOS IP Addressing Services Command Reference
DHCP conceptual information	"DHCP Overview" module
DHCP relay agent configuration	"Configuring the Cisco IOS XE DHCP Relay Agent" module
DHCP client configuration	"Configuring the Cisco IOS XE DHCP Client" module
DHCP On-Demand Address Pool Manager	"Configuring the DHCP On-Demand Address Pool Manager" module

Standards and RFCs

Standard/RFC	Title
RFC 951	*Bootstrap Protocol (BOOTP)*
RFC 1542	*Clarifications and Extensions for the Bootstrap Protocol*
RFC 2131	*Dynamic Host Configuration Protocol*
RFC 2132	*DHCP Options and BOOTP Vendor Extensions*

Technical Assistance

Description	Link
The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.	http://www.cisco.com/techsupport

Glossary

CPE --customer premises equipment. Terminating equipment, such as terminals, telephones, and modems, supplied by the service provider, installed at customer sites, and connected to the network.

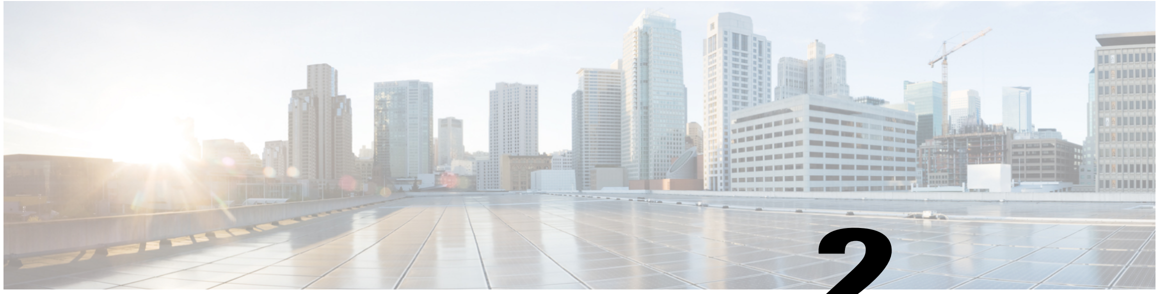
DSLAM --digital subscriber line access multiplexer. A device that connects many digital subscriber lines to a network by multiplexing the DSL traffic onto one or more network trunk lines.

ISSU --In Service Software Upgrade. ISSU is a process that allows Cisco IOS software to be updated or otherwise modified while packet forwarding continues.

ODAP --On-Demand Address Pool. ODAPs enable pools of IP addresses to be dynamically increased or reduced in size depending on the address utilization level. Once configured, the ODAP is populated with one or more subnets leased from a source server and is ready to serve address requests from DHCP clients or from PPP sessions.

RP --Route Processor. A generic term for the centralized control unit in a chassis.

SSO --Stateful Switchover. SSO refers to the implementation of Cisco IOS software that allows applications and features to maintain a defined state between an active and standby RP. When a switching occurs, forwarding and sessions are maintained. SSO makes an RP failure undetectable to the network.



CHAPTER 2

Configuring the Cisco IOS DHCP Server

Cisco devices running Cisco software include Dynamic Host Configuration Protocol (DHCP) server and the relay agent software. The Cisco IOS DHCP server is a full DHCP server implementation that assigns and manages IP addresses from specified address pools within the device to DHCP clients. The DHCP server can be configured to assign additional parameters such as the IP address of the Domain Name System (DNS) server and the default device.

This module describes the concepts and the tasks needed to configure the Cisco IOS DHCP server.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for Configuring the DHCP Server

- Before you configure a Cisco Dynamic Host Control Protocol (DHCP) server, you must understand the concepts documented in the Overview of the DHCP Server section.

- The Cisco DHCP server and the relay agent services are enabled by default. Use the **no service dhcp** command to disable the Cisco DHCP server and the relay agent and the **service dhcp** command to reenable the functionality.
- Port 67 (the DHCP server port) is closed in the Cisco DHCP/BOOTP default configuration. There are two logical parts to the **service dhcp** command: service enabled and service running. The DHCP service is enabled by default, but port 67 does not open until the DHCP service is running. If the DHCP service is running, the **show ip sockets details** or the **show sockets detail** command displays port 67 as open.
- The Cisco DHCP relay agent is enabled on an interface only when you configure the **ip helper-address** command. This command enables a DHCP broadcast to be forwarded to the configured DHCP server.

Information About the Cisco IOS DHCP Server

Overview of the DHCP Server

The Cisco DHCP server accepts address assignment requests and renewals from the client and assigns the addresses from predefined groups of addresses within DHCP address pools. These address pools can also be configured to supply additional information to the requesting client such as the IP address of the Domain Name System (DNS) server, the default device, and other configuration parameters. The Cisco DHCP server can accept broadcasts from locally attached LAN segments or from DHCP requests that have been forwarded by other DHCP relay agents within the network.

DHCP Attribute Inheritance

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.

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.

DHCP Server Address Allocation Using Option 82

The Cisco IOS DHCP server can allocate dynamic IP addresses based on the relay information option (option 82) sent by the relay agent.

DHCP provides a framework for passing configuration information to hosts on a TCP/IP network. Configuration parameters and other control information are carried in tagged data items that are stored in the options field of the DHCP message. The data items are also called options. Option 82 is organized as a single DHCP option that contains information known by the relay agent.

Automatic DHCP address allocation is based on an IP address. This IP address can either be the gateway address (giaddr field of the DHCP packet) or the IP address of an incoming interface. In some networks, it is necessary to use additional information to further determine which IP addresses to allocate. By using option

82, the Cisco IOS DHCP relay agent can include additional information about itself when forwarding client-originated DHCP packets to a DHCP server. The Cisco IOS DHCP server can also use option 82 to provide additional information to properly allocate IP addresses to DHCP clients. The information sent via option 82 is used to identify the port where the DHCP request arrives. Automatic DHCP address allocation does not parse out the individual suboptions contained in option 82. Rather, the address allocation is done by matching a configured pattern byte by byte.

This feature introduces a new DHCP class capability, which is a method to group DHCP clients based on some shared characteristics other than the subnet in which the clients reside.

For example, DHCP clients are connected to two ports of a single switch. Each port can be configured to be a part of two VLANs: VLAN1 and VLAN2. DHCP clients belong to either VLAN1 or VLAN2 and the switch can differentiate the VLAN that a particular DHCP Discover message belongs to (possibly through Layer 2 encapsulation). Each VLAN has its own subnet and all DHCP messages from the same VLAN (same switch) have the giaddr field set to the same value indicating the subnet of the VLAN.

Problems can occur while allocating IP addresses to DHCP clients that are connected to different ports of the same VLAN. These IP addresses must be part of the same subnet but the range of IP addresses must be different. In the preceding example, when a DHCP client that is connected to a port of VLAN1 must be allocated an IP address from a range of IP addresses within the VLAN’s subnet, whereas a DHCP client connecting to port 2 of VLAN1 must be allocated an IP address from another range of IP addresses. The two range of IP addresses are part of the same subnet (and have the same subnet mask). Generally, during DHCP address allocation, the DHCP server refers only to the giaddr field and is unable to differentiate between the two ranges.

To solve this problem, a relay agent residing at the switch inserts the relay information option (option 82), which carries information specific to the port, and the DHCP server inspects both the giaddr field and the inserted option 82 during the address selection process.

When you enable option 82 on a device, the following sequence of events occurs:

1. The host (DHCP client) generates a DHCP request and broadcasts it on the network.
2. When the device receives the DHCP request, it adds the option 82 information in the packet. The option 82 information contains the device MAC address (the remote ID suboption) and the port identifier, vlan-mod-port, from which the packet is received (the circuit ID suboption).
3. The device adds the IP address of the relay agent to the DHCP packet.
4. The device forwards the DHCP request that includes the option 82 field to the DHCP server.
5. The DHCP server receives the packet. If the server is option 82 capable, it uses the remote ID, the circuit ID, or both to assign IP addresses and implement policies, such as restricting the number of IP addresses that can be assigned to a single remote ID or circuit ID. The DHCP server echoes the option 82 field in the DHCP reply.
6. The DHCP server unicasts the reply to the device if the request is relayed to the server by the device. The device verifies that it originally inserted the option 82 data by inspecting remote ID and possibly circuit ID fields. The device removes the option 82 field and forwards the packet to the interface that connects to the DHCP client that sent the DHCP request.

The Cisco software refers to a pool of IP addresses (giaddr or incoming interface IP address) and matches the request to a class or classes configured in the pool in the order the classes are specified in the DHCP pool configuration.

When a DHCP address pool is configured with one or more DHCP classes, the pool becomes a restricted access pool, which means that no addresses are allocated from the pool unless one or more classes in the pool matches. This design allows DHCP classes to be used either for access control (no default class is configured on the pool) or to provide further address range partitions within the subnet of the pool.

Multiple pools can be configured with the same class, eliminating the need to configure the same pattern in multiple pools.

The following capabilities are supported for DHCP class-based address allocation:

- Specifying the full relay agent information option value as a raw hexadecimal string by using the **relay-information hex** command in new relay agent information configuration mode.
- Support for bit-masking the raw relay information hexadecimal value.
- Support for a wildcard at the end of a hexadecimal string specified by the **relay-information hex** command.

If the relay agent inserts option 82 but does not set the giaddr field in the DHCP packet, the DHCP server interface must be configured as a trusted interface by using the **ip dhcp relay information trusted** command. This configuration prevents the server from dropping the DHCP message.

How to Configure the Cisco IOS DHCP Server

Configuring a DHCP Database Agent or Disabling Conflict Logging

A DHCP database agent is any host (for example, an FTP, a TFTP, or a remote copy protocol [RCP] server) or storage media on a DHCP server (for example, disk0) that stores the DHCP bindings database. You can configure multiple DHCP database agents, and the interval between database updates and transfers for each agent.

Automatic bindings are IP addresses that are automatically mapped to the MAC addresses of hosts that are found in the DHCP database. Automatic binding information (such as lease expiration date and time, interface index, and VPN routing and forwarding [VRF] name) is stored in a database agent. The bindings are saved as text records for easy maintenance.

An address conflict occurs when two hosts use the same IP address. During address assignment, DHCP checks for conflicts by using ping and gratuitous Address Resolution Protocol (ARP). If a conflict is detected, the address is removed from the pool. The address is not assigned until the administrator resolves the conflict.

Note We strongly recommend using database agents. However, the Cisco DHCP server can run without database agents. If you choose not to configure a DHCP database agent, disable the recording of DHCP address conflicts on the DHCP server by using the **no ip dhcp conflict logging** command in global configuration mode. If there is a conflict logging but no database agent is configured, bindings during a switchover are lost when a device reboots. Possible false conflicts can occur causing the address to be removed from the address pool.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. Do one of the following:
   - **ip dhcp database** *url* [**timeout** *seconds* | **write-delay** *seconds*]
   - **no ip dhcp conflict logging**
4. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.

Step 3	Do one of the following:
	• **ip dhcp database** *url* [**timeout** *seconds* | **write-delay** *seconds*]
	• **no ip dhcp conflict logging**
	Example:
	`Device(config)# ip dhcp database ftp://user:password@172.16.1.1/router-dhcp timeout 80`
	Example:
	`Device(config)# no ip dhcp conflict logging`
		Configures a DHCP server to save automatic bindings on a remote host called a database agent.
		or
		Disables DHCP address conflict logging.

Step 4	**end**
	Example:
	`Device(config)# end`
		Exits global configuration mode and returns to privileged EXEC mode.

Excluding IP Addresses

The IP address configured on a device interface is automatically excluded from the DHCP address pool. The DHCP server assumes that all other IP addresses in a DHCP address pool subnet are available for assigning to DHCP clients.

You must exclude addresses from the pool if the DHCP server does not allocate those IP addresses to DHCP clients. Consider a scenario where two DHCP servers are set up for the same network segment (subnet) for redundancy. If DHCP servers do not coordinate their services with each other using a protocol such as DHCP failover, each DHCP server must be configured to allocate addresses from a nonoverlapping set of addresses in the shared subnet. See the Example: Configuring Manual Bindings section for a configuration example.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip dhcp excluded-address** *low-address* [*high-address*]
4. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip dhcp excluded-address** *low-address* [*high-address*] **Example:** `Device(config)# ip dhcp excluded-address 172.16.1.100 172.16.1.103`	Specifies IP addresses that the DHCP server should not assign to DHCP clients.

Step 4	**end**
	Example:
	`Device(config)# end`
		Exits global configuration mode and returns to privileged EXEC mode.

Configuring DHCP Address Pools

Configuring a DHCP Address Pool

On a per-address pool basis, specify DHCP options for the client as necessary.

You can configure a DHCP address pool with a name that is a string (such as "engineering") or an integer (such as 0). Configuring a DHCP address pool also puts the device into DHCP pool configuration mode—identified by the (dhcp-config)# prompt—from which you can configure pool parameters (for example, the IP subnet number and default device list).

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 process by which the DHCP server identifies the DHCP address pool to use for a client request is described in the Configuring Manual Bindings section.

The DHCP server identifies and uses DHCP address pools for a client request, in the following manner:

- If the client is not directly connected to the DHCP server (the giaddr field of the DHCPDISCOVER broadcast message is nonzero), the server matches the DHCPDISCOVER with the DHCP pool that has the subnet that contains the IP address in the giaddr field.
- If the client is directly connected to the DHCP server (the giaddr field is zero), the DHCP server matches the DHCPDISCOVER with DHCP pools that contain the subnets configured on the receiving interface. If the interface has secondary IP addresses, 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.

Cisco DHCP server software supports advanced capabilities for IP address allocation. See the Configuring DHCP Address Allocation Using Option 82 section for more information.

Before You Begin

Before you configure the DHCP address pool, you must:

- Identify DHCP options for devices where necessary, including the following:
    - Default boot image name
    - Default devices
    - Domain Name System (DNS) servers
    - Network Basic Input/Output System (NetBIOS) name server
    - Primary subnet
    - Secondary subnets and subnet-specific default device lists (see Configuring a DHCP Address Pool with Secondary Subnets for information on secondary subnets).
- Decide on a NetBIOS node type (b, p, m, or h).
- Decide on a DNS domain name.

Note You cannot configure manual bindings within the same pool that is configured with the **network** DHCP pool configuration command. To configure manual bindings, see the Configuring Manual Bindings section.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip dhcp pool** *name*
4. **utilization mark high** *percentage-number* [**log**]
5. **utilization mark low** *percentage-number* [**log**]
6. **network** *network-number* [*mask* | */prefix-length*] [**secondary**]
7. **domain-name** *domain*
8. **dns-server** *address* [*address2 ... address8*]
9. **bootfile** *filename*
10. **next-server** *address* [*address2 ... address8*]
11. **netbios-name-server** *address* [*address2 ... address8*]
12. **netbios-node-type** *type*
13. **default-router** *address* [*address2 ... address8*]
14. **option** *code* [**instance** *number*] {**ascii** *string* | **hex** *string* | *ip-address*}
15. **lease** {*days* [*hours* [*minutes*]] | **infinite**}
16. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip dhcp pool** *name* **Example:** `Device(config)# ip dhcp pool 1`	Creates a name for the DHCP server address pool and enters DHCP pool configuration mode.

	Command or Action	Purpose
Step 4	**utilization mark high** *percentage-number* [**log**] **Example:** `Device(dhcp-config)# utilization mark high 80 log`	(Optional) Configures the high utilization mark of the current address pool size. • The **log** keyword enables the logging of a system message. A system message will be generated for a DHCP pool when the pool utilization exceeds the configured high utilization threshold.
Step 5	**utilization mark low** *percentage-number* [**log**] **Example:** `Device(dhcp-config)# utilization mark low 70 log`	(Optional) Configures the low utilization mark of the current address pool size. • The **log** keyword enables the logging of a system message. A system message will be generated for a DHCP pool when the pool utilization falls below the configured low utilization threshold.
Step 6	**network** *network-number* [*mask* | */prefix-length*] [**secondary**] **Example:** `Device(dhcp-config)# network 172.16.0.0 /16`	Specifies the subnet network number and mask of the DHCP address pool.
Step 7	**domain-name** *domain* **Example:** `Device(dhcp-config)# domain-name cisco.com`	Specifies the domain name for the client.
Step 8	**dns-server** *address* [*address2 ... address8*] **Example:** `Device(dhcp-config)# dns server 172.16.1.103 172.16.2.103`	Specifies the IP address of a DNS server that is available to a DHCP client. • One IP address is required; however, you can specify up to eight IP addresses in one command. • Servers should be listed in order of preference.
Step 9	**bootfile** *filename* **Example:** `Device(dhcp-config)# bootfile xllboot`	(Optional) Specifies the name of the default boot image for a DHCP client. • The boot file is used to store the boot image for the client. The boot image is generally the operating system that the client uses to load.
Step 10	**next-server** *address* [*address2 ... address8*] **Example:** `Device(dhcp-config)# next-server 172.17.1.103 172.17.2.103`	(Optional) Configures the next server in the boot process of a DHCP client. • One address is required; however, you can specify up to eight addresses in one command line.

	Command or Action	Purpose
		• If multiple servers are specified, DHCP assigns them to clients in a round-robin order. The first client gets address 1, the next client gets address 2, and so on. • If this command is not configured, DHCP uses the server specified by the **ip helper address** command as the boot server.
Step 11	**netbios-name-server** *address* [*address2 ... address8*] **Example:** `Device(dhcp-config)# netbios-name-server 172.16.1.103 172.16.2.103`	(Optional) Specifies the NetBIOS WINS server that is available to a Microsoft DHCP client. • One address is required; however, you can specify up to eight addresses in one command line. • Servers should be listed in order of preference.
Step 12	**netbios-node-type** *type* **Example:** `Device(dhcp-config)# netbios-node-type h-node`	(Optional) Specifies the NetBIOS node type for a Microsoft DHCP client.
Step 13	**default-router** *address* [*address2 ... address8*] **Example:** `Device(dhcp-config)# default-router 172.16.1.100 172.16.1.101`	(Optional) Specifies the IP address of the default device for a DHCP client. • The IP address should be on the same subnet as the client. • One IP address is required; however, you can specify up to eight IP addresses in one command line. These default devices are listed in order of preference; that is, *address* is the most preferred device, *address2* is the next most preferred device, and so on. • When a DHCP client requests an IP address, the device—acting as a DHCP server—accesses the default device list to select another device that the DHCP client will use as the first hop for forwarding messages. After a DHCP client has booted, the client begins sending packets to its default device.

Step 14	**option** *code* [**instance** *number*] {**ascii** *string* | **hex** *string* | *ip-address*}
	Example:
	`Device(dhcp-config)# option 19 hex 01`
		(Optional) Configures DHCP server options.

Step 15	**lease** {*days* [*hours* [*minutes*]] | **infinite**}
	Example:
	`Device(dhcp-config)# lease 30`
		(Optional) Specifies the duration of the lease.
		• The default is a one-day lease.
		• The **infinite** keyword specifies that the duration of the lease is unlimited.

	Command or Action	Purpose

Step 16	**end**
	Example:
	`Device(dhcp-config)# end`
		Returns to privileged EXEC mode.

Configuring a DHCP Address Pool with Secondary Subnets

For any DHCP pool, you can configure a primary subnet and any number of secondary subnets. Each subnet is a range of IP addresses that the device uses to allocate an IP address to a DHCP client. The DHCP server multiple subnet functionality enables a Cisco DHCP server address pool to manage additional IP addresses by adding the addresses to a secondary subnet of an existing DHCP address pool (instead of using a separate address pool).

Configuring a secondary DHCP subnetwork places the device in DHCP pool secondary subnet configuration mode—identified by the (config-dhcp-subnet-secondary)# prompt—where you can configure a default address list that is specific to the secondary subnet. You can also specify the utilization rate of the secondary subnet, which allows pools of IP addresses to dynamically increase or reduce in size depending on the address utilization level. This setting overrides the global utilization rate.

If the DHCP server selects an address pool that contains multiple subnets, the DHCP server allocates an IP address from the subnets as follows:

- When the DHCP server receives an address assignment request, it looks for an available IP address in the primary subnet.
- When the primary subnet is exhausted, the DHCP server automatically looks for an available IP address in any of the secondary subnets maintained by the DHCP server (even though the giaddr does not necessarily match the secondary subnet). The server inspects the subnets for address availability in the order of subnets that were added to the pool.
- If the giaddr matches a secondary subnet in the pool, the DHCP server allocates an IP address from that particular secondary subnet (even if IP addresses are available in the primary subnet and irrespective of the order of secondary subnets that were added).

Note The secondary subnet in the pool is supported only for directly connected clients. To avoid multiple IP address allocation from multiple subnets, you should configure secondary IP address on the interface connected to clients. Note that the secondary subnets should not be used in pools that are used for servicing requests from DHCP relay.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip dhcp pool** *name*
4. **utilization mark high** *percentage-number* [**log**]
5. **utilization mark low** *percentage-number* [**log**]
6. **network** *network-number* [*mask* | /*prefix-length*]
7. **domain-name** *domain*
8. **dns-server** *address* [*address2 ... address8*]
9. **bootfile** *filename*
10. **next-server** *address* [*address2 ... address8*]
11. **netbios-name-server** *address* [*address2 ... address8*]
12. **netbios-node-type** *type*
13. **default-router** *address* [*address2 ... address8*]
14. **option** *code* [**instance** *number*] {**ascii** *string* | **hex** *string* | *ip-address*}
15. **lease** {*days* [*hours*] [*minutes*] | **infinite**}
16. **network** *network-number* [*mask* | /*prefix-length*] [**secondary**]
17. **override default-router** *address* [*address2 ... address8*]
18. **override utilization high** *percentage-number*
19. **override utilization low** *percentage-number*
20. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip dhcp pool** *name* **Example:** `Device(config)# ip dhcp pool 1`	Creates a name for the DHCP server address pool and enters DHCP pool configuration mode.

	Command or Action	Purpose
Step 4	**utilization mark high** *percentage-number* [**log**] **Example:** `Device(dhcp-config)# utilization mark high 80 log`	(Optional) Configures the high utilization mark of the current address pool size. • The **log** keyword enables logging of a system message. A system message is generated for a DHCP pool when the pool utilization exceeds the configured high utilization threshold.
Step 5	**utilization mark low** *percentage-number* [**log**] **Example:** `Device(dhcp-config)# utilization mark low 70 log`	(Optional) Configures the low utilization mark of the current address pool size. • The **log** keyword enables logging of a system message. A system message is generated for a DHCP pool when the pool utilization falls below the configured low utilization threshold.
Step 6	**network** *network-number* [*mask* | */prefix-length*] **Example:** `Device(dhcp-config)# network 172.16.0.0 /16`	Specifies the subnet network number and mask of the primary DHCP address pool.
Step 7	**domain-name** *domain* **Example:** `Device(dhcp-config)# domain-name cisco.com`	Specifies the domain name for the client.
Step 8	**dns-server** *address* [*address2 ... address8*] **Example:** `Device(dhcp-config)# dns server 172.16.1.103 172.16.2.103`	Specifies the IP address of a DNS server that is available to a DHCP client. • One IP address is required; however, you can specify up to eight IP addresses in one command. • Servers should be listed in the order of preference.
Step 9	**bootfile** *filename* **Example:** `Device(dhcp-config)# bootfile xllboot`	(Optional) Specifies the name of the default boot image for a DHCP client. • The boot file is used to store the boot image for the client. The boot image is generally the operating system image that the client loads.
Step 10	**next-server** *address* [*address2 ... address8*] **Example:** `Device(dhcp-config)# next-server 172.17.1.103 172.17.2.103`	(Optional) Configures the next server in the boot process of a DHCP client. • One IP address is required; however, you can specify up to eight IP addresses in one command line.

	Command or Action	Purpose
		• If multiple servers are specified, DHCP assigns the servers to clients in a round-robin order. The first client gets address 1, the next client gets address 2, and so on. • If this command is not configured, DHCP uses the server specified by the **ip helper address** command as the boot server.
Step 11	**netbios-name-server** *address* [*address2 ... address8*] **Example:** `Device(dhcp-config)# netbios-name-server 172.16.1.103 172.16.2.103`	(Optional) Specifies the NetBIOS Windows Internet Naming Service (WINS) server that is available to a Microsoft DHCP client. • One address is required; however, you can specify up to eight addresses in one command line. • Servers should be listed in order of preference.
Step 12	**netbios-node-type** *type* **Example:** `Device(dhcp-config)# netbios-node-type h-node`	(Optional) Specifies the NetBIOS node type for a Microsoft DHCP client.
Step 13	**default-router** *address* [*address2 ... address8*] **Example:** `Device(dhcp-config)# default-router 172.16.1.100 172.16.1.101`	(Optional) Specifies the IP address of the default device for a DHCP client. • The IP address should be on the same subnet as the client. • One IP address is required; however, you can specify a up to eight IP addresses in one command line. These default devices are listed in order of preference; that is, *address* is the most preferred device, *address2* is the next most preferred device, and so on. • When a DHCP client requests for an IP address, the device—acting as a DHCP server—accesses the default device list to select another device that the DHCP client uses as the first hop for forwarding messages. After a DHCP client has booted, the client begins sending packets to its default device.

Step 14	**option** *code* [**instance** *number*] {**ascii** *string* | **hex** *string* | *ip-address*}
	Example:
	`Device(dhcp-config)# option 19 hex 01`
		(Optional) Configures DHCP server options.

Step 15	**lease** {*days* [*hours*] [*minutes*] | **infinite**}
	Example:
	`Device(dhcp-config)# lease 30`
		(Optional) Specifies the duration of the lease.
		• The default is a one-day lease.
		• The **infinite** keyword specifies that the duration of the lease is unlimited.

	Command or Action	Purpose
Step 16	**network** *network-number* [*mask* | */prefix-length*] [**secondary**] **Example:** `Device(dhcp-config)# network 10.10.0.0 255.255.0.0 secondary`	(Optional) Specifies the network number and mask of a secondary DHCP server address pool. • Any number of secondary subnets can be added to a DHCP server address pool. • During execution of this command, the configuration mode changes to DHCP pool secondary subnet configuration mode, which is identified by (config-dhcp-subnet-secondary)# prompt. In this mode, the administrator can configure a default device list that is specific to the subnet. • See Troubleshooting Tips section if you are using secondary IP addresses under a loopback interface with DHCP secondary subnets.
Step 17	**override default-router** *address* [*address2 ... address8*] **Example:** `Device(config-dhcp-subnet-secondary)# override default-router 10.10.0.100 10.10.0.101`	(Optional) Specifies the default device list that is used when an IP address is assigned to a DHCP client from a particular secondary subnet. • If the subnet-specific override value is configured, this override value is used when assigning an IP address from the subnet; the network-wide default device list is used only to set the gateway device for the primary subnet. • If this subnet-specific override value is not configured, the network-wide default device list is used when assigning an IP address from the subnet. • See Example: Configuring a DHCP Address Pool with Multiple Disjoint Subnets section for a sample configuration.
Step 18	**override utilization high** *percentage-number* **Example:** `Device(config-dhcp-subnet-secondary)# override utilization high 60`	(Optional) Sets the high utilization mark of the subnet size. • This command overrides the global default setting specified by the **utilization mark high** command.
Step 19	**override utilization low** *percentage-number* **Example:** `Device(config-dhcp-subnet-secondary)# override utilization low 40`	(Optional) Sets the low utilization mark of the subnet size. • This command overrides the global default setting specified by the **utilization mark low** command.

Step 20	**end**
	Example:
	`Device(config-dhcp-subnet-secondary)# end`
		Returns to privileged EXEC mode.

Troubleshooting Tips

If you are using secondary IP addresses under a single loopback interface and using secondary subnets under a DHCP pool, use one DHCP pool to configure networks for all the secondary subnets instead of using one pool per secondary subnet. The **network** *network-number* [*mask* | */prefix-length*] [**secondary**] command must be configured under a single DHCP address pool rather than multiple DHCP address pools.

The following is the correct configuration:

```
!
ip dhcp pool dhcp_1
 network 172.16.1.0 255.255.255.0
 network 172.16.2.0 255.255.255.0 secondary
 network 172.16.3.0 255.255.255.0 secondary
 network 172.16.4.0 255.255.255.0 secondary
!
interface Loopback111
 ip address 172.16.1.1 255.255.255.255 secondary
 ip address 172.16.2.1 255.255.255.255 secondary
 ip address 172.16.3.1 255.255.255.255 secondary
 ip address 172.16.4.1 255.255.255.255 secondary
```

The following is the incorrect configuration:

```
!
ip dhcp pool dhcp_1
 network 172.16.1.0 255.255.255.0
 lease 1 20 30
 accounting default
!
ip dhcp pool dhcp_2
 network 172.16.2.0 255.255.255.0
 lease 1 20 30
 accounting default
!
ip dhcp pool dhcp_3
 network 172.16.3.0 255.255.255.0
 lease 1 20 30
 accounting default
!
ip dhcp pool dhcp_4
 network 172.16.4.0 255.255.255.0
 lease 1 20 30
 accounting default
!
interface Loopback111
 ip address 172.16.1.1 255.255.255.255 secondary
 ip address 172.16.2.1 255.255.255.255 secondary
 ip address 172.16.3.1 255.255.255.255 secondary
 ip address 172.16.4.1 255.255.255.255 secondary
```

Verifying the DHCP Address Pool Configuration

The following configuration commands are optional. You can enter the **show** commands in any order.

SUMMARY STEPS

1. **enable**
2. **show ip dhcp pool** [*name*]
3. **show ip dhcp binding** [*address*]
4. **show ip dhcp conflict** [*address*]
5. **show ip dhcp database** [*url*]
6. **show ip dhcp server statistics** [*type-number*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**show ip dhcp pool** [*name*] **Example:** `Device# show ip dhcp pool`	(Optional) Displays information about DHCP address pools.
Step 3	**show ip dhcp binding** [*address*] **Example:** `Device# show ip dhcp binding`	(Optional) Displays a list of all bindings created on a specific DHCP server. • Use the **show ip dhcp binding** command to display the IP addresses that have already been assigned. Verify that the address pool is not exhausted. If necessary, recreate the pool to create a larger pool of addresses. • Use the **show ip dhcp binding** command to display the lease expiration date and time of the IP address of the host.
Step 4	**show ip dhcp conflict** [*address*] **Example:** `Device# show ip dhcp conflict`	(Optional) Displays a list of all IP address conflicts.
Step 5	**show ip dhcp database** [*url*] **Example:** `Device# show ip dhcp database`	(Optional) Displays recent activity on the DHCP database.

	Command or Action	Purpose
Step 6	**show ip dhcp server statistics** [*type-number*] **Example:** `Device# show ip dhcp server statistics`	(Optional) Displays count information about server statistics and messages sent and received.

Configuring Manual Bindings

An address binding is a mapping between the IP address and MAC address of a client. The IP address of a client can be assigned manually by an administrator or assigned automatically from a pool by a DHCP server.

Manual bindings are IP addresses that are manually mapped to MAC addresses of hosts that are found in the DHCP database. Manual bindings are stored in the NVRAM of the DHCP server. Manual bindings are just special address pools. There is no limit to the number of manual bindings, but you can configure only one manual binding per host pool.

Automatic bindings are IP addresses that have been automatically mapped to MAC addresses of hosts that are found in the DHCP database. Because the bindings are stored in the volatile memory of the DHCP server, binding information is lost in the event of power failures or on device reloads. To prevent the loss of automatic binding information, a copy of the automatic binding information is stored on a remote host called the DHCP database agent. The bindings are periodically written to the database agent. When the device reloads, the bindings are read from the database agent to the DHCP database in the DHCP server.

Note We strongly recommend that you use database agents. However, Cisco DHCP server can function even without database agents.

Some DHCP clients send a client identifier (DHCP option 61) in the DHCP packet. To configure manual bindings for such clients, you must enter the **client-identifier** command with the hexadecimal values that identify the DHCP client. To configure manual bindings for clients that do not send a client identifier option, you must enter the **hardware-address** DHCP pool configuration command with the hexadecimal hardware address of the client.

Depending on your release, the DHCP server sends infinite lease time to the clients for which manual bindings are configured.

Depending on your release, the DHCP server sends lease time that is configured using the **lease** command to clients for which manual bindings are configured.

Note You cannot configure manual bindings within the same pool that is configured with the **network** command in DHCP pool configuration mode. See the Configuring DHCP Address Pools section for information about DHCP address pools and the **network** command.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip dhcp pool** *pool-name*
4. **host** *address* [*mask* | /*prefix-length*]
5. **client-identifier** *unique-identifier*
6. **hardware-address** *hardware-address* [*protocol-type* | *hardware-number*]
7. **client-name** *name*
8. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip dhcp pool** *pool-name* **Example:** `Device(config)# ip dhcp pool pool1`	Creates a name for the DHCP server address pool and enters DHCP pool configuration mode.
Step 4	**host** *address* [*mask* | /*prefix-length*] **Example:** `Device(dhcp-config)# host 172.16.0.1`	Specifies the IP address and subnet mask of the client. • There is no limit to the number of manual bindings you can configure. However, you can configure only one manual binding per host pool.
Step 5	**client-identifier** *unique-identifier* **Example:** `Device(dhcp-config)# client-identifier 01b7.0813.8811.66`	Specifies the unique identifier for DHCP clients. • This command is used for DHCP requests. • DHCP clients require client identifiers. You can specify the unique identifier for the client in either of the following ways: • A 7-byte dotted hexadecimal notation. For example, 01b7.0813.8811.66, where 01 represents the Ethernet media type and the remaining bytes represent the MAC address of the DHCP client.

	Command or Action	Purpose
		• A 27-byte dotted hexadecimal notation. For example, 7665.6e64.6f72.2d30.3032.342e.3937.6230.2e33.3734.312d.4661.302f.31. The equivalent ASCII string for this hexadecimal value is vendor-0024.97b0.3741-fa0/1, where vendor represents the vendor, 0024.97b0.3741 represents the MAC address of the source interface, and fa0/1 represents the source interface of the DHCP client. • See the Troubleshooting section for information about how to determine the client identifier of the DHCP client. **Note** The identifier specified here is considered for a DHCP client that sends a client identifier in the packet.
Step 6	**hardware-address** *hardware-address* [*protocol-type* | *hardware-number*] **Example:** `Device(dhcp-config)# hardware-address b708.1388.f166 ethernet`	Specifies a hardware address for the client. • This command is used for BOOTP requests. **Note** The hardware address specified here is considered for a DHCP client that does not send a client identifier in the packet.
Step 7	**client-name** *name* **Example:** `Device(dhcp-config)# client-name client1`	(Optional) Specifies the name of the client using any standard ASCII character. • The client name should not include the domain name. For example, the name client1 should not be specified as client1.cisco.com.

Step 8	**end**
	Example:
	`Device(dhcp-config)# end`
		Returns to privileged EXEC mode.

Troubleshooting Tips

You can determine the client identifier by using the **debug ip dhcp server packet** command. In the following sample output, the client is identified by the value 0b07.1134.a029:

```
Device# debug ip dhcp server packet

DHCPD:DHCPDISCOVER received from client 0b07.1134.a029 through relay 10.1.0.253.
DHCPD:assigned IP address 10.1.0.3 to client 0b07.1134.a029.
.
.
.
```

Configuring DHCP Static Mapping

The DHCP Static Mapping feature enables the assignment of static IP addresses (without creating numerous host pools with manual bindings) by using a customer-created text file that the DHCP server reads. The benefit of this feature is that it eliminates the need for a long configuration file and reduces the space required in NVRAM to maintain address pools.

A DHCP database contains the mappings between a client IP address and the hardware address, which is referred to as a binding. There are two types of bindings: manual bindings that map a single hardware address to a single IP address, and automatic bindings that dynamically map a hardware address to an IP address from a pool of IP addresses. Manual (also known as static) bindings can be configured individually directly on the device or by using the DHCP Static Mapping feature. These static bindings can be read from a separate static mapping text file. The static mapping text files are read when a device reloads or the DHCP service restarts. These files are read-only.

The read static bindings are treated just like the manual bindings, in that they are:

- Retained across DHCPRELEASEs from the clients.
- Not timed out.
- Deleted only upon deletion of the pool.
- Provided appropriate exclusions for the contained addresses, which are created at the time of the read.

Just like automatic bindings, manual (or static) bindings from the static mapping text file are also displayed by using the **show ip dhcp binding** command.

Perform this task to create the static mapping text file. You will input your addresses in the text file, which is stored in the DHCP database for the DHCP server to read. There is no limit to the number of addresses that can be stored in the file. The file format has the following elements:

- Database version number
- End-of-file designator
- Hardware type
- Hardware address
- IP address
- Lease expiration
- Time the file was created

See the following table for more details about the format of the text file.

The following is a sample static mapping text file:

```
*time* Jan 21 2005 03:52 PM
*version* 2
!IP address    Type    Hardware address     Lease expiration
10.0.0.4 /24   1       0090.bff6.081e       Infinite
10.0.0.5 /28   id      00b7.0813.88f1.66    Infinite
10.0.0.2 /21   1       0090.bff6.081d       Infinite
*end*
```

Table 2: Static Mapping Text File Field Descriptions

Field	Description
time	Specifies the time the file was created. This field allows DHCP to differentiate between the new and old database versions when multiple agents are configured. The valid format of the time is mm dd yyyy hh:mm AM/PM.
version 2	Specifies the database version number.
IP address	Specifies the static IP address. If the subnet mask is not specified, a mask is automatically assigned depending on the IP address. The IP address and the mask is separated by a space.
Type	Specifies the hardware type. For example, type "1" indicates Ethernet. The type "id" indicates that the field is a DHCP client identifier. Legal values can be found online at http://www.iana.org/assignments/arp-parameters in the "Number Hardware Type" list.
Hardware address	Specifies the hardware address. When the type is numeric, the type refers to the hardware media. Legal values can be found online at http://www.iana.org/assignments/arp-parameters in the "Number Hardware Type" list. When the type is "id," the type refers to a match on the client identifier. For more information about the client identifier, see RFC 2132, *DHCP Options and BOOTP Vendor Extensions*, section 9.14, located at http://www.ietf.org/rfc/rfc2132.txt, or the **client-identifier** command. If you are unsure about the client identifier to match with the hardware type, use the **debug dhcp detail** command to display the client identifier being sent to the DHCP server from the client.
Lease expiration	Specifies the expiration of the lease. "Infinite" specifies that the duration of the lease is unlimited.
end	End of file. DHCP uses the *end* designator to detect file truncation.

Configuring the DHCP Server to Read a Static Mapping Text File

Before You Begin

The administrator must create the static mapping text file in the correct format and configure the address pools before performing this task.

Before editing the file, you must disable the DHCP server using the **no service dhcp** command.

Note The static bindings must not be deleted when a DHCPRELEASE is received or must not be timed out by the DHCP timer. The static bindings should be created by using the **ip dhcp pool** command.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip dhcp pool** *name*
4. **origin file** *url*
5. **end**
6. **show ip dhcp binding** [*address*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip dhcp pool** *name* **Example:** `Device(config)# ip dhcp pool pool1`	Assigns a name to a DHCP pool and enters DHCP configuration mode. **Note** If you have already configured the IP DHCP pool name using the **ip dhcp pool** command and the static file URL using the **origin file** command, you must perform a fresh read using the **no service dhcp** command and the **service dhcp** command.
Step 4	**origin file** *url* **Example:** `Device(dhcp-config)# origin file tftp://10.1.0.1/static-bindings`	Specifies the URL that the DHCP server can access to locate the text file.

Step 5	**end**
	Example:
	`Device(dhcp-config)# end`
		Returns to privileged EXEC mode.

	Command or Action	Purpose
Step 6	**show ip dhcp binding** [*address*] **Example:** `Device# show ip dhcp binding`	(Optional) Displays a list of all bindings created on a specific DHCP server.

Examples

The following sample output from the **show ip dhcp binding** command displays address bindings that are configured:

```
Device# show ip dhcp binding

00:05:14:%SYS-5-CONFIG_I: Configured from console by console
Bindings from all pools not associated with VRF:
IP address  Client-ID/            Ls expir   Type    Hw address           User name
10.9.9.4/8  0063.7363.2d30.3036.  Infinite   Static  302e.3762.2e39.3634. 632d.4574.8892.
10.9.9.1/24 0063.6973.636f.2d30.  Infinite   Static  3036.302e.3437.3165. 2e64.6462.342d.
```

The following sample output displays each entry in the static mapping text file:

```
*time* Jan 21 2005 22:52 PM
!IP address     Type        Hardware address                              Lease expiration
10.19.9.1 /24    id          0063.6973.636f.2d30.3036.302e.3437
10.9.9.4         id          0063.7363.2d30.3036.302e.3762.2e39.3634.632d  Infinite
*end*
```

The following sample debug output shows the reading of the static mapping text file from the TFTP server:

```
Device# debug ip dhcp server

Loading abc/static_pool from 10.19.192.33 (via Ethernet0):
[OK - 333 bytes]
*May 26 23:14:21.259: DHCPD: contacting agent tftp://10.19.192.33/abc/static_pool (attempt
 0)
*May 26 23:14:21.467: DHCPD: agent tftp://10.19.192.33/abc/static_pool is responding.
*May 26 23:14:21.467: DHCPD: IFS is ready.
*May 26 23:14:21.467: DHCPD: reading bindings from tftp://10.19.192.33/abc/static_pool.
*May 26 23:14:21.707: DHCPD: read 333 / 1024 bytes.
*May 26 23:14:21.707: DHCPD: parsing text line
*time* Apr 22 2002 11:31 AM
*May 26 23:14:21.707: DHCPD: parsing text line ““
*May 26 23:14:21.707: DHCPD: parsing text line
!IP address Type Hardware address Lease expiration
*May 26 23:14:21.707: DHCPD: parsing text line
“10.9.9.1 /24 id 0063.6973.636f.2d30.3036.302e.3437”
*May 26 23:14:21.707: DHCPD: creating binding for 10.9.9.1
*May 26 23:14:21.707: DHCPD: Adding binding to radix tree (10.9.9.1)
*May 26 23:14:21.707: DHCPD: Adding binding to hash tree
*May 26 23:14:21.707: DHCPD: parsing text line
“10.9.9.4 id 0063.7363.2d30.3036.302e.3762.2e39.3634.632d”
*May 26 23:14:21.711: DHCPD: creating binding for 10.9.9.4
*May 26 23:14:21.711: DHCPD: Adding binding to radix tree (10.9.9.4)
*May 26 23:14:21.711: DHCPD: Adding binding to hash tree
*May 26 23:14:21.711: DHCPD: parsing text line “Infinite”
*May 26 23:14:21.711: DHCPD: parsing text line “”
*May 26 23:14:21.711: DHCPD: parsing text line
!IP address Interface-index Lease expiration VRF
*May 26 23:14:21.711: DHCPD: parsing text line “*end*”
*May 26 23:14:21.711: DHCPD: read static bindings from tftp://10.19.192.33/abcemp/static_pool.
```

Customizing DHCP Server Operation

By default, the DHCP server pings a pool address twice before assigning a particular address to a requesting client. If the ping is unanswered, the DHCP server assumes (with a high probability) that the address is not in use and assigns the address to the requesting client.

By default, the DHCP server waits for 2 seconds before timing out a ping packet.

You can configure the DHCP server to ignore and not reply to any BOOTP requests that the server receives. This functionality is beneficial when there is a mix of BOOTP and DHCP clients in a network segment and there is a BOOTP server and a Cisco DHCP server servicing the network segment. The BOOTP server is configured with static bindings for the BOOTP clients and the BOOTP clients must obtain their addresses from the BOOTP server. However, DHCP servers can also respond to BOOTP requests and the DHCP server may offer an address that causes the BOOTP clients to boot with the address from the DHCP server, instead of the address from the BOOTP server. Configuring the DHCP server to ignore BOOTP requests ensures that the BOOTP clients will receive address information from the BOOTP server and will not accept an address from a DHCP server.

Cisco software can forward these ignored BOOTP request packets to another DHCP server if the **ip helper-address** command is configured on the incoming interface.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip dhcp ping packets** *number*
4. **ip dhcp ping timeout** *milliseconds*
5. **ip dhcp bootp ignore**
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip dhcp ping packets** *number* **Example:** `Device(config)# ip dhcp ping packets 5`	(Optional) Specifies the number of ping packets the DHCP server sends to a pool address before assigning the address to a requesting client.

	Command or Action	Purpose
		- The default is two packets. Setting the *number* argument to a value of 0 disables the DHCP server ping operation.
Step 4	**ip dhcp ping timeout** *milliseconds* **Example:** `Device(config)# ip dhcp ping timeout 850`	(Optional) Specifies the duration the DHCP server waits for a ping reply from an address pool.
Step 5	**ip dhcp bootp ignore** **Example:** `Device(config)# ip dhcp bootp ignore`	(Optional) Allows the DHCP server to selectively ignore and not reply to received BOOTP requests. - The **ip dhcp bootp ignore** command applies to all DHCP pools configured on the device. BOOTP requests cannot be selectively ignored on a per-DHCP pool basis.

Step 6	**end**
	Example:
	`Device(config)# end`
		Returns to privileged EXEC mode.

Configuring a Remote Device to Import DHCP Server Options from a Central DHCP Server

The Cisco DHCP server can dynamically configure options such as the Domain Name System (DNS) and Windows Internet Name Service (WINS) addresses to respond to DHCP requests from local clients behind the customer premises equipment (CPE). Earlier, network administrators configured the Cisco DHCP server on each device manually. Now, the Cisco DHCP server is enhanced to allow configuration information to be updated automatically. Network administrators can configure one or more centralized DHCP servers to update specific DHCP options within the DHCP pools. The remote servers can request or “import” these option parameters from centralized servers.

This section contains the following tasks:

Configuring the Central DHCP Server to Update DHCP Options

Perform the following task to configure the Central DHCP Server to update DHCP options:

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip dhcp pool** *name*
4. **network** *network-number* [*mask* | */prefix-length*]
5. **dns-server** *address* [*address2 ... address8*]
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip dhcp pool** *name* **Example:** `Device(config)# ip dhcp pool 1`	Creates a name for the DHCP server address pool and enters DHCP pool configuration mode.
Step 4	**network** *network-number* [*mask* | */prefix-length*] **Example:** `Device(dhcp-config)# network 172.16.0.0 /16`	Specifies the subnet number and mask of the DHCP address pool.
Step 5	**dns-server** *address* [*address2 ... address8*] **Example:** `Device(dhcp-config)# dns server 172.16.1.103 172.16.2.103`	(Optional) Specifies the IP address of a DNS server that is available to a DHCP client. • One IP address is required; however, you can specify up to eight IP addresses in one command line. • Servers should be listed in the order of preference.

Step 6	**end**
	Example:
	`Device(dhcp-config)# end`
		Returns to privileged EXEC mode.

Configuring the Remote Device to Import DHCP Options

Perform the following task to configure the remote device to import DHCP options:

Note When two servers provide DHCP addresses to a single device configured with **ip address dhcp** on two different interfaces, the imported information is merged and, for those options that take a single value, the last known option value will be used.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip dhcp pool** *pool-name*
4. **network** *network-number* [*mask* | */prefix-length*]
5. **import all**
6. **exit**
7. **interface** *type number*
8. **ip address dhcp**
9. **end**
10. **show ip dhcp import**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip dhcp pool** *pool-name* **Example:** `Device(config)# ip dhcp pool pool1`	Creates a name for the DHCP server address pool and enters DHCP pool configuration mode.

	Command or Action	Purpose
Step 4	**network** *network-number* [*mask* | /*prefix-length*] **Example:** `Device(dhcp-config)# network 172.30.0.0 /16`	Specifies the subnet network number and mask of the DHCP address pool.

Step 5	**import all**
	Example:
	`Device(dhcp-config)# import all`
		Imports DHCP option parameters into the DHCP server database.

Step 6	**exit** **Example:** `Device(dhcp-config)# exit`	Exits DHCP pool configuration mode and enters global configuration mode.
Step 7	**interface** *type number* **Example:** `Device(config)# interface FastEthernet 0/0`	Configures an interface and enters interface configuration mode.
Step 8	**ip address dhcp** **Example:** `Device(config-if)# ip address dhcp`	Specifies that the interface acquires an IP address through DHCP.

Step 9	**end**
	Example:
	`Device(config-if)# end`
		Returns to privileged EXEC mode.

Step 10	**show ip dhcp import** **Example:** `Device# show ip dhcp import`	Displays the options that are imported from the central DHCP server.

Configuring DHCP Address Allocation Using Option 82

Enabling Option 82 for DHCP Address Allocation

By default, the Cisco DHCP server uses information provided by option 82 to allocate IP addresses. If the DHCP address allocation is disabled, perform the task described in this section to reenable this capability.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip dhcp use class**
4. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip dhcp use class** **Example:** `Device(config)# ip dhcp use class`	Controls DHCP classes that are used for address allocation. • This functionality is enabled by default. • Use the **no** form of this command to disable this functionality without deleting the DHCP class configuration.

Step 4	**end**
	Example:
	`Device(config)# end`
		Returns to privileged EXEC mode.

Troubleshooting Tips

If DHCP classes are configured in the pool, but the DHCP server does not use the classes, verify if the **no ip dhcp use class** command was configured.

Defining the DHCP Class and Relay Agent Information Patterns

Before You Begin

You must know the hexadecimal value of each byte location in option 82 to configure the **relay-information hex** command. The option 82 format may vary from product to product. Contact the relay agent vendor for this information.

Perform this task to define the DHCP class and relay agent information patterns:

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip dhcp class** *class-name*
4. **relay agent information**
5. **relay-information hex** *pattern* [*] [**bitmask** *mask*]
6. Repeat Steps 3 through 5 for each DHCP class you need to configure.
7. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip dhcp class** *class-name* **Example:** `Device(config)# ip dhcp class CLASS1`	Defines a DHCP class and enters DHCP class configuration mode.
Step 4	**relay agent information**	Enters relay agent information option configuration mode.

	Command or Action	Purpose
	Example: `Device(dhcp-class)# relay agent information`	• If you omit this step, the DHCP class matches any relay agent information option, whether the relay agent information option value is available or not.
Step 5	**relay-information hex** *pattern* [*] [**bitmask** *mask*] **Example:** `Device(dhcp-class-relayinfo)# relay-information hex 01030a0b0c02050000000123`	(Optional) Specifies a hexadecimal value for full relay information option. • The *pattern* argument creates a pattern that is used to match the DHCP class. • If you omit this step, no pattern is configured and it is considered a match to any relay agent information option value, but the relay information option must be available in the DHCP packet. • You can configure multiple **relay-information hex** commands in a DHCP class.
Step 6	Repeat Steps 3 through 5 for each DHCP class you need to configure.	

Step 7	**end**
	Example:
	`Device(dhcp-class-relayinfo)# end`
		Returns to privileged EXEC mode.

Troubleshooting Tips

Use the **debug ip dhcp server class** command to display the class matching results.

Defining the DHCP Address Pool

Perform this task to define the DHCP address pool:

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip dhcp pool** *name*
4. **network** *network-number* [*mask* | */prefix-length*]
5. **class** *class-name*
6. **address range** *start-ip end-ip*
7. Repeat Steps 5 and 6 for each DHCP class you need to associate with the DHCP pool.
8. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip dhcp pool** *name* **Example:** `Device# ip dhcp pool ABC`	Configures a DHCP address pool on a Cisco IOS DHCP server and enters DHCP pool configuration mode. • Multiple pools can be configured with the same class, eliminating the need to configure the same pattern in multiple pools.
Step 4	**network** *network-number* [*mask* | */prefix-length*] **Example:** `Device(dhcp-config)# network 10.0.20.0`	Configures the subnet and mask for a DHCP address pool on a Cisco IOS DHCP server.

Step 5	**class** *class-name*
	Example:
	`Device(dhcp-config)# class CLASS1`
		Associates a class with a pool and enters DHCP pool class configuration mode.
		• This command also creates a DHCP class if the DHCP class is not yet defined.

	Command or Action	Purpose
Step 6	**address range** *start-ip end-ip* **Example:** `Device(dhcp-pool-class)# address range 10.0.20.1 10.0.20.100`	(Optional) Sets an address range for the DHCP class in a DHCP server address pool. • If this command is not configured for a class, the default value is the entire subnet of the pool. Each class in the DHCP pool is examined for a match in the order configured.
Step 7	Repeat Steps 5 and 6 for each DHCP class you need to associate with the DHCP pool.	

Step 8	**end**
	Example:
	`Device(dhcp-pool-class)# end`
		Returns to privileged EXEC mode.

Configuring a Static Route with the Next-Hop Dynamically Obtained Through DHCP

This task enables static routes to be assigned using a DHCP default gateway as the next-hop device. This behavior was not possible before the introduction of this feature because the gateway IP address is not known until after the DHCP address assignment. You cannot configure a static route with the CLI without knowing that DHCP-supplied address.

The static routes are updated in the routing table when the default gateway is assigned by the DHCP server. The routes remain in the routing table until the DHCP lease expires and then the routes are removed.

When a DHCP client releases an address, the corresponding static route (the route configured using the **ip route** command) is automatically removed from the routing table. If the DHCP router option (option 3 of the DHCP packet) changes during the client renewal, the DHCP default gateway changes to the new IP address supplied after the renewal.

This feature is particularly useful for VPN deployments such as Dynamic Multipoint VPNs (DMVPNs). This feature is useful when a nonphysical interface, such as a multipoint generic routing encapsulation (mGRE) tunnel, is configured on a device and certain traffic must be excluded from entering the tunnel interface.

Before You Begin

Verify all DHCP client and server configuration steps. Ensure that the DHCP client and server are properly defined to supply a DHCP device option 3 of the DHCP packet.

Note

- If the DHCP client is not able to obtain an IP address or the default device IP address, the static route is not installed in the routing table.
- If the lease has expired and the DHCP client cannot renew the address, the DHCP IP address assigned to the client is released and any associated static routes are removed from the routing table.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip route** *prefix mask* {*ip-address* | *interface-type interface-number* [*ip-address*]} **dhcp** [*distance*]
4. **end**
5. **show ip route**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip route** *prefix mask* {*ip-address* | *interface-type interface-number* [*ip-address*]} **dhcp** [*distance*] **Example:** `Device(config)# ip route 192.168.1.1 255.255.255.255 192.168.2.2 dhcp`	Assigns a static route for the default next-hop device when the DHCP server is accessed for an IP address. • If more than one interface is configured to obtain an IP address from a DHCP server, use the **ip route** *prefix mask interface-type interface-number* **dhcp** command for each interface. If the interface is not specified, the route is added to the routing table as soon as any of the interfaces obtain an IP address and a default device.

Step 4	**end**
	Example:
	`Device(config)# end`
		Returns to privileged EXEC mode.

	Command or Action	Purpose
Step 5	**show ip route** **Example:** `Device# show ip route`	(Optional) Displays the current state of the routing table.

Clearing DHCP Server Variables

Perform this task to clear DHCP server variables:

SUMMARY STEPS

1. **enable**
2. **clear ip dhcp binding** {*address* | *****}
3. **clear ip dhcp conflict** {*address* | *****}
4. **clear ip dhcp server statistics**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**clear ip dhcp binding** {*address* | *****} **Example:** `Device# clear ip dhcp binding *`	Deletes an automatic address binding from the DHCP database. • Specifying the *address* argument clears the automatic binding for a specific (client) IP address, whereas specifying an asterisk (*****) clears all automatic bindings.
Step 3	**clear ip dhcp conflict** {*address* | *****} **Example:** `Device# clear ip dhcp conflict 172.16.1.103`	Clears an address conflict from the DHCP database. • Specifying the *address* argument clears the conflict for a specific IP address, whereas specifying an asterisk (*****) clears conflicts for all addresses.
Step 4	**clear ip dhcp server statistics** **Example:** `Device# clear ip dhcp server statistics`	Resets all DHCP server counters to 0.

Configuration Examples for the Cisco IOS DHCP Server

Example: Configuring the DHCP Database Agent

The following example shows how to store bindings on host 172.16.4.253. The file transfer protocol is FTP. The server waits for 2 minutes (120 seconds) before performing database changes.

```
ip dhcp database ftp://user:password@172.16.4.253/router-dhcp write-delay 120
```

Example: Excluding IP Addresses

In the following example, server A and server B service the subnet 10.0.20.0/24. If the subnet is split equally between the two servers, server A is configured to allocate IP addresses 10.0.20.1 to 10.0.20.125 and server B is configured to allocate IP addresses 10.0.20.126 to 10.0.20.254.

Server A

```
ip dhcp excluded-address 10.0.20.126 10.0.20.255
!
ip dhcp pool A
 network 10.0.20.0 255.255.255.0
```

Server B

```
ip dhcp excluded-address 10.0.20.0 10.0.20.125
!
ip dhcp pool B
 network 10.0.20.0 255.255.255.0
```

Example: Configuring DHCP Address Pools

In the following example, three DHCP address pools are created: one in network 172.16.0.0, one in subnetwork 172.16.1.0, and one in subnetwork 172.16.2.0. Attributes from network 172.16.0.0—such as the domain name, Domain Name System (DNS) server, (Network Basic Input/Output System) NetBIOS name server, and NetBIOS node type—are inherited in subnetworks 172.16.1.0 and 172.16.2.0. In each pool, clients are granted 30-day leases and all addresses in each subnetwork, except the excluded addresses, are available to the DHCP server for assigning to clients. The table below lists the IP addresses for the devices in three DHCP address pools.

Table 3: DHCP Address Pool Configuration

Pool 0 (Network 172.16.0.0)	**Pool 1 (Subnetwork 172.16.1.0)**	**Pool 2 (Subnetwork 172.16.2.0)**			
Device	IP Address	Device	IP Address	Device	IP Address

Pool 0 (Network 172.16.0.0)	Pool 1 (Subnetwork 172.16.1.0)	Pool 2 (Subnetwork 172.16.2.0)			
Default devices	—	Default devices	172.16.1.100 172.16.1.101	Default devices	172.16.2.100 172.16.2.101
DNS server	172.16.1.102 172.16.2.102	—	—	—	—
NetBIOS name server	172.16.1.103 172.16.2.103	—	—	—	—
NetBIOS node type	h-node	—	—	—	—

```
ip dhcp database ftp://user:password@172.16.4.253/router-dhcp write-delay 120
ip dhcp excluded-address 172.16.1.100 172.16.1.103
ip dhcp excluded-address 172.16.2.100 172.16.2.103
!
ip dhcp pool 0
 network 172.16.0.0 /16
 domain-name cisco.com
 dns-server 172.16.1.102 172.16.2.102
 netbios-name-server 172.16.1.103 172.16.2.103
 netbios-node-type h-node
!
ip dhcp pool 1
 network 172.16.1.0 /24
 default-router 172.16.1.100 172.16.1.101
 lease 30
!
ip dhcp pool 2
 network 172.16.2.0 /24
 default-router 172.16.2.100 172.16.2.101
 lease 30
```

Example: Configuring a DHCP Address Pool with Multiple Disjoint Subnets

Multiple disjoint subnets in a DHCP pool can be used in any of the following network topologies:

- IP address pooling—The DHCP client and server reside on the same subnet.
- DHCP relay—The DHCP client and DHCP server communicate through a DHCP relay agent where the relay interface is configured with secondary IP addresses.
- Hierarchical DHCP—The DHCP server is configured as the DHCP subnet allocation server. The DHCP client and DHCP subnet allocation server communicate through an on-demand address pool (ODAP) router.

In the following example, one DHCP address pool named pool3 is created; the primary subnet is 172.16.0.0/16, one secondary subnet is 172.16.1.0/24, and the other secondary subnet is 172.16.2.0/24.

- When IP addresses in the primary subnet are exhausted, the DHCP server inspects the secondary subnets in the order in which the subnets were added to the pool.

- When the DHCP server allocates an IP address from the secondary subnet 172.16.1.0/24, the server uses the subnet-specific default device list that consists of IP addresses 172.16.1.100 and 172.16.1.101. However, when the DHCP server allocates an IP address from the subnet 172.16.2.0/24, the server uses the pool-wide list that consists of the four IP addresses from 172.16.0.100 to 172.16.0.103.
- Other attributes from the primary subnet 172.16.0.0/16—such as the domain name, DNS server, NetBIOS name server, and NetBIOS node type—are inherited in both the secondary subnets.
- DHCP clients are granted 30-day leases on IP addresses in the pool. All addresses in each subnet, except the excluded addresses, are available to the DHCP server for assigning to clients.

The table below lists the IP addresses for the devices in the DHCP address pool that consists of three disjoint subnets.

Table 4: DHCP Address Pool Configuration with Multiple Disjoint Subnets

Primary Subnet (172.16.0.0/16)	**First Secondary Subnet (172.16.1.0/24)**	**Second Secondary Subnet (172.16.2.0/24)**			
Device	IP Address	Device	IP Address	Device	IP Address
Default devices	172.16.0.100 172.16.0.101 172.16.0.102 172.16.0.103	Default devices	172.16.1.100 172.16.1.101	Default devices	172.16.0.100 172.16.0.101 172.16.0.102 172.16.0.103
DNS server	172.16.1.102 172.16.2.102	—	—	—	—
NetBIOS name server	172.16.1.103 172.16.2.103	—	—	—	—
NetBIOS node type	h-node	—	—	—	—

```
ip dhcp database ftp://user:password@172.16.4.253/router-dhcp write-delay 120
ip dhcp excluded-address 172.16.0.100 172.16.1.103
ip dhcp excluded-address 172.16.1.100 172.16.1.101
!
ip dhcp pool pool3
 network 172.16.0.0 /16
 default-router 172.16.0.100 172.16.2.101 172.16.0.102 172.16.0.103
 domain-name cisco.com
 dns-server 172.16.1.102 172.16.2.102
 netbios-name-server 172.16.1.103 172.16.2.103
 netbios-node-type h-node
 lease 30
!
 network 172.16.1.0 /24 secondary
  override default-router 172.16.1.100 172.16.1.101
  end
!
 network 172.16.2.0 /24 secondary
```

Example: Configuring Manual Bindings

The following example shows how to create a manual binding for a client named example1.abc.com that sends a client identifier in the DHCP packet. The MAC address of the client is 02c7.f800.0422 and the IP address of the client is 172.16.2.254.

```
ip dhcp pool pool1
 host 172.16.2.254
 client-identifier  01b7.0813.8811.66
 client-name example1
```

The following example shows how to create a manual binding for a client named example2.abc.com that does not send a client identifier in the DHCP packet. The MAC address of the client is 02c7.f800.0422 and the IP address of the client is 172.16.2.253.

```
ip dhcp pool pool2
 host 172.16.2.253
 hardware-address 02c7.f800.0422 ethernet
 client-name example1
```

Because attributes are inherited, the two preceding configurations are equivalent to the following:

```
ip dhcp pool pool1
 host 172.16.2.254 255.255.255.0
 hardware-address 02c7.f800.0422 ieee802
 client-name client1
 default-router 172.16.2.100 172.16.2.101
 domain-name abc.com
 dns-server 172.16.1.102 172.16.2.102
 netbios-name-server 172.16.1.103 172.16.2.103
 netbios-node-type h-node
```

Example: Configuring Static Mapping

The following example shows how to restart the DHCP server, configure the pool, and specify the URL where the static mapping text file is stored:

```
no service dhcp
service dhcp
ip dhcp pool abcpool
origin file tftp://10.1.0.1/staticfilename
```

Note The static mapping text file can be copied to flash memory on the device and served by the TFTP process of the device. In this case, the IP address in the original file line must be an address owned by the device and one additional line of configuration is required on the device:**tftp-server flash** *static-filename*.

Example: Configuring the Option to Ignore all BOOTP Requests

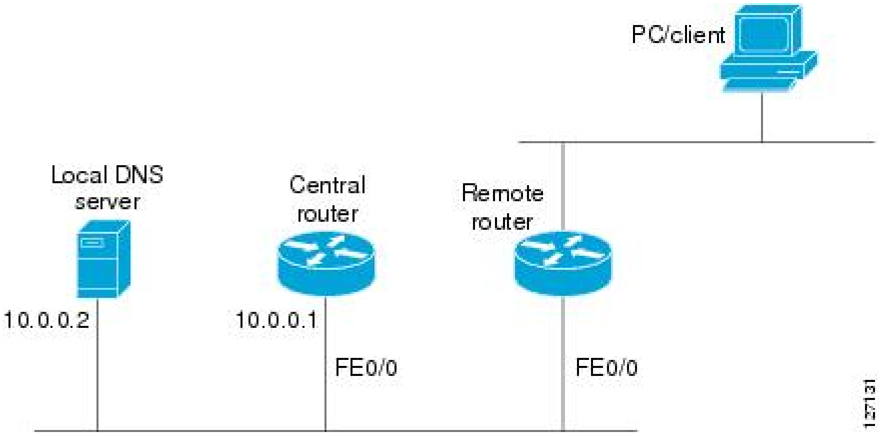
The following example shows two DHCP pools that are configured on the device and that the device's DHCP server is configured to ignore all received BOOTP requests. If a BOOTP request is received from subnet 10.0.18.0/24, the request will be dropped by the device (because the **ip helper-address** command is not configured). If there is a BOOTP request from subnet 192.168.1.0/24, the request will be forwarded to 172.16.1.1 via the **ip helper-address** command.

```
version 12.2
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname Router
!
ip subnet-zero
!
ip dhcp bootp ignore
!
ip dhcp pool ABC
   network 192.168.1.0 255.255.255.0
   default-router 192.168.1.3
   lease 2
!
ip dhcp pool DEF
   network 10.0.18.0 255.255.255.0
!
ip cef
!
interface FastEthernet0/0
 no ip address
 shutdown
 duplex half
!
interface Ethernet1/0
 ip address 10.0.18.68 255.255.255.0
 duplex half
!
interface Ethernet1/1
 ip address 192.168.1.1 255.255.255.0
 ip helper-address 172.16.1.1
 duplex half
!
interface Ethernet1/2
 shutdown
 duplex half
!
interface Ethernet1/3
 no ip address
 shutdown
 duplex half
!
interface FastEthernet2/0
 no ip address
 shutdown
 duplex half
!
ip route 172.16.1.1 255.255.255.255 e1/0
no ip http server
no ip pim bidir-enable
!
call rsvp-sync
!
mgcp profile default
!
dial-peer cor custom
!
gatekeeper
 shutdown
!
line con 0
line aux 0
line vty 0 4
!
end
```

Example: Importing DHCP Options

The following example shows how to configure a remote and central server to support the importing of DHCP options. The central server is configured to automatically update DHCP options, such as DNS and WINS addresses, within the DHCP pools. In response to a DHCP request from a local client behind CPE equipment, the remote server can request or "import" these option parameters from the centralized server. See the figure below for a diagram of the network topology.

Figure 2: DHCP Example Network Topology



Central Device

```
!do not assign this range to DHCP clients
ip dhcp-excluded address 10.0.0.1 10.0.0.5
!
ip dhcp pool central
! Specifies network number and mask for DHCP clients
 network 10.0.0.0 255.255.255.0
! Specifies the domain name for the client
 domain-name central
! Specifies DNS server that will respond to DHCP clients when they need to correlate host
! name to ip address
 dns-server 10.0.0.2
!Specifies the NETBIOS WINS server
 netbios-name-server 10.0.0.2
!
interface FastEthernet0/0
 ip address 10.0.0.1 255.255.255.0
 duplex auto
 speed auto
```

Remote Device

```
ip dhcp pool client
! Imports DHCP option parameters into DHCP server database
 import all
 network 172.16.2.254 255.255.255.0
!
interface FastEthernet0/0
 ip address dhcp
 duplex auto
 speed auto
```

Example: Configuring DHCP Address Allocation Using Option 82

This example shows how to configure two DHCP classes. CLASS1 defines the group of DHCP clients whose address requests contain the relay agent information option with the specified hexadecimal values. CLASS2 defines the group of DHCP clients whose address requests contain the configured relay agent information suboptions. CLASS3 has no pattern configured and is treated as a “match to any” class. This type of class is useful for specifying a “default” class.

The subnet of pool ABC has been divided into three ranges without further subnetting the 10.0.20.0/24 subnet. If there is a DHCP Discover message from the 10.0.20.0/24 subnet with option 82 matching that of class CLASS1, an available address in the range from 10.0.20.1 to 10.0.20.100 will be allocated. If there is no free address in CLASS1’s address range, the DHCP Discover message will be matched against CLASS2, and so on.

Therefore, each class in the DHCP pool will be examined for a match in the order configured by the user. In pool ABC, the order of matching is CLASS1, CLASS2, and finally CLASS3. In pool DEF, class CLASS2 does not have any address range configured. By default, the address range for a particular class is the pool’s entire subnets. Therefore, clients matching CLASS2 may be allocated addresses from 10.0.20.1 to 10.0.20.254.

Multiple pools can be configured with the same class, eliminating the need to configure the same patterns in multiple pools. For example, there may be a need to specify that one or more pools must be used only to service a particular class of devices (for example, cable modems and IP phones).

```
! Defines the DHCP classes and relay information patterns
ip dhcp class CLASS1
 relay agent information
  relay-information hex 01030a0b0c02050000000123
  relay-information hex 01030a0b0c02*
  relay-information hex 01030a0b0c02050000000000 bitmask 0000000000000000000000FF
ip dhcp class CLASS2
 relay agent information
  relay-information hex 01040102030402020102
  relay-information hex 01040101030402020102
ip dhcp class CLASS3
 relay agent information
! Associates the DHCP pool with DHCP classes
ip dhcp pool ABC
 network 10.0.20.0 255.255.255.0
 class CLASS1
  address range 10.0.20.1 10.0.20.100
class CLASS2
  address range 10.0.20.101 10.0.20.200
 class CLASS3
  address range 10.0.20.201 10.0.20.254
ip dhcp pool DEF
 network 172.64.2.2 255.255.255.0
 class CLASS1
  address range 172.64.2.3 172.64.2.10
 class CLASS2
```

Example: Configuring a Static Route with the Next-Hop Dynamically Obtained Through DHCP

The following example shows how to configure two Ethernet interfaces to obtain the next-hop device IP address from the DHCP server:

```
ip route 10.10.10.0 255.255.255.0 dhcp 200
ip route 10.10.20.1 255.255.255.255 ethernet 1 dhcp
```

Additional References for Cisco IOS DHCP Server

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Command List, All Releases
DHCP commands: complete command syntax, command mode, command history, defaults, usage guidelines, and examples	Cisco IOS IP Addressing Services Command Reference
DHCP conceptual information	“DHCP Overview” module
DHCP relay agent configuration	“Configuring the Cisco IOS DHCP Relay Agent” module
DHCP server on-demand address pools	“Configuring the DHCP Server On-Demand Address Pool Manager” module
DHCP client configuration	“Configuring the Cisco IOS DHCP Client” module
DHCP advanced features	“Configuring DHCP Services for Accounting and Security” module
DHCP enhancements for edge-session management	“Configuring DHCP Enhancements for Edge-Session Management” module
DHCP options	“DHCP Options” appendix in the *Network Registrar User’s Guide*, Release 6.1.1

RFCs

RFCs	Title
RFC 951	*Bootstrap Protocol (BOOTP)*
RFC 1542	*Clarifications and Extensions for the Bootstrap Protocol*
RFC 2131	*Dynamic Host Configuration Protocol*
RFC 2132	*DHCP Options and BOOTP Vendor Extensions*

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for the Cisco IOS DHCP Server

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to . An account on Cisco.com is not required.

Table 5: Feature Information for the Cisco IOS DHCP Server

Feature Name	Releases	Feature Configuration Information
DHCP Server Import All Enhancement	Cisco IOS XE Release 3.2SE	The DHCP Server Import All Enhancement feature is an enhancement to the **import all** command. Prior to this feature, the options imported through the **import all** command were overwritten by those imported by another subsystem. Through this feature, options imported by multiple subsystems can coexist in the DHCP address pool. When the session is terminated or the lease is released, the imported options are cleared.

Feature Name	Releases	Feature Configuration Information
DHCP Server Multiple Subnet	Cisco IOS XE Release 3.2SE	The DHCP Server Multiple Subnet feature enables multiple subnets to be configured under the same DHCP address pool. The following commands were introduced or modified: **network**(DHCP), **override default-router**.
DHCP Server Option to Ignore all BOOTP Requests	Cisco IOS XE Release 3.2SE	The DHCP Server Option to Ignore all BOOTP Requests feature allows the Cisco IOS DHCP server to selectively ignore and not reply to received Bootstrap Protocol (BOOTP) request packets. The following command was introduced or modified: **ip dhcp bootp ignore**.

CHAPTER 3

Configuring the DHCP Server On-Demand Address Pool Manager

The Cisco IOS XE DHCP server on-demand address pool (ODAP) manager is used to centralize the management of large pools of addresses and simplify the configuration of large networks. ODAP provides a central management point for the allocation and assignment of IP addresses. When a Cisco IOS XE router is configured as an ODAP manager, pools of IP addresses are dynamically increased or reduced in size depending on the address utilization level. A DHCP pool configured in the router can also be used as an IP address pooling mechanism. The IP address pooling mechanism is configured in the router to specify the source of IP addresses for PPP peers.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for Configuring the DHCP Server On-Demand Address Pool Manager

Before you configure the ODAP manager, you should understand the concepts documented in the “DHCP Overview” module.

You must configure standard Multiprotocol Label Switching (MPLS) Virtual Private Networks (VPNs) unless you intend to use non-MPLS VPNs.

In order for the IP address pooling mechanism to work correctly, the VPN routing and forwarding instance (VRF) of the PPP session must match that configured on the pool. Typically this matching is done either by configuring the **ip vrf forwarding** *vrf-name* command on the virtual template interface, or if AAA is used to authorize the PPP user, it can be part of the user’s profile configuration.

Note For a default session, you can apply access interface VRF and VRF service simultaneously.

Restrictions for Configuring the DHCP Server On-Demand Address Pool Manager

- The **ip dhcp excluded-address** global configuration command cannot be used to exclude addresses from VRF associated pools.
- The **vrf** DHCP pool configuration command is currently not supported for host pools.
- Attribute inheritance is not supported on VRF pools.
- A router can be configured as a subnet allocation server and a DHCP server at the same time with one restriction: separate pools must be created for subnet allocation and IP address assignment. An address pool cannot be used by DHCP for both subnet allocation and IP address assignment.

Information About the DHCP Server On-Demand Address Pool Manager

ODAP Manager Operation

ODAPs enable pools of IP addresses to be dynamically increased or reduced in size depending on the address utilization level. Once configured, the ODAP is populated with one or more subnets leased from a source server and is ready to serve address requests from DHCP clients or from PPP sessions. The source server can be a remote DHCP server or a RADIUS server (via AAA). Currently, only the Cisco Access Registrar RADIUS server supports ODAPs. Subnets can be added to the pool when a certain utilization level (high utilization mark) is achieved. When the utilization level falls below a certain level (low utilization mark), a subnet can be returned to the server from which it was originally leased. Summarized routes for each leased subnet must be inserted or removed from the related VRF with each addition or removal of subnets into the ODAP.

ODAPs support address assignment using DHCP for customers using private addresses such as in MPLS VPNs. VPNs allow the possibility that two pools in separate networks can have the same address space, with private network addresses, served by the same DHCP server. These IP addresses can be distinguished by a VPN identifier to help select the VPN to which the client belongs.

Each ODAP is configured and associated with a particular MPLS VPN. Cisco IOS XE software also supports non-MPLS VPN address pools by adding pool name support to the **peer default ip address dhcp-pool** *pool-name*command.

For MPLS VPNs, each VPN is associated with one or more VRFs. The VRF is a key element in the VPN technology because it maintains the routing information that defines a customer VPN site. This customer site is attached to a provider edge (PE) router. A VRF consists of an IP routing table, a derived Cisco Express Forwarding (CEF) table, a set of interfaces that use the forwarding table, and a set of rules and routing protocol parameters that control the information that is included in the routing table.

A PPP session belonging to a specific VPN is only allocated an address from the ODAP associated with that VPN. These PPP sessions are terminated on a Virtual Home Gateway (VHG)/PE router where the ODAP is configured. The VHG/PE router maps the remote user to the corresponding MPLS VPNs.

For PPP sessions, individual address allocation from an ODAP follows a First Leased subnet First (FLF) policy. FLF searches for a free address beginning on the first leased subnet, followed by a search on the second leased subnet if no free address is available in the first subnet, and so on. This policy provides the benefit of grouping the leased addresses over time to a set of subnets, which allows an efficient subnet release and route summarization.

However, the FLF policy differs from the normal DHCP address selection policy. Normal DHCP address selection takes into account the IP address of the receiving interface or the gateway address if it is nonzero. To support both policies, the DHCP server needs to be able to distinguish between a normal DHCP address request and an address request for a PPP client. The ODAP manager uses an IP address pooling mechanism for PPP that allows the DHCP server to distinguish between a normal DHCP address request and a request from a PPP client.

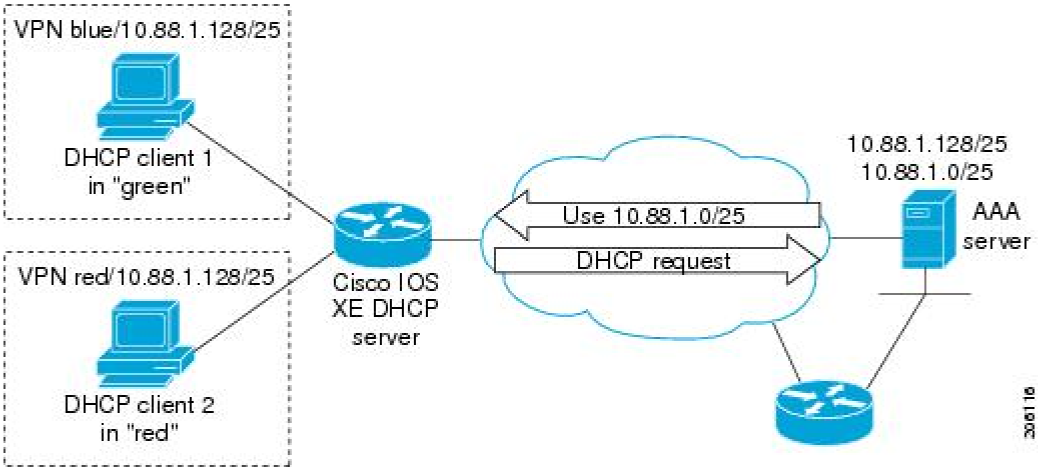
Subnet release from an ODAP follows a Last Leased subnet First (LLF) policy, which prefers the last leased subnet to be released first. This LLF policy searches for a releasable subnet (a subnet with no addresses currently being leased) starting with the last leased subnet. If a releasable subnet is found (candidate subnet), it is released, and the summarized route for that subnet is removed. If more than one releasable subnet exists at that time, only the most recently allocated is released. If there are no releasable subnets, no action is taken. If by releasing the candidate subnet, the high utilization mark is reached, the subnet is not released. The first leased subnet is never released (regardless of the instantaneous utilization level) until the ODAP is disabled.

When a DHCP pool receives multiple subnets from an upstream DHCP server, an address from each subnet is automatically configured on the client connected interface so that the addresses within the subnets can be requested by DHCP clients.

The first address in the first subnet is automatically assigned to the primary address on the interface. The first address of each subsequent subnet is assigned to secondary addresses on the interface. In addition, as client addresses are reclaimed, the count of lease addresses for that subnet is decremented. Once a lease counter for a subnet reaches zero (that is, lease expiry), the subnet is returned to the pool. The previous address on the interface is removed and the first secondary address on the interface is promoted as the primary address of the interface.

The figure below shows an ODAP manager configured on the Cisco IOS XE DHCP server. The ODAP requests an initial pool from the AAA server. Clients make DHCP requests and the DHCP server fulfills requests from the pool. When the utilization rate meets 90 percent, the ODAP manager requests an expansion and the AAA server allocates another subnet from which the ODAP manager can allocate addresses.

Figure 3: ODAP Address Pool Management for MPLS VPNs



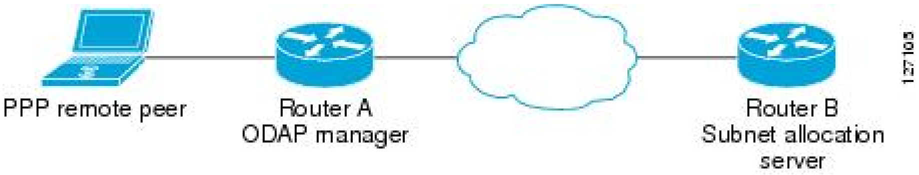
Subnet Allocation Server Operation

You can also configure the ODAP manager to allocate subnets instead of individual IP addresses.

This capability allows the network operator to configure a Cisco IOS XE router as a subnet allocation server. The operation of a subnet allocation server is similar to the operation of a DHCP server, except that pools of subnets are created and assigned instead of pools of IP addresses. Subnet allocation pools are created and configured by using the **subnet prefix-length** command in DHCP pool configuration mode. The size of each assigned or allocated subnet is set by the *prefix-length* argument, using standard Common InterDomain Routing (CIDR) bit count notation to determine the number of addresses that are configured in each subnet lease.

When a DHCP server is configured as a subnet allocation server, it provides subnet allocation pools for ODAP manager allocation. In the figure below, Router B is the subnet allocation server and allocates subnets to the ODAP manager based on the demand for IP addresses and subnet availability. Router B is configured to allocate an initial amount of address space in the form of subnets to the ODAP manager. The size of the subnet allocated by the ODAP manager is determined by the subnet size that is configured on the subnet allocation server. The ODAP manager will then assign addresses to clients from these subnets and allocate more subnets as the need for address space increases.

Figure 4: Subnet Allocation Server Topology



When the ODAP manager allocates a subnet, the subnet allocation server creates a subnet binding. This binding is stored in the DHCP database for as long as the ODAP manager requires the address space. The binding is removed and the subnet is returned to the subnet pool only when the ODAP manager releases the subnet as address space utilization decreases.

The subnet allocation server can also be associated with a VRF. A VRF consists of an IP routing table, a derived CEF table, a set of interfaces that use the forwarding table, and a set of rules and routing protocol parameters that control the information that is included in the routing table.

Benefits of Using ODAPs

Efficient Address Management

The ODAP manager allows customers to optimize their use of IP addresses, thus conserving address space.

Efficient Route Summarization and Update

The ODAP manager inserts a summarized route when a subnet is added to the ODAP.

Multiple VRF and Independent Private Addressing Support

The ODAP manager automatically injects subnet routing information into the appropriate VRF.

How to Configure the DHCP Server On-Demand Address Pool Manager

Specifying DHCP ODAPs as the Global Default Mechanism

Perform this task to specify that the global default mechanism to use is on-demand address pooling.

IP addressing allows configuration of a global default address pooling mechanism. The DHCP server needs to be able to distinguish between a normal DHCP address request and an address request for a PPP client.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip address-pool dhcp-pool**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip address-pool dhcp-pool** **Example:** `Router(config)# ip address-pool dhcp-pool`	Specifies on-demand address pooling as the global default IP address mechanism. • For remote access (PPP) sessions into MPLS VPNs, IP addresses are obtained from locally configured VRF-associated DHCP pools. **Note** You must use two separate DHCP address pools for global configuration mode and VRF mode. If you change a global configuration pool to VRF mode, then all the IP addresses in the global pool will be lost. Hence make sure that you have a VRF pool for an interface in order to add an interface under a VRF.

Defining DHCP ODAPs on an Interface

Perform this task to configure on-demand address pools on an interface.

The interface on-demand address pooling configuration overrides the global default mechanism on that interface.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **peer default ip address dhcp-pool** [*pool-name*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Router(config)# interface Virtual-Template1`	Specifies the interface and enters interface configuration mode.
Step 4	**peer default ip address dhcp-pool** [*pool-name*] **Example:** `Router(config-if)# peer default ip address dhcp-pool mypool`	Specifies an IP address from an on-demand address pool to be returned to a remote peer connecting to this interface. • The *pool-name* argument supports non-MPLS VPNs and is mandatory if the session is not associated with any VRF. Multiple pool names can be accepted but must be separated by white space.

Configuring the DHCP Pool as an ODAP

Perform this task to configure a DHCP address pool as an ODAP pool.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip dhcp pool** *pool-name*
4. **vrf** *name*
5. **origin** {**dhcp** | **aaa**| **ipcp**} [**subnet size initial** *size* [**autogrow** *size*]]
6. **utilization mark low** *percentage-number*
7. **utilization mark high** *percentage-number*
8. **end**
9. **show ip dhcp pool** [*pool-name*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable**	Enables privileged EXEC mode.

	Command or Action	Purpose
	Example: `Router> enable`	• Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip dhcp pool** *pool-name* **Example:** `Router(config)# ip dhcp pool red-pool`	Configures a DHCP address pool on a Cisco IOS XE DHCP server and enters DHCP pool configuration mode.
Step 4	**vrf** *name* **Example:** `Router(dhcp-config)# vrf red`	(Optional) Associates the address pool with a VRF name. • Only use this command for MPLS VPNs.
Step 5	**origin** {**dhcp** | **aaa**| **ipcp**} [**subnet size initial** *size* [**autogrow** *size*]] **Example:** `Router(dhcp-config)# origin dhcp subnet size initial /16 autogrow /16`	Configures an address pool as an on-demand address pool. • If you do not configure the pool as an autogrow pool, the pool will not request additional subnets if one subnet is already in the pool. • You can enter size as either the subnet mask (nnnn.nnnn.nnnn.nnnn) or prefix size (/nn). The valid values are /0 and /4 to /30. • When a DHCP pool receives multiple subnets from an upstream DHCP server, an address from each subnet is automatically configured on the client connected interface so that the addresses within the subnets can be requested by DHCP clients. The first address in the first subnet is automatically assigned to the primary address on the interface. The first address of each subsequent subnet is assigned to secondary addresses on the interface. In addition, as client addresses are reclaimed, the count of lease addresses for that subnet is decremented. Once a lease counter for a subnet reaches zero (that is, lease expiry), the subnet is returned to the pool. The previous address on the interface is removed and the first secondary address on the interface is promoted as the primary address of the interface. • If the **origin aaa** option is configured, AAA must be configured.
Step 6	**utilization mark low** *percentage-number* **Example:** `Router(dhcp-config)# utilization mark low 40`	Sets the low utilization mark of the pool size. • This command cannot be used unless the **autogrow** *size* option of the **origin** command is configured. • The default value is 0 percent.

	Command or Action	Purpose
Step 7	**utilization mark high** *percentage-number* **Example:** `Router(dhcp-config)# utilization mark high 60`	Sets the high utilization mark of the pool size. • This command cannot be used unless the **autogrow** *size* option of the **origin** command is configured. • The default value is 100 percent.

Step 8	**end**
	Example:
	`Router(dhcp-config)# end`
		Returns to global configuration mode.

Step 9	**show ip dhcp pool** [*pool-name*] **Example:** `Router# show ip dhcp pool`	(Optional) Displays information about DHCP address pools. • Information about the primary and secondary interface address assignment is also displayed.

Configuring ODAPs to Obtain Subnets Through IPCP Negotiation

Perform this task to configure your router to use subnets obtained through IP Control Protocol (IPCP) negotiation.

You can assign IP address pools to customer premises equipment (CPE) devices, which, in turn, assign IP addresses to the CPE and to a DHCP pool. This functionality has three requirements:

- The Cisco IOS XE CPE device must be able to request and use the subnet.
- The RADIUS server (via AAA) must be able to provide that subnet and insert the framed route into the proper VRF table.
- The PE router must be able to facilitate providing the subnet through (IPCP) negotiation.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip dhcp pool** *pool-name*
4. **import all**
5. **origin ipcp**
6. **exit**
7. **interface** *type number*
8. **ip address pool** *pool-name*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip dhcp pool** *pool-name* **Example:** `Router(config)# ip dhcp pool red-pool`	Configures a DHCP address pool on a Cisco IOS XE DHCP server and enters DHCP pool configuration mode.

Step 4	**import all**
	Example:
	`Router(dhcp-config)# import all`
		Imports option parameters into the Cisco IOS XE DHCP server database.

Step 5	**origin ipcp** **Example:** `Router(dhcp-config)# origin ipcp`	Configures an address pool as an on-demand address pool using IPCP as the subnet allocation protocol.
Step 6	**exit** **Example:** `Router(dhcp-config)# exit`	Exits DHCP pool configuration mode.
Step 7	**interface** *type number* **Example:** `Router(config)# interface GigabitEthernet 0/0/0`	Specifies the interface and enters interface configuration mode.
Step 8	**ip address pool** *pool-name* **Example:** `Router(config-if)# ip address pool red-pool`	Specifies that the interface IP address will be automatically configured from the named pool, when the pool is populated with a subnet from IPCP.

Configuring AAA

Perform this task to configure AAA.

To allow ODAP to obtain subnets from the AAA server, the AAA client must be configured on the VHG/PE router.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **aaa new-model**
4. **aaa authorization configuration default group radius**
5. Do one of the following:
    - **aaa accounting network default start-stop group radius**
    - or
    - **aaa accounting network default stop-only group radius**
6. **aaa session-id common**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**aaa new-model** **Example:** `Router(config)# aaa new-model`	Enables AAA access control.

	Command or Action	Purpose
Step 4	**aaa authorization configuration default group radius** **Example:** `Router(config)# aaa authorization configuration default group radius`	Downloads static route configuration information from the AAA server using RADIUS.

Step 5	Do one of the following:
	• **aaa accounting network default start-stop group radius**
	• or
	• **aaa accounting network default stop-only group radius**
	Example:
	`Router(config)# aaa accounting network default start-stop group radius`
	Example:
	Example:
	`Router(config)# aaa accounting network default stop-only group radius`
		Enables AAA accounting of requested services for billing or security purposes when you use RADIUS. Sends a “start” accounting notice at the beginning of a process.
		or
		Enables AAA accounting of requested services for billing or security purposes when you use RADIUS. Sends a “stop” accounting notice at the end of the requested user process.

Step 6	**aaa session-id common** **Example:** `Router(config)# aaa session-id common`	Ensures that the same session ID will be used for each AAA accounting service type within a call.

Configuring RADIUS

ODAP AAA Profile

The AAA server sends the RADIUS Cisco AV pair attributes “pool-addr” and “pool-mask” to the Cisco IOS XE DHCP server in the access request and access accept. The pool-addr attribute is the IP address and the pool-mask attribute is the network mask (for example, pool-addr=192.168.1.0 and pool-mask=255.255.0.0). Together, these attributes make up a network address (address/mask) that is allocated by the AAA server to the Cisco IOS XE DHCP server.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip radius source-interface** *subinterface-name*
4. **radius-server host** *ip-address* **auth-port** *port-number* **acct-port** *port-number*
5. **radius server attribute 32 include-in-access-req**
6. **radius server attribute 44 include-in-access-req**
7. **radius-server vsa send accounting**
8. **radius-server vsa send authentication**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.

Step 3	**ip radius source-interface** *subinterface-name*
	Example:
	`Router(config)#`
	`ip radius source-interface GigabitEthernet0/0/0`
		Forces RADIUS to use the IP address of a specified interface for all outgoing RADIUS packets.

Step 4	**radius-server host** *ip-address* **auth-port** *port-number* **acct-port** *port-number*
	Example:
	`Router(config)#`
	`radius-server host 172.16.1.1 auth-port 1645 acct-port 1646`
		Specifies a RADIUS server host.
		• The *ip-address* argument specifies the IP address of the RADIUS server host.

Step 5	**radius server attribute 32 include-in-access-req**
	Example:
	`Router(config)#`
	`radius server attribute 32 include-in-access-req`
		Sends RADIUS attribute 32 (NAS-Identifier) in an access request or accounting request.

	Command or Action	Purpose

Step 6	**radius server attribute 44 include-in-access-req**
	Example:
	`Router(config)#`
	`radius server attribute 44 include-in-access-req`
		Sends RADIUS attribute 44 (Accounting Session ID) in an access request or accounting request.

Step 7	**radius-server vsa send accounting**
	Example:
	`Router(config)#`
	`radius-server vsa send accounting`
		Configures the network access server (NAS) to recognize and use vendor-specific accounting attributes.

Step 8	**radius-server vsa send authentication**
	Example:
	`Router(config)#`
	`radius-server vsa send authentication`
		Configures the NAS to recognize and use vendor-specific authentication attributes.

What to Do Next

Disabling ODAPs

This task shows how to disable an ODAP from a DHCP pool.

When an ODAP is disabled, all leased subnets are released. If active PPP sessions are using addresses from the released subnets, those sessions will be reset. DHCP clients leasing addresses from the released subnets will not be able to renew their leases.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip dhcp pool** *pool-name*
4. **no origin** {**dhcp**| **aaa**| **ipcp**}

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable**	Enables privileged EXEC mode.

	Command or Action	Purpose
	Example: `Router> enable`	- Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip dhcp pool** *pool-name* **Example:** `Router(config)# ip dhcp pool red-pool`	Configures a DHCP address pool on a Cisco IOS XE DHCP server and enters DHCP pool configuration mode.

Step 4	**no origin** {**dhcp**| **aaa**| **ipcp**}
	Example:
	`Router(dhcp-config)# no origin dhcp`
		Disables the ODAP.

Verifying ODAP Operation

Perform this task to verify ODAP operation.

SUMMARY STEPS

1. **enable**
2. **show ip dhcp pool** [*pool-name*] The following output is for two DHCP pools: Green and Global. Pool Green is configured with a high utilization mark of 50 and a low utilization mark of 30. The pool is also configured to obtain more subnets when the high utilization mark is reached (autogrow). The Subnet size field indicates the values configured in the **origin** command as the initial and incremental subnet sizes that would be requested by the pool named Green. The Total addresses field is a count of all the usable addresses in the pool. The Leased addresses field is a total count of how many bindings were created from the pool. The Pending event field shows subnet request, which means that a subnet request is pending for the pool. The subnet request was scheduled because the Leased addresses count has exceeded the high utilization level of the pool. Subnets currently added to pool Green are shown in sequence. The Current index column shows the address that would be allocated next from this subnet. The IP address range column shows the range of usable addresses from the subnet. The Leased addresses column shows individual count of bindings created from each subnet. Three subnets are currently added to pool Green. The first two subnets have used all their addresses and thus the Current index is showing 0.0.0.0. Notice that pool Green and pool Global can have the same subnet (172.16.0.1-172.16.0.6) because pool Green is configured to be in VRF Green, while pool Global is configured to be in the global address space.
3. **show ip dhcp binding** The following output shows the bindings from pool Green. The Type field shows On-demand, which indicates that the address binding was created for a PPP session. The Lease expiration field shows Infinite, which means that the binding is valid as long as the session is up. If a subnet must be released back to the leasing server while the session is still up, the session is reset so that it will be forced to obtain a new IP address. The Hardware address column for an On-demand entry shows the identifier for the session as detected by PPP. There are no bindings shown under the Bindings from all pools not associated with VRF field because the Global pool has not allocated any addresses.

DETAILED STEPS

Step 1 **enable**

Enables privileged EXEC mode. Enter your password if prompted.

Example:

```
Router> enable
```

Step 2 **show ip dhcp pool** [*pool-name*] The following output is for two DHCP pools: Green and Global. Pool Green is configured with a high utilization mark of 50 and a low utilization mark of 30. The pool is also configured to obtain more subnets when the high utilization mark is reached (autogrow). The Subnet size field indicates the values configured in the **origin** command as the initial and incremental subnet sizes that would be requested by the pool named Green. The Total addresses field is a count of all the usable addresses in the pool. The Leased addresses field is a total count of how many bindings were created from the pool. The Pending event field shows subnet request, which means that a subnet request is pending for the pool. The subnet request was scheduled because the Leased addresses count has exceeded the high utilization level of the pool. Subnets currently added to pool Green are shown in sequence. The Current index column shows the address that would be allocated next from this subnet. The IP address range column shows the range of usable addresses from the subnet. The Leased addresses column shows individual count of bindings created from each subnet. Three subnets are currently added to pool Green. The first two subnets have used all their addresses and thus the Current index is showing 0.0.0.0. Notice that pool Green and pool Global can have the same subnet (172.16.0.1-172.16.0.6) because pool Green is configured to be in VRF Green, while pool Global is configured to be in the global address space.

Example:

```
Router# show ip dhcp pool
Pool Green :
 Utilization mark (high/low)    : 50 / 30
 Subnet size (first/next)       : 24 / 24 (autogrow)
 VRF name                       : Green
 Total addresses                : 18
 Leased addresses               : 13
 Pending event                  : subnet request
 3 subnets are currently in the pool :
 Current index        IP address range                    Leased addresses
 0.0.0.0              172.16.0.1       - 172.16.0.6        6
 0.0.0.0              172.16.0.9       - 172.16.0.14       6
 172.16.0.18          172.16.0.17      - 172.16.0.22       1
Pool Global :
 Utilization mark (high/low)    : 100 / 0
 Subnet size (first/next)       : 24 / 24 (autogrow)
 Total addresses                : 6
 Leased addresses               : 0
 Pending event                  : none
 1 subnet is currently in the pool :
 Current index        IP address range                    Leased addresses
 172.16.0.1           172.16.0.1       - 172.16.0.6        0
```

Step 3 **show ip dhcp binding** The following output shows the bindings from pool Green. The Type field shows On-demand, which indicates that the address binding was created for a PPP session. The Lease expiration field shows Infinite, which means that the binding is valid as long as the session is up. If a subnet must be released back to the leasing server while the session is still up, the session is reset so that it will be forced to obtain a new IP address. The Hardware address column for an On-demand entry shows the identifier for the session as detected by PPP. There are no bindings shown under the Bindings from all pools not associated with VRF field because the Global pool has not allocated any addresses.

Example:

```
Router# show ip dhcp binding

Bindings from all pools not associated with VRF:
IP address       Hardware address        Lease expiration        Type
Bindings from VRF pool Green:
IP address       Hardware address        Lease expiration        Type
172.16.0.1       5674.312d.7465.7374.    Infinite                On-demand
                 2d38.3930.39
172.16.0.2       5674.312d.7465.7374.    Infinite                On-demand
                 2d38.3839.31
172.16.0.3       5674.312d.7465.7374.    Infinite                On-demand
                 2d36.3432.34
172.16.0.4       5674.312d.7465.7374.    Infinite                On-demand
                 2d38.3236.34
172.16.0.5       5674.312d.7465.7374.    Infinite                On-demand
                 2d34.3331.37
172.16.0.6       5674.312d.7465.7374.    Infinite                On-demand
                 2d37.3237.39
172.16.0.9       5674.312d.7465.7374.    Infinite                On-demand
                 2d39.3732.36
172.16.0.10      5674.312d.7465.7374.    Infinite                On-demand
                 2d31.3637
172.16.0.11      5674.312d.7465.7374.    Infinite                On-demand
                 2d39.3137.36
172.16.0.12      5674.312d.7465.7374.    Infinite                On-demand
                 2d37.3838.30
172.16.0.13      5674.312d.7465.7374.    Infinite                On-demand
                 2d32.3339.37
172.16.0.14      5674.312d.7465.7374.    Infinite                On-demand
                 2d31.3038.31
172.16.0.17      5674.312d.7465.7374.    Infinite                On-demand
```

```
                 2d38.3832.38
172.16.0.18      5674.312d.7465.7374.    Infinite               On-demand
                 2d32.3735.31
```

Troubleshooting Tips

If DHCP classes are configured in the pool, but the DHCP server does not use the classes, verify if the **no ip dhcp use class** command was configured.

Monitoring and Maintaining the ODAP

This task shows how to monitor and maintain the ODAP.

Note the following behavior for the **clear ip dhcp binding**, **clear ip dhcp conflict**, and **clear ip dhcp subnet** commands:

- If you do not specify the **pool** *pool-name* option and an IP address is specified, it is assumed that the IP address is an address in the global address space and will look among all the non-VRF DHCP pools for the specified binding/conflict/subnet.
- If you do not specify the **pool** *pool-name* option and the * option is specified, it is assumed that all automatic/ or on-demand bindings/conflicts/subnets in all VRF and non-VRF pools are to be deleted.
- If you specify both the **pool** *pool-name* option and the * option, all automatic or on-demand bindings/conflicts/subnets in the specified pool only will be cleared.
- If you specify the **pool** *pool-name* option and an IP address, the specified binding/conflict or the subnet containing the specified IP address will be deleted from the specified pool.

SUMMARY STEPS

1. **enable**
2. **clear ip dhcp** [**pool** *pool-name*] **binding** {* | *address*}
3. **clear ip dhcp** [**pool** *pool-name*] **conflict** {* | *address*}
4. **clear ip dhcp** [**pool** *pool-name*] **subnet**{*| *address*}
5. **debug dhcp details**
6. **debug ip dhcp server events**
7. **show ip dhcp import**
8. **show ip interface** [*type number*]
9. **show ip dhcp pool** *pool-name*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable**	Enables privileged EXEC mode.

	Command or Action	Purpose
	Example: `Router> enable`	• Enter your password if prompted.

Step 2	**clear ip dhcp** [**pool** *pool-name*] **binding** {***** | *address*}
	Example:
	`Router# clear ip dhcp binding *`
		Deletes an automatic address binding or objects from a specific pool from the DHCP server database.

Step 3	**clear ip dhcp** [**pool** *pool-name*] **conflict** {***** | *address*}
	Example:
	`Router# clear ip dhcp conflict *`
		Clears an address conflict or conflicts from a specific pool from the DHCP server database.

Step 4	**clear ip dhcp** [**pool** *pool-name*] **subnet**{*****| *address*}
	Example:
	`Router# clear ip dhcp subnet *`
		Clears all currently leased subnets in the named DHCP pool or all DHCP pools if *name* is not specified.

Step 5	**debug dhcp details** **Example:** `Router# debug dhcp details`	Monitors the subnet allocation/releasing in the on-demand address pools.
Step 6	**debug ip dhcp server events** **Example:** `Router# debug ip dhcp server events`	Reports DHCP server events, like address assignments and database updates.
Step 7	**show ip dhcp import** **Example:** `Router# show ip dhcp import`	Displays the option parameters that were imported into the DHCP server database.
Step 8	**show ip interface** [*type number*] **Example:** `Router# show ip interface`	Displays the usability status of interfaces configured for IP.
Step 9	**show ip dhcp pool** *pool-name* **Example:** `Router# show ip dhcp pool green`	Displays DHCP address pool information.

Configuring DHCP ODAP Subnet Allocation Server Support

Configuring a Global Subnet Pool on a Subnet Allocation Server

Global Subnet Pools

Global subnet pools are created in a centralized network. The ODAP manager allocates subnets from the subnet allocation server based on subnet availability. When the ODAP manager allocates a subnet, the subnet allocation server creates a subnet binding. This binding is stored in the DHCP database for as long as the ODAP manager requires the address space. The binding is destroyed and the subnet is returned to the subnet pool only when the ODAP manager releases the subnet as address space utilization decreases.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip dhcp pool** *pool-name*
4. **network** *network-number* [*mask*| / *prefix-length*]
5. **subnet prefix-length** *prefix-length*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip dhcp pool** *pool-name* **Example:** `Router(config)# ip dhcp pool GLOBAL-POOL`	Enters DHCP pool configuration mode and specifies the subnet pool name.
Step 4	**network** *network-number* [*mask*| / *prefix-length*]	Configures the subnet number and mask for a DHCP address pool on a DHCP server.

	Command or Action	Purpose
	Example: `Router(dhcp-config)# network 10.0.0.0 255.255.255.0`	• The subnet mask or the prefix length can be configured in this step. The values that can be configured for the *prefix-length* argument follow CIDR bit count notation. The forward slash character must be used when configuring the *prefix-length* argument.
Step 5	**subnet prefix-length** *prefix-length* **Example:** `Router(dhcp-config)# subnet prefix-length 8`	Configures the subnet prefix length. The range of the *prefix-length* argument is from 1 to 31. • This command configures the number of IP addresses that each subnet is configured to allocate from the subnet pool. The values that can be configured for the *prefix-length* argument follow CIDR bit count notation format.

Configuring a VRF Subnet Pool on a Subnet Allocation Server

VRF Subnet Pools

A subnet allocation server can be configured to assign subnets from VRF subnet allocation pools for MPLS VPN clients. VPN routes between the ODAP manager and the subnet allocation server are configured based on VRF name or VPN ID configuration. The VRF and VPN ID are configured to maintain routing information that defines customer VPN sites. The VPN customer site (or Customer Equipment [CE]) is attached to a provider edge (PE) router. The VRF is used to specify the VPN and consists of an IP routing table, a derived Cisco Express Forwarding (CEF) table, a set of interfaces that use the forwarding table, and a set of rules and routing protocol parameters that control the information that is included in the routing table.

Before You Begin

The VRF name and VPN ID can be configured on the ODAP manager and subnet allocation server prior to the configuration of the subnet allocation pool.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip dhcp pool** *pool-name*
4. **vrf** vrf-name
5. **network** *network-number* [*mask* |*/prefix-length*]
6. **subnet prefix-length** *prefix-length*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip dhcp pool** *pool-name* **Example:** `Router(config)# ip dhcp pool VRF-POOL`	Enters DHCP pool configuration mode and specifies the subnet pool name.
Step 4	**vrf** vrf-name **Example:** `Router(dhcp-config)# vrf RED`	Associates the on-demand address pool with a VPN routing and forwarding (VRF) instance name (or tag). • The **vrf**keyword and *vrf-name* argument are used to specify the VPN for the VRF pool. The *vrf-name* argument must match the VRF name (or tag) that is configured for the client.
Step 5	**network** *network-number* [*mask* |*/prefix-length*] **Example:** `Router(dhcp-config)# network 10.1.1.0 /24`	Configures the subnet number and mask for a DHCP address pool on a Cisco IOS XE DHCP server. • The subnet mask or the prefix length can be configured in this step. The values that can be configured for the *prefix-length*argument follow CIDR bit count notation. The forward slash character must be used when configuring the *prefix-length* argument.
Step 6	**subnet prefix-length** *prefix-length* **Example:** `Router(dhcp-config)# subnet prefix-length 16`	Configures the subnet prefix length. The range of the *prefix-length* argument is from 1 to 31. • This command configures the number of IP addresses that each subnet is configured to allocate from the subnet pool. The values that can be configured for the *prefix-length*argument follow CIDR bit count notation format.

Using a VPN ID to Configure a VRF Subnet Pool on a Subnet Allocation Server

Perform this task to configure a VRF subnet pool, using a VPN ID, on a subnet allocation server.

VRF Pools and VPN IDs

A subnet allocation server can also be configured to assign subnets from VPN subnet allocation pools based on the VPN ID of a client. The VPN ID (or Organizational Unique Identifier [OUI]) is a unique identifier assigned by the IEEE.

Before You Begin

The VRF name and VPN ID can be configured on the ODAP manager and subnet allocation server prior to the configuration of the subnet allocation pool.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip vrf vrf-name**
4. **rd** *route-distinguisher*
5. **route-target both** route-target-number
6. **vpn id** vpn-id
7. **exit**
8. **ip dhcp pool** pool-name
9. **vrf** vrf-name
10. **network** *network-number* [*mask* |*/prefix-length*]
11. **subnet prefix-length** *prefix-length*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip vrf vrf-name** **Example:** `Router(config)#ip vrf RED`	Creates a VRF routing table and specifies the VRF name (or tag). • The *vrf-name* argument must match the VRF name that is configured for the client and VRF pool in Step 9.
Step 4	**rd** *route-distinguisher*	Creates routing and forwarding tables for a VRF instance created in Step 3.

	Command or Action	Purpose
	Example: `Router(config-vrf)# rd 100:1`	• There are two formats for configuring the route distinguisher argument. It can be configured in the as-number:network number (ASN:nn) format, as shown in the example, or it can be configured in the IP address:network number format (IP-address:nn).
Step 5	**route-target both** route-target-number **Example:** `Router(config-vrf)# route-target both 100:1`	Creates a route-target extended community for the VRF instance that was created in Step 3. • The **both** keyword is used to specify which routes should be imported and exported to the target VPN extended community (or the ODAP manager in this configuration). • The *route-target-number*argument follows the same format as the *route-distinguisher* argument in Step 4. These two arguments must match.
Step 6	**vpn id** vpn-id **Example:** `Router(config-vrf)# vpn id 1234:123456`	Configures the VPN ID. • This command is only used if the client (ODAP manager) is also configured with or assigned a VPN ID.
Step 7	**exit** **Example:** `Router(config-vrf)# exit`	Exits VRF configuration mode and enters global configuration mode.
Step 8	**ip dhcp pool** pool-name **Example:** `Router(config)# ip dhcp pool VPN-POOL`	Enters DHCP pool configuration mode and specifies the subnet pool name. • The **VRF**keyword and *vrf-name* argument are used to specify the VPN for the VRF pool. The *vrf-name* argument must match the VRF name (or tag) that is configured for the client.
Step 9	**vrf** vrf-name **Example:** `Router(dhcp-config)#vrf RED`	Associates the on-demand address pool with a VRF instance name. • The *vrf-name* argument must match the *vrf-name* argument that was configured in Step 3.
Step 10	**network** *network-number* [*mask* |*/prefix-length*] **Example:** `Router(dhcp-config)# network 192.168.0.0 /24`	Configures the subnet number and mask for a DHCP address pool on a Cisco IOS XE DHCP server. • The subnet mask or the prefix length can be configured in this step. The values that can be configured for the *prefix-length*argument follow CIDR bit count notation. The forward slash character must be used when configuring the *prefix-length* argument.
Step 11	**subnet prefix-length** *prefix-length*	Configures the subnet prefix length.

	Command or Action	Purpose
	Example: `Router(dhcp-config)# subnet prefix-length 16`	• The range of the *prefix-length* argument is from 1 to 31. • This command configures the number of IP addresses that each subnet is configured to allocate from the subnet pool. The values that can be configured for the *prefix-length* argument follow CIDR bit count notation format.

Verifying Subnet Allocation and DHCP Bindings

Perform this task to verify subnet allocation and DHCP bindings. The **show**commands need not be entered in any specific order.

The **show ip dhcp pool** and **show ip dhcp binding**commands need not be issued together or even in the same session because there are differences in the information that is provided. These commands, however, can be used to display and verify subnet allocation and DHCP bindings. The **show running-config | begin dhcp** command is used to display the local configuration of DHCP and the configuration of the **subnet prefix-length** command.

SUMMARY STEPS

1. **enable**
2. **show running-config | begin dhcp**
3. **show ip dhcp pool** [*pool-name*]
4. **show ip dhcp binding** [*ip-address*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**show running-config | begin dhcp** **Example:** `Router# show running-config | begin dhcp`	Displays the local configuration of the router. • The configuration of the **subnet prefix-length** command will be displayed under the DHCP pools, for which subnet lease allocation has been configured. The subnet allocation size will be shown, following this command, in CIDR bit count notation. • The sample output is filtered with the **begin** keyword to start displaying output at the DHCP section of the running configuration.

	Command or Action	Purpose
Step 3	**show ip dhcp pool** [*pool-name*] **Example:** `Router# show ip dhcp pool`	Displays information about DHCP pools. • This command can be used to verify subnet allocation pool configuration on both the subnet allocation server and the ODAP manager. • The output of this command displays specific address pool information, including the name of the pool, utilization of address space, subnet size, number of total addresses, number of leased address, and pending events.
Step 4	**show ip dhcp binding** [*ip-address*] **Example:** `Router# show ip dhcp binding`	Displays information about DHCP bindings. • This command can be used to display subnet allocation to DHCP binding mapping information. • The output from this command displays binding information for individual IP address assignment and allocated subnets. The output that is generated for DHCP IP address assignment and subnet allocation is almost identical, except that subnet leases display an IP address followed by the subnet mask (which shows the size of the allocated subnet). Bindings for individual IP address display only an IP address and are not followed by a subnet mask.

Troubleshooting the DHCP ODAP Subnet Allocation Server

Perform this task to troubleshoot the DHCP ODAP subnet allocation server.

SUMMARY STEPS

1. **enable**
2. **debug dhcp** [**detail**]
3. **debug ip dhcp server** {**events** | **packets** | **linkage**}

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**debug dhcp** [**detail**] **Example:** `Router# debug dhcp detail`	Displays debugging information about DHCP client activities and monitors the status of DHCP packets. • This example is issued with the **detail**keyword on the ODAP manager. The **detail**keyword is used to display and monitor the lease entry structure

	Command or Action	Purpose
		of the client and the state transitions of lease entries. This command also displays the values of the op, htype, hlen, hops, server identifier option, xid, secs, flags, ciaddr, yiaddr, siaddr, and giaddr fields of the DHCP packet that are shown in addition to the length of the options field.

Step 3	**debug ip dhcp server** {**events** | **packets** | **linkage**}
	Example:
	`Router# debug ip dhcp server packets`
	Example:
	`Router# debug ip dhcp server events`
		Enables DHCP server debugging.
		• This example is issued with the **packets** and events keywords on the subnet allocation server. The output displays lease transition and reception, as well as database information.

Configuration Examples for DHCP Server On-Demand Address Pool Manager

Specifying DHCP ODAPs as the Global Default Mechanism Example

The following example shows how to configure the on-demand address pooling mechanism to be used to serve an address request from a PPP client.

```
ip address-pool dhcp-pool
!
ip dhcp pool Green-pool
```

Defining DHCP ODAPs on an Interface Example

The following example shows how to configure an interface to retrieve an IP address from an on-demand address pool:

```
interface Virtual-Template 1
 ip vrf forwarding green
 ip unnumbered loopback1
 ppp authentication chap
 peer default ip address dhcp-pool
!
```

Configuring the DHCP Pool as an ODAP Example

The following example shows two ODAPs configured to obtain their subnets from an external DHCP server:

```
Router# show running-config
Building configuration...
Current configuration : 3943 bytes
!
version 12.2
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname Router
!
no logging console
enable password password
!
username vpn_green_net1 password 0 lab
username vpn_red_net1 password 0 lab
ip subnet-zero
!
ip dhcp pool green_pool
   vrf Green
   utilization mark high 60
   utilization mark low 40
   origin dhcp subnet size initial /24 autogrow /24
!
ip dhcp pool red_pool
   vrf Red
   origin dhcp
!
ip vrf Green
 rd 200:1
 route-target export 200:1
 route-target import 200:1
!
ip vrf Red
 rd 300:1
 route-target export 300:1
 route-target import 300:1
ip cef
ip address-pool dhcp-pool
!
no voice hpi capture buffer
no voice hpi capture destination
!
interface Loopback0
 ip address 192.0.2.1 255.255.255.255
!
interface Loopback1
 ip vrf forwarding Green
 ip address 192.0.2.2 255.255.255.255
!
interface Loopback2
 ip vrf forwarding Red
 ip address 192.0.2.3 255.255.255.255
!
interface ATM2/0
 no ip address
 shutdown
 no atm ilmi-keepalive
!
interface ATM3/0
 no ip address
 no atm ilmi-keepalive
!
interface Ethernet4/0
 ip address 192.0.2.4 255.255.255.224
 duplex half
!
interface Ethernet4/1
 ip address 192.0.2.5 255.255.255.0
 duplex half
!
interface Ethernet4/2
 ip address 192.0.2.6 255.255.255.0
 duplex half
 tag-switching ip
!
interface Virtual-Template1
 ip vrf forwarding Green
 ip unnumbered Loopback1
 ppp authentication chap
!
interface Virtual-Template2
 ip vrf forwarding Green
 ip unnumbered Loopback1
 ppp authentication chap
!
interface Virtual-Template3
 ip vrf forwarding Green
 ip unnumbered Loopback1
 ppp authentication chap
!
interface Virtual-Template4
 ip vrf forwarding Red
 ip unnumbered Loopback2
 ppp authentication chap
!
interface Virtual-Template5
 ip vrf forwarding Red
 ip unnumbered Loopback2
 ppp authentication chap
!
interface Virtual-Template6
 ip vrf forwarding Red
 ip unnumbered Loopback2
 ppp authentication chap
!
router ospf 100
 log-adjacency-changes
 redistribute connected
 network 209.165.200.225 255.255.255.224 area 0
 network 209.165.200.226 255.255.255.224 area 0
 network 209.165.200.227 255.255.255.224 area 0
!
router bgp 100
 no synchronization
 bgp log-neighbor-changes
 neighbor 192.0.2.1 remote-as 100
 neighbor 192.0.2.2 update-source Loopback0
 !
 address-family ipv4 vrf Red
 redistribute connected
 redistribute static
 no auto-summary
 no synchronization
 network 110.0.0.0
 exit-address-family
 !
 address-family ipv4 vrf Green
 redistribute connected
 redistribute static
 no auto-summary
 no synchronization
 network 100.0.0.0
 exit-address-family
 !
 address-family vpnv4
 neighbor 3.3.3.3 activate
 neighbor 3.3.3.3 send-community extended
 exit-address-family
!
ip classless
ip route 172.19.0.0 255.255.0.0 10.0.105.1
no ip http server
ip pim bidir-enable
!
call rsvp-sync
!
mgcp profile default
!
dial-peer cor custom
!
gatekeeper
 shutdown
!
line con 0
 exec-timeout 0 0
line aux 0
line vty 0 4
 password password
 login
!
end
```

Configuring the DHCP Pool as an ODAP for Non-MPLS VPNs Example

The following example shows how to configure an interface to retrieve an IP address from an on-demand address pool. In this example, two non-VRF ODAPs are configured. There are two virtual templates and two DHCP address pools, usergroup1 and usergroup2. Each virtual template interface is configured to obtain IP addresses for the peer from the associated address pool.

```
!
ip dhcp pool usergroup1
 origin dhcp subnet size initial /24 autogrow /24
 lease 0 1
!
ip dhcp pool usergroup2
 origin dhcp subnet size initial /24 autogrow /24
 lease 0 1
!
interface virtual-template1
 ip unnumbered loopback1
 peer default ip address dhcp-pool usergroup1
!
interface virtual-template2
 ip unnumbered loopback1
 peer default ip address dhcp-pool usergroup2
```

IPCP Subnet Mask Delivery Example

The following example shows a Cisco 827 router configured to use IPCP subnet masks:

```
Router# show running-config
 Building configuration...

 Current configuration :1479 bytes
 !
 version 12.2
 no service single-slot-reload-enable
 no service pad
 service timestamps debug datetime msec
 service timestamps log uptime
 no service password-encryption
```

```
!
hostname Router
!
no logging buffered
logging rate-limit console 10 except errors
!
username 6400-nrp2 password 0 lab
ip subnet-zero
ip dhcp smart-relay
!
ip dhcp pool IPPOOLTEST
   import all
   origin ipcp
!
no ip dhcp-client network-discovery
!
interface Ethernet0
 ip address pool IPPOOLTEST
 ip verify unicast reverse-path
 hold-queue 32 in
!
interface ATM0
 no ip address
 atm ilmi-keepalive
 bundle-enable
 dsl operating-mode auto
 hold-queue 224 in
!
interface ATM0.1 point-to-point
 pvc 1/40
  no ilmi manage
  encapsulation aal5mux ppp dialer
  dialer pool-member 1
 !
!
interface Dialer0
 ip unnumbered Ethernet0
 ip verify unicast reverse-path
 encapsulation ppp
 dialer pool 1
 dialer-group 1
 no cdp enable
 ppp authentication chap callin
 ppp chap hostname Router
 ppp chap password 7 12150415
 ppp ipcp accept-address
 ppp ipcp dns request
 ppp ipcp wins request
 ppp ipcp mask request
!
ip classless
ip route 0.0.0.0 0.0.0.0 Dialer0
no ip http server
!
dialer-list 1 protocol ip permit
line con 0
 exec-timeout 0 0
 transport input none
 stopbits 1
line vty 0 4
 login
!
scheduler max-task-time 5000
end
```

Configuring AAA and RADIUS Example

The following example shows one pool “Green” configured to obtain its subnets from the AAA (RADIUS) server located at IP address 172.16.1.1:

```
!
aaa new-model
!
aaa authorization configuration default group radius
aaa accounting network default start-stop group radius
aaa session-id common
!
ip subnet-zero
!
ip dhcp ping packets 0
!
ip dhcp pool Green
   vrf Green
   utilization mark high 50
   utilization mark low 30
   origin aaa subnet size initial /28 autogrow /28
!
ip vrf Green
 rd 300:1
 route-target export 300:1
 route-target import 300:1
!
interface Ethernet1/1
 ip address 172.16.1.12 255.255.255.0
 duplex half
!
interface Virtual-Template1
 ip vrf forwarding Green
 no ip address
!
ip radius source-interface Ethernet1/1
!
!IP address of the RADIUS server host
radius-server host 172.16.1.1 auth-port 1645 acct-port 1646
radius-server retransmit 3
radius-server attribute 32 include-in-access-req
radius-server attribute 44 include-in-access-req
radius-server key cisco
radius-server vsa send accounting
radius-server vsa send authentication
```

Configuring a Global Pool on a Subnet Allocation Server Example

The following example shows how to configure a router to be a subnet allocation server and create a global subnet allocation pool named “GLOBAL-POOL” that allocates subnets from the 10.0.0.0/24 network. The use of the **subnet prefix-length** command in this example configures the size of each subnet that is allocated from the subnet pool to support 254 host IP addresses.

```
ip dhcp pool GLOBAL-POOL
 network 10.0.0.0 255.255.255.0
 subnet prefix-length 24
!
```

Configuring a VRF Pool on a Subnet Allocation Server Example

The following example shows how to configure a router to be a subnet allocation server and create a VRF subnet allocation pool named "VRF-POOL" that allocates subnets from the 172.16.0.0/16 network and configures the VPN to match the VRF named "RED." The use of the **subnet prefix-length** command in this example configures the size of each subnet that is allocated from the subnet pool to support 62 host IP addresses.

```
 ip dhcp pool VRF-POOL
 vrf RED
 network 172.16.0.0 /16
 subnet prefix-length 26
!
```

Using a VPN ID to Configure a VRF Pool on a Subnet Allocation Server Example

The following example shows how to configure a router to be a subnet allocation server and create a VRF subnet allocation pool named "VRF-POOL" that allocates subnets from the 192.168.0.0/24 network and configures the VRF named "RED." The VPN ID must match the unique identifier that is assigned to the client site. The route target and route distinguisher are configured in the as-number:network-number format. The route target and route distinguisher must match. The configuration of the **subnet prefix-length** command in this example configures the size of each subnet that is allocated from the subnet pool to support 30 host IP addresses.

```
ip vrf RED
 rd 100:1
 route-target both 100:1
 vpn id 1234:123456
 exit
 ip dhcp pool VPN-POOL
  vrf RED
  network 192.168.0.0 /24
  subnet prefix-length /27
  exit
```

Verifying Local Configuration on a Subnet Allocation Server Example

The following example is output from the **show running-config**command. This command can be used to verify the local configuration on a subnet allocation server. The output from this command displays the configuration of the **subnet prefix-length** command under the DHCP pool named "GLOBAL-POOL." The total size of the subnet allocation pool is set to 254 addresses with the **network** command. The use of the **subnet prefix-length** command configures this pool to allocate a subnet that will support 254 host IP addresses. Because the total pool size supports only 254 addresses, only one subnet can be allocated from this pool.

```
Router# show running-config | begin dhcp
ip dhcp pool GLOBAL-POOL
   network 10.0.0.0 255.255.255.0
   subnet prefix-length 24
!
```

Verifying Address Pool Allocation Information Example

The following examples are output from the **show ip dhcp pool**command. This command can be used to verify subnet allocation pool configuration on the subnet allocation server and the ODAP manager. The output from this command displays information about the address pool name, utilization level, configured subnet size, total number of addresses (from subnet), pending events, and specific subnet lease information.

The following sample output shows that the configured subnet allocation size is /24 (254 IP addresses), that there is a pending subnet allocation request, and that no subnets are in the pool:

```
Router# show ip dhcp pool ISP-1
Pool ISP-1 :
 Utilization mark (high/low)    :100 / 0
 Subnet size (first/next)       :24 / 24 (autogrow)
 Total addresses                :0
 Leased addresses               :0
 Pending event                  :subnet request
 0 subnet is currently in the pool
```

The next example shows that the configured subnet allocation size is /24 (254 IP address), the configured VRF name is “RED” and a subnet containing 254 IP addresses has been allocated but no IP addresses have been leased from the subnet:

```
Router# show ip dhcp pool SUBNET-ALLOC
Pool SUBNET-ALLOC :
 Utilization mark (high/low)    :100 / 0
 Subnet size (first/next)       :24 / 24 (autogrow)
 VRF name                       :RED
 Total addresses                :254
 Leased addresses               :0
 Pending event                  :none
 1 subnet is currently in the pool :
 Current index        IP address range                    Leased addresses
 10.0.0.1              10.0.0.1          - 10.0.0.254         0
```

Verifying Subnet Allocation and DHCP Bindings Example

The following example is from the **show ip dhcp binding** command. This command can be used to display subnet allocation to DHCP binding mapping information. The output of this command shows the subnet lease to MAC address mapping, the lease expiration, and the lease type (subnet lease bindings are configured to be automatically created and released by default). The output that is generated for DHCP IP address assignment and subnet allocation is almost identical, except that subnet leases display an IP address followed by the subnet mask (which shows the size of the allocated subnet) in CIDR bit count notation. Bindings for individual IP address display only an IP address and are not followed by a subnet mask.

```
Router# show ip dhcp binding
Bindings from all pools not associated with VRF:
IP address          Client-ID/              Lease expiration        Type
                    Hardware address/
                    User name
10.0.0.0/26         0063.6973.636f.2d64.    Mar 29 2003 04:36 AM    Automatic
                    656d.6574.6572.2d47.
                    4c4f.4241.4c
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Command List, All Releases
DHCP commands: complete command syntax, command modes, command history, defaults, usage guidelines, and examples.	Cisco IOS IP Addressing Services Command Reference
DHCP conceptual information	"DHCP Overview" module
DHCP server configuration	"Configuring the Cisco IOS XE DHCP Server" module
DHCP server on-demand address pools	"Configuring the DHCP Server On-Demand Address Pool Manager" module
DHCP relay agent configuration	"Configuring the Cisco IOS XE DHCP Relay Agent" module
DHCP advanced features	"Configuring DHCP Services for Accounting and Security" module

RFCs

RFCs	Title
RFC 2131	Dynamic Host Configuration Protocol
RFC 2132	DHCP Options and BOOTP Vendor Extensions

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for the DHCP Server On-Demand Address Pool Manager

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to . An account on Cisco.com is not required.

Table 6: Feature Information for the DHCP On-Demand Address Pool Manager

Feature Name	Releases	Feature Configuration Information
DHCP Server On-Demand Address Pool Manager for Non-MPLS VPNs	12.2(15)T 12.2(28)SB 12.2(33)SRC	This feature was enhanced to provide ODAP support for non-MPLS VPNs. The following command was modified by this feature: **peer default ip address**.
DHCP ODAP Server Support	12.2(15)T 12.2(28)SB 12.2(33)SRC	This feature introduces the capability to configure a DHCP server (or router) as a subnet allocation server. This capability allows the Cisco IOS DHCP server to be configured with a pool of subnets for lease to ODAP clients. The following commands were introduced or modified by this feature: **show ip dhcp binding**, **subnet prefix-length**.

Feature Name	Releases	Feature Configuration Information
DHCP Server On-Demand Address Pool Manager	12.2(8)T 12.28(SB) 12.2(33)SRC	The ODAP manager is used to centralize the management of large pools of addresses and simplify the configuration of large networks. ODAP provides a central management point for the allocation and assignment of IP addresses. When a Cisco IOS router is configured as an ODAP manager, pools of IP addresses are dynamically increased or reduced in size depending on the address utilization level. The following commands were introduced or modified: **aaa session-id**, **clear ip dhcp binding**, **clear ip dhcp conflict**, **clear ip dhcp subnet**, **ip address-pool**, **ip address pool**, **ip dhcp aaa default username**, **origin**, **peer default ip address**, **show ip dhcp pool**, **utilization mark high**, **utilization mark low**, **vrf**.

Glossary

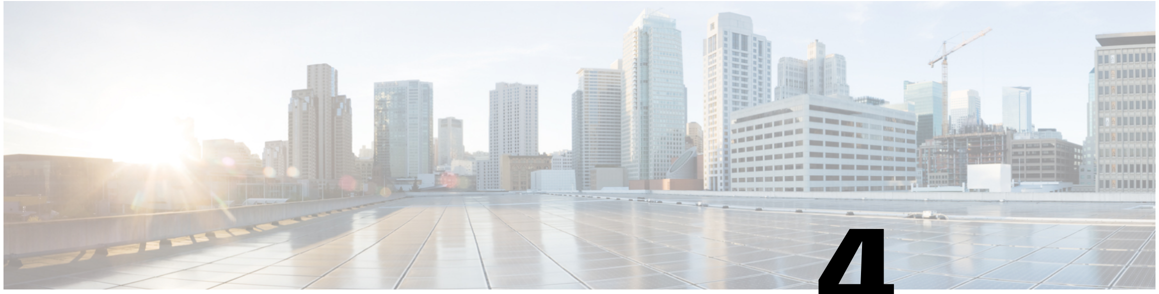
client—A host trying to configure its interface (obtain an IP address) using DHCP or BOOTP protocols.

DHCP—Dynamic Host Configuration Protocol.

DHCP options and suboptions—Configuration parameters and other control information are carried in tagged data items that are stored in the options field of the DHCP message. Options provide a method of appending additional information. Vendors that want to provide additional information to their client not designed into the protocol can use options.

giaddr—Gateway IP address field of the DHCP packet. The giaddr provides the DHCP server with information about the IP address subnet in which the client resides. The giaddr also provides the DHCP server with an IP address where the DHCP response messages can be sent.

relay agent—A router that forwards DHCP and BOOTP messages between a server and a client on different subnets.



CHAPTER 4

Configuring the Cisco IOS DHCP Relay Agent

All Cisco devices that run Cisco software include a DHCP server and the relay agent software. A DHCP relay agent is any host or IP device that forwards DHCP packets between clients and servers. This module describes the concepts and tasks needed to configure the Cisco IOS DHCP relay agent.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for Configuring the Cisco IOS DHCP Relay Agent

- Before you configure the DHCP relay agent, you should understand the concepts documented in the “DHCP Overview” module.
- The Cisco IOS DHCP server and relay agent are enabled by default. You can verify whether they have been disabled by checking your configuration file. If they have been disabled, the **no service dhcp**

command will appear in the configuration file. Use the **service dhcp** command to reenable the functionality if necessary.

- The Cisco IOS DHCP relay agent will be enabled on an interface only when the **ip helper-address** command is configured. This command enables the DHCP broadcast to be forwarded to the configured DHCP server.

Information About the DHCP Relay Agent

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 device, where IP datagrams are switched between networks somewhat transparently. By contrast, relay agents receive DHCP messages and then generate a new DHCP message to send out on another interface. The relay agent sets the gateway IP address (giaddr field of the DHCP packet) and, if configured, adds the relay agent information option (option82) in the packet and forwards it to the DHCP server. The reply from the server is forwarded back to the client after removing option 82.

The DHCP relay agent supports the use of unnumbered interfaces. An unnumbered interface can “borrow” the IP address of another interface already configured on the device, which conserves network and address space. For DHCP clients connected though the unnumbered interfaces, the DHCP relay agent automatically adds a static host route once the DHCP client obtains an address, specifying the unnumbered interface as the outbound interface. The route is automatically removed once the lease time expires or when the client releases the address.

How to Configure the DHCP Relay Agent

Specifying the Packet Forwarding Address

Perform this task to configure the DHCP relay agent to forward packets to a DHCP server.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **ip helper-address** *address*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Device(config)# interface GigabitEthernet0/0/0`	Configures an interface and enters interface configuration mode.
Step 4	**ip helper-address** *address* **Example:** `Device(config-if)# ip helper-address 172.16.1.2`	Forwards UPD broadcasts, including BOOTP and DHCP. • The *address*argument can be a specific DHCP server address, or it can be the network address if other DHCP servers are on the destination network segment. Using the network address enables other servers to respond to DHCP requests. • If you have multiple servers, you can configure one helper address for each server.

Configuring Support for the Relay Agent Information Option

Automatic DHCP address allocation is typically based on an IP address, which may be either the gateway IP address (giaddr field of the DHCP packet) or the incoming interface IP address. In some networks, additional information may be required to further determine the IP addresses that need to be allocated. By using the relay agent information option (option 82), the Cisco IOS relay agent can include additional information about itself when forwarding client-originated DHCP packets to a DHCP server. Cisco software supports this functionality by using the **ip dhcp relay information option** command. The relay agent will automatically add the circuit identifier suboption and the remote ID suboption to the relay agent information option and forward them to the DHCP server.

The DHCP server can use this information to assign IP addresses, perform access control, and set quality of service (QoS) and security policies (or other parameter-assignment policies) for each subscriber of a service provider network.

The figure below shows how the relay agent information option is inserted into the DHCP packet as follows:

1. The DHCP client generates a DHCP request and broadcasts it on the network.

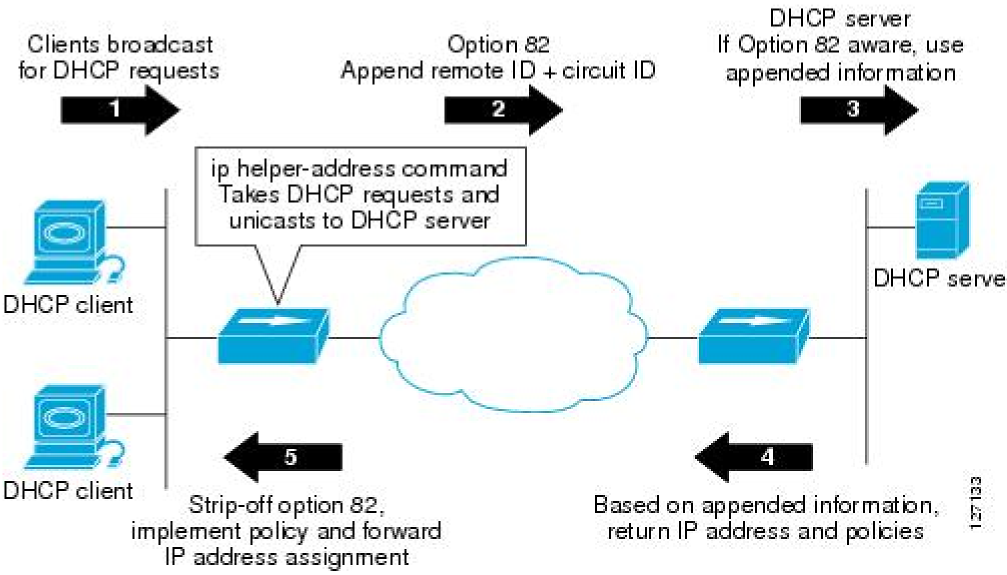
2 The DHCP relay agent intercepts the broadcast DHCP request packet and inserts the relay agent information option (option 82) into the packet. The relay agent information option contains related suboptions.

3 The DHCP relay agent unicasts the DHCP packet to the DHCP server.

4 The DHCP server receives the packet, uses the suboptions to assign IP addresses and other configuration parameters to the packet, and forwards the packet back to the client.

5 The suboption fields are stripped off of the packet by the relay agent while forwarding the packet to the client.

Figure 5: Operation of the Relay Agent Information Option


Clients broadcast for DHCP requests
1
Option 82
Append remote ID + circuit ID
2
DHCP server
If Option 82 aware, use appended information
3
ip helper-address command
Takes DHCP requests and unicasts to DHCP server
DHCP client
DHCP server
DHCP client
5
4
Strip-off option 82, implement policy and forward IP address assignment
Based on appended information, return IP address and policies
127133

A DHCP relay agent may receive a message from another DHCP relay agent that already contains relay information. By default, the relay information from the previous relay agent is replaced. If this behavior is not suitable for your network, you can use the **ip dhcp relay information policy** {**drop** | **keep** | **replace**} global configuration command to change it.

To ensure the correct operation of the reforwarding policy, disable the relay agent information check by using the **no ip dhcp relay information check** global configuration command.

Before You Begin

It is important to understand how DHCP options work. See the "DHCP Overview" module for more information.

Note

- If the **ip dhcp relay information** command is configured in global configuration mode but not configured in interface configuration mode, the global configuration is applied to all interfaces.
- If the **ip dhcp relay information** command is configured in both global configuration mode and interface configuration mode, the interface configuration command takes precedence over the global configuration command. However, the global configuration is applied to interfaces without the interface configuration.
- If the **ip dhcp relay information** command is not configured in global configuration mode but is configured in interface configuration mode, only the interface with the configuration option applied is affected. All other interfaces are not impacted by the configuration.

See the "Configuring Relay Agent Information Option Support per Interface" section for more information on per-interface support for the relay agent information option.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip dhcp relay information option**
4. **ip dhcp relay information check**
5. **ip dhcp relay information policy** {**drop** | **keep** | **replace**}
6. **ip dhcp relay information trust-all**
7. **end**
8. **show ip dhcp relay information trusted-sources**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip dhcp relay information option** **Example:** `Device(config)# ip dhcp relay information option`	Enables the system to insert the DHCP relay agent information option (option-82 field) in BOOTREQUEST messages forwarded to a DHCP server. • This function is disabled by default.

	Command or Action	Purpose
Step 4	**ip dhcp relay information check** **Example:** `Device(config)# ip dhcp relay information check`	(Optional) Configures DHCP to check whether the relay agent information option in forwarded BOOTREPLY messages is valid. • By default, DHCP verifies whether the option-82 field in DHCP reply packets that it receives from the DHCP server is valid. If an invalid message is received, the relay agent drops the packet. If a valid message is received, the relay agent removes the option-82 field and forwards the packet. Use the **ip dhcp relay information check** command to reenable this functionality if it has been disabled.
Step 5	**ip dhcp relay information policy** {**drop** | **keep** | **replace**} **Example:** `Device(config)# ip dhcp relay information policy replace`	(Optional) Configures the reforwarding policy (that specifies what a relay agent should do if a message already contains relay information) for a DHCP relay agent.
Step 6	**ip dhcp relay information trust-all** **Example:** `Device(config)# ip dhcp relay information trust-all`	(Optional) Configures all interfaces on a device as trusted sources of the DHCP relay information option. • By default, if the gateway address is set to all zeros in the DHCP packet and the relay agent information option is already present in the packet, the DHCP relay agent will discard the packet. Use the **ip dhcp relay information trust-all** command to override this behavior and accept the packets. • This command is useful if there is a switch placed between the client and the relay agent that may insert option 82. Use this command to ensure that these packets do not get dropped. • You can configure an individual interface as a trusted source of the DHCP relay information option by using the **ip dhcp relay information trusted** interface configuration mode command.

Step 7	**end**
	Example:
	`Device(config)# end`
		Returns to privileged EXEC mode.

Step 8	**show ip dhcp relay information trusted-sources** **Example:** `Device# show ip dhcp relay information trusted-sources`	(Optional) Displays all interfaces that are configured to be a trusted source for the DHCP relay information option.

Configuring Per-Interface Support for the Relay Agent Information Option

The interface configuration allows a Cisco device to reach subscribers with different DHCP option 82 requirements on different interfaces.

Before You Begin

It is important to understand how DHCP options work. See the "DHCP Overview" module for more information.

Note

- If the **ip dhcp relay information** command is configured in global configuration mode but not configured in interface configuration mode, the global configuration is applied to all interfaces.
- If the **ip dhcp relay information** command is configured in both global configuration mode and interface configuration mode, the interface configuration command takes precedence over the global configuration command. However, the global configuration is applied to interfaces without the interface configuration.
- If the **ip dhcp relay information** command is not configured in global configuration mode but is configured in interface configuration mode, only the interface on which the configuration option is applied is affected. All other interfaces are not impacted by the configuration.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **ip dhcp relay information option-insert** [**none**]
5. **ip dhcp relay information check-reply** [**none**]
6. **ip dhcp relay information policy-action** {**drop** | **keep** | **replace**}
7. **exit**
8. Repeat Steps 3 through 7 to configure relay agent information settings on different interfaces.

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.

	Command or Action	Purpose
Step 3	**interface** *type number* **Example:** `Device(config)# interface FastEthernet0/0`	Configures an interface and enters interface configuration mode.
Step 4	**ip dhcp relay information option-insert** [**none**] **Example:** `Device(config-if)# ip dhcp relay information option-insert`	Enables the system to insert the DHCP relay agent information option (option-82 field) in forwarded BOOTREQUEST messages to a DHCP server. • This function is disabled by default. However, if support for the relay agent information option is configured in global configuration mode, but not configured in interface configuration mode, the interface inherits the global configuration. • The **ip dhcp relay information option-insert none** interface configuration command is saved in the running configuration. This command takes precedence over any global relay agent information configuration.
Step 5	**ip dhcp relay information check-reply** [**none**] **Example:** `Device(config-if)# ip dhcp relay information check-reply`	Configures a DHCP server to validate the relay information option in forwarded BOOTREPLY messages. • By default, DHCP verifies whether the option-82 field in the DHCP reply packets that it receives from the DHCP server is valid. If an invalid message is received, the relay agent drops the packet. If a valid message is received, the relay agent removes the option-82 field and forwards the packet. Use the **ip dhcp relay information check-reply** command to reenable this functionality if it has been disabled. • The **ip dhcp relay information check-reply none** interface configuration command option is saved in the running configuration. This command takes precedence over any global relay agent information configuration.
Step 6	**ip dhcp relay information policy-action** {**drop** | **keep** | **replace**} **Example:** `Device(config-if)# ip dhcp relay information policy-action replace`	Configures the information reforwarding policy (that specifies what a relay agent should do if a message already contains relay information) for a DHCP relay agent.
Step 7	**exit** **Example:** `Device(config-if)# exit`	Exits interface configuration mode.

	Command or Action	Purpose
Step 8	Repeat Steps 3 through 7 to configure relay agent information settings on different interfaces.	—

Configuring the Subscriber Identifier Suboption of the Relay Agent Information Option

Perform this task to enable an Internet service provider (ISP) to add a unique identifier to the subscriber-identifier suboption of the relay agent information option.

The unique identifier enables an ISP to identify a subscriber, to assign specific actions to that subscriber (for example, assignment of host IP address, subnet mask, and domain name system DNS), and to trigger accounting.

Before the introduction of this feature, if a subscriber moved, each ISP had to be informed of the change and all ISPs had to reconfigure the DHCP settings for the affected customers at the same time. Even if the service was not changed, every move involved administrative changes in the ISP environment. With the introduction of this feature, if a subscriber moves from one Network Access Server to another, there is no need for a change in the configuration on the part of the DHCP server or ISP.

Before You Begin

You should configure the unique identifier for each subscriber.

The new configurable subscriber-identifier option should be configured on the interface connected to the client. When a subscriber moves from one interface to the other, the interface configuration should also be changed.

The server should be able to recognize the new suboption.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip dhcp relay information option**
4. **interface** *type number*
5. **ip dhcp relay information option subscriber-id** *string*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip dhcp relay information option** **Example:** `Device(config)# ip dhcp relay information option`	Enables the system to insert the DHCP relay agent information option (option-82 field) in forwarded BOOTREQUEST messages to a DHCP server. • This function is disabled by default.
Step 4	**interface** *type number* **Example:** `Device(config)# interface atm4/0/0`	Configures an interface and enters interface configuration mode.
Step 5	**ip dhcp relay information option subscriber-id** *string* **Example:** `Device(config-if)# ip dhcp relay information option subscriber-id newsubscriber123`	Specifies that a DHCP relay agent add a subscriber identifier suboption to the relay information option. • The *string* argument can be up to a maximum of 50 characters and can be alphanumeric. **Note** If more than 50 characters are configured, the string is truncated. **Note** The **ip dhcp relay information option subscriber-id**command is disabled by default to ensure backward capability.

Configuring DHCP Relay Class Support for Client Identification

DHCP relay class support for client identification allows the Cisco relay agent to forward client-generated DHCP messages to different DHCP servers based on the content of the following four options:

- Option 60: vendor class identifier
- Option 77: user class
- Option 124: vendor-identifying vendor class
- Option 125: vendor-identifying vendor-specific information

Each option identifies the type of client that is sending the DHCP message.

Relay pools provide a method to define DHCP pools that are not used for address allocation. These relay pools can specify that DHCP messages from clients on a specific subnet should be forwarded to a specific DHCP server. These relay pools can be configured with relay classes inside the pool that help determine the forwarding behavior.

For example, after receiving the option in a DHCP DISCOVER message, the relay agent will match and identify the relay class from the relay pool and then direct the DHCP DISCOVER message to the DHCP server associated with that identified relay class.

In an example application, a Cisco device acting as a DHCP relay agent receives DHCP requests from two VoIP services (H.323 and the Session Initiation Protocol [SIP]). The requesting devices are identified by option 60.

Both VoIP services have a different back-office infrastructure, so they cannot be serviced by the same DHCP server. Requests for H.323 devices must be forwarded to the H.323 server, and requests from SIP devices must be forwarded to the SIP server. The solution is to configure the relay agent with relay classes that are configured to match option 60 values sent by the client devices. Based on the option value, the relay agent will match and identify the relay class, and forward the DHCP DISCOVER message to the DHCP server associated with the identified relay class.

The Cisco IOS DHCP server examines the relay classes that are applicable to a pool and then uses the exact match class regardless of the configuration order. If the exact match is not found, the DHCP server uses the first default match found.

Before You Begin

It is important to understand how DHCP options work. See the “DHCP Overview” module for more information.

You must know the hexadecimal value of each byte location in the options to be able to configure the **option hex** command. The format may vary from product to product. Contact the relay agent vendor for this information.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip dhcp class** *class-name*
4. **option** *code* **hex** *hex-pattern* [*****][**mask** *bit-mask-pattern*]
5. **exit**
6. Repeat Steps 3 through 5 for each DHCP class that you need to configure.
7. **ip dhcp pool** *name*
8. **relay source** *ip-address subnet-mask*
9. **class** *class-name*
10. **relay target** [**vrf** *vrf-name* | **global**] *ip-address*
11. **exit**
12. Repeat Steps 9 through 11 for each DHCP class that you need to configure.

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. - Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip dhcp class** *class-name* **Example:** `Device(config)# ip dhcp class SIP`	Defines a DHCP class and enters DHCP class configuration mode.
Step 4	**option** *code* **hex** *hex-pattern* [*****][**mask** *bit-mask-pattern*] **Example:** `Device(dhcp-class)# option 60 hex 010203`	Enables the relay agent to make forwarding decisions based on DHCP options inserted in the DHCP message.
Step 5	**exit** **Example:** `Device(dhcp-class)# exit`	Exits DHCP class configuration mode.
Step 6	Repeat Steps 3 through 5 for each DHCP class that you need to configure.	—
Step 7	**ip dhcp pool** *name* **Example:** `Device(config)# ip dhcp pool ABC`	Configures a DHCP pool on a DHCP server and enters DHCP pool configuration mode.
Step 8	**relay source** *ip-address subnet-mask* **Example:** `Device(dhcp-config)# relay source 10.2.0.0 255.0.0.0`	Configures the relay source. • This command is similar to the **network** command in a normal DHCP network pool, because it restricts the use of the address pool to packets arriving on the interface whose configured IP address and mask match the relay source configuration.

Step 9	**class** *class-name*
	Example:
	`Device(dhcp-config)# class SIP`
		Associates a class with a DHCP pool and enters DHCP pool class configuration mode.

	Command or Action	Purpose
Step 10	**relay target** [**vrf** *vrf-name* | **global**] *ip-address* **Example:** `Device(config-dhcp-pool-class)# relay target 10.21.3.1`	Configures an IP address for a DHCP server to which packets are forwarded.
Step 11	**exit** **Example:** `Device(config-dhcp-pool-class)# exit`	Exits DHCP pool class configuration mode.
Step 12	Repeat Steps 9 through 11 for each DHCP class that you need to configure.	—

Configuring DHCP Relay Agent Support for MPLS VPNs

Perform this task to configure DHCP relay agent support for MPLS VPNs.

Before You Begin

Before configuring DHCP relay support for MPLS VPNs, you must configure standard MPLS VPNs.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip dhcp relay information option vpn**
4. **interface** *type number*
5. **ip helper-address vrf** *name* [**global**] *address*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip dhcp relay information option vpn** **Example:** `Device(config)# ip dhcp relay information option vpn`	Enables the system to insert VPN suboptions into the DHCP relay agent information option in forwarded BOOTREQUEST messages to a DHCP server and sets the gateway address to the outgoing interface toward the DHCP server. • The VPN suboptions are also added to the BOOTP broadcast packets when the command is configured.
Step 4	**interface** *type number* **Example:** `Device(config)# interface GigabitEthernet0/0/0`	Configures an interface and enters interface configuration mode.
Step 5	**ip helper-address vrf** *name* [**global**] *address* **Example:** `Device(config-if)# ip helper-address vrf blue 172.27.180.232`	Forwards UDP broadcasts, including BOOTP, received on an interface. • If the DHCP server resides in a different VPN or global space that is different from the VPN, then the **vrf** *name* or **global** options allow you to specify the name of the VRF or global space in which the DHCP server resides.

Configuring Support for Relay Agent Information Option Encapsulation

When two relay agents are relaying messages between the DHCP client and the DHCP server, the relay agent closer to the server, by default, replaces the first option 82 information with its own option 82. The remote ID and circuit ID information from the first relay agent is lost. In some deployment scenarios, it is necessary to maintain the initial option 82 from the first relay agent, in addition to the option 82 from the second relay agent, for example, in a situation where an Intelligent Services Gateway (ISG) acting as a second relay agent is connected to a Layer 2 device. The Layer 2 device connects to the household and identifies the household with its own option 82.

The DHCP Relay Option 82 Encapsulation feature allows the second relay agent to encapsulate option 82 information in a received message from the first relay agent if the second relay agent is configured to add its own option 82 information. This configuration allows the DHCP server to use option 82 information from both relay agents. The DHCP server can use the VPN information from the second relay agent, along with the option 82 information from the first relay agent, to send correct address assignments and other configuration parameters for the client devices based on the VRF, option 60, and encapsulated option 82. The reply message from the DHCP server to the DHCP client traverses the same path as the request messages through the two relay agents to the DHCP client.

The figure below shows the processing that occurs on the two relay agents and the DHCP server when this feature is configured:

1 The DHCP client generates a DHCP message (including option 60) and broadcasts it on the network.

2 The first DHCP relay agent intercepts the broadcast DHCP request packet and inserts its own option 82 in the packet.

3 The relay agent automatically adds the circuit ID suboption and the remote ID suboption to option 82 and forwards them to the second relay agent.

4 The second relay agent encapsulates the first relay agent's option 82 and inserts its own option 82.

5 The gateway IP address (giaddr) is set to the incoming interface on the second relay agent and the original giaddr from the first relay agent is encapsulated.

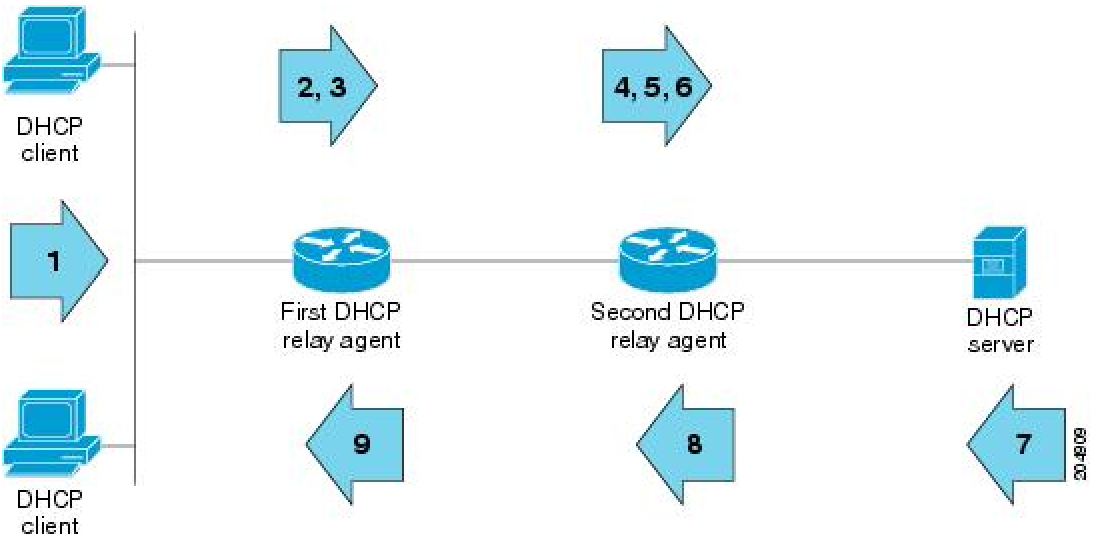
6 The second DHCP relay agent unicasts the DHCP packet to the DHCP server.

7 The DHCP server receives the packet and uses the VPN suboption information from the second relay agent, along with the option 82 information from the first relay agent, to assign IP addresses and other configuration parameters and forwards the packet back to the second relay agent.

8 When the second relay agent receives the reply message from the server, it restores the encapsulated option 82 and prior giaddr from the first relay agent. The reply message is then sent to the prior giaddr.

9 The first relay agent strips option 82 off from the packet before forwarding the packet to the client.

Figure 6: Processing DHCP Relay Agent Information Option Encapsulation Support



SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip dhcp relay information option**
4. **ip dhcp relay information option vpn**
5. **ip dhcp relay information policy encapsulate**
6. **interface** *type number*
7. **ip dhcp relay information policy-action encapsulate**
8. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip dhcp relay information option** **Example:** `Device(config)# ip dhcp relay information option`	Enables the system to insert the DHCP relay agent information option (option-82 field) in forwarded BOOTREQUEST messages to a DHCP server. • This function is disabled by default.
Step 4	**ip dhcp relay information option vpn** **Example:** `Device(config)# ip dhcp relay information option vpn`	(Optional) Enables the system to insert VPN suboptions into the DHCP relay agent information option in forwarded BOOTREQUEST messages to a DHCP server and sets the gateway address to the outgoing interface toward the DHCP server. • The VPN suboptions are also added to the BOOTP broadcast packets when the command is configured.
Step 5	**ip dhcp relay information policy encapsulate** **Example:** `Device(config)# ip dhcp relay information policy encapsulate`	Enables the system to encapsulate the DHCP relay agent information option (option-82 field) received from a prior relay agent in forwarded BOOTREQUEST messages to a DHCP server. • Option 82 information from both relay agents will be forwarded to the DHCP server.
Step 6	**interface** *type number*	(Optional) Configures an interface and enters interface configuration mode.

	Command or Action	Purpose
	Example: `Device(config)# interface FastEthernet0/0`	• If you configure the global configuration command, there is no need to configure the interface configuration command unless you want to apply a different configuration on a specific interface.
Step 7	**ip dhcp relay information policy-action encapsulate** **Example:** `Device(config-if)# ip dhcp relay information policy-action encapsulate`	(Optional) Enables the system to encapsulate the DHCP relay agent information option (option-82 field) received on an interface from a prior relay agent in forwarded BOOTREQUEST messages to a DHCP server on an interface. • This function is disabled by default. This command has precedence over the global configuration command. However, if the relay agent information option encapsulation support is configured in global configuration mode, but not in interface configuration mode, the interface inherits the global configuration.

Step 8	**end**
	Example:
	`Device(config-if)# end`
		Returns to privileged EXEC mode.

Setting the Gateway Address of the DHCP Broadcast to a Secondary Address Using Smart Relay Agent Forwarding

You only need to configure helper addresses on the interface where the UDP broadcasts that you want to forward to the DHCP server are being received. You only need to configure the **ip dhcp smart-relay** command if you have secondary addresses on that interface and you want the device to step through each IP network when forwarding DHCP requests. If smart relay agent forwarding is not configured, all requests are forwarded using the primary IP address on the interface.

If the **ip dhcp smart-relay** command is configured, the relay agent counts the number of times that the client retries sending a request to the DHCP server when there is no DHCPOFFER message from the DHCP server. After three retries, the relay agent sets the gateway address to the secondary address. If the DHCP server still does not respond after three more retries, then the next secondary address is used as the gateway address.

This functionality is useful when the DHCP server cannot be configured to use secondary pools.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip dhcp smart-relay**
4. **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip dhcp smart-relay** **Example:** `Device(config)# ip dhcp smart-relay`	Allows the DHCP relay agent to switch the gateway address (giaddr field of a DHCP packet) to a secondary address when there is no DHCPOFFER message from a DHCP server.
Step 4	**exit** **Example:** `Device(config)# exit`	Returns to privileged EXEC mode.

Configuring Support for Private and Standard Suboption Numbers

Some features that are not standardized will use the private Cisco relay agent suboption numbers. After the features are standardized, the relay agent suboptions are assigned the Internet Assigned Numbers Authority (IANA) numbers. Cisco software supports both private and IANA numbers for these suboptions.

Perform this task to configure the DHCP client to use private or IANA standard relay agent suboption numbers.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip dhcp compatibility suboption link-selection** {**cisco** | **standard**}
4. **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable**	Enables privileged EXEC mode.

	Command or Action	Purpose
	Example: `Device> enable`	• Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip dhcp compatibility suboption link-selection** {**cisco** | **standard**} **Example:** `Device(config)# ip dhcp compatibility suboption link-selection standard`	Configures the DHCP client to use private or IANA standard relay agent suboption numbers.
Step 4	**exit** **Example:** `Device(config)# exit`	(Optional) Exits global configuration mode and returns to privileged EXEC mode.

Troubleshooting the DHCP Relay Agent

Perform this task to troubleshoot the DHCP relay agent.

The **show ip route dhcp** command is useful to help you understand any problems with the DHCP relay agent adding routes to clients from unnumbered interfaces. All routes added to the routing table by the DHCP server and relay agent are displayed.

SUMMARY STEPS

1. **enable**
2. **show ip route dhcp**
3. **show ip route dhcp** *ip-address*
4. **show ip route vrf** *vrf-name* **dhcp**
5. **clear ip route** [**vrf** *vrf-name*] **dhcp** [*ip-address*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**show ip route dhcp** **Example:** `Device# show ip route dhcp`	Displays all routes added by the DHCP server and relay agent.
Step 3	**show ip route dhcp** *ip-address* **Example:** `Device# show ip route dhcp 172.16.1.3`	Displays all routes added by the DHCP server and relay agent associated with an IP address.
Step 4	**show ip route vrf** *vrf-name* **dhcp** **Example:** `Device# show ip route vrf red dhcp`	Displays all routes added by the DHCP server and relay agent associated with the named VRF.
Step 5	**clear ip route** [**vrf** *vrf-name*] **dhcp** [*ip-address*] **Example:** `Device# clear ip route dhcp`	Removes routes from the routing table added by the DHCP server and relay agent for the DHCP clients on unnumbered interfaces.

Configuration Examples for the Cisco IOS DHCP Relay Agent

Example: Configuring Support for the Relay Agent Information Option

The following example shows how to enable the DHCP server, the relay agent, and the insertion and removal of the DHCP relay information option (option 82). Note that the Cisco IOS DHCP server is enabled by default. In this example, the DHCP server is disabled:

```
! Reenables the DHCP server.
service dhcp
ip dhcp relay information option
!
interface ethernet0/0
 ip address 192.168.100.1 255.255.255.0
 ip helper-address 10.55.11.3
```

Example: Configuring Per-Interface Support for the Relay Agent Information Option

The following example shows that for subscribers who are being serviced by the same aggregation device, the relay agent information option for ATM subscribers must be processed differently from that for Ethernet digital subscribers. For ATM subscribers, the relay agent information option is configured to be removed from the packet by the relay agent before forwarding the packet to the client. For Ethernet subscribers, the connected device provides the relay agent information option, and the option is configured to remain in the packet and be forwarded to the client.

```
ip dhcp relay information trust-all
interface Loopback0
 ip address 10.16.0.1 255.255.255.0
!
interface ATM3/0
 no ip address
!
interface ATM3/0.1
 ip helper-address 10.16.1.2
 ip unnumbered loopback0
 ip dhcp relay information option-insert
!
interface Loopback1
 ip address 10.18.0.1 255.255.255.0
!
interface Ethernet4
 no ip address
!
interface Ethernet4/0.1
 encapsulation dot1q 123
 ip unnumbered loopback1
 ip helper-address 10.18.1.2
 ip dhcp relay information policy-action keep
```

Example: Configuring the Subscriber Identifier Suboption of the Relay Agent Information Option

The following example shows how to add a unique identifier to the subscriber-identifier suboption of the relay agent information option:

```
ip dhcp relay information option
!
interface Loopback0
 ip address 10.1.1.129 255.255.255.192
!
interface ATM4/0
 no ip address
!
interface ATM4/0.1 point-to-point
 ip helper-address 10.16.1.2
 ip unnumbered Loopback0
 ip dhcp relay information option subscriber-id newperson123
 atm route-bridged ip
 pvc 88/800
 encapsulation aal5snap
```

Example: Configuring DHCP Relay Class Support for Client Identification

In the following example, DHCP messages are received from DHCP clients on subnet 10.2.2.0. The relay agent will match and identify the relay class from the relay pool and forward the DHCP message to the appropriate DHCP server identified by the **relay target** command.

```
!
ip dhcp class H323
 option 60 hex 010203
!
ip dhcp class SIP
 option 60 hex 040506
!
! The following is the relay pool:
ip dhcp pool pool1
 relay source 10.2.2.0 255.255.255.0
 class H323
  relay target 192.168.2.1
  relay target 192.168.3.1
!
 class SIP
  relay target 192.168.4.1
```

Example: Configuring DHCP Relay Agent Support for MPLS VPNs

In the following example, the DHCP relay agent receives a DHCP request on Ethernet interface 0/1 and sends the request to the DHCP server located at IP helper address 10.44.23.7, which is associated with the VRF named vrf1:

```
ip dhcp relay information option vpn
!
interface ethernet 0/1
 ip helper-address vrf vrf1 10.44.23.7
!
```

Example: Configuring Support for Relay Agent Information Option Encapsulation

In the following example, DHCP relay agent 1 is configured globally to insert the relay agent information option into the DHCP packet. DHCP relay agent 2 is configured to add its own relay agent information option, including the VPN information, and to encapsulate the relay agent information option received from DHCP relay agent 1. The DHCP server receives the relay agent information options from both the relay agents, uses this information to assign IP addresses and other configuration parameters, and forwards them back to the client.

DHCP Relay Agent 1

```
ip dhcp relay information option
```

DHCP Relay Agent 2

```
ip dhcp relay information option
ip dhcp relay information option vpn
ip dhcp relay information option encapsulation
```

Example: Setting the Gateway Address of the DHCP Broadcast to a Secondary Address Using Smart Relay Agent Forwarding

In the following example, the router will forward the DHCP broadcast received on Ethernet interface 0/0 to the DHCP server (10.55.11.3), by inserting 192.168.100.1 in the giaddr field of the DHCP packet. If the DHCP server has a scope or pool configured for the 192.168.100.0/24 network, the server will respond; otherwise, it will not respond.

Because the **ip dhcp smart-relay** global configuration command is configured, if the router sends three requests using 192.168.100.1 in the giaddr field and does not get a response, the router will move on and start using 172.16.31.254 in the giaddr field instead. Without the smart relay functionality, the router uses only 192.168.100.1 in the giaddr field.

```
ip dhcp smart-relay
!
interface ethernet0/0
 ip address 192.168.100.1 255.255.255.0
 ip address 172.16.31.254 255.255.255.0
 ip helper-address 10.55.11.3
!
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
IPv6 commands	Cisco IOS IPv6 Command Reference
IPv6 addressing and connectivity	*IPv6 Configuration Guide*
Cisco IOS IPv6 features	Cisco IOS IPv6 Feature Mapping

Standards and RFCs

Standard/RFC	Title
RFCs for IPv6	*IPv6 RFCs*

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for the Cisco IOS DHCP Relay Agent

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to . An account on Cisco.com is not required.

Table 7: Feature Information for the Cisco IOS DHCP Relay Agent

Feature Name	Releases	Feature Information
DHCP Class Support for Client Identification	12.4(11)T	The DHCP Class Support for Client Identification feature enhances the DHCP class mechanism to support options 60, 77, 124, and 125. These options identify the type of client that is sending the DHCP message. The DHCP relay agent can make forwarding decisions based on the content of the options in the DHCP message sent by the client. The following command was introduced by this feature: **option hex**.

Feature Name	Releases	Feature Information
DHCP Relay MPLS VPN Support	12.2(8) 12.2(28)SB 12.2(33)SRC	DHCP relay support for MPLS VPNs enables a network administrator to conserve address space by allowing overlapping addresses. The relay agent can support multiple clients on different VPNs, and many of these clients from different VPNs can share the same IP address. The following commands were modified by this feature: **ip dhcp relay information option**, and **ip helper address**.
DHCP Relay Option 82 Encapsulation	12.2(33)SRD	This feature allows a second DHCP relay agent to encapsulate the relay agent information option (option 82) from a prior relay agent, to add its own option 82, and to forward the packet to the DHCP server. The DHCP server can use the VPN information from the second relay agent, along with the option 82 information from the first relay agent, to send correct address assignments and other configuration parameters for the client devices based on the VRF, option 60, and encapsulated option 82. The following commands were modified by this feature: **ip dhcp relay information policy**, and **ip dhcp relay information policy-action**.

Feature Name	Releases	Feature Information
DHCP Relay Option 82 per Interface Support	12.2(31)SB2 12.2(33)SRC 12.4(6)T	This feature enables support for the DHCP relay agent information option (option 82) on a per-interface basis. The interface configuration allows different DHCP servers, with different DHCP option 82 requirements to be reached from one Cisco router. The following commands were introduced by this feature: **ip dhcp relay information check-reply**, **ip dhcp relay information option-insert**, and **ip dhcp relay information policy-action**.
DHCP Subscriber Identifier Suboption of Option 82	12.2(28)SB 12.2(33)SRB 12.3(14)T	This feature enables an ISP to add a unique identifier to the subscriber-identifier suboption of the relay agent information option. The following command was introduced by this feature: **ip dhcp relay information option subscriber-id**.
DHCPv4 Relay per Interface VPN ID Support	12.4(11)T	The DHCPv4 Relay per Interface VPN ID Support feature allows the Cisco IOS DHCP relay agent to be configured per interface to override the global configuration of the **ip dhcp relay information option vpn** command. This feature allows subscribers with different relay information option VPN ID requirements on different interfaces to be reached from one Cisco router. The following command was introduced by this feature: **ip dhcp relay information option vpn-id**.
DHCPv6 Bulk Lease Query	15.1(1)S	The Cisco IOS DHCPv6 relay agent supports bulk lease query in accordance with RFC 5460. The following commands were introduced or modified by this feature: **debug ipv6 dhcp relay** and **ipv6 dhcp-relay bulk-lease**.

Glossary

CPE --customer premises equipment. Terminating equipment, such as terminals, telephones, and modems, supplied by the service provider, installed at customer sites, and connected to the network.

DSLAM --digital subscriber line access multiplexer. A device that connects many digital subscriber lines to a network by multiplexing the DSL traffic onto one or more network trunk lines.

ISSU --In Service Software Upgrade. ISSU is a process that allows Cisco IOS software to be updated or otherwise modified while packet forwarding continues.

ODAP --On-Demand Address Pool. ODAPs enable pools of IP addresses to be dynamically increased or reduced in size depending on the address utilization level. Once configured, the ODAP is populated with one or more subnets leased from a source server and is ready to serve address requests from DHCP clients or from PPP sessions.

RP --Route Processor. A generic term for the centralized control unit in a chassis.

SSO --Stateful Switchover. SSO refers to the implementation of Cisco IOS software that allows applications and features to maintain a defined state between an active and standby RP. When a switching occurs, forwarding and sessions are maintained. SSO makes an RP failure undetectable to the network.

CHAPTER 5

DHCP Client

The Cisco Dynamic Host Configuration Protocol (DHCP) Client feature allows a Cisco device to act as a host requesting configuration parameters, such as an IP address, from a DHCP server.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Restrictions for the DHCP Client

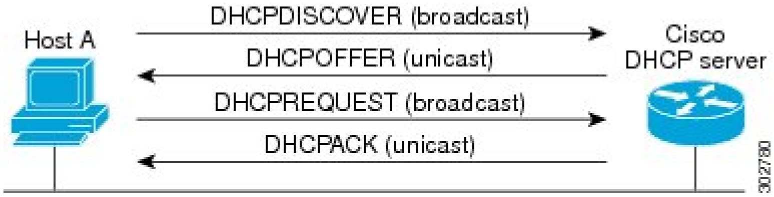
The DHCP client can be configured on Ethernet interfaces.

Information About the DHCP Client

DHCP Client Operation

The Dynamic Host Configuration Protocol (DHCP) provides a framework for passing configuration information to hosts on a TCP/IP network. A DHCP client is an Internet host using DHCP to obtain configuration parameters such as an IP address. The figure below 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 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 7: DHCP Request for an IP Address from a DHCP Server



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. 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.

DHCP Client Overview

The configurable dynamic host configuration protocol client functionality allows a DHCP client to use a user-specified client identifier, class identifier, or suggested lease time when requesting an address from a DHCP server.

Configuration parameters and other control information are carried in tagged data items that are stored in the options field of the DHCP message. The DHCP client provides flexibility by allowing the following options to be configured for a DHCP client:

- Option 12—This option specifies the name of the client. The name may or may not be qualified with the local domain.
- Option 51—This option is used in a client request (DHCPDISCOVER or DHCPREQUEST) to allow the client to request a lease time for the IP address.
- Option 55—This option allows the DHCP client to request certain options from the DHCP server. The **ip dhcp client request** command allows the system administrator to turn off some of the requested options, thus removing them from the request list.

- Option 60—This option allows the user to configure the vendor class identifier string to use in the DHCP interaction.
- Option 61—This option is used by DHCP clients to specify their unique identifier. DHCP servers use this value to index their database of address bindings. This value is expected to be unique for all clients in an administrative domain.
- Option 120—This option is used to specify a 32-bit (binary) IPv4 address to be used by the Session Initiation Protocol (SIP) client to locate a SIP server.
- Option 121—This option is used to configure classless static routes by specifying classless network destinations; that is, each routing table entry includes a subnet mask. Upto ten classless static routes are supported using option 121 on the DHCP client.

  Note If a request includes both static routes and classless static routes, the client uses only the classless static routes. If the DHCP server returns both a classless static route option and a router option, the DHCP client ignores the router option.

- Option 125—This option is used by DHCP clients and servers to exchange vendor-specific information.

How to Configure the DHCP Client

Configuring the DHCP Client

Cisco devices running Cisco software include the Dynamic Host Configuration Protocol (DHCP) server and relay agent software, which are enabled by default. Your device can act as both the DHCP client and the DHCP server. Use the **ip address dhcp** command to obtain IP address information for the configured interface.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **ip address dhcp**
5. **end**
6. **debug dhcp detail**
7. **debug ip dhcp server packets**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable**	Enables privileged EXEC mode.

	Command or Action	Purpose
	Example: `Device> enable`	• Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Device(config)# interface GigabitEthernet 0/0/1`	Configures an interface type and enters interface configuration mode.
Step 4	**ip address dhcp** **Example:** `Device(config-if)# ip address dhcp`	Acquires an IP address on an interface from DHCP.

Step 5	**end**
	Example:
	`Device(config-if)# end`
		Returns to privileged EXEC mode.

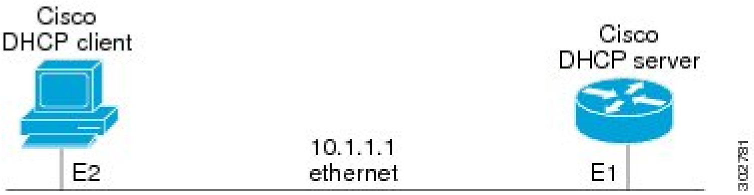
Step 6	**debug dhcp detail** **Example:** `Device# debug dhcp detail`	Displays the DHCP packets that were sent and received.
Step 7	**debug ip dhcp server packets** **Example:** `Device# debug ip dhcp server packets`	Displays the server side of the DHCP interaction.

Configuration Examples for the DHCP Client

Example: Configuring the DHCP Client

The figure below shows a simple network diagram of a Dynamic Host Configuration Protocol (DHCP) client on an Ethernet LAN.

Figure 8: Topology Showing a DHCP Client with a Gigabit Ethernet Interface



On the DHCP server, the configuration is as follows:

```
ip dhcp pool 1
 network 10.1.1.0 255.255.255.0
 lease 1 6
```

On the DHCP client, the configuration is as follows on interface E2:

```
interface GigabitEthernet 0/0/0
 ip address dhcp
```

This configuration allows the DHCP client to acquire an IP address from the DHCP server through Gigabit Ethernet interface 0/0/0.

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Command List, All Releases
DHCP commands	Cisco IOS IP Addressing Services Command Reference
DHCP conceptual information	"DHCP Overview" module in the *IP Addressing: DHCP Configuration Guide*

RFCs

RFCs	Title
RFC 2131	*Dynamic Host Configuration Protocol*
RFC 2132	*DHCP Options and BOOTP Vendor Extensions*

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for the DHCP Client

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to . An account on Cisco.com is not required.

Table 8: Feature Information for the DHCP Client

Feature Name	Releases	Feature Information
DHCP Client	12.1(3)T 12.1(14)EA1 12.2(2)T 12.2(27)SBA Cisco IOS XE Release 2.3	The DHCP client is defined as an Internet host using DHCP to obtain configuration parameters such as an IP address.

CHAPTER 6

Configuring DHCP Services for Accounting and Security

Cisco IOS XE software supports several capabilities that enhance DHCP security, reliability, and accounting in Public Wireless LANs (PWLANs). This functionality can also be used in other network implementations. This module describes the concepts and tasks needed to configure DHCP services for accounting and security.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for Configuring DHCP Services for Accounting and Security

Before you configure DHCP services for accounting and security, you should understand the concepts documented in the “DHCP Overview” module.

Information About DHCP Services for Accounting and Security

DHCP Operation in Public Wireless LANs

The configuration of DHCP in a public wireless LAN (PWLAN) simplifies the configuration of wireless clients and reduces the overhead necessary to maintain the network. DHCP clients are leased IP addresses by the DHCP server and then authenticated by the Service Selection Gateway (SSG), which allows the clients to access network services. The DHCP server and client exchange DHCP messages for IP address assignments. When a DHCP server assigns an IP address to a client, a DHCP binding is created. The IP address is leased to the client until the client explicitly releases the IP address and disconnects from the network. If the client disconnects without releasing the address, the server terminates the lease after the lease time is over. In either case, the DHCP server removes the binding and the IP address is returned to the pool.

Security Vulnerabilities in Public Wireless LANs

As more people start using PWLANs, security becomes an important concern. Most implementations of PWLANs rely on DHCP for users to obtain an IP address while in a hot spot (such as a coffee shop, airport terminal, hotel, and so on) and use this IP address provided by the DHCP server throughout their session.

IP spoofing is a common technique used by hackers to spoof IP addresses. For example, customer A obtains an IP address from DHCP and has already been authenticated to use the PWLAN, but a hacker spoofs the IP address of customer A and uses this IP address to send and receive traffic. Customer A will still be billed for the service even though he or she is not using the service.

Address Resolution Protocol (ARP) table entries are dynamic by design. Request and reply ARP packets are sent and received by all the networking devices in a network. In a DHCP network, the DHCP server stores the leased IP address to the MAC address or the client-identifier of the client in the DHCP binding. But as ARP entries are learned dynamically, an unauthorized client can spoof the IP address given by the DHCP server and start using that IP address. The MAC address of this unauthorized client will replace the MAC address of the authorized client in the ARP table allowing the unauthorized client to freely use the spoofed IP address.

DHCP Services for Security and Accounting Overview

DHCP security and accounting features have been designed and implemented to address the security concerns in PWLANs but also can be used in other network implementations.

DHCP accounting provides authentication, authorization, and accounting (AAA) and Remote Authentication Dial-In User Service (RADIUS) support for DHCP. The AAA and RADIUS support improves security by sending secure START and STOP accounting messages. The configuration of DHCP accounting adds a layer of security that allows DHCP lease assignment and termination to be triggered for the appropriate RADIUS START and STOP accounting records so that the session state is properly maintained by upstream devices, such as an SSG. This additional security can help to prevent unauthorized clients or hackers from gaining illegal entry to the network by spoofing authorized DHCP leases.

The DHCP Secured IP Address Assignment feature prevents IP spoofing by synchronizing the database of the DHCP server with the ARP table to avoid address hijacking. This secure ARP functionality adds an entry to the ARP table for a client when an address is allocated that can be deleted by the DHCP server only when a binding expires.

The third feature is ARP autologoff, which adds finer control for probing when authorized users log out. The **arp probe interval** command specifies when to start a probe (the timeout), how frequent a peer is probed (the interval), and the maximum number of retries (the count).

DHCP Lease Limits

You can control the number of subscribers globally or on a per-interface basis by configuring a DHCP lease limit. This functionality allows an Internet service provider (ISP) to limit the number of leases available to clients per household or connection.

How to Configure DHCP Services for Accounting and Security

Configuring AAA and RADIUS for DHCP Accounting

RADIUS provides the accounting capability for the transmission of secure START and STOP messages. AAA and RADIUS are enabled prior to the configuration of DHCP accounting but can also be enabled to secure an insecure DHCP network. The configuration steps in this section are required for configuring DHCP accounting in a new or existing network.

RADIUS Accounting Attributes

DHCP accounting introduces the attributes shown in the table below. These attributes are processed directly by the RADIUS server when DHCP accounting is enabled. These attributes can be monitored in the output of the **debug radius** command. The output will show the status of the DHCP leases and specific configuration details about the client. The **accounting** keyword can be used with the **debug radius** command to filter the output and display only DHCP accounting messages.

Table 9: RADIUS Accounting Attributes

Attribute	Description
Calling-Station-ID	The output from this attribute displays the MAC address of the client.
Framed-IP-Address	The output from this attribute displays the IP address that is leased to the client.

Attribute	Description
Acct-Terminate-Cause	The output from this attribute displays the message “session-timeout” if a client does not explicitly disconnect.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **aaa new-model**
4. **aaa group server radius** *group-name*
5. **server** *ip-address* **auth-port** *port-number* **acct-port** *port-number*
6. **exit**
7. **aaa accounting** {**system** | **network** | **exec** | **connection** | **commands** *level*} {**default** | *list-name*} {**start-stop** | **stop-only** | **none**} [**broadcast**] **group** *group-name*
8. **aaa session-id** {**common** | **unique**}
9. **ip radius source-interface** *type number* [**vrf** *vrf-name*]
10. **radius-server host** {*hostname* | *ip-address*} [**auth-port** *port-number*] [**acct-port** *port-number*]
11. **radius-server retransmit** *number-of-retries*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**aaa new-model** **Example:** `Router(config)# aaa new-model`	Enables the AAA access control model. • DHCP accounting functions only in the access control model. **Note** TACACS and extended TACACS commands are not available after this command is configured and are not supported by DHCP accounting.

	Command or Action	Purpose
Step 4	**aaa group server radius** *group-name* **Example:** `Router(config)# aaa group server radius RGROUP-1`	Creates a server group for AAA or TACACS+ services and enters server group RADIUS configuration mode. • The server group is created in this step so that accounting services can be applied.
Step 5	**server** *ip-address* **auth-port** *port-number* **acct-port** *port-number* **Example:** `Router(config-sg-radius)# server 10.0.0.1 auth-port 1645 acct-port 1646`	Specifies the servers that are members of the server group that was created in Step 4. • You must open port numbers for authorization and accounting. 1645 is the default port number for authorization, and 1646 is the default port number for accounting. The range of port numbers that can be specified is from 0 to 65535. • The values entered for the **auth-port** *port-number*and **acct-port** *port-number* keywords and arguments must match the port numbers that will be configured in Step 10.
Step 6	**exit** **Example:** `Router(config-sg-radius)# exit`	Exits server group RADIUS configuration mode and enters global configuration mode.
Step 7	**aaa accounting** {**system** | **network** | **exec** | **connection** | **commands** *level*} {**default** | *list-name*} {**start-stop** | **stop-only** | **none**} [**broadcast**] **group** *group-name* **Example:** `Router(config)# aaa accounting network RADIUS-GROUP1 start-stop group RGROUP-1`	Configures RADIUS accounting for the specified server group. • The RADIUS accounting server is specified in the first *list-name* argument (RADIUS-GROUP1), and the target server group is specified in the second *group-name*argument (RGROUP-1). • This command enables start and stop accounting for DHCP accounting. The **start-stop** keyword enables the transmission of both START and STOP accounting messages. The **stop-only** keyword will enable the generation and verification of STOP accounting messages only.

Step 8	**aaa session-id** {**common** | **unique**}
	Example:
	`Router(config)# aaa session-id common`
		Specifies whether the same session ID will be used for each AAA accounting service type within a call or whether a different session ID will be assigned to each accounting service type.

Step 9	**ip radius source-interface** *type number* [**vrf** *vrf-name*] **Example:** `Router(config)# ip radius source-interface Ethernet 0`	Forces RADIUS to use the IP address of the specified interface for all outgoing RADIUS packets.

	Command or Action	Purpose
Step 10	**radius-server host** {*hostname* | *ip-address*} [**auth-port** *port-number*] [**acct-port** *port-number*] **Example:** `Router(config)# radius-server host 10.1.1.1 auth-port 1645 acct-port 1646`	Specifies the RADIUS server host. • The values entered for the **auth-port** *port-number*and **acct-port** *port-number* keywords and arguments must match the port numbers that were configured in Step 5.
Step 11	**radius-server retransmit** *number-of-retries* **Example:** `Router(config)# radius-server retransmit 3`	Specifies the number of times that Cisco IOS software will look for RADIUS server hosts.

Troubleshooting Tips

You can use the **debug ip dhcp server packet** and **debug ip server events** commands to troubleshoot the DHCP lease limit.

Configuring DHCP Accounting

Perform this task to configure DHCP accounting.

DHCP accounting is enabled with the **accounting** command. This command configures DHCP to operate with AAA and RADIUS to enable secure START and STOP accounting messages. This configuration adds a layer of security that allows DHCP lease assignment and termination to be triggered for the appropriate RADIUS START and STOP accounting records so that the session state is properly maintained by upstream devices, such as the SSG.

DHCP accounting is configured on a per-client or per-lease basis. Separate DHCP accounting processes can be configured on a per-pool basis.

Before You Begin

You must configure an SSG for client authentication. AAA and RADIUS must be enabled before DHCP accounting will operate.

Note The following restrictions apply to DHCP accounting:

- DHCP accounting can be configured only for DHCP network pools in which bindings are created automatically and destroyed upon lease termination or when the client sends a DHCPRELEASE message.
- DHCP bindings are destroyed when the **clear ip dhcp binding** or **no service dhcp** commands are entered, which also triggers an accounting STOP message. You should exercise caution when entering these commands if a pool is configured with DHCP accounting, as these commands will clear active leases.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip dhcp pool** *pool-name*
4. **accounting** *method-list-name*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip dhcp pool** *pool-name* **Example:** `Device(config)# ip dhcp pool WIRELESS-POOL`	Configures a DHCP address pool and enters DHCP pool configuration mode.
Step 4	**accounting** *method-list-name* **Example:** `Device(dhcp-config)# accounting RADIUS-GROUP1`	Enables DHCP accounting if the specified server group is configured to run RADIUS accounting. • The example configures DHCP accounting START and STOP messages to be sent if RADIUS-GROUP1 is configured as a start-stop group. STOP messages will only be sent if RADIUS-GROUP1 is configured as a stop-only group. See Step

	Command or Action	Purpose
		7 in the "Configuring AAA and RADIUS for DHCP Accounting" configuration task table for more details.

Verifying DHCP Accounting

Perform this task to verify the DHCP accounting configuration.

The debug radius, debug ip dhcp server events, debug aaa accounting, debug aaa id commands do not need to be issued together or in the same session as there are differences in the information that is provided. These commands, however, can be used to display DHCP accounting start and stop events, AAA accounting messages, and information about AAA and DHCP hosts and clients. See the "RADIUS Accounting Attributes" section of this module for a list of AAA attributes that have been introduced by DHCP accounting. The show running-config | begin dhcp command can be used to display the local DHCP configuration including the configuration of DHCP accounting.

SUMMARY STEPS

1. **enable**
2. **debug radius accounting**
3. **debug ip dhcp server events**
4. **debug aaa accounting**
5. **debug aaa id**
6. **show running-config | begin dhcp**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables higher privilege levels, such as privileged EXEC mode. • Enter your password if prompted.
Step 2	**debug radius accounting** **Example:** `Device# debug radius accounting`	Displays RADIUS events on the console of the device. • These events provide information about RADIUS processes. DHCP accounting information can be filtered with the accounting keyword. START and STOP accounting messages will be displayed in the output.

	Command or Action	Purpose
Step 3	**debug ip dhcp server events** **Example:** `Device# debug ip dhcp server events`	Displays DHCP IP address assignments, DHCP lease expirations, and DHCP database changes.
Step 4	**debug aaa accounting** **Example:** `Device# debug aaa accounting`	Displays AAA accounting events. • START and STOP accounting messages will be displayed in the output.
Step 5	**debug aaa id** **Example:** `Device# debug aaa id`	Displays AAA events as they relate to unique AAA session IDs.
Step 6	**show running-config | begin dhcp** **Example:** `Device# show running-config | begin dhcp`	The **show running-config** command is used to display the local configuration of the device. The sample output is filtered with the **begin** keyword to start displaying output at the DHCP section of the running configuration.

Securing ARP Table Entries to DHCP Leases

Perform this task to secure ARP table entries to DHCP leases in the DHCP database.

When the **update arp** command is used, ARP table entries and their corresponding DHCP leases are secured automatically for all new leases and DHCP bindings. However, existing active leases are not secured. These leases are still insecure until they are renewed. When the lease is renewed, it is treated as a new lease and will be secured automatically. If this command is disabled on the DHCP server, all existing secured ARP table entries will automatically change to dynamic ARP entries.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip dhcp pool** *pool -name*
4. **update arp**
5. **renew deny unknown**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip dhcp pool** *pool -name* **Example:** `Device(config)# ip dhcp pool WIRELESS-POOL`	Configures a DHCP address pool and enters DHCP pool configuration mode.
Step 4	**update arp** **Example:** `Device(dhcp-config)# update arp`	Secures insecure ARP table entries to the corresponding DHCP leases. • Existing active DHCP leases will not be secured until they are renewed. Using the **no update arp** command will change secured ARP table entries back to dynamic ARP table entries.
Step 5	**renew deny unknown** **Example:** `Device(dhcp-config)# renew deny unknown`	(Optional) Configures the renewal policy for unknown clients. • See the Troubleshooting Tips section for information about when to use this command.

Troubleshooting Tips

Use the following command to debug any errors that you may encounter when you configure DHCP to automatically generate a unique ID:

- **debug ip dhcp server packets**

Configuring DHCP Authorized ARP

Perform this task to configure DHCP authorized ARP, which disables dynamic ARP learning on an interface.

DHCP authorized ARP has a limitation in supporting accurate one-minute billing. DHCP authorized ARP probes for authorized users once or twice, 30 seconds apart. In a busy network the possibility of missing reply packets increases, which can cause a premature logoff. If you need a more accurate and finer control for probing of the authorized user, configure the **arp probe interval** command. This command specifies when to start a probe, the interval between unsuccessful probes, and the maximum number of retries before triggering an automatic logoff.

Note If both static and authorized ARP are installing the same ARP entry, static configuration overrides authorized ARP. You can install a static ARP entry by using the **arp** global configuration command. You can only remove a nondynamic ARP entry by the same method in which it was installed.

The ARP timeout period should not be set to less than 30 seconds. The feature is designed to send out an ARP message every 30 seconds, beginning 90 seconds before the ARP timeout period specified by the **arp timeout**command. This behavior allows probing for the client at least three times before giving up on the client. If the ARP timeout is set to 60 seconds, an ARP message is sent twice, and if it is set to 30 seconds, an ARP message is sent once. An ARP timeout period set to less than 30 seconds can yield unpredictable results.

>

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **ip address** *ip-address mask*
5. **arp authorized**
6. **arp timeout** *seconds*
7. **arp probe interval** *seconds* **count** *number*
8. **end**
9. **show arp**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.

	Command or Action	Purpose
Step 3	**interface** *type number* **Example:** `Router(config)# interface ethernet 1`	Configures an interface type and enters interface configuration mode.
Step 4	**ip address** *ip-address mask* **Example:** `Router(config-if)# ip address 209.165.200.224 209.165.200.224`	Sets a primary IP address for an interface.
Step 5	**arp authorized** **Example:** `Router(config-if)# arp authorized`	Disables dynamic ARP learning on an interface. • The IP address to MAC address mapping can be installed only by the authorized subsystem.
Step 6	**arp timeout** *seconds* **Example:** `Router(config-if)# arp timeout 60`	Configures how long an entry remains in the ARP cache.
Step 7	**arp probe interval** *seconds* **count** *number* **Example:** `Router(config-if)# arp probe interval 5 count 30`	(Optional) Specifies an interval, in seconds, and number of probe retries. • *seconds* --Interval, in seconds, after which the next probe will be sent to see if a peer is present. The range is from 1 to 10. • *number* --Number of probe retries. If there is no reply after the count has been reached, the peer has logged off. The range is from 1 to 60. **Note** You must use the **no** form of the command to stop the probing process.

Step 8	**end**
	Example:
	`Router(config-if)# end`
		Exits interface configuration mode and returns to privileged EXEC mode.

Step 9	**show arp** **Example:** `Router# show arp`	(Optional) Displays the entries in the ARP table.

Configuring a DHCP Lease Limit to Globally Control the Number of Subscribers

Perform this task to globally control the number of DHCP leases allowed for clients behind an ATM Routed Bridged Encapsulation (RBE) unnumbered interface or serial unnumbered interface.

This feature allows an ISP to globally limit the number of leases available to clients per household or connection.

If this feature is enabled on a Cisco IOS DHCP relay agent connected to clients through unnumbered interfaces, the relay agent keeps information about the DHCP leases offered to the clients per subinterface. When a DHCPACK message is forwarded to the client, the relay agent increments the number of leases offered to clients on that subinterface. If a new DHCP client tries to obtain an IP address and the number of leases has already reached the configured lease limit, DHCP messages from the client will be dropped and will not be forwarded to the DHCP server.

If this feature is enabled on the Cisco IOS DHCP server directly connected to clients through unnumbered interfaces, the server allocates addresses and increments the number of leases per subinterface. If a new client tries to obtain an IP address, the server will not offer an IP address if the number of leases on the subinterface has already reached the configured lease limit.

Note This feature is not supported on numbered interfaces. The lease limit can be applied only to ATM with RBE unnumbered interfaces or serial unnumbered interfaces.

>

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip dhcp limit lease log**
4. **ip dhcp limit lease per interface** *lease-limit*
5. **end**
6. **show ip dhcp limit lease** [*type number*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.

	Command or Action	Purpose
Step 3	**ip dhcp limit lease log** **Example:** `Router(config)# ip dhcp limit lease log`	(Optional) Enables DHCP lease violation logging when a DHCP lease limit threshold is exceeded. • If this command is configured, any lease limit violations will display in the output of the **show ip dhcp limit lease** command.
Step 4	**ip dhcp limit lease per interface** *lease-limit* **Example:** `Router(config)# ip dhcp limit lease per interface 2`	Limits the number of leases offered to DHCP clients behind an ATM RBE unnumbered or serial unnumbered interface.

Step 5	**end**
	Example:
	`Router(config)# end`
		Exits global configuration mode and returns to privileged EXEC mode.

Step 6	**show ip dhcp limit lease** [*type number*] **Example:** `Router# show ip dhcp limit lease`	(Optional) Displays the number of times the lease limit threshold has been violated. • You can use the **clear ip dhcp limit lease** privileged EXEC command to manually clear the stored lease violation entries.

Troubleshooting Tips

To verify the configuration, you can use the **debug dhcp detail** EXEC command to display the DHCP packets that were sent and received. To display the server side of the DHCP interaction, use the **debug ip dhcp server packets** command.

Configuring a DHCP Lease Limit to Control the Number of Subscribers on an Interface

Perform this task to limit the number of DHCP leases allowed on an interface.

This feature allows an ISP to limit the number of leases available to clients per household or connection on an interface.

If this feature is enabled on the Cisco IOS XE DHCP server directly connected to clients through unnumbered interfaces, the server allocates addresses and increments the number of leases per subinterface. If a new client tries to obtain an IP address, the server will not offer an IP address if the number of leases on the subinterface has already reached the configured lease limit.

Note This feature is not supported on numbered interfaces. The lease limit can be applied only to ATM with RBE unnumbered interfaces or serial unnumbered interfaces.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip dhcp limit lease log**
4. **interface** *type number*
5. **ip dhcp limit lease** *lease-limit*
6. **end**
7. **show ip dhcp limit lease** [*type number*]
8. **show ip dhcp server statistics** [*type number*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip dhcp limit lease log** **Example:** `Device(config)# ip dhcp limit lease log`	(Optional) Enables DHCP lease violation logging when a DHCP lease limit threshold is exceeded. • If this command is configured, any lease limit violations will display in the output of the **show ip dhcp limit lease** command.
Step 4	**interface** *type number* **Example:** `Device(config)# interface Serial0/0/0`	Enters interface configuration mode.
Step 5	**ip dhcp limit lease** *lease-limit* **Example:** `Device(config-if)# ip dhcp limit lease 6`	Limits the number of leases offered to DHCP clients per interface. • The interface configuration will override any global setting specified by the **ip dhcp limit lease per interface** global configuration command.

	Command or Action	Purpose

Step 6	**end**
	Example:
	`Device(config-if)# end`
		Exits the configuration mode and returns to privileged EXEC mode.

Step 7	**show ip dhcp limit lease** [*type number*] **Example:** `Device# show ip dhcp limit lease Serial0/0/0`	(Optional) Displays the number of times the lease limit threshold has been violated. • You can use the **clear ip dhcp limit lease** privileged EXEC command to manually clear the stored lease violation entries.
Step 8	**show ip dhcp server statistics** [*type number*] **Example:** `Device# show ip dhcp server statistics Serial 0/0/0`	(Optional) Displays DHCP server statistics.

Troubleshooting Tips

Use the **debug ip dhcp server class** command to display the class matching results.

Configuration Examples for DHCP Services for Accounting and Security

Example Configuring AAA and RADIUS for DHCP Accounting

The following example shows how to configure AAA and RADIUS for DHCP accounting:

```
aaa new-model
aaa group server radius RGROUP-1
 server 10.1.1.1 auth-port 1645 acct-port 1646
 exit
aaa accounting network RADIUS-GROUP1 start-stop group RGROUP-1
aaa session-id common
ip radius source-interface Ethernet 0
radius-server host 10.1.1.1 auth-port 1645 acct-port 1646
radius-server retransmit 3
exit
```

Example Configuring DHCP Accounting

DHCP accounting is configured on a per-client or per-lease basis. Separate DHCP accounting processes can be configured on a per-pool basis. The following example shows how to configure DHCP accounting START and STOP messages to be sent if RADIUS-GROUP1 is configured as a start-stop group:

```
ip dhcp pool WIRELESS-POOL
 accounting RADIUS-GROUP1
 exit
```

Example Verifying DHCP Accounting

DHCP accounting is enabled after both RADIUS and AAA for DHCP are configured. DHCP START and STOP accounting generation information can be monitored with the **debug radius accounting** and **debug ip dhcp server events**commands. See the "RADIUS Accounting Attributes" task for a list of AAA attributes that have been introduced by DHCP accounting.

The following is sample output from the **debug radius accounting**command. The output shows the DHCP lease session ID, the MAC address, and the IP address of the client interface.

```
00:00:53: RADIUS: Pick NAS IP for uid=2 tableid=0 cfg_addr=10.0.18.3 best_addr=0.0.0.0
00:00:53: RADIUS(00000002): sending
00:00:53: RADIUS(00000002): Send to unknown id 21645/1 10.1.1.1 :1646, Accounting-Request,
 len 76
00:00:53: RADIUS: authenticator C6 FE EA B2 1F 9A 85 A2 - 9A 5B 09 B5 36 B5 B9 27
00:00:53: RADIUS: Acct-Session-Id [44] 10 "00000002"
00:00:53: RADIUS: Framed-IP-Address [8] 6 10.0.0.10
00:00:53: RADIUS: Calling-Station-Id [31] 16 "00000c59df76"
00:00:53: RADIUS: Acct-Status-Type [40] 6 Start [1]
00:00:53: RADIUS: Service-Type [6] 6 Framed [2]
00:00:53: RADIUS: NAS-IP-Address [4] 6 10.0.18.3
00:00:53: RADIUS: Acct-Delay-Time [41] 6 0
```

The following is sample output from the **debug ip dhcp server events**command. The output was generated on a DHCP server and shows an exchange of DHCP messages between the client and server to negotiate a DHCP lease. The acknowledgment that confirms to the DHCP server that the client has accepted the assigned IP address triggers the accounting START message. It is shown in the last line of the following output:

```
00:45:50:DHCPD:DHCPDISCOVER received from client
0063.6973.636f.2d30.3030.312e.3432.6339.2e65.6337.352d.4574.31 on
interface Ethernet0.
00:45:52:DHCPD:assigned IP address 10.10.10.16 to client
0063.6973.636f.2d30.3030.312e.3432.6339.2e65.6337.352d.4574.31.
00:45:52:DHCPD:Sending DHCPOFFER to client
0063.6973.636f.2d30.3030.312e.3432.6339.2e65.6337.352d.4574.31(10.10.10.16)
00:45:52:DHCPD:broadcasting BOOTREPLY to client 0001.42c9.ec75.
00:45:52:DHCPD:DHCPREQUEST received from client
0063.6973.636f.2d30.3030.312e.3432.6339.2e65.6337.352d.4574.31.
00:45:52:DHCPD:Sending DHCPACK to client
0063.6973.636f.2d30.3030.312e.3432.6339.2e65.6337.352d.4574.31
(10.10.10.16).
00:45:52:DHCPD:broadcasting BOOTREPLY to client 0001.42c9.ec75.
00:45:52:DHCPD:triggered Acct Start for 0001.42c9.ec75 (10.10.10.16).
```

The following is sample output from the **debug ip dhcp server events**command. The output was generated on a DHCP server and shows the receipt of an explicit release message from the DHCP client. The DHCP server triggers an accounting STOP message and then returns the IP address to the DHCP pool. Information about the accounting STOP message is shown in the third line of the following output:

```
00:46:26:DHCPD:DHCPRELEASE message received from client
```

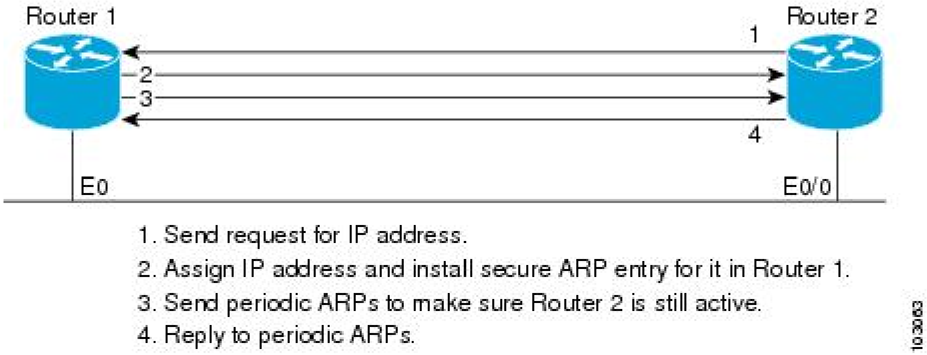
```
0063.6973.636f.2d30.3030.312e.3432.6339.2e65.6337.352d.4574.31 (10.10.10.16)
00:46:26:DHCPD:triggered Acct Stop for (10.10.10.16).
00:46:26:DHCPD:returned 10.10.10.16 to address pool WIRELESS-POOL.
```

Example Configuring DHCP Authorized ARP

Router 1 is the DHCP server that assigns IP addresses to the routers that are seeking IP addresses, and Router 2 is the DHCP client configured to obtain its IP address through the DHCP server. Because the **update arp** DHCP pool configuration command is configured on Router 1, the router will install a secure ARP entry in its ARP table. The **arp authorized** command stops any dynamic ARP on that interface. Router 1 sends periodic ARPs to Router 2 to make sure that the client is still active. Router 2 responds with an ARP reply. Unauthorized clients cannot respond to these periodic ARPs. The unauthorized ARP responses are blocked at the DHCP server. The timer for the entry is refreshed on Router 1 upon receiving the response from the authorized client.

See the figure below for a sample topology.

Figure 9: Sample Topology for DHCP Authorized ARP



1. Send request for IP address.
2. Assign IP address and install secure ARP entry for it in Router 1.
3. Send periodic ARPs to make sure Router 2 is still active.
4. Reply to periodic ARPs.

Router 1 (DHCP Server)

```
ip dhcp pool name1
 network 10.0.0.0 255.255.255.0
 lease 0 0 20
 update arp
!
interface Ethernet 0
 ip address 10.0.0.1 255.255.255.0
 half-duplex
 arp authorized
 arp timeout 60
! optional command to adjust the periodic ARP probes sent to the peer
 arp probe interval 5 count 15
```

Router 2 (DHCP Client)

```
interface Ethernet 0/0
 ip address dhcp
 half-duplex
```

Example Verifying DHCP Authorized ARP

The following is sample output from the **show arp** command on Router 1 (see the figure above):

```
Router1# show arp
Protocol  Address          Age (min)  Hardware Addr   Type   Interface
Internet  10.0.0.3               0    0004.dd0c.ffcb  ARPA   Ethernet01
Internet  10.0.0.1               -    0004.dd0c.ff86  ARPA   Ethernet0
```

The following is sample output from the **show arp** command on Router 2 (see the figure above):

```
Router2# show arp
Protocol  Address          Age (min)  Hardware Addr   Type   Interface
Internet  10.0.0.3               -    0004.dd0c.ffcb  ARPA   Ethernet0/02
Internet  10.0.0.1               0    0004.dd0c.ff86  ARPA   Ethernet0/0
```

Example Configuring a DHCP Lease Limit

In the following example, if more than three clients try to obtain an IP address from ATM interface 4/0.1, the DHCPDISCOVER packets will not be forwarded to the DHCP server. If the DHCP server resides on the same router, DHCP will not reply to more than three clients.

```
ip dhcp limit lease per interface 3
!
interface loopback 0
 ip address 10.1.1.129 255.255.255.192
!
interface ATM 4/0.1
 no ip address
!
interface ATM 4/0.1 point-to-point
 ip helper-address 172.16.1.2
 ip unnumbered loopback 0
 atm route-bridged ip
  pvc 88/800
  encapsulation aal5snap
```

In the following example, five DHCP clients are allowed to receive IP addresses. If a sixth client tries to obtain an IP address, the DHCPDISCOVER messages will not be forwarded to the DHCP server and a trap will be sent to the SNMP manager.

```
ip dhcp limit lease log
!
ip dhcp pool pool1
 network 10.1.1.0 255.255.255.0
!
interface loopback 0
 ip address 10.1.1.1 255.255.255.0
!
interface serial 0/0.2 point-to-point
 ip dhcp limit lease 5
 ip unnumbered loopback 0
 exit
snmp-server enable traps dhcp interface
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS Commands	Cisco IOS Master Command List, All Releases
DHCP commands: complete command syntax, command mode, command history, defaults, usage guidelines, and examples	Cisco IOS IP Addressing Services Command Reference
DHCP conceptual information	"DHCP Overview" module
DHCP relay agent configuration	"Configuring the Cisco IOS XE DHCP Relay Agent" module
DHCP client configuration	"Configuring the Cisco IOS XE DHCP Client" module
DHCP On-Demand Address Pool Manager	"Configuring the DHCP On-Demand Address Pool Manager" module

Standards and RFCs

Standard/RFC	Title
RFC 951	*Bootstrap Protocol (BOOTP)*
RFC 1542	*Clarifications and Extensions for the Bootstrap Protocol*
RFC 2131	*Dynamic Host Configuration Protocol*
RFC 2132	*DHCP Options and BOOTP Vendor Extensions*

Technical Assistance

Description	Link
The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.	http://www.cisco.com/techsupport

Technical Assistance

Description	Link
The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.	http://www.cisco.com/techsupport

Feature Information for DHCP Services for Accounting and Security

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to . An account on Cisco.com is not required.

Table 10: Feature Information for DHCP Services for Accounting and Security

Feature Name	Releases	Feature Information
DHCP per Interface Lease Limit and Statistics	12.2(33)SRC	This feature limits the number of DHCP leases offered to DHCP clients on an interface. DHCP server statistics reporting was enhanced to display interface-level statistics. The following commands were introduced or modified by this feature: **clear ip dhcp limit lease**, **ip dhcp limit lease**, **ip dhcp limit lease log**, **show ip dhcp limit lease**, **show ip dhcp server statistics**.
DHCP Lease Limit per ATM RBE Unnumbered Interface	12.2(28)SB 12.3(2)T 15.1(1)S	This feature limits the number of DHCP leases per subinterface offered to DHCP clients connected from an ATM RBE unnumbered interface or serial unnumbered interface of the DHCP server or DHCP relay agent. The following command was introduced by this feature: **ip dhcp limit lease per interface**.
ARP Auto-logoff	12.3(14)T	The ARP Auto-logoff feature enhances DHCP authorized ARP by providing finer control and probing of authorized clients to detect a logoff. The following command was introduced by this feature: **arp probe interval**.

Feature Name	Releases	Feature Information
DHCP Authorized ARP	12.2(33)SRC 12.3(4)T	DHCP authorized ARP enhances the DHCP and ARP components of the Cisco IOS software to limit the leasing of IP addresses to mobile users to authorized users. This feature enhances security in PWLANs by blocking ARP responses from unauthorized users at the DHCP server. The following command was introduced by this feature: **arp authorized**.
DHCP Accounting	12.2(15)T 12.2(28)SB 12.2(33)SRB	DHCP accounting introduces AAA and RADIUS support for DHCP configuration. The following command was introduced by this feature: **accounting**.
DHCP Secured IP Address Assignment	12.2(15)T 12.2(28)SB 12.2(33)SRC	DHCP secure IP address assignment provides the capability to secure ARP table entries to DHCP leases in the DHCP database. This feature secures and synchronizes the MAC address of the client to the DHCP binding, preventing hackers or unauthorized clients from spoofing the DHCP server and taking over a DHCP lease of an authorized client. The following commands were introduced or modified by this feature: **show ip dhcp server statistics**, **update arp**.

CHAPTER 7

Configuring DHCP Enhancements for Edge-Session Management

The DHCP Enhancements for Edge-Session Management feature provides the capability of simultaneous service by multiple Internet Service Providers (ISPs) to customers using one network infrastructure. The end-user customer may change ISPs at any time.

The DHCP enhancements evolved out of the Service Gateways (SGs) requirement to receive information from the DHCP server about when client DISCOVER packets (session initiation) are received, when an address has been allocated to a client, and when a client has released a DHCP lease or the lease has expired (session termination).

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About DHCP Enhancements for Edge-Session Management

DHCP Servers and Relay Agents

DHCP provides a framework for passing configuration information dynamically to hosts on a TCP/IP network. A DHCP client is an Internet host using DHCP to obtain configuration parameters such as an IP address.

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. By contrast, relay agents receive DHCP messages and then generate a new DHCP message to send on another interface.

For more information, refer to the DHCP modules in the *Cisco IOS IP Addressing Services Configuration Guide* , Release 12.4.

On-Demand Address Pool Management

An On-Demand Address Pool (ODAP) is used to centralize the management of large pools of addresses and simplifies the configuration of large networks. ODAP provides a central management point for the allocation and assignment of IP addresses.

When a Cisco router is configured as an ODAP manager, pools of IP addresses are dynamically increased or reduced in size depending on the address utilization level. The ODAP manager is supported by centralized Remote Authentication Dial-In User Service (RADIUS) or DHCP servers and is configured to request an initial pool of addresses from either the RADIUS or DHCP server.

The ODAP manager controls IP address assignment and will allocate additional IP addresses as necessary. This method of address allocation and assignment optimizes the use of available address space and simplifies the configuration of medium and large-sized networks.

For more information, see the “Configuring the DHCP Server On-Demand Address Pool Manager” module.

Design of the DHCP Enhancements for Edge-Session Management Feature

With the DHCP Enhancements for Edge-Session Management feature, a DHCP server and relay agent are separate, but closely coupled. The basic design of the feature encompasses two types of configuration at the edge of an ISP network as follows:

- DHCP server and an SG that are co-resident (in the same device)
- DHCP relay agent and an SG that are co-resident

DHCP Server Co-Resident with the SG

With this configuration, the DHCP server is in the same device as the SG and allocates addresses from locally configured address pools or acquires a subnet of addresses to allocate from some other system in the network. There are no changes to the server address allocation function to support the configuration.

This configuration enables the DHCP server to notify the SG that it has received a broadcast sent by the end-user DHCP client. The SG passes the MAC address and other information to the DHCP server. The SG also passes a class name (for example, the name of the ISP), which is used by the DHCP server to match a pool-class definition.

Lease-state notifications are always made by the DHCP server to the SG, because the information is already present.

Note The local configuration may also be performed by an ODAP that acquires subnets for the address pools from another DHCP server or a RADIUS server.

DHCP Relay Agent Co-Resident with the SG

With this configuration, the relay agent is in the same device as the SG and intercedes in DHCP sessions to appear as the DHCP server to the DHCP client. As the server, the relay agent may obtain enough information about the DHCP session to notify the SG of all events (for example, lease termination).

Appearing to be the DHCP server is performed by using the DHCP functionality that is currently in use on unnumbered interfaces. This functionality enables the relay agent to substitute its own IP address for the server.

The packet is passed by the relay agent to the DHCP server and the SG is notified of the receipt. Following the notification, an inquiry is made by the relay agent to the SG about which DHCP class name to use. Then, the packet is passed by the relay agent to the selected DHCP server.

The end-user DHCP client MAC address and other pertinent information is passed to the SG. The SG returns the DHCP class name to use when matching a DHCP pool if the SG is configured to do so. If the DHCP relay agent is not acting as a server, it relays the packet to the DHCP server.

Note An address pool may have one DHCP class defined to specify one central DHCP server to which the relay agent passes the packet, or it may have multiple DHCP classes defined to specify a different DHCP server for each client.

Benefits of the DHCP Enhancements for Edge-Session Management

The benefits of the DHCP Enhancements for Edge-Session Management feature are as follows:

- Allows the full DHCP server system to be located farther inside the network, while only running a relatively simple DHCP relay agent at the edge.
- Simplifies the DHCP configuration at the edge.

- Allows all DHCP server administration to occur closer to the middle of the network on one centralized DHCP server, or on separate DHCP servers (one for each ISP).
- Allows each ISP full control over all DHCP options and lease times.
- Allows both the DHCP server and client configurations to be used on the same edge system simultaneously.

How to Configure DHCP Enhancements for Edge-Session Management

Configuring the DHCP Address Pool and a Class Name

Perform this task to configure a DHCP server that assigns addresses from an address pool for a specific class name that has been assigned by an SG that is co-resident with the DHCP server at the edge.

If a DHCP server is resident in the same device as an SG and both are at the edge, a class name and address pool should be configured. In this case, the DHCP server notifies an SG of a DISCOVER broadcast received from a client and the SG returns a class name. The returned class name designates an address range of an address pool. The DHCP server sends the MAC address and IP address of the incoming interface or the specified relay-agent address to the SG.

Note If the DHCP server has its address pools defined locally or retrieves the subnets from ISP DHCP servers or AAA servers using ODAP, additional DHCP server configuration on behalf of the SG is not required.

If dynamic allocation of the address pool is required using ODAP, the **origin** command is specified.

Before You Begin

The specification of the class name is required in the DHCP address-pool configuration and in the SG system itself to designate each DHCP client class name. A default class name should be configured if a user does not have one.

Each address pool should be associated with one or more DHCP classes (address-provider ISPs). When the DHCP client selects an ISP, the selection becomes the class name designated by the SG.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip dhcp pool** *name*
4. **origin** {**dhcp** | **file** *url*}
5. **network** *network-number* [*mask* | *prefix-length*]
6. **class** *class-name*
7. **address range** *start-ip end-ip*
8. Repeat Steps 3, 5, and 6.
9. **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip dhcp pool** *name* **Example:** `Router(config)# ip dhcp pool abc-pool`	Configures a DHCP address pool on a Cisco IOS DHCP server and enters DHCP pool configuration mode. The *name* argument is the name of the pool and may either be a symbolic string (such as engineering) or an integer (such as 0).

Step 4	**origin** {**dhcp** | **file** *url*}
	Example:
	`Router(dhcp-config)# origin dhcp`
		(Optional) Configures an address pool as an On-Demand Address Pool (ODAP) or static mapping pool. The argument and keywords are as follows:

Step 5	**network** *network-number* [*mask* | *prefix-length*] **Example:** `Router(dhcp-config)# network 10.10.0.0 255.255.0.0`	Configures the subnet number and mask for a DHCP address pool on a Cisco IOS DHCP server. The arguments are as follows: • *network-number* --The IP address of the DHCP address pool. Use this argument if ODAP is not the IP address assignment method. • *mask* --(Optional) The bit combination that renders which portion of the address of the DHCP address pool refers to the network or subnet and which part refers to the host.

	Command or Action	Purpose
		• *prefix-length* --(Optional) The number of bits that comprise the address prefix. The prefix is an alternative way of specifying the network mask of the client. The prefix length must be preceded by a forward slash (/).

Step 6	**class** *class-name*
	Example:
	`Router(dhcp-config)# class abc-pool`
		Associates a class with a DHCP address pool and enters DHCP pool-class configuration mode. The *class-name* argument is the name of the class. It should match the DHCP address pool name.
		Repeat this step to specify a default class name if required by the SG.

Step 7	**address range** *start-ip end-ip* **Example:** `Router(config-dhcp-pool-class)# address range 10.10.5.0 10.99.99.99`	(Optional) Configures an IP address range from which the DHCP server would allocate the IP addresses. If an SG returned an IP address that is not configured, no action is taken. This step enables the allocation of an address from a range for the class name specified in the previous step. **Note** The **address range** command cannot be used with a relay pool that is configured with the **relay destination** command. Further, if no address range is assigned to a class name, the address is specified with the **network** command.
Step 8	Repeat Steps 3, 5, and 6.	If there is an interface configured with multiple subnets and different ISPs, repeat this step to match the number of subnets. See the "Multiple DHCP Pools and Different ISPs" Configuration Example.
Step 9	**exit** **Example:** `Router(config-dhcp-pool-class)# exit`	Exits to DHCP pool configuration mode.

Configuring a Relay Pool with a Relay Source and Destination

Perform this task to configure a relay pool when the DHCP relay and SG are resident in the same device at the edge, and all end users will obtain addresses from one pool. This task replaces the IP helper-address interface configuration.

If the SG notifies the relay agent that DHCP session notifications are required for a particular DHCP client, the relay agent will retain enough information about the DHCP session to notify the SG of all events (for example, lease termination). The relay intercedes DHCP sessions and assumes the role of the DHCP server. The IP address configuration becomes a dynamically changing value depending on the DHCP client information and the SG device policy information.

Note If a relay agent is interceding in DHCP sessions and assuming the role of the DHCP server, the use of DHCP authentication is not possible.

>

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip dhcp pool** *name*
4. **update arp**
5. **relay source** *ip-address subnet-mask*
6. **relay destination** [**vrf** *vrf-name* | **global**] *ip-address*
7. **accounting** *method-list-name*
8. **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip dhcp pool** *name* **Example:** `Router(config)# ip dhcp pool abc-pool`	Configures a DHCP address pool on a Cisco IOS DHCP server and enters DHCP pool configuration mode. The *name* argument is the name of the pool and may either be a symbolic string (such as engineering) or an integer (such as 0). More than one name may be configured.
Step 4	**update arp** **Example:** `Router(dhcp-config)# update arp`	(Optional) Configures secure and dynamic Address Resolution Protocol (ARP) entries in the ARP table to their corresponding DHCP bindings. **Note** If the system is allocating an address from an address pool, it will add secure ARP. If the system is relaying a packet using an address pool, it will also add secure ARP.
Step 5	**relay source** *ip-address subnet-mask*	Configures the relay source. The *ip-address*and *subnet-mask* arguments are the IP address and subnet mask for the relay source.

	Command or Action	Purpose
	Example: `Router(dhcp-config)# relay source 10.0.0.0 255.0.0.0`	**Note** This command is similar to the **network** command in a normal DHCP network pool, because it restricts the use of the address pool to packets arriving on the interface whose configured IP address and mask matches the relay source configuration.
Step 6	**relay destination** [**vrf** *vrf-name* | **global**] *ip-address* **Example:** `Router(dhcp-config)# relay destination 10.5.5.0`	Configures the IPv4 address of a remote DHCP server to which DHCP client packets are sent. The arguments and keywords are as follows: • **vrf** --(Optional) Virtual routing and forwarding (VRF). The *vrf-name* argument is the name of the VRF associated with the relay destination IP address. • **global** --(Optional) Global IP address. Use the this keyword when the relay agent is in the global address space and the relay source is in a VRF. • *ip-address* --IP address of the relay destination. **Note** When using the **relay destination** command, the *ip-address* argument is assumed to be in the same VRF as the address pool under which the command was configured. If the relay destination IP address is in a different VRF, or in the global address space, then the **vrf** *vrf-name* or **global** keywords need to be specified.
Step 7	**accounting** *method-list-name* **Example:** `Router(dhcp-config)# accounting RADIUS-GROUP1`	(Optional) Enables DHCP accounting if the specified server group is configured to run RADIUS accounting. • AAA and RADIUS must be enabled before DHCP accounting will operate. • The example configures DHCP accounting START and STOP messages to be sent if RADIUS-GROUP1 is configured as a start-stop group. STOP messages will only be sent if RADIUS-GROUP1 is configured as a stop-only group. See “Configuring DHCP Services for Accounting and Security” module for more information on DHCP accounting.
Step 8	**exit** **Example:** `Router(dhcp-config)# exit`	Exits to global configuration mode.

Configuring a Relay Pool for a Remote DHCP Server

Perform this task to use an SG-supplied class name when selecting the remote DHCP server in a configured relay pool, which is used to specify how DHCP client packets should be relayed. Multiple configurations of relay targets may appear in a pool-class definition in which case all addresses are used for relay purposes.

Note The **relay source** command cannot be used with the **network** command or **origin** command since those commands implicitly designate the incoming interface and are used to define a different type of pool. It associates the relay only with an interface in the same way that the **ip helper-address** command does by its presence as an interface configuration command.

>

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip dhcp pool** *name*
4. **relay source** *ip-address subnet-mask*
5. **relay destination** [**vrf** *vrf-name* | **global**] *ip-address*
6. **accounting method-list-name**
7. **class** *class-name*
8. **relay target** [**vrf** *vrf-name* | **global**] *ip-address*
9. **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip dhcp pool** *name* **Example:** `Router(config)# ip dhcp pool abc-pool`	Configures a DHCP address pool on a Cisco IOS DHCP server and enters DHCP pool configuration mode. The *name* argument is the name of the pool and may either be a symbolic string (such as engineering) or an integer (such as 0). You may specify more than one DHCP address pool.
Step 4	**relay source** *ip-address subnet-mask* **Example:** `Router(dhcp-config)# relay source 10.0.0.0 255.0.0.0`	Configures the relay source. The *ip-address*and *subnet-mask* arguments are the IP address and subnet mask for the relay source. **Note** This command is similar to the **network** command in a normal DHCP network pool, because it restricts the use of the address pool to packets arriving on the interface whose configured IP address and mask matches the relay source configuration.

	Command or Action	Purpose
Step 5	**relay destination** [**vrf** *vrf-name* | **global**] *ip-address* **Example:** `Router(dhcp-config)# relay destination 10.5.5.0`	Configures the IPv4 address of a remote DHCP server to which DHCP client packets are sent. The arguments and keywords are as follows: • **vrf** --(Optional) Virtual routing and forwarding (VRF). The *vrf-name* argument is the name of the VRF associated with the relay destination IP address. • **global** --(Optional) Global IP address. Use the this keyword when the relay agent is in the global address space and the relay source is in a VRF. • *ip-address* --IP address of the relay destination. **Note** When using the **relay destination** command, the *ip-address* argument is assumed to be in the same VRF as the address pool under which the command was configured. If the relay destination IP address is in a different VRF, or in the global address space, then the **vrf** *vrf-name* or **global** keywords need to be specified.
Step 6	**accounting method-list-name** **Example:** `Router(dhcp-config)# accounting RADIUS-GROUP1`	(Optional) Enables DHCP accounting if the specified server group is configured to run RADIUS accounting. • AAA and RADIUS must be enabled before DHCP accounting will operate. • The example configures DHCP accounting START and STOP messages to be sent if RADIUS-GROUP1 is configured as a start-stop group. STOP messages will only be sent if RADIUS-GROUP1 is configured as a stop-only group. See “Configuring DHCP Services for Accounting and Security” module for more information on DHCP accounting.

Step 7	**class** *class-name*
	Example:
	`Router(dhcp-config)# class abc-pool`
		Associates a class with a DHCP address pool and enters DHCP pool-class configuration mode. The *class-name* argument is the name of the class. You may configure more than one class name.

Step 8	**relay target** [**vrf** *vrf-name* | **global**] *ip-address* **Example:** `Router(config-dhcp-pool-class)# relay target 10.0.0.0`	Configures the relay target IP address. The arguments and keywords are as follows: • **vrf** --(Optional) Virtual routing and forwarding (VRF). The *vrf-name* argument is the name of VRF associated with the relay target IP address and more than one target may be specified. • **global** --(Optional) Global IP address space. • *ip-address* --IP address of the relay target. More than one target IP address may be specified. **Note** This command specifies the destination for the relay function in the same manner as the **ip helper-address** command. **Note** When using the **relay target** command, the *ip-address* argument is assumed to be in the same VRF as the address pool under which the command was configured. If the relay target IP address is in a different VRF, or in the global address space, then the **vrf** *vrf-name* or **global** keywords need to be specified.

	Command or Action	Purpose
Step 9	**exit** **Example:** `Router(config-dhcp-pool-class)# exit`	Exits to DHCP pool configuration mode.

Configuring Other Types of Relay Pools

Configuring Relay Information for an Address Pool

Perform this task to configure relay information for an address pool. In this configuration, the SG sends one class name that results in the DISCOVER packet being relayed to a server at the IP address configured using the **relay target**command. If the SG sends a class name that is not configured as being associated with the address pool, then no action is taken.

Note Specifying the **address range** command and **relay target** command in a pool-class definition is not possible, because this would allocate an address and relay for the same packet.

>

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip dhcp pool** *name*
4. **network** *network-number* [*mask* | *prefix-length*]
5. **class** *class-name*
6. **relay target** [**vrf** *vrf-name* | **global**] *ip-address*
7. **exit**
8. Repeat Steps 5 through 7 for each DHCP class you need to configure.

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip dhcp pool** *name* **Example:** `Router(config)# ip dhcp pool abc-pool`	Configures a DHCP address pool on a Cisco IOS DHCP server and enters DHCP pool configuration mode. The *name* argument is the name of the pool and may either be a symbolic string (such as engineering) or an integer (such as 0).
Step 4	**network** *network-number* [*mask* | *prefix-length*] **Example:** `Router(dhcp-config)# network 10.0.0.0 255.0.0.0`	Configures the subnet number and mask for a DHCP address pool on a Cisco IOS DHCP server. The arguments are as follows: • *network-number* --The IP address of the DHCP address pool. • *mask* --(Optional) The bit combination that renders which portion of the address of the DHCP address pool refers to the network or subnet and which part refers to the host. • *prefix-length* --(Optional) The number of bits that comprise the address prefix. The prefix is an alternative way of specifying the network mask of the client. The prefix length must be preceded by a forward slash (/).

Step 5	**class** *class-name*
	Example:
	`Router(dhcp-config)# class abc-pool`
		Associates a class with a DHCP address pool and enters DHCP pool-class configuration mode. The *class-name* argument is the name of the class. More than one class name may be configured.
		Note If no relay target or address range is configured for a DHCP pool class name, the DHCP pool configuration is used as the class by default.

Step 6	**relay target** [**vrf** *vrf-name* | **global**] *ip-address* **Example:** `Router(config-dhcp-pool-class)# relay target 10.0.0.0`	Configures the relay target IP address. The arguments and keywords for the **relay target** command are as follows: • **vrf** --(Optional) Virtual routing and forwarding (VRF). The *vrf-name* argument is the name of VRF associated with the relay target IP address and more than one target may be specified. • **global** --(Optional) Global IP address space. • *ip-address* --IP address of the relay target. More than one target IP address may be specified. **Note** When using the **relay target** command, the *ip-address* argument is assumed to be in the same VRF as the address pool under which the command was configured. If the relay target IP address is in a different VRF, or in the global address space, then the **vrf** *vrf-name* or **global** keywords need to be specified.

	Command or Action	Purpose
Step 7	**exit** **Example:** `Router(config-dhcp-pool-class)# exit`	Exits to DHCP pool configuration mode.
Step 8	Repeat Steps 5 through 7 for each DHCP class you need to configure.	--

Configuring Multiple Relay Sources for a Relay Pool

Perform this task to configure multiple relay sources for a relay pool. The configuration is similar to configuring an IP helper address on multiple interfaces. Pools are matched to the IP addresses on an incoming interface in the order in which the interfaces display when the **show running-config**command is used. Once a relay is found or an address allocation is found, the search stops.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **ip address** *ip-address mask* [**secondary**]
5. **exit**
6. **ip dhcp pool** *name*
7. **relay source** *ip-address subnet-mask*
8. **relay destination** [**vrf** *vrf-name* | **global**] *ip-address*
9. **accounting** *method-list-name*
10. Repeat Steps 6 and 7 for each configured DHCP pool.
11. **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Router(config)# interface ethernet1`	Configures an interface and enters interface configuration mode. The arguments are as follows:
Step 4	**ip address** *ip-address mask* [**secondary**] **Example:** `Router(config-if)# ip address 10.0.0.0 255.0.0.0`	Sets a primary or secondary IP address for an interface.
Step 5	**exit** **Example:** `Router(config-if)# exit`	Exits to global configuration mode.
Step 6	**ip dhcp pool** *name* **Example:** `Router(config)# ip dhcp pool abc-pool1`	Configures a DHCP address pool on a DHCP server and enters DHCP pool configuration mode. The *name* argument is the name of the pool and may either be a symbolic string (such as engineering) or an integer (such as 0). More than one pool may be assigned.
Step 7	**relay source** *ip-address subnet-mask* **Example:** `Router(dhcp-config)# relay source 10.0.0.0 255.0.0.0`	Configures the relay source. The *ip-address*and *subnet-mask* arguments are the IP address and subnet mask for the relay source. **Note** This command is similar to the **network** command in a normal DHCP network pool, because it restricts the use of the address pool to packets arriving on the interface whose configured IP address and mask matches the relay source configuration.
Step 8	**relay destination** [**vrf** *vrf-name* | **global**] *ip-address* **Example:** `Router(dhcp-config)# relay destination 10.5.5.0`	Configures the IPv4 address of a remote DHCP server to which DHCP client packets are sent. The arguments and keywords are as follows: • **vrf** --(Optional) Virtual routing and forwarding (VRF). The *vrf-name* argument is the name of the VRF associated with the relay destination IP address. • **global** --(Optional) Global IP address. Use the this keyword when the relay agent is in the global address space and the relay source is in a VRF. • *ip-address* --IP address of the relay destination.

	Command or Action	Purpose
		Note When using the **relay destination** command, the *ip-address* argument is assumed to be in the same VRF as the address pool under which the command was configured. If the relay destination IP address is in a different VRF, or in the global address space, then the **vrf** *vrf-name* or **global** keywords need to be specified.
Step 9	**accounting** *method-list-name* **Example:** `Router(dhcp-config)# accounting RADIUS-GROUP1`	(Optional) Enables DHCP accounting if the specified server group is configured to run RADIUS accounting. • AAA and RADIUS must be enabled before DHCP accounting will operate. • The example configures DHCP accounting START and STOP messages to be sent if RADIUS-GROUP1 is configured as a start-stop group. STOP messages will only be sent if RADIUS-GROUP1 is configured as a stop-only group. See "Configuring DHCP Services for Accounting and Security" module for more information on DHCP accounting.
Step 10	Repeat Steps 6 and 7 for each configured DHCP pool.	--
Step 11	**exit** **Example:** `Router(dhcp-config)# exit`	Exits to global configuration mode.

Configuration Examples for DHCP Enhancements for Edge Session Management

DHCP Address Range and Class Name Configuration Example

The following example shows how to configure an address range for a particular network and class name for a DHCP pool.

```
ip dhcp pool abc-pool
 network 10.10.0.0 255.255.0.0
 class abc-pool
  address range 10.10.5.0 10.10.5.99
```

DHCP Server Co-Resident with SG Configuration Example

In the following example, the ISPs are ABC and DEF companies. The ABC company has its addresses assigned from an address pool that is dynamically allocated using ODAP. The DEF company has its customer addresses assigned from the address pool 10.100.0.0/16. Customers not associated with any ISP will have an address allocated from the address pool 10.1.0.0/16 and the lease time is set to 10 minutes.

```
!Interface configuration
interface ethernet1
 ip address 10.20.0.1. 255.255.0.0
 ip address 10.1.0.1 255.255.0.0 secondary
 ip address 10.100.0.1 255.255.0.0 secondary
!Address pool for ABC customers
ip dhcp pool abc-pool
 network 20.1.0.0 255.255.0.0
 class abc
!
!Address pool for DEF customers
ip dhcp pool def-pool
 network 10.100.0.0 255.255.0.0
 class def
!Address pool for customers without an ISP
ip dhcp pool temp
 network 10.1.0.0 255.255.0.0
 lease 0 0 10
 class default
```

DHCP Relay Agent Co-Resident with SG Configuration Example

In the following example, there are two ISPs: abcpool and defpool. The abcpool ISP and its customers are allowed to have addresses in the ranges 10.1.0.0/16 and 30.1.0.0/16 and are relayed to the DHCP server at 10.55.10.1. The defpool ISP and its customers are allowed to have addresses in the ranges 20.1.0.0/16 and 40.4.0.0/16 and are relayed to the DHCP server at 12.10.2.1.

```
!Address ranges:
interface ethernet1
 ip address 10.1.0.0 255.255.0.0
 ip address 10.2.0.0 255.255.0.0 secondary
interface ethernet2
 ip address 10.3.0.0 255.255.0.0
 ip address 10.4.0.0 255.255.0.0 secondary
!Address pools for abcpool1 and abcpool2:
ip dhcp pool abcpool1
 relay source 10.1.0.0 255.255.0.0
 class abcpool
  relay target 10.5.10.1
!Address pool for abcpool2:
ip dhcp pool abcpool2
 relay source 10.1.0.0 255.255.0.0
 class abcpool
  relay target 10.55.10.1
!Address pools for defpool1 and defpool2:
ip dhcp pool defpool1
 relay source 10.1.0.0 255.255.0.0
 class defpool
  relay target 10.10.2.1
ip dhcp pool defpool2
 relay source 10.4.0.0 255.255.0.0
 class defpool
  relay target 10.10.2.1
```

Multiple DHCP Pools and Different ISPs Configuration Example

The following example shows how to configure one interface and multiple DHCP pools that have different ISPs by using the **network** command.

```
interface ethernet1
 ip address 10.0.0.1 255.0.0.0
 ip address 10.1.0.1 255.0.0.0
!
ip dhcp pool x
 network 10.0.0.0 255.0.0.0
 class ISP1
!
ip dhcp pool y
 network 10.1.0.0 255.0.0.0
 class ISP2
```

Multiple Relay Sources and Destinations Configuration Example

In the following example, multiple relay sources and destinations may be configured for a relay pool. This is similar the ip helper-address configuration on multiple interfaces. Pools are matched to the (possibly multiple) IP addresses on an incoming interface in the order in which they appear when using the **show running-config** command to display information about that interface. Once either a relay is found or an address allocation is found, the search stops. For example, given the following configuration:

```
interface ethernet1
 ip address 10.0.0.1 255.0.0.0
 ip address 10.0.0.5 255.0.0.0 secondary
ip dhcp pool x
 relay source 10.0.0.0 255.0.0.0
 relay destination 10.0.0.1
ip dhcp pool y
 relay source 10.0.0.0 255.0.0.0
 relay destination 10.0.0.1
```

In the following example, the DHCP client packet would be relayed to 10.0.0.1, if the SG specified ISP1 as the class name, and would be relayed to 10.0.0.5, if the SG specified ISP2 as the class name.

```
interface ethernet1
 ip address 10.0.0.1 255.0.0.0
 ip address 10.0.0.5 255.0.0.0 secondary
ip dhcp pool x
 relay source 10.0.0.0 255.0.0.0
 relay destination 10.2.0.0 255.0.0.0
 class ISP1
  relay target 10.0.0.1
 class ISP2
  relay target 10.0.0.5
```

SG-Supplied Class Name Configuration Example

In the following example, an SG-supplied class name is to be used in selecting the remote DHCP server to which packets should be relayed.

```
ip dhcp pool abc-pool-1
 relay source 10.1.0.0 255.255.0.0
 relay destination 10.1.0.0
 class classname1
  relay target 10.20.10.1
```

```
class classname2
 relay target 10.0.10.1
class classname3
```

In the example above, an SG-supplied class name, called classname1, would relay the DHCP DISCOVER packet to the server at the relay target IP address 10.20.10.1, while SG classname2 would relay the DHCP DISCOVER packet to the server at the relay target IP address 10.0.10.1. This configuration relays the packet to destination IP address 10.0.0.1, because the pool matches the first configured address on the interface. If the SG returns a classname3, then the default pool is the default address specified as the relay destination. If the SG returns any class name other than classname1, classname2, or classname3, then no relay action is taken.

Additional References

The following sections provide references related to configuring DHCP Enhancements for Edge-Session Management.

Related Documents

Related Topic	Document Title
DHCP commands: complete command syntax, command modes, command history, defaults, usage guidelines, and examples	*Cisco IOS IP Addressing Services Command Reference*
DHCP conceptual information	“DHCP Overview” module
DHCP server configuration	“Configuring the Cisco IOS DHCP Server” module
DHCP client configuration	“Configuring the Cisco IOS DHCP Client” module
DHCP relay agent configuration	“Configuring the Cisco IOS DHCP Relay Agent” module
DHCP server on-demand address pool manager configuration	“Configuring the DHCP Server On-Demand Address Pool Manager” module
DHCP advanced features	“Configuring DHCP Services for Accounting and Security” module
DHCP options	“DHCP Options” appendix in the *Network Registrar User’s Guide* , Release 6.1.1

Standards

Standards	Title
No new or modified standards are supported by this functionality.	--

MIBs

MIBs	MIBs Link
No new or modified MIBs are supported by this feature.	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFCs	Title
RFC 951	*Bootstrap Protocol (BOOTP)*
RFC 1542	*Clarifications and Extensions for the Bootstrap Protocol*
RFC 2131	*Dynamic Host Configuration Protocol*
RFC 2685	*Virtual Private Networks Identifier*
RFC 3046	*DHCP Relay Information Option*

Technical Assistance

Description	Link
The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.	http://www.cisco.com/techsupport

Feature Information for DHCP Enhancements for Edge-Session Management

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to . An account on Cisco.com is not required.

Table 11: Feature Information for DHCP Enhancements for Edge-Session Management

Feature Name	Releases	Feature Configuration Information
DHCP Relay Accounting	12.4(6)T	The DHCP Relay Accounting feature allows a Cisco IOS DHCP relay agent to send a RADIUS accounting start packet when an address is assigned to a client and a RADIUS accounting stop packet when the address is released. This feature is enabled by using the **accounting** command with relay pools that use the **relay destination** command in DHCP pool configuration mode. No new commands were introduced by this feature.
DHCP Enhancements for Edge-Session Management	12.3(14)T 12.2(28)SB 12.2(33)SRC	The DHCP Enhancements for Edge-Session Management feature provides the capability of simultaneous service by multiple ISPs to customers using one network infrastructure. The end-user customer may change ISPs at any time. The following commands were introduced by this feature: **relay destination**, **relay source**,and **relay target**.

CHAPTER 8

DHCP: Automatic IPv4 Address Pool Assignment for DMVPN Spokes

The DHCP: Automatic IPv4 Address Pool Assignment for DMVPN Spokes feature uses the Dynamic Host Configuration Protocol (DHCP) On-Demand Address Pool (ODAP) feature to support the centralized management of overall IP addresses and zero touch Spoke DMVPN deployments.

Dynamic IP address allocation for the DMVPN Spoke's generic routing encapsulation (GRE) tunnel interface is supported. The Spoke devices in DMVPN deployments must be configured statically for local DHCP pools so that they can distribute addresses to hosts on their inside LAN interface. This involves substantial administrative overhead. The management of large pools of IP subnets needs to be centralized to simplify the configuration of subnets allocated to LAN interfaces in large DMVPN networks.

The Cisco implementation of DHCP provides an additional functionality of ODAP subnet allocation. The ODAP subnet allocation allows DHCP to be used to not only allocate and install an IP address for the DMVPN mGRE tunnel on the Spoke, but also to allocate an IP subnet to be used by the Spoke to distribute addresses on its inside LAN interface. ODAP is used to centralize the management of large pools of addresses and simplify the configuration of large networks. ODAP provides a central management point for the allocation and assignment of subnets and IP addresses.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About DHCP: Automatic IPv4 Address Pool Assignment for DMVPN Spokes

ODAP Client Support on DMVPN Spoke

The Cisco IOS DHCP ODAP feature supports centralized management of IP addresses and zero touch spoke DMVPN deployments. After the IP address is assigned to the DMVPN mGRE tunnel on the spoke, DHCP is used to allocate an IP subnet that is to be used by the spoke to distribute addresses to hosts on its inside LAN interface.

The following enhancements are made on the ODAP client side to support the DHCP- Automatic IPv4 Address Pool Assignment for DMVPN Spokes feature:

- In the existing implementation of IOS ODAP client, the outgoing interface for sending a subnet allocation request cannot be specified. Therefore, subnet allocation request DHCP packets are sent on all the interfaces. This is not desirable in a DMVPN environment. A new CLI is introduced that allows the administrator to specify the outgoing interface for sending the subnet allocation request. The target ODAP server's IP address can also be specified in the same CLI.
- By default, the Cisco IOS DHCP ODAP client module prepares the client ID to be sent in the subnet allocation request by concatenating the router hostname with the subnet pool name. The subnet allocation server uses this client ID to identify and allocate subnets. This naming convention will not work well in a DMVPN environment. The IOS DHCP ODAP client module is enhanced to use an administrator-configured client ID.
- By default, Cisco IOS ODAP requests only one subnet when sending the initial request for subnets at the time of configuration. The existing CLI is enhanced to allow the administrator to configure the number of subnets that need to be requested in the initial request for subnets.
- With the existing implementation of the ODAP client, the DMVPN spoke will lose all the subnet information it had acquired after a reboot or reload. Any new subnet allocation request after a reload will result in a new subnet allocated to the spoke. This is not desirable in the DMVPN deployment scenario. The subnet allocation protocol provides a mechanism for recovering the previously allocated subnet after the subnet client reboots or reloads. As part of this feature, the ODAP client is enhanced to request previously allocated subnets after a reload or reboot. If the server does not reply with any previously allocated subnets, the client will learn that no subnets were allocated to it earlier, and will then switch back to the subnet allocation request for new subnets.

Apart from using DHCP, the DMVPN hub also can use the RADIUS AAA protocol for getting the subnet allocated for IP address allocation to its local LAN. With the RADIUS method of subnet allocation, the subsequent request for subnet allocation from the client will not result in the allocation of a new subnet.

ODAP Server Support on DMVPN Hub

The IOS ODAP server (that is, subnet allocation server) can be used in a DMVPN deployment at the hub node. The subnet allocation server also can reside outside the DMVPN network. In either case, the IOS ODAP server has limited usability in a DMVPN deployment. As part of the DHCP: Automatic IPv4 Address Pool Assignment for DMVPN Spokes feature, the following enhancements were made to the IOS subnet allocation server:

- The existing implementation of the ODAP server supports only requests for new subnets. It does not understand the request for previously allocated subnets that the client can send at the time of reboot or reload. As part of this feature, the ODAP server is enhanced to recognize the request for previously allocated subnets and reply with all the previously allocated subnets to the client instead of allocating new ones.
- The IOS software has database agent support that is used to store the IP address bindings to the nonvolatile storage (like the FTP file). This file can be read by the DHCP server at the time of reload or restart. The database agent support provides the persistent storage mechanism for IP address bindings. The IOS software supports persistent storage for ODAP subnet bindings.

Note Relay agent support is not required for ODAP requests in a DMVPN environment irrespective of the ODAP server location.

DHCP Static Mapping

The DHCP static mapping binding feature allows you to configure many manual bindings without creating as many DHCP host pools. This feature allows the administrator to create a file with the static DHCP bindings (IP or client ID pair) that gets read when the DHCP server is started. While reading this static mapping file, manual or static DHCP bindings get created on the DHCP server with infinite lease. Few DMVPN deployments use this feature for assigning static IP address to spoke nodes. As part of the DHCP: Automatic IPv4 Address Pool Assignment for DMVPN Spokes feature, the DHCP static mapping binding feature is enhanced to make it more usable in DMVPN deployments. The following enhancements were made:

- It is not feasible for the administrator to know the client ID of each spoke node in advance for the purpose of mentioning the it in the DHCP static mapping file. The static mapping file, instead of containing the IP address to client ID mapping, is enhanced to contain the IP address to ASCII format client ID, which can be configured on the requesting clients.
- In the existing implementation of the DHCP static mapping bindings feature, file is read only in beginning at the time of configuration or when the DHCP server is started. An administrator configurable periodic timer is available with the DHCP: Automatic IPv4 Address Pool Assignment for DMVPN Spokes feature so that the static mapping file can be read periodically and the DHCP bindings on the server remain up to date. The **origin file** command is enhanced to allow you to specify the periodic refresh timer.
- Apart from providing a periodic timer for refreshing the static mapping file, you can refresh the static mapping bindings without affecting the present DHCP bindings on the server using the **odap server** command.

- The client ID shown in the DHCP debugs and in the **show** command outputs is displayed in ASCII string format to make it more readable. This change will apply only to static bindings. You can enable or disable this feature using the **ip dhcp debug ascii-client-id** command.

NHRP Support

In a DMVPN environment, the IPsec tunnel connecting the DMVPN spoke to hub must be built before any IP packet exchange can happen through GRE tunnel interface. Next Hop Resolution Protocol (NHRP) is integrated with DHCP to work in scenarios where the DMVPN spoke acts as a DHCP relay agent or DHCP server.

Configuring DHCP: Automatic IPv4 Address Pool Assignment for DMVPN Spokes

Assigning an IPv4 Address Pool for DMPVN Spokes

For more information about configuring DMVPN, see the Dynamic Multipoint VPN (DMVPN) module. You can use the **odap server** {**rebind-time** *percent-value* | **renew-time***percent-value*} command to configure ODAP server parameters. Perform this task to assign IPv4 address pool for DMVPN spokes.

Before You Begin

Note You should configure the DHCP server ODAP. For more information, see the Configuring the DHCP Server On-Demand Address Pool Manager module.

You must configure the DMVPN hub as a DHCP server. For more information about configuring the spoke address dynamically on a DMVPN network using DHCP, see the DHCP: Tunnels Support module.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip dhcp pool** *pool-name*
4. **origin dhcp number** *number*
5. **odap client** {**client-id** *id* [**interface** *type number*] [**target-server** *ip-address*] | **interface** *type number* [**client-id** *id*] [**target-server** *ip-address* | **target-server** *ip-address* [**client-id** *id*] [**interface** *type number*]
6. **origin dhcp** [**subnet size initial** *size* [**autogrow** *size*]]
7. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip dhcp pool** *pool-name* **Example:** `Router(config)# ip dhcp pool pool1`	Configures a DHCP address pool on a Cisco IOS DHCP server and enters DHCP pool configuration mode.
Step 4	**origin dhcp number** *number* **Example:** `Router(dhcp-config)# origin dhcp number 3`	Configures the initial number of subnets that should be requested by the ODAP client.
Step 5	**odap client** {**client-id** *id* [**interface** *type number*] [**target-server** *ip-address*] | **interface** *type number* [**client-id** *id*] [**target-server** *ip-address* | **target-server** *ip-address* [**client-id** *id*] [**interface** *type number*] **Example:** `Router(dhcp-config)# odap client client-id id1 interface gigabitethernet 0/0 target-server 192.168.10.1`	Configures ODAP client parameters.
Step 6	**origin dhcp** [**subnet size initial** *size* [**autogrow** *size*]]	Configures an address pool as an ODAP. • If you do not configure the pool as an autogrow pool, the pool will not request additional subnets if one subnet is already in the pool. • You can enter the value for the *size* argument as either the subnet mask (nnnn.nnnn.nnnn.nnnn) or prefix size (/nn). The valid values are /0 and /4 to /30. • When a DHCP pool receives multiple subnets from an upstream DHCP server, an address from each subnet is automatically configured on the client connected interface so that the addresses within the subnets can be requested by DHCP clients. The first address in the first subnet is automatically assigned to the primary address on the interface. The first address of each subsequent subnet is assigned to secondary addresses on the interface. In addition, as client addresses are reclaimed, the count of lease addresses for that

	Command or Action	Purpose
		subnet is decremented. Once a lease counter for a subnet reaches zero (that is, lease expiry), the subnet is returned to the pool. The previous address on the interface is removed and the first secondary address on the interface is promoted as the primary address of the interface.

Step 7	**end**
	Example:
	`Router(dhcp-config)# end`
		Exits DHCP pool configuration mode and returns to privileged EXEC mode.

Configuration Examples for DHCP: Automatic IPv4 Address Pool Assignment for DMVPN Spokes

Example: Assigning an IPv4 Address Pool for DMVPN Spokes

```
Router# configure terminal
Router(config)# ip dhcp pool pool1
Router(dhcp-config)# origin dhcp number 3
Router(dhcp-config)# odap client client-id id1 interface gigabitethernet 0/0 target-server
 192.168.10.1
Router(dhcp-config)# origin dhcp subnet size initial /16 autogrow /16
Rotuer(dhcp-config)# end
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
DMVPN commands	Cisco IOS Security Command Reference
On-Demand Address Pool Manager	Configuring the DHCP Server On-Demand Address Pool Manager
Dynamic Multipoint VPN	Configuring DMVPN

Related Topic	Document Title
Configuring the node (or spoke) of generic routing encapsulation (GRE) tunnel interfaces dynamically using DHCP	DHCP: Tunnels Support

Standards and RFCs

Standard/RFC	Title
None	-

MIBs

MIB	MIBs Link
None	To locate and download MIBs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for DHCP: Automatic IPv4 Address Pool Assignment for DMVPN Spokes

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to . An account on Cisco.com is not required.

Table 12: Feature Information for DHCP: Automatic IPv4 Address Pool Assignment for DMVPN Spokes

Feature Name	Releases	Feature Information
DHCP: Automatic IPv4 Address Pool Assignment for DMVPN Spokes	15.2(1)T	The DHCP: Automatic IPv4 Address Pool Assignment for DMVPN Spokes feature uses the DHCP ODAP feature to support the centralized management of overall IP addresses and zero touch spoke DMVPN deployments. The following commands were introduced or modified: **ip dhcp debug ascii-client-id**, **odap client**, **odap server**, **origin**.

CHAPTER 9

DHCPv6 Prefix Delegation Using AAA

This feature enables the Dynamic Host Configuration Protocol for IPv6 (DHCPv6) server to use AAA to obtain the prefix assignment through an AAA/RADIUS authorization request.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About DHCPv6 Prefix Delegation Using AAA

Prefix Delegation

An IPv6 prefix delegating device selects IPv6 prefixes to be assigned to a requesting device upon receiving a request from the client. The delegating device might select prefixes for a requesting device in the following ways:

- Dynamic assignment from a pool of available prefixes.

- Dynamic assignment from a pool name obtained from the RADIUS server.
- Assignment of prefix obtained from the RADIUS sever.

Contrary to IPv4 address assignment, an IPv6 user will be assigned a prefix, not a single address. Typically the Internet service provider (ISP) assigns a 64- or 48-bit prefix.

DHCP SIP Server Options

Two DHCP for IPv6 Session Initiation Protocol (SIP) server options describe a local outbound SIP proxy: one carries a list of domain names, the other a list of IPv6 addresses. These two options can be configured in a DHCPv6 configuration pool.

How to Configure DHCPv6 Prefix Delegation Using AAA

Configuring DHCPv6 AAA and SIP Options

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 dhcp pool** *poolname*
4. **prefix-delegation aaa** [**method-list** *method-list*] [*lifetime*]
5. **sip address** *ipv6-address*
6. **sip domain-name** *domain-name*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ipv6 dhcp pool** *poolname* **Example:** `Router(config)# ipv6 dhcp pool pool1`	Configures a DHCP for IPv6 configuration information pool and enters DHCP for IPv6 pool configuration mode.

	Command or Action	Purpose
Step 4	**prefix-delegation aaa** [**method-list** *method-list*] [*lifetime*] **Example:** `Router(config-dhcp)# prefix-delegation aaa method-list list1`	Specifies that prefixes are to be acquired from AAA servers.
Step 5	**sip address** *ipv6-address* **Example:** `Router(config-dhcp)# sip address 2001:DB8::2`	Configures a SIP server IPv6 address to be returned in the SIP server's IPv6 address list option to clients.
Step 6	**sip domain-name** *domain-name* **Example:** `Router(config-dhcp)# sip domain sip1.cisco.com`	Configures a SIP server domain name to be returned in the SIP server's domain name list option to clients.

Configuration Examples for DHCPv6 Prefix Delegation Using AAA

Example: Configuring DHCPv6 AAA and SIP Options

```
Device# show ipv6 dhcp pool
DHCPv6 pool: dhcpv6-aaa-pool
Prefix from AAA server
method list name: dhcpv6_aaa
preferred lifetime 180, valid lifetime 240
SIP server address: 2000:DB8:1
SIP server domain name: testing-1
Active clients: 0
```

Additional References

Related Documents

Related Topic	Document Title
IPv6 addressing and connectivity	*IPv6 Configuration Guide*
Cisco IOS commands	Cisco IOS Master Command List, All Releases

Related Topic	Document Title
IPv6 commands	Cisco IOS IPv6 Command Reference
Cisco IOS IPv6 features	Cisco IOS IPv6 Feature Mapping

Standards and RFCs

Standard/RFC	Title
RFCs for IPv6	*IPv6 RFCs*

MIBs

MIB	MIBs Link
	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for DHCPv6 Prefix Delegation Using AAA

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to . An account on Cisco.com is not required.

Table 13: Feature Information for DHCPv6 Prefix Delegation Using AAA

Feature Name	Releases	Feature Information
DHCPv6 Prefix Delegation Using AAA	12.3(4)T	The DHCPv6 server can use AAA to obtain the prefix assignment through an AAA/RADIUS authorization request. The following commands were introduced or modified: **ipv6 dhcp pool**, **prefix-delegation aaa**, **sip address**, **sip domain-name**.

CHAPTER 10

DHCPv6 Server Stateless Autoconfiguration

Hierarchical Dynamic Host Configuration Protocol for IPv6 (DHCPv6) for stateless configuration parameters allows a stateless or stateful DHCPv6 client to export configuration parameters (DHCPv6 options) to a local DHCPv6 server pool. The local DHCPv6 server can then provide the imported configuration parameters to other DHCPv6 clients.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

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Information About DHCPv6 Server Stateless Autoconfiguration

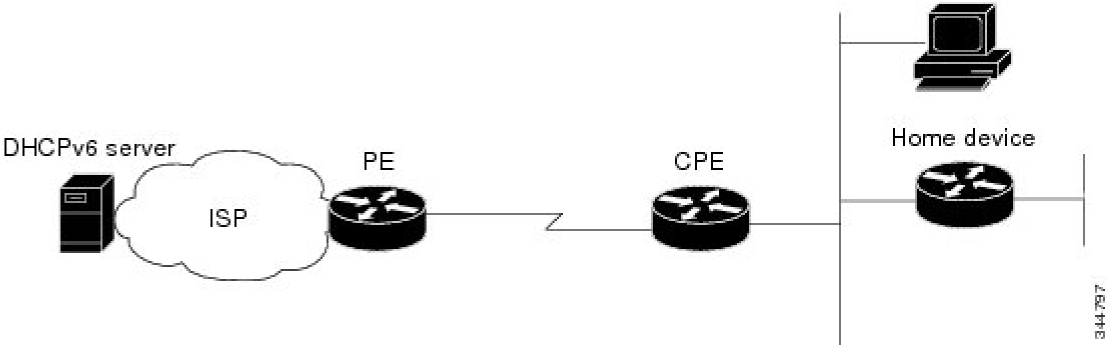
DHCPv6 Server Stateless Autoconfiguration

Hierarchical Dynamic Host Configuration Protocol for IPv6 (DHCPv6) for stateless configuration parameters allows a stateless or stateful DHCPv6 client to export configuration parameters (DHCPv6 options) to a local

DHCPv6 server pool. The local DHCPv6 server can then provide the imported configuration parameters to other DHCPv6 clients.

The figure below shows a typical broadband deployment.

Figure 10: Broadband Topology



The customer premises edge (CPE) interface toward the provider edge (PE) can be a stateless or stateful DHCPv6 client. In either case, the ISP-side DHCPv6 server might provide configuration parameters such as Domain Name System (DNS) server addresses, domain names, and Simple Network Time Protocol (SNTP) servers to the DHCP client on the CPE. Such information can be specific to ISPs.

In addition to being a DHCPv6 client (for example, toward the ISP), the CPE can act as a DHCPv6 server to the home network. For example, neighbor discovery followed by a stateless or stateful DHCPv6 client can occur on the link between the CPE and the home devices. In some cases, the information to be provided to the home network is the same as that obtained from the ISP-side DHCPv6 server. Because this information can be dynamically changed, it cannot be hard-configured in the CPE's configuration. Therefore, the DHCPv6 component on the CPE allows automatic importing of configuration parameters from the DHCPv6 client to the DHCPv6 server pool.

DHCPv6 supports the options for IPv6 on the server described in the following sections.

Information Refresh Server Option

The DHCPv6 information refresh server option can specify a maximum limit for the length of time a client should wait before refreshing the information retrieved from DHCPv6. This option is used with stateless DHCPv6 because there are no addresses or other entities with lifetimes that can tell the client when to contact the DHCPv6 server to refresh its configuration.

NIS- and NIS+-Related Server Options

Users can configure the network information service (NIS) or NIS plus (NIS+) address or domain name of a DHCPv6 server using NIS- and NIS+-related options, and then import that information to the DHCPv6 client.

SIP Server Options

Session Initiation Protocol (SIP) server options contain either a list of domain names or a list of IPv6 addresses that can be mapped to one or more SIP outbound proxy servers. One option carries a list of domain names, and the other option carries a list of 128-bit IPv6 addresses.

SIP is an application-layer control protocol that can establish, modify, and terminate multimedia sessions or calls. A SIP system has several logical components: user agents, proxy servers, redirect servers, and registrars. User agents can contain SIP clients; proxy servers always contain SIP clients.

SNTP Server Option

The Simple Network Time Protocol (SNTP) server option provides a list of one or more IPv6 addresses of SNTP servers available to the client for synchronization. Clients use these SNTP servers to synchronize their system time to that of the standard time servers. The DHCPv6 server can list the SNTP servers in decreasing order of preference, but clients treat the list of SNTP servers as an ordered list.

How to Configure DHCPv6 Server Stateless Autoconfiguration

Configuring the Stateless DHCPv6 Server

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 dhcp pool** *poolname*
4. **dns-server** *ipv6-address*
5. **domain-name** *domain*
6. **exit**
7. **interface** *type number*
8. **ipv6 dhcp server** *poolname* [**rapid-commit**] [**preference** *value*] [**allow-hint**]
9. **ipv6 nd other-config flag**
10. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ipv6 dhcp pool** *poolname* **Example:** `Device(config)# ipv6 dhcp pool dhcp-pool`	Configures a Dynamic Host Configuration Protocol for IPv6 (DHCPv6) configuration information pool and enters DHCPv6 pool configuration mode.

	Command or Action	Purpose
Step 4	**dns-server** *ipv6-address* **Example:** `Device(config-dhcp)# dns-server 2001:DB8:3000:3000::42`	Specifies the Domain Name System (DNS) IPv6 servers available to a DHCPv6 client.
Step 5	**domain-name** *domain* **Example:** `Device(config-dhcp)# domain-name example.com`	Configures a domain name for a DHCPv6 client.
Step 6	**exit** **Example:** `Device(config-dhcp)# exit`	Exits DHCPv6 pool configuration mode, and returns the device to global configuration mode.
Step 7	**interface** *type number* **Example:** `Device(config)# interface serial 3`	Specifies an interface type and number, and places the device in interface configuration mode.
Step 8	**ipv6 dhcp server** *poolname* [**rapid-commit**] [**preference** *value*] [**allow-hint**] **Example:** `Device(config-if)# ipv6 dhcp server dhcp-pool`	Enables DHCPv6 on an interface.
Step 9	**ipv6 nd other-config flag** **Example:** `Device(config-if)# ipv6 nd other-config flag`	Sets the “other stateful configuration” flag in IPv6 router advertisements (RAs).

Step 10	**end**
	Example:
	`Device(config-if)# end`
		Returns to privileged EXEC mode.

Configuring the Stateless DHCPv6 Client

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **ipv6 address autoconfig** [**default**]
5. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Device(config)# interface serial 3`	Specifies an interface type and number, and places the device in interface configuration mode.
Step 4	**ipv6 address autoconfig** [**default**] **Example:** `Device(config-if)# ipv6 address autoconfig`	Enables automatic configuration of IPv6 addresses using stateless autoconfiguration on an interface and enables IPv6 processing on the interface.

Step 5	**end**
	Example:
	`Device(config-if)# end`
		Returns to privileged EXEC mode.

Enabling Processing of Packets with Source Routing Header Options

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 source-route**
4. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ipv6 source-route** **Example:** `Device(config)# ipv6 source-route`	Enables processing of the IPv6 type 0 routing header.

Step 4	**end**
	Example:
	`Device(config-if)# end`
		Returns to privileged EXEC mode.

Configuration Examples for DHCPv6 Server Stateless Autoconfiguration

Example: Configuring the Stateless DHCPv6 Function

The following example shows how to use the Dynamic Host Configuration Protocol for IPv6 (DHCPv6) function to configure clients with information about the name lookup system. The server is configured with a DHCP pool, which contains the name lookup information that is to be passed to clients. It does not need to contain a prefix pool. This DHCP pool is attached to the access link to customers (Ethernet 0/0) when you enter the **ipv6 dhcp server** command. The access link also has the **ipv6 nd other-config-flag** command enabled. Router advertisement (RA) messages sent from this interface inform clients that they should use DHCPv6 for "other" (for example, nonaddress) configuration information.

```
ipv6 dhcp pool dhcp-pool
 dns-server 2001:DB8:A:B::1
 dns-server 2001:DB8:3000:3000::42
 domain-name example.com
!
interface Ethernet 0/0
 description Access link down to customers
 ipv6 address 2001:DB8:1234:42::1/64
 ipv6 nd other-config-flag
 ipv6 dhcp server dhcp-pool
```

The client has no obvious DHCPv6 configuration. However, the **ipv6 address autoconfig** command on the uplink to the service provider (Ethernet 0/0) causes the following two events:

- Addresses are autoconfigured on the interface, based on prefixes in RA messages received from the server.
- If received RA messages have the "other configuration" flag set, the interface attempts to acquire the other (for example, nonaddress) configuration from any DHCPv6 servers.

Additional References for DHCP Overview

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Command List, All Releases
DHCP commands	Cisco IOS IP Addressing Services Command Reference
IPv6 commands	Cisco IOS IPv6 Command Reference
IPv6 addressing and connectivity	*IPv6 Configuration Guide*
Cisco IOS IPv6 features	Cisco IOS IPv6 Feature Mapping

Standards and RFCs

Standard/RFC	Title
RFC 951	*Bootstrap Protocol (BOOTP)*
RFC 1542	*Clarifications and Extensions for the Bootstrap Protocol*
RFCs for IPv6	*IPv6 RFCs*

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for DHCPv6 Server Stateless Autoconfiguration

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to . An account on Cisco.com is not required.

Table 14: Feature Information for DHCPv6 Server Stateless Autoconfiguration

Feature Name	Releases	Feature Information
DHCPv6 Server Stateless Autoconfiguration	3.2.0SG 12.2(46)SE 12.2(52)SG 12.4(15)T 15.0(2)SG	Hierarchical DHCPv6 for stateless configuration parameters allows a stateless or stateful DHCPv6 client to export configuration parameters (DHCPv6 options) to a local DHCPv6 server pool. The following commands were introduced or modified: **dns-server**, **domain-name**, **ipv6 address autoconfig**, **ipv6 dhcp pool**, **ipv6 dhcp server**, **ipv6 nd other-config-flag**, **ipv6 source-route**.

CHAPTER 11

DHCPv6 Relay and Server - MPLS VPN Support

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About DHCPv6 Relay and Server - MPLS VPN Support

DHCPv6 Server and Relay—MPLS VPN Support

To facilitate managed central services in a Multiprotocol Label Switching (MPLS)-based network, DHCPv6 must be made MPLS-aware so that a single resource can be used to serve multiple VPNs instead of dedicating a resource to a single VPN.

The DHCPv6 server implementation of MPLS VPN allows a per-pool configuration so that DHCPv6 pools can be associated with a VPN routing and forwarding (VRF) instance. The DHCPv6 server differentiates clients from various VRFs and assigns an IPv6 prefix accordingly from the respective VRF pools. Meanwhile, the DHCPv6 bindings store the clients' VRF information.

The DHCPv6 relay implementation allows the configuration of the destination VRF instance to which the relay messages will be forwarded. The relay adds the client's VPN information while forwarding the client's DHCPv6 requests toward the server, and the relay agent then processes the client's VPN information in reply packets from the server.

The relay agent adds IPv6 static routes for delegated prefixes in corresponding clients' VRF, and the relay agent's high availability (HA) functionality synchronizes the VRF information while synchronizing static routes created by the relay process.

The DHCPv6 relay and server VRF-aware features are disabled by default.

How to Configure DHCPv6 Relay and Server - MPLS VPN Support

Configuring a VRF-Aware Relay and Server for MPLS VPN Support

Configuring a VRF-Aware Relay

Note You do not have to configure this feature on specified interfaces. If you want the feature to be enabled globally only on a device, perform steps 1, 2, and 3

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 dhcp-relay option vpn**
4. **interface** *type number*
5. **ipv6 dhcp relay option vpn**
6. **ipv6 dhcp relay destination** *ipv6-address* [*interface-type interface-number* | **vrf** *vrf-name* | **global**]
7. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ipv6 dhcp-relay option vpn** **Example:** `Device(config)# ipv6 dhcp-relay option vpn`	Enables the DHCP for IPv6 relay VRF-aware feature globally.
Step 4	**interface** *type number* **Example:** `Device(config)# interface gigabitethernet 0/0/0`	Specifies an interface type and number, and enters interface configuration mode.
Step 5	**ipv6 dhcp relay option vpn** **Example:** `Device(config-if)# ipv6 dhcp relay option vpn`	Enables the DHCP for IPv6 relay VRF-aware feature on the specified interface. Enabling this command supersedes the configuration that is enabled by using the **ipv6 dhcp-relay option vpn** command.
Step 6	**ipv6 dhcp relay destination** *ipv6-address* [*interface-type interface-number* | **vrf** *vrf-name* | **global**] **Example:** `Device(config-if)# ipv6 dhcp relay destination FE80::250:A2FF:FEBF:A056 ethernet 0/0`	Specifies a destination address to which client messages are forwarded.

Step 7	**end**
	Example:
	`Device(config-if)# end`
		Returns to privileged EXEC mode.

Configuring a VRF-Aware Server

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **ipv6 dhcp server vrf enable**
5. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Device(config)# interface gigabitethernet 0/0/0`	Specifies an interface type and number, and enters interface configuration mode.
Step 4	**ipv6 dhcp server vrf enable** **Example:** `Device(config-if)# ipv6 dhcp server vrf enable`	Enables the DHCPv6 server VRF-aware feature on an interface.

Step 5	**end**
	Example:
	`Device(config-if)# end`
		Returns to privileged EXEC mode.

Configuration Examples for DHCPv6 Server - MPLS VPN Support

Example: Configuring a VRF-Aware Relay

```
Device# show ipv6 dhcp relay binding

Relay Bindings associated with default vrf:
Prefix: 2001:DB8:0:1::/64 (Ethernet0/0)
  DUID: 00030001AABBCC006500
  IAID: 196609
  lifetime: 2592000
  expiration: 12:34:28 IST Oct 14 2010
Summary:
  Total number of Relay bindings = 1
  Total number of Relay bindings added by Bulk lease = 0
RELAY#
```

Example: Configuring a VRF-Aware Server

```
Device# show ipv6 dhcp binding

Client: FE80::A8BB:CCFF:FE00:6400
  DUID: 00030001AABBCC006400
  VRF : global
  Interface : Ethernet0/0
  IA PD: IA ID 0x00030001, T1 302400, T2 483840
    Prefix: 2001::1/64
            preferred lifetime 604800, valid lifetime 2592000
            expires at Oct 15 2010 03:18 PM (2591143 seconds)

Device# show ipv6 route static

IPv6 Routing Table - default - 4 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       B - BGP, R - RIP, I1 - ISIS L1, I2 - ISIS L2
       IA - ISIS interarea, IS - ISIS summary, D - EIGRP, EX - EIGRP external
       ND - Neighbor Discovery
       O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
S   2001::/64 [1/0]
     via FE80::A8BB:CCFF:FE00:6400, Ethernet0/0
```

Additional References

Related Documents

Related Topic	Document Title
IPv6 addressing and connectivity	*IPv6 Configuration Guide*
Cisco IOS commands	Cisco IOS Master Command List, All Releases

Related Topic	Document Title
IPv6 commands	*Cisco IOS IPv6 Command Reference*
Cisco IOS IPv6 features	Cisco IOS IPv6 Feature Mapping

Standards and RFCs

Standard/RFC	Title
RFCs for IPv6	*IPv6 RFCs*

MIBs

MIB	MIBs Link
	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for DHCPv6 Relay and Server - MPLS VPN Support

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to . An account on Cisco.com is not required.

Table 15: Feature Information for DHCPv6 Relay and Server - MPLS VPN Support

Feature Name	Releases	Feature Information
VRF aware DHCPv6 relay		The VRF aware DHCPv6 relay feature ensures that the DHCPv6 relay involved in forwarding IP addresses is VRF aware.

CHAPTER 12

IPv6 Access Services: DHCPv6 Relay Agent

A Dynamic Host Configuration Protocol for IPv6 (DHCPv6) relay agent, which may reside on the client's link, is used to relay messages between the client and the server.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About IPv6 Access Services: DHCPv6 Relay Agent

DHCPv6 Relay Agent

A DHCPv6 relay agent, which may reside on the client’s link, is used to relay messages between the client and the server. The DHCPv6 relay agent operation is transparent to the client. A DHCPv6 client locates a DHCPv6 server using a reserved, link-scoped multicast address. For direct communication between the DHCPv6 client and the DHCPv6 server, both of them must be attached to the same link. However, in some situations where ease of management, economy, or scalability is a concern, it is desirable to allow a DHCPv6 client to send a message to a DHCPv6 server that is not connected to the same link.

DHCPv6 Relay Agent Notification for Prefix Delegation

The DHCPv6 relay agent notification for prefix delegation allows the device working as a DHCPv6 relay agent to find prefix delegation options by reviewing the contents of a DHCPv6 RELAY-REPLY packet that is relayed by the relay agent to the client. When a prefix delegation option is found by the relay agent, the relay agent extracts the information about the prefix that is being delegated and inserts an IPv6 static route matching the prefix delegation information onto the relay agent. Future packets destined to that prefix via relay will be forwarded based on the information contained in the prefix delegation. The IPv6 static route is then left in the routing table until the prefix delegation lease time expires or the relay agent receives a release packet from the client releasing the prefix delegation.

No user configuration is required for this feature. Static route management is done automatically by the relay agent.

IPv6 routes are added when the relay agent relays a RELAY-REPLY packet, and IPv6 routes are deleted when the prefix delegation lease time expires or the relay agent receives a release message. An IPv6 static route in the routing table of the relay agent can be updated when the prefix delegation lease time is extended.

The DHCP—DHCPv6 Relay Agent Notification for Prefix Delegation feature leaves a static IPv6 route on the routing table of the relay agent. The registered IPv6 address allows unicast reverse packet forwarding (uRPF) to work by allowing the device doing the reverse lookup to confirm that the IPv6 address on the relay agent is not malformed or spoofed. The static route that remains in the routing table of the relay agent can be redistributed to other routing protocols to advertise the subnets to other nodes. Static routes will be removed when a DHCP_DECLINE message is sent by the client.

DHCPv6 Relay Options: Remote-ID for Gigabit Ethernet and Fast Ethernet Interfaces

The DHCPv6 Ethernet Remote ID Option feature adds the remote identification (remote-ID) option to relayed (RELAY-FORWARD) DHCPv6 packets.

The remote-ID option provides information to the DHCPv6 server, which includes port information, the system’s DUID, and the VLAN ID. This information can be used to uniquely identify both the relay and the port on the relay through which the client packet arrived. The DHCPv6 server uses this information to select parameters specific to a particular user, host, or subscriber modem.

The addition of the remote-ID option to the RELAY-FORWARD packet occurs automatically and no user configuration is necessary.

The DHCPv6 server does not need to echo the remote-ID option in the RELAY-REPLY packet. The Internet Assigned Numbers Authority (IANA) has assigned the DHCPv6 option code 37 for the relay agent remote-ID option.

If the remote-ID option is included in the RELAY-REPLY packet, the option is removed from the packet before it is relayed to the client.

DHCPv6 Relay Options: Reload Persistent Interface ID

The DHCPv6 Relay—Reload Persistent Interface ID Option feature makes the interface ID option persistent. The interface ID is used by relay agents to decide which interface should be used to forward a RELAY-REPLY packet. A persistent interface-ID option will not change if the device acting as a relay agent goes offline during a reload or a power outage. When the device acting as a relay agent returns online, it is possible that changes to the internal interface index of the relay agent may have occurred in certain scenarios (such as, when the relay agent reboots and the number of interfaces in the interface index changes, or when the relay agents boot up and has more virtual interfaces than it did before the reboot). This feature prevents such scenarios from causing any problems.

This feature changes the DHCPv6 interface-ID option to be expressed as the short form of the interface name. The interface name as the DHCPv6 interface ID helps avoid potential problems that could arise due to physical or logical interfaces changing on the relay agent after a reload.

DHCPv6 Relay Chaining

DHCPv6 messages can be relayed through multiple relay agents. This configuration is called *relay chaining*. A relay chaining configuration can be supported only when each relay agent adds information to DHCPv6 messages before relaying them. The information helps in relaying the DHCPv6 reply back to the DHCPv6 client through the same path.

The delegated IPv6 prefix must be routable in order to be useful. The actual DHCPv6 Prefix Delegation (PD) client may not be permitted to inject routes into the delegating network. In service provider (SP) networks, for example, an edge device typically acts as a DHCPv6 relay agent, and this edge device often has the responsibility to maintain routes within the SP network for clients' PD bindings. In the event that DHCPv6 requests and responses are relayed through a chain of DHCPv6 relays, there may be a need to introduce appropriate routes (particularly with DHCPv6 PD) in the Forwarding Information Base (FIB) so that routing is handled transparently.

DHCPv6 Relay Agent Notification for Prefix Delegation

The DHCPv6 relay agent notification for prefix delegation allows the device working as a DHCPv6 relay agent to find prefix delegation options by reviewing the contents of a DHCPv6 RELAY-REPLY packet that is relayed by the relay agent to the client. When a prefix delegation option is found by the relay agent, the relay agent extracts the information about the prefix that is being delegated and inserts an IPv6 static route matching the prefix delegation information onto the relay agent. Future packets destined to that prefix via relay will be forwarded based on the information contained in the prefix delegation. The IPv6 static route is then left in the routing table until the prefix delegation lease time expires or the relay agent receives a release packet from the client releasing the prefix delegation.

No user configuration is required for this feature. Static route management is done automatically by the relay agent.

IPv6 routes are added when the relay agent relays a RELAY-REPLY packet, and IPv6 routes are deleted when the prefix delegation lease time expires or the relay agent receives a release message. An IPv6 static route in the routing table of the relay agent can be updated when the prefix delegation lease time is extended.

The DHCP—DHCPv6 Relay Agent Notification for Prefix Delegation feature leaves a static IPv6 route on the routing table of the relay agent. The registered IPv6 address allows unicast reverse packet forwarding (uRPF) to work by allowing the device doing the reverse lookup to confirm that the IPv6 address on the relay agent is not malformed or spoofed. The static route that remains in the routing table of the relay agent can be redistributed to other routing protocols to advertise the subnets to other nodes. Static routes will be removed when a DHCP_DECLINE message is sent by the client.

DHCPv6 Relay SSO and ISSU

In specific Cisco networking devices that support dual route processors (RPs), stateful switchover (SSO) takes advantage of RP redundancy to increase network availability. The feature establishes one of the RPs as the active processor while the other RP is designated as the standby processor, and then synchronizing critical state information between them. Following an initial synchronization between the two processors, SSO dynamically maintains RP state information between them.

The Cisco in-service software upgrade (ISSU) process allows Cisco software to be updated or otherwise modified while packet forwarding continues. In most networks, planned software upgrades are a significant cause of downtime. ISSU allows the Cisco software to be modified while packet forwarding continues. This increases network availability and reduces downtime caused by planned software upgrades.

The SSO and the ISSU use redundant hardware, with the active and standby RP each running an instance of the DHCPv6 relay agent. Both instances exchange run-time state data.

DHCPv6 Relay Options: Remote ID for Ethernet Interfaces

This feature adds the remote identification (remote-ID) option to relayed (RELAY-FORWARD) DHCPv6 packets.

The remote-ID option provides information to the DHCPv6 server, including port information, the system's DUID, and the VLAN ID. Collectively, this information can be used to uniquely identify both the relay and the port on the relay through which the client's packet arrived. The DHCPv6 server uses this information to select parameters specific to a particular user, host, or subscriber modem. This feature works only for Ethernet interfaces at this time.

This feature introduces no user configuration. Because the addition of the remote-ID option to the RELAY-FORWARD packet occurs automatically, no user configuration is necessary.

The DHCPv6 server does not need to echo the remote-ID option in the RELAY-REPLY packet. Internet Assigned Numbers Authority (IANA) has assigned the DHCPv6 option code 37 for the relay agent remote-ID option.

If the remote-ID option is included in the RELAY-REPLY packet, the option is stripped out of the packet before the packet is relayed to the client.

DHCPv6 Relay Options: Reload Persistent Interface ID Option

This feature makes the interface-ID option, which is used by relay agents to decide which interface should be used when forwarding a RELAY-REPLY packet, persistent. A persistent interface-ID option will not change if the router acting as a relay agent goes offline (such as during a reload or a power outage). When the router acting as a relay agent returns online, it is possible that changes to the internal interface index of the relay agent may have occurred in certain scenarios (such as cases where the relay agent reboots and has a change in the number of interfaces in the interface index, or the relay agents boots up and has more virtual interfaces than it did before the reboot). This feature prevents this scenario from causing any problems.

This feature changes the DHCPv6 interface-ID option to be expressed as simply the short form of the interface name. This syntax helps avoid potential problems that could arise due to physical or logical interfaces changing on the relay agent after a reload.

How to Configure IPv6 Access Services: DHCPv6 Relay Agent

Configuring the DHCPv6 Relay Agent

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **ipv6 dhcp relay destination** *ipv6-address* [*interface-type interface-number*]
5. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Device(config)# interface gigabitethernet 4/2/0`	Specifies an interface type and number, and enters interface configuration mode.
Step 4	**ipv6 dhcp relay destination** *ipv6-address* [*interface-type interface-number*] **Example:** `Device(config-if) ipv6 dhcp relay destination FE80::250:A2FF:FEBF:A056 gigabitethernet 4/3/0`	Specifies a destination address to which client packets are forwarded and enables the DHCPv6 relay service on the interface.

Step 5	**end**
	Example:
	`Device(config-if)# end`
		Returns to privileged EXEC mode.

Configuration Examples for IPv6 Access Services: DHCPv6 Relay Agent

Example: Configuring the DHCPv6 Relay Agent

```
Device# show ipv6 dhcp interface

Ethernet1/0 is in relay mode
  Relay destinations:
    3FFB:C00:C18:6:A8BB:CCFF:FE03:2701
Serial3/0 is in relay mode
  Relay destinations:
    3FFB:C00:C18:6:A8BB:CCFF:FE03:2600
    FE80::A8BB:CCFF:FE03:2801 on Serial3/0
    FF05::1:3
```

Additional References

Related Documents

Related Topic	Document Title
IPv6 addressing and connectivity	*IPv6 Configuration Guide*
Cisco IOS commands	Cisco IOS Master Command List, All Releases
IPv6 commands	Cisco IOS IPv6 Command Reference
Cisco IOS IPv6 features	Cisco IOS IPv6 Feature Mapping

Standards and RFCs

Standard/RFC	Title
RFCs for IPv6	*IPv6 RFCs*

MIBs

MIB	MIBs Link
	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for IPv6 Access Services: DHCPv6 Relay Agent

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to . An account on Cisco.com is not required.

Table 16: Feature Information for IPv6 Access Services: DHCPv6 Relay Agent

Feature Name	Releases	Feature Information
IPv6 Access Services: DHCPv6 Relay Agent	12.2(46)SE 12.2(50)SG 12.2(33)SRC 12.2(33)SXI 12.3(11)T 12.4 15.0(2)SG 3.2.0SG Cisco IOS XE Release 2.2 Cisco IOS XE Release 3.8 15.3(1)S Cisco IOS XE Release 3.9S	A DHCP relay agent, which may reside on the client's link, is used to relay messages between the client and server. The following commands were introduced or modified: **ipv6 dhcp relay destination**, **show ipv6 dhcp interface**.
DHCP: DHCPv6 Relay SSO/ISSU	12.2(33)SRE	SSO and ISSU use redundant hardware, with the active and standby RP each running an instance of the DHCP relay agent.
DHCPv6 Relay Agent Notification for Prefix Delegation	12.2(46)SE 12.2(33)SRC 12.2(33)SXI 15.0(1)S	DHCPv6 relay agent notification for prefix delegation allows the device working as a DHCPv6 relay agent to find prefix delegation options by reviewing the contents of a DHCPv6 packet that is being relayed by the relay agent to the client.
DHCPv6 Relay: Reload Persistent Interface ID Option	12.2(46)SE 12.2(52)SG 12.2(33)SRC 12.2(33)SXI 15.0(2)SG 3.2.0SG Cisco IOS XE Release 3.9S	This feature makes the interface-ID option, which is used by relay agents to decide which interface should be used when forwarding a RELAY-REPLY packet, persistent.
DHCPv6—Relay chaining for Prefix Delegation		This feature enables DHCPv6 messages to be relayed through multiple relay agents.

CHAPTER 13

IPv6 Access Services: Stateless DHCPv6

The stateless Dynamic Host Configuration Protocol for IPv6 (DHCPv6) feature allows DHCPv6 to be used for configuring a node with parameters that do not require a server to maintain any dynamic state for the node.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About IPv6 Access Services: Stateless DHCPv6

Information Refresh Server Option

The DHCPv6 information refresh option can specify an upper boundary for the length of time a client should wait before refreshing information retrieved from DHCPv6. This option is used with stateless DHCPv6, because there are no addresses or other entities with lifetimes that can tell the client when to contact the DHCPv6 server to refresh its configuration.

SIP Server Options

Session initiation protocol (SIP) server options contain either a list of domain names or IPv6 addresses that can be mapped to one or more SIP outbound proxy servers. One option carries a list of domain names, and the other option carries a list of 128-bit IPv6 addresses.

SIP is an application-layer control protocol that can establish, modify and terminate multimedia sessions or calls. A SIP system has several logical components: user agents, proxy servers, redirect servers, and registrars. User agents may contain SIP clients; proxy servers always contain SIP clients.

SNTP Server Option

The SNTP server option provides a list of one or more IPv6 addresses of SNTP servers available to the client for synchronization. The clients use these SNTP servers to synchronize their system time to that of the standard time servers. The server may list the SNTP servers in decreasing order of preference, but clients must treat the list of SNTP servers as an ordered list.

How to Configure IPv6 Access Services: Stateless DHCPv6

Configuring the Stateless DHCPv6 Function

The server maintains no state related to clients; for example, no prefix pools and records of allocation are maintained. Therefore, this function is "stateless" DHCPv6.

Configuring the Stateless DHCPv6 Server

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 dhcp pool** *poolname*
4. **dns-server** *ipv6-address*
5. **domain-name** *domain*
6. **exit**
7. **interface** *type number*
8. **ipv6 dhcp server** *poolname* [**rapid-commit**] [**preference** *value*] [**allow-hint**]
9. **ipv6 nd other-config flag**
10. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ipv6 dhcp pool** *poolname* **Example:** `Device(config)# ipv6 dhcp pool dhcp-pool`	Configures a Dynamic Host Configuration Protocol for IPv6 (DHCPv6) configuration information pool and enters DHCPv6 pool configuration mode.
Step 4	**dns-server** *ipv6-address* **Example:** `Device(config-dhcp)# dns-server 2001:DB8:3000:3000::42`	Specifies the Domain Name System (DNS) IPv6 servers available to a DHCPv6 client.
Step 5	**domain-name** *domain* **Example:** `Device(config-dhcp)# domain-name example.com`	Configures a domain name for a DHCPv6 client.
Step 6	**exit** **Example:** `Device(config-dhcp)# exit`	Exits DHCPv6 pool configuration mode, and returns the device to global configuration mode.
Step 7	**interface** *type number* **Example:** `Device(config)# interface serial 3`	Specifies an interface type and number, and places the device in interface configuration mode.
Step 8	**ipv6 dhcp server** *poolname* [**rapid-commit**] [**preference** *value*] [**allow-hint**] **Example:** `Device(config-if)# ipv6 dhcp server dhcp-pool`	Enables DHCPv6 on an interface.

	Command or Action	Purpose
Step 9	**ipv6 nd other-config flag** **Example:** `Device(config-if)# ipv6 nd other-config flag`	Sets the “other stateful configuration” flag in IPv6 router advertisements (RAs).

Step 10	**end**
	Example:
	`Device(config-if)# end`
		Returns to privileged EXEC mode.

Configuring the Stateless DHCPv6 Client

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **ipv6 address autoconfig** [**default**]
5. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Device(config)# interface serial 3`	Specifies an interface type and number, and places the device in interface configuration mode.

	Command or Action	Purpose
Step 4	**ipv6 address autoconfig** [**default**] **Example:** `Device(config-if)# ipv6 address autoconfig`	Enables automatic configuration of IPv6 addresses using stateless autoconfiguration on an interface and enables IPv6 processing on the interface.

Step 5	**end**
	Example:
	`Device(config-if)# end`
		Returns to privileged EXEC mode.

Enabling Processing of Packets with Source Routing Header Options

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 source-route**
4. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ipv6 source-route** **Example:** `Device(config)# ipv6 source-route`	Enables processing of the IPv6 type 0 routing header.

	Command or Action	Purpose

Step 4	**end**
	Example:
	`Device(config-if)# end`
		Returns to privileged EXEC mode.

Importing Stateless DHCPv6 Server Options

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 dhcp pool** *poolname*
4. **import dns-server**
5. **import domain-name**
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ipv6 dhcp pool** *poolname* **Example:** `Router(config)# ipv6 dhcp pool pool1`	Configures a DHCPv6 configuration information pool and enters DHCPv6 pool configuration mode.

Step 4	**import dns-server**
	Example:
	`Router(config-dhcp)# import dns-server`
		Imports the DNS recursive name server option to a DHCPv6 client.

	Command or Action	Purpose

Step 5	**import domain-name**
	Example:
	`Router(config-dhcp)# import domain-name`
		Imports the domain search list option to a DHCPv6 client.

Step 6	**end**
	Example:
	`Router(config-dhcp)# end`
		Returns to privileged EXEC mode.

Configuring the SNTP Server Option

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 dhcp pool** *poolname*
4. **sntp address** *ipv6-address*
5. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ipv6 dhcp pool** *poolname* **Example:** `Device(config)# ipv6 dhcp pool pool1`	Configures a DHCPv6 configuration information pool and enters DHCPv6 pool configuration mode.

	Command or Action	Purpose
Step 4	**sntp address** *ipv6-address* **Example:** `Device(config-dhcp)# sntp address 2001:DB8:2000:2000::33`	Specifies the SNTP server list to be sent to the client.

Step 5	**end**
	Example:
	`Device(config-dhcp)# end`
		Returns to privileged EXEC mode.

Importing SIP Server Information

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 dhcp pool** *poolname*
4. **import sip address**
5. **import sip domain-name**
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ipv6 dhcp pool** *poolname* **Example:** `Router(config)# ipv6 dhcp pool pool1`	Configures a DHCPv6 configuration information pool and enters DHCPv6 pool configuration mode.

	Command or Action	Purpose

Step 4	**import sip address**
	Example:
	`Router(config-dhcp)# import sip address`
		Imports the SIP server IPv6 address list option to the outbound SIP proxy server.

Step 5	**import sip domain-name**
	Example:
	`Router(config-dhcp)# import sip domain-name`
		Imports a SIP server domain-name list option to the outbound SIP proxy server.

Step 6	**end**
	Example:
	`Router(config-dhcp)# end`
		Returns to privileged EXEC mode.

Importing the SNTP Server Option

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 dhcp pool** *poolname*
4. **import sntp address** *ipv6-address*
5. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.

	Command or Action	Purpose
Step 3	**ipv6 dhcp pool** *poolname* **Example:** `Device(config)# ipv6 dhcp pool pool1`	Configures a DHCPv6 configuration information pool and enters DHCPv6 pool configuration mode.

Step 4	**import sntp address** *ipv6-address*
	Example:
	`Device(config-dhcp)# import sntp address 2001:DB8:2000:2000::33`
		Imports the SNTP server option to a DHCPv6 client.

Step 5	**end**
	Example:
	`Device(config-dhcp)# end`
		Returns to privileged EXEC mode.

Configuration Examples for IPv6 Access Services: Stateless DHCPv6

Example: Configuring the Stateless DHCPv6 Function

The following example shows how to use the Dynamic Host Configuration Protocol for IPv6 (DHCPv6) function to configure clients with information about the name lookup system. The server is configured with a DHCP pool, which contains the name lookup information that is to be passed to clients. It does not need to contain a prefix pool. This DHCP pool is attached to the access link to customers (Ethernet 0/0) when you enter the **ipv6 dhcp server** command. The access link also has the **ipv6 nd other-config-flag** command enabled. Router advertisement (RA) messages sent from this interface inform clients that they should use DHCPv6 for “other” (for example, nonaddress) configuration information.

```
ipv6 dhcp pool dhcp-pool
 dns-server 2001:DB8:A:B::1
 dns-server 2001:DB8:3000:3000::42
 domain-name example.com
!
interface Ethernet 0/0
 description Access link down to customers
 ipv6 address 2001:DB8:1234:42::1/64
 ipv6 nd other-config-flag
 ipv6 dhcp server dhcp-pool
```

The client has no obvious DHCPv6 configuration. However, the **ipv6 address autoconfig** command on the uplink to the service provider (Ethernet 0/0) causes the following two events:

- Addresses are autoconfigured on the interface, based on prefixes in RA messages received from the server.
- If received RA messages have the “other configuration” flag set, the interface attempts to acquire the other (for example, nonaddress) configuration from any DHCPv6 servers.

Additional References

The following sections provide references related to configuring the DHCP ODAP manager.

Related Documents

Related Topic	Document Title
DHCP commands: complete command syntax, command modes, command history, defaults, usage guidelines, and examples	*Cisco IOS IP Addressing Services Command Reference*
DHCP conceptual information	“DHCP Overview” module
DHCP server configuration	“Configuring the Cisco IOS XE DHCP Server” module
DHCP client configuration	“Configuring the Cisco IOS XE DHCP Client” module
DHCP relay agent configuration	“Configuring the Cisco IOS XE DHCP Relay Agent” module
DHCP advanced features	“Configuring DHCP Services for Accounting and Security” module

Standards

Standards	Title
No new or modified standards are supported by this functionality.	--

MIBs

MIBs	MIBs Link
No new or modified MIBs are supported by this feature.	To locate and download MIBs for selected platforms, Cisco IOS XE software releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFCs	Title
RFC 951	*Bootstrap Protocol (BOOTP)*
RFC 1542	*Clarifications and Extensions for the Bootstrap Protocol*
RFC 2131	*Dynamic Host Configuration Protocol*
RFC 2685	*Virtual Private Networks Identifier*
RFC 3046	*DHCP Relay Information Option*

Technical Assistance

Description	Link
The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.	http://www.cisco.com/public/support/tac/home.shtml

Feature Information for IPv6 Access Services: Stateless DHCPv6

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to . An account on Cisco.com is not required.

Table 17: Feature Information for IPv6 Access Services: Stateless DHCPv6

Feature Name	Releases	Feature Information
IPv6 Access Services: Stateless DHCPv6	12.2(18)SXE 12.3(4)T 12.2(33)SXI	Stateless DHCPv6 allows DHCPv6 to be used for configuring a node with parameters that do not require a server to maintain any dynamic state for the node. The following commands were introduced or modified: **dns-server**, **domain-name**, **import dns-server**, **import domain-name**, **import sip address**, **import sip domain-name**, **import sntp address**, **ipv6 address autoconfig**, **ipv6 dhcp pool**, **ipv6 dhcp server**, **ipv6 nd other-config-flag**, **ipv6 source-route**, **sntp address**.

CHAPTER 14

DHCPv6 Server Timer Options

The Dynamic Host Configuration Protocol for IPv6 (DHCPv6) server options are part of DHCP stateless autoconfiguration.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About DHCPv6 Server Timer Options

Information Refresh Server Option

The DHCPv6 information refresh option can specify an upper boundary for the length of time a client should wait before refreshing information retrieved from DHCPv6. This option is used with stateless DHCPv6, because there are no addresses or other entities with lifetimes that can tell the client when to contact the DHCPv6 server to refresh its configuration.

NIS- and NIS+-Related Server Options

Users can configure the network information service (NIS) or NIS plus (NIS+) address or domain name of a DHCPv6 server using NIS- and NIS+-related options, and then import that information to the DHCPv6 client.

SNTP Server Option

The SNTP server option provides a list of one or more IPv6 addresses of SNTP servers available to the client for synchronization. The clients use these SNTP servers to synchronize their system time to that of the standard time servers. The server may list the SNTP servers in decreasing order of preference, but clients must treat the list of SNTP servers as an ordered list.

How to Configure DHCPv6 Server Timer Options

Configuring the Information Server Refresh Option

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 dhcp pool** *poolname*
4. **information refresh** {*days* [*hours minutes*] | **infinity**}
5. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ipv6 dhcp pool** *poolname* **Example:** `Device(config)# ipv6 dhcp pool pool1`	Configures a DHCPv6 configuration information pool and enters DHCPv6 pool configuration mode.

	Command or Action	Purpose

Step 4	**information refresh** {*days* [*hours minutes*] | **infinity**}
	Example:
	`Device(config-dhcp)# information refresh 1 1 1`
		Specifies the information refresh time to be sent to the client.

Step 5	**end**
	Example:
	`Device(config-dhcp)# end`
		Returns to privileged EXEC mode.

Importing the Information Server Refresh Option

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 dhcp pool** *poolname*
4. **import information refresh**
5. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ipv6 dhcp pool** *poolname* **Example:** `Device(config)# ipv6 dhcp pool pool1`	Configures a DHCPv6 configuration information pool and enters DHCPv6 pool configuration mode.

	Command or Action	Purpose

Step 4	**import information refresh**
	Example:
	`Device(config-dhcp)# import information refresh`
		Imports the information refresh time option to a DHCPv6 client.

Step 5	**end**
	Example:
	`Device(config-dhcp)# end`
		Returns to privileged EXEC mode.

Configuring NIS- and NISP-Related Server Options

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 dhcp pool** *poolname*
4. **nis address** *ipv6-address*
5. **nis domain-name** *domain-name*
6. **nisp address** *ipv6-address*
7. **nisp domain-name** *domain-name*
8. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.

	Command or Action	Purpose
Step 3	**ipv6 dhcp pool** *poolname* **Example:** `Device(config)# ipv6 dhcp pool pool1`	Configures a DHCPv6 configuration information pool and enters DHCPv6 pool configuration mode.
Step 4	**nis address** *ipv6-address* **Example:** `Device(config-dhcp)# nis address 2001:DB8:1000:1000::30`	Specifies the NIS address of an IPv6 server to be sent to the client.
Step 5	**nis domain-name** *domain-name* **Example:** `Device(config-dhcp)# nis domain-name domain1`	Enables a server to convey a client's NIS domain name information to the client.
Step 6	**nisp address** *ipv6-address* **Example:** `Device(config-dhcp)# nisp address 2001:DB8:3000:3000::42`	Specifies the NIS+ address of an IPv6 server to be sent to the DHCPv6 client.
Step 7	**nisp domain-name** *domain-name* **Example:** `Device(config-dhcp)# nisp domain-name domain2`	Enables a server to convey a client's NIS+ domain name information to the DHCPv6 client.

Step 8	**end**
	Example:
	`Device(config-dhcp)# end`
		Returns to privileged EXEC mode.

Importing NIS- and NIS+-Related Server Options

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 dhcp pool** *poolname*
4. **import nis address**
5. **import nis domain-name**
6. **import nisp address**
7. **import nisp domain-name**
8. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ipv6 dhcp pool** *poolname* **Example:** `Device(config)# ipv6 dhcp pool pool1`	Configures a DHCPv6 configuration information pool and enters DHCPv6 pool configuration mode.

Step 4	**import nis address**
	Example:
	`Device(config-dhcp)# import nis address`
		Imports the NIS servers option to a DHCPv6 client.

Step 5	**import nis domain-name**
	Example:
	`Device(config-dhcp)# import nis domain-name`
		Imports the NIS domain name option to a DHCPv6 client.

	Command or Action	Purpose

Step 6	**import nisp address**
	Example:
	`Device(config-dhcp)# import nisp address`
		Imports the NISP address option to a DHCPv6 client.

Step 7	**import nisp domain-name**
	Example:
	`Device(config-dhcp)# import nisp domain-name`
		Imports the NISP domain name option to a DHCPv6 client.

Step 8	**end**
	Example:
	`Device(config-dhcp)# end`
		Returns to privileged EXEC mode.

Configuring the SNTP Server Option

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 dhcp pool** *poolname*
4. **sntp address** *ipv6-address*
5. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.

	Command or Action	Purpose
Step 3	**ipv6 dhcp pool** *poolname* **Example:** `Device(config)# ipv6 dhcp pool pool1`	Configures a DHCPv6 configuration information pool and enters DHCPv6 pool configuration mode.
Step 4	**sntp address** *ipv6-address* **Example:** `Device(config-dhcp)# sntp address 2001:DB8:2000:2000::33`	Specifies the SNTP server list to be sent to the client.

Step 5	**end**
	Example:
	`Device(config-dhcp)# end`
		Returns to privileged EXEC mode.

Importing the SNTP Server Option

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 dhcp pool** *poolname*
4. **import sntp address** *ipv6-address*
5. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.

	Command or Action	Purpose
Step 3	**ipv6 dhcp pool** *poolname* **Example:** `Device(config)# ipv6 dhcp pool pool1`	Configures a DHCPv6 configuration information pool and enters DHCPv6 pool configuration mode.

Step 4	**import sntp address** *ipv6-address*
	Example:
	`Device(config-dhcp)# import sntp address 2001:DB8:2000:2000::33`
		Imports the SNTP server option to a DHCPv6 client.

Step 5	**end**
	Example:
	`Device(config-dhcp)# end`
		Returns to privileged EXEC mode.

Configuration Examples for DHCPv6 Server Timer Options

Example: Configuring DHCPv6 Server Timer Options

```
Device# show ipv6 dhcp pool

DHCPv6 pool: pool1
  Domain name: domain1
  NIS server domain name: ndomain1
  NIS server domain name: ndomain2
  SNTP server address: 2001:DB8::1
  Imported Information refresh: 90060
  Active clients: 0
```

Additional References

Related Documents

Related Topic	Document Title
IPv6 addressing and connectivity	*IPv6 Configuration Guide*
Cisco IOS commands	Cisco IOS Master Command List, All Releases

Related Topic	Document Title
IPv6 commands	Cisco IOS IPv6 Command Reference
Cisco IOS IPv6 features	Cisco IOS IPv6 Feature Mapping

Standards and RFCs

Standard/RFC	Title
RFCs for IPv6	*IPv6 RFCs*

MIBs

MIB	MIBs Link
	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for DHCPv6 Server Timer Options

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to . An account on Cisco.com is not required.

Table 18: Feature Information for DHCPv6 Server Timer Options

Feature Name	Releases	Feature Information
DHCPv6 Client Information Refresh Option	12.2(46)SE 12.4(15)T	The DHCPv6 information refresh option can specify an upper boundary for the length of time a client should wait before refreshing information retrieved from DHCPv6. The following commands were introduced or modified: **import information refresh**, **information refresh**, **ipv6 dhcp pool**, **show ipv6 dhcp pool**.
DHCPv6 Server Timer Options	12.2(46)SE 12.4(15)T	The DHCPv6 server options are part of DHCP stateless autoconfiguration. The following commands were introduced or modified: **import nis-address**, **import nis domain-name**, **import nisp address**, **import nisp domain-name**, **ipv6 dhcp pool**, **nis address**, **nis domain-name**, **nisp address**, **nisp domain-name**, **show ipv6 dhcp pool**.

CHAPTER 15

IPv6 Access Services: DHCPv6 Prefix Delegation

The Dynamic Host Configuration Protocol for IPv6 (DHCPv6) prefix delegation feature can be used to manage link, subnet, and site addressing changes.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About IPv6 Access Services: DHCPv6 Prefix Delegation

DHCPv6 Prefix Delegation

The IPv6 Access Services—DHCPv6 Prefix Delegation feature can be used to manage link, subnet, and site addressing changes. Dynamic Host Configuration Protocol for IPv6 (DHCPv6) can be used in environments to deliver stateful and stateless information, which are defined as follows:

- Stateful prefix delegation—Address assignment is centrally managed and clients must obtain configuration information such as address autoconfiguration and neighbor discovery that is not available through protocols.
- Stateless prefix delegation—Stateless configuration parameters do not require a server to maintain any dynamic state for individual clients, such as Domain Name System (DNS) server addresses and domain search list options.

Extensions to DHCPv6 also enable prefix delegation, through which an ISP can automate the process of assigning prefixes to a customer for use within the customer's network. The prefix delegation occurs between a provider edge (PE) device and customer premises equipment (CPE) using the DHCPv6 prefix delegation option. Once the ISP has delegated prefixes to a customer, the customer may further subnet and assign prefixes to the links in the customer's network.

Node Configuration Without Prefix Delegation

Stateless Dynamic Host Configuration Protocol for IPv6 (DHCPv6) allows the DHCPv6 to be used for configuring a node with parameters that do not require a server to maintain any dynamic state for the node. The use of stateless DHCPv6 is controlled by router advertisement (RA) messages that are multicast by devices. The DHCPv6 client invokes stateless DHCPv6 when it receives an RA. The DHCPv6 server responds to a stateless DHCPv6 request with configuration parameters, such as the Domain Name System (DNS) servers and domain search list options.

Client and Server Identification

Each DHCPv6 client and server is identified by a DHCP unique identifier (DUID). The DUID is carried in client identifier and server identifier options. The DUID is unique across all DHCP clients and servers, and it is stable for any specific client or server. DHCPv6 uses DUIDs based on link-layer addresses for both the client and server identifier. The device uses the MAC address from the lowest-numbered interface to form the DUID. The network interface is assumed to be permanently attached to the device.

When a DHCPv6 client requests two prefixes with the same DUID but with different identity association identifiers (IAIDs) on two different interfaces, these prefixes are considered to be for two different clients, and the interface information is maintained for both.

Rapid Commit

The DHCPv6 client can obtain configuration parameters from a server either through a rapid two-message exchange (solicit, reply) or through a four-message exchange (solicit, advertise, request, and reply). By default, the four-message exchange is used. When the rapid-commit option is enabled by both the client and the server, the two-message exchange is used.

DHCPv6 Client, Server, and Relay Functions

The DHCPv6 client, server, and relay functions are mutually exclusive on an interface. When one of these functions is enabled and a user tries to configure a different function on the same interface, one of the following messages is displayed: “Interface is in DHCP client mode,” “Interface is in DHCP server mode,” or “Interface is in DHCP relay mode.”

The following sections describe these functions:

Client Function

The DHCPv6 client function can be enabled on individual IPv6-enabled interfaces.

The DHCPv6 client can request and accept those configuration parameters that do not require a server to maintain any dynamic state for individual clients, such as DNS server addresses and domain search list options.

The DHCPv6 client can also request the delegation of prefixes. The prefixes acquired from a delegating device will be stored in a local IPv6 general prefix pool. The prefixes in the general prefix pool can then be referred to from other applications; for example, the general prefix pool can be used to number device downstream interfaces.

Server Selection

A DHCPv6 client builds a list of potential servers by sending a solicit message and by collecting advertise message replies from servers. These messages are ranked based on the preference value, and servers may add a preference option to their advertise messages explicitly stating their preference value. If the client needs to acquire prefixes from servers, only servers that have advertised prefixes are considered.

IAPD and IAID

An Identity Association for Prefix Delegation (IAPD) is a collection of prefixes assigned to a requesting device. A requesting device may have more than one IAPD; for example, one for each of its interfaces.

Each IAPD is identified by an IAID. The IAID is chosen by the requesting device and is unique among the IAPD IAIDs on the requesting device. IAIDs are made consistent across reboots by using information from the associated network interface, which is assumed to be permanently attached to the device.

Server Function

The DHCPv6 server function can be enabled on individual IPv6-enabled interfaces.

The DHCPv6 server can provide configuration parameters that do not require the server to maintain any dynamic state for individual clients, such as DNS server addresses and domain search list options. The DHCPv6 server may be configured to perform prefix delegation.

All the configuration parameters for clients are independently configured into DHCPv6 configuration pools, which are stored in the NVRAM. A configuration pool can be associated with a particular DHCPv6 server on an interface when it is started. Prefixes that are to be delegated to clients may be specified either as a list of preassigned prefixes for a particular client or as IPv6 local prefix pools that are also stored in the NVRAM. The list of manually configured prefixes or IPv6 local prefix pools can be referenced and used by DHCPv6 configuration pools.

The DHCPv6 server maintains an automatic binding table in memory to track the assignment of some configuration parameters, such as prefixes between the server and its clients. Automatic bindings can be stored permanently in the database agent, such as a remote TFTP server or a local NVRAM file system.

Configuration Information Pool

A DHCPv6 configuration information pool is a named entity that includes information about available configuration parameters and policies that the control assignment of the parameters to clients from the pool. A pool is configured independently and is associated with the DHCPv6 service through the CLI.

Each configuration pool can contain the following configuration parameters and operational information:

- Prefix delegation information, which includes:

    - A prefix pool name and associated preferred and valid lifetimes
    - A list of available prefixes for a particular client and associated preferred and valid lifetimes

- A list of IPv6 addresses of DNS servers
- A domain search list, which is a string containing domain names for the DNS resolution

DHCP for IPv6 Address Assignment

DHCPv6 enables DHCP servers to pass configuration parameters, such as IPv6 network addresses, to IPv6 clients. The DHCPv6 Individual Address Assignment feature manages nonduplicate address assignment in the correct prefix based on the network where the host is connected. Assigned addresses can be from one or multiple prefix pools. Additional options, such as the default domain and DNS name-server address, can be passed back to the client. Address pools can be assigned for use on a specific interface or on multiple interfaces, or the server can automatically find the appropriate pool.

Prefix Assignment

A prefix-delegating router (DHCPv6 server) selects prefixes to be assigned to a requesting router (DHCPv6 client) upon receiving a request from the client. The server can select prefixes for a requesting client by using static and dynamic assignment mechanisms. Administrators can manually configure a list of prefixes and associated preferred and valid lifetimes for an IAPD of a specific client that is identified by its DUID.

When the delegating router receives a request from a client, it checks if there is a static binding configured for the IAPD in the client’s message. If a static binding is present, the prefixes in the binding are returned to the client. If no such binding is found, the server attempts to assign prefixes for the client from other sources.

The Cisco IOS XE DHCPv6 server can assign prefixes dynamically from an IPv6 local prefix pool. When the server receives a prefix request from a client, it attempts to obtain unassigned prefixes from the pool. After the client releases the previously assigned prefixes, the server returns them to the pool for reassignment.

An IPv6 prefix delegating router can also select prefixes for a requesting router based on an external authority such as a RADIUS server using the Framed-IPv6-Prefix attribute.

Automatic Binding

Each DHCPv6 configuration pool has an associated binding table. The binding table contains records of all prefixes in the configuration pool that have been explicitly delegated to clients. Each entry in the binding table contains the following information:

- Client DUID.
- Client IPv6 address.
- A list of IAPDs associated with the client.
- A list of prefixes delegated to each IAPD.
- Preferred and valid lifetimes for each prefix.
- The configuration pool to which this binding table belongs.
- The network interface on which the server that is using the pool is running.

A binding table entry is automatically created whenever a prefix is delegated to a client from the configuration pool, and the entry is updated when the client renews, rebinds, or confirms the prefix delegation. A binding table entry is deleted when the client voluntarily releases all the prefixes in the binding, the valid lifetimes of all prefixes have expired, or administrators run the **clear ipv6 dhcp binding** command.

Binding Database

Each permanent storage to which the binding database is saved is called the database agent. A database agent can be a remote host, such as an FTP server, or a local file system, such as the NVRAM.

Automatic bindings are maintained in the RAM and can be saved to some permanent storage so that information about configurations, such as prefixes assigned to clients, is not lost after a system reload. The bindings are stored as text records for easy maintenance. Each record contains the following information:

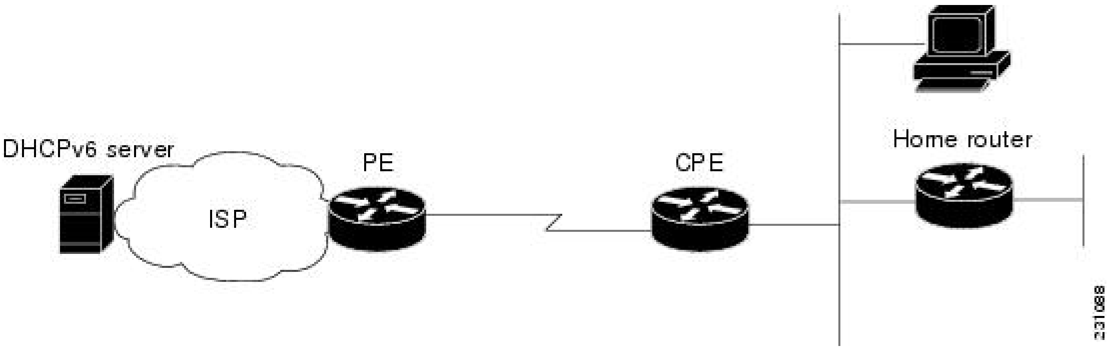
- DHCPv6 pool name from which the configuration was assigned to the client.
- Interface identifier from which the client requests were received.
- The client IPv6 address.
- The client DUID.
- IAID of the IAPD.
- Prefix delegated to the client.
- The prefix length.
- The prefix preferred lifetime in seconds.
- The prefix valid lifetime in seconds.
- The prefix expiration time stamp.
- Optional local prefix pool name from which the prefix was assigned.

DHCPv6 Server Stateless Autoconfiguration

Hierarchical DHCPv6 for stateless configuration parameters allows a stateless or stateful DHCPv6 client to export configuration parameters (DHCPv6 options) to a local DHCPv6 server pool. The local DHCPv6 server can then provide the imported configuration parameters to other DHCPv6 clients.

The figure below shows a typical broadband deployment.

Figure 11: Broadband Topology



The CPE interface towards the PE can be a stateless or stateful DHCPv6 client. In either case, the ISP-side DHCPv6 server may provide configuration parameters such as DNS server addresses, domain names, and

Simple Network Time Protocol (SNTP) servers to the DHCP client on the CPE. Such information can be specific to ISPs.

In addition to being a DHCPv6 client (for example, towards the ISP), the CPE may act as a DHCPv6 server to the home network. For example, neighbor discovery followed by a stateless or stateful DHCPv6 client can occur on the link between the CPE and the home devices (such as the home router or PC). In some cases, the information to be provided to the home network is the same as that obtained from the ISP-side DHCPv6 server. Because this information can be dynamically changed, it cannot be hard-configured in the CPE's configuration. Therefore, the DHCPv6 component on the CPE allows automatic importing of configuration parameters from the DHCPv6 client to the DHCPv6 server pool.

DHCPv6 supports the following options for IPv6 on the server:

Information Refresh Server Option

The DHCPv6 information refresh option can specify a maximum limit for the length of time a client should wait before refreshing the information retrieved from DHCPv6. This option is used with stateless DHCPv6 because there are no addresses or other entities with lifetimes that can tell the client when to contact the DHCPv6 server to refresh its configuration.

NIS- and NIS+-Related Server Options

Users can configure the network information service (NIS) or NIS plus (NIS+) address or domain name of a DHCPv6 server using NIS- and NIS+-related options, and then import that information to the DHCPv6 client.

SIP Server Options

Session Initiation Protocol (SIP) server options contain either a list of domain names or a list of IPv6 addresses that can be mapped to one or more SIP outbound proxy servers. One option carries a list of domain names, and the other option carries a list of 128-bit IPv6 addresses.

SIP is an application-layer control protocol that can establish, modify, and terminate multimedia sessions or calls. A SIP system has several logical components: user agents, proxy servers, redirect servers, and registrars. User agents may contain SIP clients; proxy servers always contain SIP clients.

SNTP Server Option

The SNTP server option provides a list of one or more IPv6 addresses of SNTP servers available to the client for synchronization. Clients use these SNTP servers to synchronize their system time to that of the standard time servers. The DHCPv6 server may list the SNTP servers in decreasing order of preference, but clients treat the list of SNTP servers as an ordered list.

How to Configure IPv6 Access Services: DHCPv6 Prefix Delegation

Configuring the DHCPv6 Server Function

Configuring the DHCPv6 Configuration Pool

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 dhcp pool** *poolname*
4. **domain-name** *domain*
5. **dns-server** *ipv6-address*
6. **prefix-delegation** *ipv6-prefix* / *prefix-length* *client-duid* [**iaid** *iaid*] [*lifetime*]
7. **prefix-delegation pool** *poolname* [**lifetime** *valid-lifetime preferred-lifetime*]
8. **exit**
9. **interface** *type* *number*
10. **ipv6 dhcp server** *poolname* [**rapid-commit**] [**preference** *value*] [**allow-hint**]
11. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ipv6 dhcp pool** *poolname* **Example:** `Device(config)# ipv6 dhcp pool pool1`	Configures a DHCPv6 configuration information pool and enters DHCPv6 pool configuration mode.

	Command or Action	Purpose
Step 4	**domain-name** *domain* **Example:** `Device(config-dhcp)# domain-name example.com`	Configures a domain name for a DHCPv6 client.
Step 5	**dns-server** *ipv6-address* **Example:** `Device(config-dhcp)# dns-server 2001:DB8:3000:3000::42`	Specifies the DNS IPv6 servers available to a DHCPv6 client.
Step 6	**prefix-delegation** *ipv6-prefix* / *prefix-length* *client-duid* [**iaid** *iaid*] [*lifetime*] **Example:** `Device(config-dhcp)# prefix-delegation 2001:DB8:1263::/48 0005000400F1A4D070D03`	Specifies a manually configured numeric prefix to be delegated to a specified client's IAPD.
Step 7	**prefix-delegation pool** *poolname* [**lifetime** *valid-lifetime* *preferred-lifetime*] **Example:** `Device(config-dhcp)# prefix-delegation pool pool1 lifetime 1800 60`	Specifies a named IPv6 local prefix pool from which prefixes are delegated to DHCPv6 clients.
Step 8	**exit** **Example:** `Device(config-dhcp)# exit`	Exits DHCPv6 pool configuration mode, and returns the device to global configuration mode.
Step 9	**interface** *type* *number* **Example:** `Device(config)# interface serial 3`	Specifies an interface type and number, and enters interface configuration mode.
Step 10	**ipv6 dhcp server** *poolname* [**rapid-commit**] [**preference** *value*] [**allow-hint**] **Example:** `Device(config-if)# ipv6 dhcp server pool1`	

Step 11	**end**
	Example:
	`Device(config-if)# end`
		Returns to privileged EXEC mode.

Configuring a Binding Database Agent for the Server Function

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 dhcp database** *agent* [**write-delay** *seconds*] [**timeout** *seconds*]
4. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ipv6 dhcp database** *agent* [**write-delay** *seconds*] [**timeout** *seconds*] **Example:** `Device(config)# ipv6 dhcp database tftp://10.0.0.1/dhcp-binding`	Specifies DHCPv6 binding database agent parameters.

Step 4	**end**
	Example:
	`Device(config)# end`
		Returns to privileged EXEC mode.

Configuring the DHCPv6 Client Function

General prefixes can be defined dynamically from a prefix received by a DHCPv6 prefix delegation client. The delegated prefix is stored in a general prefix.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **ipv6 dhcp client pd** {*prefix-name* | **hint** *ipv6-prefix*} [**rapid-commit**]
5. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Device(config)# interface fastethernet 0/0/0`	Specifies an interface type and number, and enters interface configuration mode.
Step 4	**ipv6 dhcp client pd** {*prefix-name* | **hint** *ipv6-prefix*} [**rapid-commit**] **Example:** `Device(config-if)# ipv6 dhcp client pd dhcp-prefix`	Enables the DHCPv6 client process and enables a request for prefix delegation through a specified interface.

Step 5	**end**
	Example:
	`Device(config-if)# end`
		Returns to privileged EXEC mode.

Deleting Automatic Client Bindings from the DHCPv6 Binding Table

SUMMARY STEPS

1. **enable**
2. **clear ipv6 dhcp binding** [*ipv6-address*] [**vrf** *vrf-name*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**clear ipv6 dhcp binding** [*ipv6-address*] [**vrf** *vrf-name*] **Example:** `Device# clear ipv6 dhcp binding`	Deletes automatic client bindings from the DHCPv6 binding table.

Configuration Examples for IPv6 Access Services: DHCPv6 Prefix Delegation

Examples: Configuring the DHCPv6 Server Function

In the following example, Dynamic Host Configuration Protocol for IPv6 (DHCPv6) clients are connected to the DHCPv6 server on Ethernet interface 0/0. The server is configured to use parameters from the DHCP pool called dhcp-pool. This pool provides clients with the IPv6 address of a Domain Name System (DNS) server and the domain name to be used. It also specifies that prefixes can be delegated from the prefix pool called client-prefix-pool1. The prefixes delegated will have valid and preferred lifetimes of 1800 and 600 seconds, respectively. The prefix pool named client-prefix-pool1 has a prefix of length /40 from which it will delegate (sub) prefixes of length /48.

```
ipv6 dhcp pool dhcp-pool
 prefix-delegation pool client-prefix-pool1 lifetime 1800 600
 dns-server 2001:DB8:3000:3000::42
 domain-name example.com
!
interface Ethernet 0/0
 description downlink to clients
 ipv6 address FEC0:240:104:2001::139/64
 ipv6 dhcp server dhcp-pool
```

```
!
ipv6 local pool client-prefix-pool1 2001:DB8:1200::/40 48
```

The following example from the **show ipv6 dhcp** command shows the DHCP unique identifier (DUID) of the device:

```
Device# show ipv6 dhcp

This device's DHCPv6 unique identifier(DUID): 000300010002FCA5DC1C
```

In the following example, the **show ipv6 dhcp binding** command shows information about two clients, including their DUIDs, IAPDs, prefixes, and preferred and valid lifetimes:

```
Device# show ipv6 dhcp binding

Client: FE80::202:FCFF:FEA5:DC39 (Ethernet2/1)
  DUID: 000300010002FCA5DC1C
  IA PD: IA ID 0x00040001, T1 0, T2 0
    Prefix: 3FFE:C00:C18:11::/68
            preferred lifetime 180, valid lifetime 12345
            expires at Nov 08 2002 02:24 PM (12320 seconds)
Client: FE80::202:FCFF:FEA5:C039 (Ethernet2/1)
  DUID: 000300010002FCA5C01C
  IA PD: IA ID 0x00040001, T1 0, T2 0
    Prefix: 3FFE:C00:C18:1::/72
            preferred lifetime 240, valid lifetime 54321
            expires at Nov 09 2002 02:02 AM (54246 seconds)
    Prefix: 3FFE:C00:C18:2::/72
            preferred lifetime 300, valid lifetime 54333
            expires at Nov 09 2002 02:03 AM (54258 seconds)
    Prefix: 3FFE:C00:C18:3::/72
            preferred lifetime 280, valid lifetime 51111
```

In the following example, the **show ipv6 dhcp database** command provides information on the binding database agents TFTP, NVRAM, and flash:

```
Device# show ipv6 dhcp database

Database agent tftp://172.19.216.133/db.tftp:
  write delay: 69 seconds, transfer timeout: 300 seconds
  last written at Jan 09 2003 01:54 PM,
     write timer expires in 56 seconds
  last read at Jan 06 2003 05:41 PM
  successful read times 1
  failed read times 0
  successful write times 3172
  failed write times 2
Database agent nvram:/dhcpv6-binding:
  write delay: 60 seconds, transfer timeout: 300 seconds
  last written at Jan 09 2003 01:54 PM,
     write timer expires in 37 seconds
  last read at never
  successful read times 0
  failed read times 0
  successful write times 3325
  failed write times 0
Database agent flash:/dhcpv6-db:
  write delay: 82 seconds, transfer timeout: 3 seconds
  last written at Jan 09 2003 01:54 PM,
    write timer expires in 50 seconds
  last read at never
  successful read times 0
  failed read times 0
  successful write times 2220
  failed write times 614
```

Example: Configuring the DHCPv6 Configuration Pool

In the following example, the **show ipv6 dhcp pool** command provides information on the configuration pool named svr-p1, including the static bindings, prefix information, the DNS server, and the domain names found in the svr-p1 pool:

```
Device# show ipv6 dhcp pool

DHCPv6 pool: svr-p1
  Static bindings:
    Binding for client 000300010002FCA5C01C
      IA PD: IA ID 00040002,
        Prefix: 3FFE:C00:C18:3::/72
                preferred lifetime 604800, valid lifetime 2592000
      IA PD: IA ID not specified; being used by 00040001
        Prefix: 3FFE:C00:C18:1::/72
                preferred lifetime 240, valid lifetime 54321
        Prefix: 3FFE:C00:C18:2::/72
                preferred lifetime 300, valid lifetime 54333
        Prefix: 3FFE:C00:C18:3::/72
                preferred lifetime 280, valid lifetime 51111
  Prefix from pool: local-p1, Valid lifetime 12345, Preferred lifetime 180
  DNS server: 2001:DB8:1001::1
  DNS server: 2001:DB8:1001::2
  Domain name: example1.net
  Domain name: example2.net
  Domain name: example3.net
Active clients: 2
Current configuration : 22324 bytes
!
! Last configuration change at 14:59:38 PST Tue Jan 16 2001
! NVRAM config last updated at 04:25:39 PST Tue Jan 16 2001 by bird
!
hostname Device
!
ip cef
ipv6 unicast-routing
ipv6 cef
ipv6 cef accounting prefix-length
!
!
interface Ethernet0
 ip address 10.4.9.11 255.0.0.0
 media-type 10BaseT
 ipv6 address 2001:DB8:C18:1::/64 eui-64
```

Example: Configuring the DHCPv6 Client Function

In the following example, this Dynamic Host Configuration Protocol for IPv6 (DHCPv6) client has three interfaces. Ethernet interface 0/0 is the upstream link to a service provider, which has a DHCPv6 server function enabled. The Fast Ethernet interfaces 0/0 and 0/1 are links to local networks.

The upstream interface, Ethernet interface 0/0, has the DHCPv6 client function enabled. Prefixes delegated by the provider are stored in the general prefix called prefix-from-provider.

The local networks, Fast Ethernet interfaces 0/0 and 0/1, both assign interface addresses based on the general prefix called prefix-from-provider. The bits on the left of the addresses come from the general prefix, and the bits on the right of the addresses are specified statically.

```
interface Ethernet 0/0
 description uplink to provider DHCP IPv6 server
 ipv6 dhcp client pd prefix-from-provider
!
```

```
interface FastEthernet 0/0
 description local network 0
 ipv6 address prefix-from-provider ::5:0:0:0:100/64
!
interface FastEthernet 0/1
 description local network 1
 ipv6 address prefix-from-provider ::6:0:0:0:100/64
```

Example: Configuring a Database Agent for the Server Function

The DHCPv6 server is configured to store table bindings to the file named dhcp-binding on the server at address 10.0.0.1 using the TFTP protocol. The bindings are saved every 120 seconds.

```
ipv6 dhcp database tftp://10.0.0.1/dhcp-binding write-delay 120
```

The following example shows how to specify DHCP for IPv6 binding database agent parameters and store binding entries in bootflash:

```
ipv6 dhcp database bootflash
```

Example: Displaying DHCP Server and Client Information on the Interface

The following is sample output from the **show ipv6 dhcp interface** command. In the first example, the command is used on a device that has an interface acting as a DHCPv6 server. In the second example, the command is used on a device that has an interface acting as a DHCPv6 client:

```
Device1# show ipv6 dhcp interface

Ethernet2/1 is in server mode
  Using pool: svr-p1
  Preference value: 20
  Rapid-Commit is disabled

Device2# show ipv6 dhcp interface

Ethernet2/1 is in client mode
  State is OPEN (1)
  List of known servers:
    Address: FE80::202:FCFF:FEA1:7439, DUID 000300010002FCA17400
    Preference: 20
      IA PD: IA ID 0x00040001, T1 120, T2 192
        Prefix: 3FFE:C00:C18:1::/72
                preferred lifetime 240, valid lifetime 54321
                expires at Nov 08 2002 09:10 AM (54319 seconds)
        Prefix: 3FFE:C00:C18:2::/72
                preferred lifetime 300, valid lifetime 54333
                expires at Nov 08 2002 09:11 AM (54331 seconds)
        Prefix: 3FFE:C00:C18:3::/72
                preferred lifetime 280, valid lifetime 51111
                expires at Nov 08 2002 08:17 AM (51109 seconds)
      DNS server: 2001:DB8:1001::1
      DNS server: 2001:DB8:1001::2
      Domain name: example1.net
      Domain name: example2.net
      Domain name: example3.net
    Prefix name is cli-p1
    Rapid-Commit is enabled
```

Additional References

Related Documents

Related Topic	Document Title
IPv6 addressing and connectivity	*IPv6 Configuration Guide*
Cisco IOS commands	Cisco IOS Master Command List, All Releases
IPv6 commands	*Cisco IOS IPv6 Command Reference*
Cisco IOS IPv6 features	Cisco IOS IPv6 Feature Mapping

Standards and RFCs

Standard/RFC	Title
RFCs for IPv6	*IPv6 RFCs*

MIBs

MIB	MIBs Link
	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for IPv6 Access Services: DHCPv6 Prefix Delegation

Table 19: Feature Information for IPv6 Access Services: DHCPv6 Prefix Delegation

Feature Name	Releases	Feature Information
IPv6 Access Services: DHCPv6 Prefix Delegation	12.0(32)S 12.2(28)SB 12.2(33)SRA 12.2(18)SXE 12.3(4)T 12.4 12.4(2)T 15.0(1)S Cisco IOS XE Release 2.1	The DHCPv6 Prefix Delegation feature can be used to manage link, subnet, and site addressing changes. DHCPv6 can be used in environments to deliver stateful and stateless information. The following commands were introduced or modified: **clear ipv6 dhcp binding**, **dns-server**, **domain-name**, **ipv6 dhcp client pd**, **ipv6 dhcp database**, **ipv6 dhcp pool**, **ipv6 dhcp server**, **prefix-delegation**, **prefix-delegation pool**, **show ipv6 dhcp**, **show ipv6 dhcp binding**, **show ipv6 dhcp interface**, **show ipv6 dhcp pool**.
DHCP—DHCPv6 Individual Address Assignment		This feature manages non-duplicate address assignment in the correct prefix based on the network where the host is connected.

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