CHAPTER 21

Configuring DHCP Features and IP Source Guard

This chapter describes how to configure DHCP snooping and the option-82 data insertion features on the Catalyst 3750 switch. It also describes how to configure the IP source guard feature. Unless otherwise noted, the term *switch* refers to a standalone switch and to a switch stack.

Note For complete syntax and usage information for the commands used in this chapter, refer to the command reference for this release, and refer to the "DHCP Commands" section in the *Cisco IOS IP Command Reference, Volume 1 of 3: Addressing and Services, Release 12.2*.

This chapter consists of these sections:

- Understanding DHCP Features, page 21-1
- Configuring DHCP Features, page 21-7
- Displaying DHCP Snooping Information, page 21-14
- Understanding IP Source Guard, page 21-15
- Configuring IP Source Guard, page 21-16
- Displaying IP Source Guard Information, page 21-19

Understanding DHCP Features

DHCP is widely used in LAN environments to dynamically assign host IP addresses from a centralized server, which significantly reduces the overhead of administration of IP addresses. DHCP also helps conserve the limited IP address space because IP addresses no longer need to be permanently assigned to hosts; only those hosts that are connected to the network consume IP addresses.

The switch supports these DHCP features:

- DHCP Server, page 21-2
- DHCP Relay Agent, page 21-2
- DHCP Snooping, page 21-2
- Option-82 Data Insertion, page 21-3
- DHCP Snooping and Switch Stacks, page 21-6
- Cisco IOS DHCP Server Database, page 21-5
- DHCP Snooping Binding Database, page 21-5

For information about the DHCP client, refer to the "*Configuring DHCP*" section of the "*IP Addressing and Services*" section of the *Cisco IOS IP Configuration Guide, Release 12.2*.

DHCP Server

The DHCP server assigns IP addresses from specified address pools on a switch or router to DHCP clients and manages them. If the DHCP server cannot give the DHCP client the requested configuration parameters from its database, it can forward the request to one or more secondary DHCP servers defined by the network administrator.

DHCP Relay Agent

A DHCP relay agent is a Layer 3 device that forwards DHCP packets between clients and servers. Relay agents forward requests and replies between clients and servers when they are not on the same physical subnet. Relay agent forwarding is different from the normal Layer 2 forwarding, in which IP datagrams are switched transparently between networks. Relay agents receive DHCP messages and generate new DHCP messages to send on egress interfaces.

DHCP Snooping

DHCP snooping is a DHCP security feature that provides network security by filtering untrusted DHCP messages and by building and maintaining a DHCP snooping binding database, also referred to as a DHCP snooping binding table. For more information about this database, see the "Displaying the DHCP Snooping Binding Database" section on page 21-14.

DHCP snooping acts like a firewall between untrusted hosts and DHCP servers. You use DHCP snooping to differentiate between untrusted interfaces connected to the end user and trusted interfaces connected to the DHCP server or another switch.

Note For DHCP snooping to function properly, all DHCP servers must be connected to the switch through trusted interfaces.

An untrusted DHCP message is a message that is received from outside the network or firewall. When you use DHCP snooping in a service-provider environment, an untrusted message is sent from a device that is not in the service-provider network, such as a customer's switch. Messages from unknown devices are untrusted because they can be sources of traffic attacks.

The DHCP snooping binding database has the MAC address, the IP address, the lease time, the binding type, the VLAN number, and the interface information that corresponds to the local untrusted interfaces of a switch. It does not have information regarding hosts interconnected with a trusted interface.

In a service-provider network, a trusted interface is connected to a port on a device in the same network. An untrusted interface is connected to an untrusted interface in the network or to an interface on a device that is not in the network.

When a switch receives a packet on an untrusted interface and the interface belongs to a VLAN in which DHCP snooping is enabled, the switch compares the source MAC address and the DHCP client hardware address. If the addresses match (the default), the switch forwards the packet. If the addresses do not match, the switch drops the packet.

The switch drops a DHCP packet when one of these situations occurs:

- A packet from a DHCP server, such as a DHCPOFFER, DHCPACK, DHCPNAK, or DHCPLEASEQUERY packet, is received from outside the network or firewall.
- A packet is received on an untrusted interface, and the source MAC address and the DHCP client hardware address do not match.
- The switch receives a DHCPRELEASE or DHCPDECLINE broadcast message that has a MAC address in the DHCP snooping binding database, but the interface information in the binding database does not match the interface on which the message was received.
- A DHCP relay agent forwards a DHCP packet that includes a relay-agent IP address that is not 0.0.0.0, or the relay agent forwards a packet that includes option-82 information to an untrusted port.

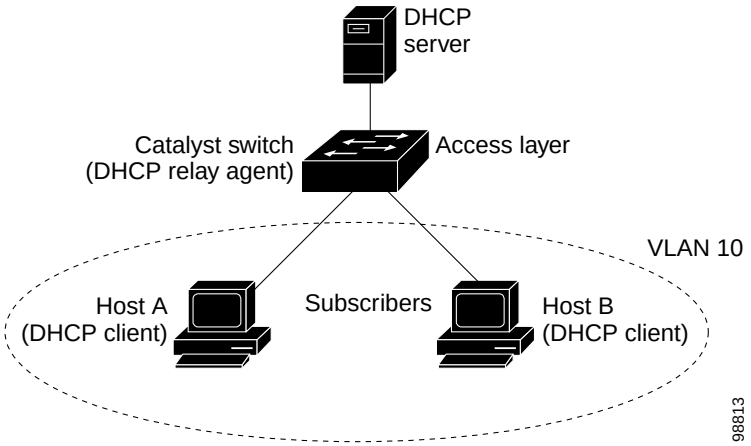
Option-82 Data Insertion

In residential, metropolitan Ethernet-access environments, DHCP can centrally manage the IP address assignments for a large number of subscribers. When the DHCP option-82 feature is enabled on the switch, a subscriber device is identified by the switch port through which it connects to the network (in addition to its MAC address). Multiple hosts on the subscriber LAN can be connected to the same port on the access switch and are uniquely identified.

Note The DHCP option-82 feature is supported only when DHCP snooping is enabled globally and on the VLANs to which subscriber devices using this feature are assigned.

Figure 21-1 is an example of a metropolitan Ethernet network in which a centralized DHCP server assigns IP addresses to subscribers connected to the switch at the access layer. Because the DHCP clients and their associated DHCP server do not reside on the same IP network or subnet, a DHCP relay agent (the Catalyst switch) is configured with a helper address to enable broadcast forwarding and to transfer DHCP messages between the clients and the server.

Figure 21-1 DHCP Relay Agent in a Metropolitan Ethernet Network



When you enable the DHCP snooping information option 82 on the switch, this sequence of events occurs:

- The host (DHCP client) generates a DHCP request and broadcasts it on the network.
- When the switch receives the DHCP request, it adds the option-82 information in the packet. The option-82 information is the switch MAC address (the remote ID suboption) and the port identifier, **vlan-mod-port**, from which the packet is received (the circuit ID suboption).
- If the IP address of the relay agent is configured, the switch adds this IP address in the DHCP packet.
- The switch forwards the DHCP request that includes the option-82 field to the DHCP server.
- The DHCP server receives the packet. If the server is option-82-capable, it can use 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. Then the DHCP server echoes the option-82 field in the DHCP reply.
- The DHCP server unicasts the reply to the switch if the request was relayed to the server by the switch. The switch verifies that it originally inserted the option-82 data by inspecting the remote ID and possibly the circuit ID fields. The switch removes the option-82 field and forwards the packet to the switch port that connects to the DHCP client that sent the DHCP request.

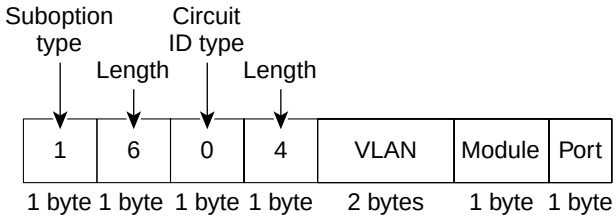
When the previously described sequence of events occurs, the values in these fields in Figure 21-2 do not change:

- Circuit ID suboption fields
  - Suboption type
  - Length of the suboption type
  - Circuit ID type
  - Length of the circuit ID type
- Remote ID suboption fields
  - Suboption type
  - Length of the suboption type
  - Remote ID type
  - Length of the circuit ID type

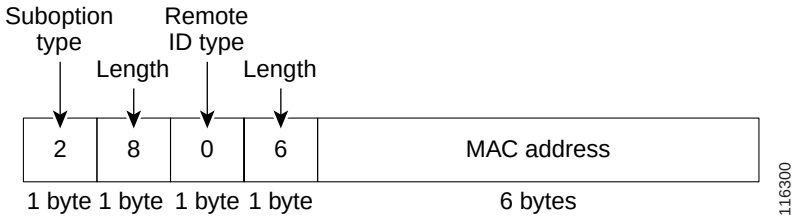
Figure 21-2 shows the packet formats for the remote ID suboption and the circuit ID suboption. For the circuit ID suboption, the module number corresponds to the switch number in the stack. The switch uses the packet formats when DHCP snooping is globally enabled and when the **ip dhcp snooping information option** global configuration command is entered.

Figure 21-2 Suboption Packet Formats

Circuit ID Suboption Frame Format



Remote ID Suboption Frame Format



Cisco IOS DHCP Server Database

During the DHCP-based autoconfiguration process, the designated DHCP server uses the Cisco IOS DHCP server database. It has IP addresses, *address bindings*, and configuration parameters, such as the boot file.

An address binding is a mapping between an IP address and a MAC address of a host in the Cisco IOS DHCP server database. You can manually assign the client IP address, or the DHCP server can allocate an IP address from a DHCP address pool. For more information about manual and automatic address bindings, refer to the "Configuring DHCP" chapter of the *Cisco IOS IP Configuration Guide, Release 12.2*.

DHCP Snooping Binding Database

When DHCP snooping is enabled, the switch uses the DHCP snooping binding database to store information about untrusted interfaces. The database can have up to 512 bindings.

Each database entry (*binding*) has an IP address, an associated MAC address, the lease time (in hexadecimal format), the interface to which the binding applies, and the VLAN to which the interface belongs. A *checksum* value, the end of each entry, is the number of bytes from the start of the file to end of the entry. Each entry is 72 bytes, followed by a space and then the checksum value.

To keep the bindings when the switch reloads, you must use the DHCP snooping database agent. If the agent is disabled, the switch loses its DHCP snooping bindings and its connectivity when it reloads. The switch also loses connectivity.

The database agent stores the bindings in a file at a configured location. When reloading, the switch reads the binding file to build the DHCP snooping binding database. The switch keeps the file current by updating it when the database changes.

When a switch learns of new bindings or when it loses bindings, the switch updates the entries in the database and in the binding file. The frequency at which database and file are updated is based on a configurable delay, and the updates are batched. If the database and file are not updated in a specified time (set by the write-delay and abort-timeout values), the update stops.

This is the format of the file that has the bindings:

```
<initial-checksum>
TYPE DHCP-SNOOPING
VERSION 1
BEGIN
<entry-1> <checksum-1>
<entry-2> <checksum-1-2>
...
...
<entry-n> <checksum-1-2-..-n>
END
```

Each entry in the file is tagged with a checksum value that the switch uses to verify the entries when it reads the file. The *initial-checksum* entry on the first line distinguishes entries associated with the latest file update from entries associated with a previous file update.

This is an example of a binding file:

```
3ebe1518
TYPE DHCP-SNOOPING
VERSION 1
BEGIN
1.1.1.1 512 0001.0001.0005 3EBE2881 Gi1/0/1 e5e1e733
1.1.1.1 512 0001.0001.0002 3EBE2881 Gi1/0/1 4b3486ec
1.1.1.1 1536 0001.0001.0004 3EBE2881 Gi1/0/1 f0e02872
1.1.1.1 1024 0001.0001.0003 3EBE2881 Gi1/0/1 ac41adf9
1.1.1.1 1 0001.0001.0001 3EBE2881 Gi1/0/1 34b3273e
END
```

When the switch starts and the calculated checksum value equals the stored checksum value, the switch reads entries from the binding file and adds the bindings to its DHCP snooping binding database. The switch ignores an entry when one of these situations occurs:

- The switch reads the entry and the calculated checksum value does not equal the stored checksum value. The entry and the ones following it are ignored.
- An entry has an expired lease time (the switch might not remove a binding entry when the lease time expires).
- The interface in the entry no longer exists on the system.
- The interface is a routed interface or a DHCP snooping-trusted interface.

DHCP Snooping and Switch Stacks

DHCP snooping is managed on the stack master. When a new switch joins the stack, the switch receives the DHCP snooping configuration from the stack master. When a member leaves the stack, all DHCP snooping address bindings associated with the switch age out.

When a stack merge occurs, all DHCP snooping bindings in the stack master are lost if it is no longer the stack master. With a stack partition, the existing stack master is unchanged, and the bindings belonging to the partitioned switches age out. The new master of the partitioned stack begins processing the new incoming DHCP packets. For more information about switch stacks, see Chapter 5, “Managing Switch Stacks.”

Configuring DHCP Features

These sections describe how to configure the DHCP server, the DHCP relay agent, DHCP snooping, option 82, the Cisco IOS DHCP server binding database, and the DHCP snooping binding database on your switch:

- Default DHCP Configuration, page 21-7
- DHCP Snooping Configuration Guidelines, page 21-8
- Configuring the DHCP Server, page 21-8
- DHCP Server and Switch Stacks, page 21-9
- Configuring the DHCP Relay Agent, page 21-9
- Specifying the Packet Forwarding Address, page 21-9
- Enabling DHCP Snooping and Option 82, page 21-10
- Enabling DHCP Snooping on Private VLANs, page 21-12
- Enabling the Cisco IOS DHCP Server Database, page 21-12
- Enabling the DHCP Snooping Binding Database Agent, page 21-12

Default DHCP Configuration

Table 21-1 shows the default DHCP configuration.

Table 21-1 Default DHCP Configuration

Feature	Default Setting
DHCP server	Enabled[1]
DHCP relay agent	Enabled[2]
DHCP packet forwarding address	None configured
Checking the relay agent information	Enabled (invalid messages are dropped)[2]
DHCP relay agent forwarding policy	Replace the existing relay agent information[2]
Cisco IOS DHCP server binding database[3]	Enabled[4]
DHCP snooping enabled globally	Disabled
DHCP snooping information option	Enabled
DHCP snooping limit rate	None configured
DHCP snooping trust	Untrusted
DHCP snooping VLAN	Disabled
DHCP snooping MAC address verification	Enabled
DHCP snooping binding database agent[3]	Enabled

1. The switch responds to DHCP requests only if it is configured as a DHCP server.
2. The switch relays DHCP packets only if the IP address of the DHCP server is configured on the SVI of the DHCP client.
3. This feature is supported only when your switch is running the enhanced multilayer image (EMI).
4. The switch gets network addresses and configuration parameters only from a device configured as DHCP server.

DHCP Snooping Configuration Guidelines

These are the configuration guidelines for DHCP snooping.

- You must globally enable DHCP snooping on the switch.
- DHCP snooping is not active until DHCP snooping is enabled on a VLAN.
- Before globally enabling DHCP snooping on the switch, make sure that the devices acting as the DHCP server and the DHCP relay agent are configured and enabled.
- When you globally enable DHCP snooping on the switch, these Cisco IOS commands are not available until snooping is disabled. If you enter these commands, the switch returns an error message, and the configuration is not applied.
  - **ip dhcp relay information check** global configuration command
  - **ip dhcp relay information policy** global configuration command
  - **ip dhcp relay information trust-all** global configuration command
  - **ip dhcp relay information trusted** interface configuration command
- Before configuring the DHCP snooping information option on your switch, be sure to configure the device that is acting as the DHCP server. For example, you must specify the IP addresses that the DHCP server can assign or exclude, or you must configure DHCP options for these devices.
- Before configuring the DHCP relay agent on your switch, make sure to configure the device that is acting as the DHCP server. For example, you must specify the IP addresses that the DHCP server can assign or exclude, configure DHCP options for devices, or set up the DHCP database agent.
- If the DHCP relay agent is enabled but DHCP snooping is disabled, the DHCP option-82 data insertion feature is not supported.
- If a switch port is connected to a DHCP server, configure a port as trusted by entering the **ip dhcp snooping trust** interface configuration command.
- If a switch port is connected to a DHCP client, configure a port as untrusted by entering the **no ip dhcp snooping trust** interface configuration command.
- Follow these guidelines when configuring the DHCP snooping binding database:
  - Because both NVRAM and the flash memory have limited storage capacity, we recommend that you store the binding file on a TFTP server.
  - You must create an empty file at the configured URL on network-based URLs (such as TFTP and FTP) before the switch can initially write bindings to the binding file at that URL for the first time.
  - To ensure that the lease time in the database is accurate, we recommend that NTP is enabled and configured. For more information, see the "Configuring NTP" section on page 7-4.
  - If NTP is not configured, the switch writes binding changes to the binding file only when the switch system clock is synchronized with NTP.

Configuring the DHCP Server

The switch can act as a DHCP server. By default, the Cisco IOS DHCP server and relay agent features are enabled on your switch but are not configured. These features are not operational.

For procedures to configure the switch as a DHCP server, refer to the "Configuring DHCP" section of the "IP addressing and Services" section of the *Cisco IOS IP Configuration Guide, Release 12.2*.

DHCP Server and Switch Stacks

The DHCP binding database is managed on the stack master. When a new stack master is assigned, the new master downloads the saved binding database from the TFTP server. If the stack master fails, all unsaved bindings are lost. The IP addresses associated with the lost bindings are released. You should configure an automatic backup by using the **ip dhcp database** *url* [**timeout** *seconds* | **write-delay** *seconds*] global configuration command.

When a stack merge occurs, the stack master that becomes a stack member loses all of the DHCP lease bindings. With a stack partition, the new master in the partition acts as a new DHCP server without any of the existing DHCP lease bindings.

For more information about the switch stack, see Chapter 5, "Managing Switch Stacks."

Configuring the DHCP Relay Agent

Beginning in privileged EXEC mode, follow these steps to enable the DHCP relay agent on the switch:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**service dhcp**	Enable the DHCP server and relay agent on your switch. By default, this feature is enabled.
Step 3	**end**	Return to privileged EXEC mode.
Step 4	**show running-config**	Verify your entries.
Step 5	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

To disable the DHCP server and relay agent, use the **no service dhcp** global configuration command.

Refer to the "*Configuring DHCP*" section of the "IP Addressing and Services" section of the *Cisco IOS IP Configuration Guide, Release 12.2* for these procedures:

- Checking (validating) the relay agent information
- Configuring the relay agent forwarding policy

Specifying the Packet Forwarding Address

If the DHCP server and the DHCP clients are on different networks or subnets, you must configure the switch with the **ip helper-address** *address* interface configuration command. The general rule is to configure the command on the Layer 3 interface closest to the client. The address used in the **ip helper-address** command can be a specific DHCP server IP address, or it can be the network address if other DHCP servers are on the destination network segment. Using the network address enables any DHCP server to respond to requests.

Beginning in privileged EXEC mode, follow these steps to specify the packet forwarding address:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface vlan** *vlan-id*	Enter interface configuration mode, and create a switch virtual interface.
Step 3	**ip address** *ip-address subnet-mask*	Configure the interface with an IP address and an IP subnet.
Step 4	**ip helper-address** *address*	Specify the DHCP packet forwarding address. The helper address 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.
Step 5	**exit**	Return to global configuration mode.
Step 6	**interface range** *port-range* or **interface** *interface-id*	Configure multiple physical ports that are connected to the DHCP clients, and enter interface range configuration mode. or Configure a single physical port that is connected to the DHCP client, and enter interface configuration mode.
Step 7	**switchport mode access**	Define the VLAN membership mode for the port.
Step 8	**switchport access vlan** *vlan-id*	Assign the ports to the same VLAN as configured in Step 2.
Step 9	**end**	Return to privileged EXEC mode.
Step 10	**show running-config**	Verify your entries.
Step 11	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

To remove the DHCP packet forwarding address, use the **no ip helper-address** *address* interface configuration command.

Enabling DHCP Snooping and Option 82

Beginning in privileged EXEC mode, follow these steps to enable DHCP snooping on the switch.

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**ip dhcp snooping**	Enable DHCP snooping globally.

	Command	Purpose
Step 3	**ip dhcp snooping vlan** *vlan-range*	Enable DHCP snooping on a VLAN or range of VLANs. The range is 1 to 4094. You can enter a single VLAN ID identified by VLAN ID number, a series of VLAN IDs separated by commas, a range of VLAN IDs separated by hyphens, or a range of VLAN IDs separated by entering the starting and ending VLAN IDs separated by a space.
Step 4	**ip dhcp snooping information option**	Enable the switch to insert and remove DHCP relay information (option-82 field) in forwarded DHCP request messages to the DHCP server. The default is enabled.
Step 5	**interface** *interface-id*	Enter interface configuration mode, and specify the interface to be configured.
Step 6	**ip dhcp snooping trust**	(Optional) Configure the interface as trusted or untrusted. You can use the **no** keyword to configure an interface to receive messages from an untrusted client. The default is untrusted.
Step 7	**ip dhcp snooping limit rate** *rate*	(Optional) Configure the number of DHCP packets per second than an interface can receive. The range is 1 to 4294967294. The default is no rate limit configured. **Note** We recommend an untrusted rate limit of not more than 100 packets per second. If you configure rate limiting for trusted interfaces, you might need to increase the rate limit if the port is a trunk port assigned to more than one VLAN on which DHCP snooping is enabled.
Step 8	**ip dhcp snooping verify mac-address**	(Optional) Configure the switch to verify that the source MAC address in a DHCP packet that is received on untrusted ports matches the client hardware address in the packet. The default is to verify that the source MAC address matches the client hardware address in the packet.
Step 9	**end**	Return to privileged EXEC mode.
Step 10	**show running-config**	Verify your entries.
Step 11	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

To disable DHCP snooping, use the **no ip dhcp snooping** global configuration command. To disable DHCP snooping on a VLAN or range of VLANs, use the **no ip dhcp snooping vlan** *vlan-range* global configuration command. To disable the insertion and removal of the option-82 field, use the **no ip dhcp snooping information option** global configuration command.

This example shows how to enable DHCP snooping globally and on VLAN 10 and to configure a rate limit of 100 packets per second on a port:

```
Switch(config)# ip dhcp snooping
Switch(config)# ip dhcp snooping vlan 10
Switch(config)# ip dhcp snooping information option
Switch(config)# interface gigabitethernet2/0/1
Switch(config-if)# ip dhcp snooping limit rate 100
```

Enabling DHCP Snooping on Private VLANs

You can enable DHCP snooping on private VLANs. If DHCP snooping is enabled, the configuration is propagated to both a primary VLAN and its associated secondary VLANs. If DHCP snooping is enabled on the primary VLAN, it is also configured on the secondary VLANs.

If DHCP snooping is already configured on the primary VLAN and you configure DHCP snooping with different settings on a secondary VLAN, the configuration for the secondary VLAN does not take effect. If DHCP snooping is not configured on the primary VLAN and you configure DHCP snooping on a secondary VLAN, the configuration takes affect only on the secondary VLAN.

When you manually configure DHCP snooping on a secondary VLAN, this message appears:

```
DHCP Snooping configuration may not take effect on secondary vlan XXX.
```

The **show ip dhcp snooping** privileged EXEC command output shows all VLANs, including primary and secondary private VLANs, on which DHCP snooping is enabled.

Enabling the Cisco IOS DHCP Server Database

For procedures to enable and configure the Cisco IOS DHCP server database, refer to the "DHCP Configuration Task List" section in the "Configuring DHCP" chapter of the *Cisco IOS IP Configuration Guide, Release 12.2*.

Enabling the DHCP Snooping Binding Database Agent

Beginning in privileged EXEC mode, follow these steps to enable and configure the DHCP snooping binding database agent on the switch.

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**ip dhcp snooping database** {**flash**[*number*]**:**/*filename* | **ftp:**//*user***:***password*@*host*/*filename* | **rcp:**//*user*@*host*/*filename*}	Specify the URL for the database agent or the binding file by using one of these forms: • **flash**[*number*]**:**/*filename* (Optional) Use the *number* parameter to specify the stack member number of the stack master. The range for *number* is 1 to 9. • **ftp:**//*user***:***password***@***host*/*filename* • **rcp:**//*user***@***host*/*filename* • **tftp:**//*host*/*filename*
Step 3	**ip dhcp snooping database timeout** *seconds*	Specify when to stop the database transfer process after the binding database changes. The range is from 0 to 86400. Use 0 for an infinite duration. The default is 300 seconds (5 minutes).
Step 4	**ip dhcp snooping database write-delay** *seconds*	Specify the duration for which the transfer should be delayed after the binding database changes. The range is from 15 to 86400 seconds. The default is 300 seconds (5 minutes).
Step 5	**end**	Return to privileged EXEC mode.

	Command	Purpose
Step 6	**ip dhcp snooping binding** *mac-address* **vlan** *vlan-id ip-address* **interface** *interface-id* **expiry** *seconds*	(Optional) Add binding entries to the DHCP snooping binding database. The *vlan-id* range is from 1 to 4904. The *seconds* range is from 1 to 4294967295. Enter this command for each entry that you add.
Step 7	**show ip dhcp snooping database** [**detail**]	Display the status and statistics of the DHCP snooping binding database agent.
Step 8	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

To delete the database agent or binding file, use the **no ip dhcp snooping database** interface configuration command. To reset the timeout or delay values, use the **ip dhcp snooping database timeout** *seconds* or the **ip dhcp snooping database write-delay** *seconds* interface configuration command.

To clear the statistics of the DHCP snooping binding database agent, use the **clear ip dhcp snooping database statistics** privileged EXEC command. To renew the database, use the **renew ip dhcp snooping database** privileged EXEC command.

To delete binding entries from the DHCP snooping binding database, use the **no ip dhcp snooping binding** *mac-address* **vlan** *vlan-id ip-address* **interface** *interface-id* **expiry** *seconds* privileged EXEC command. Enter this command for each entry that you delete.

This example shows how to enable the DHCP snooping binding database agent, configure the database agent, and add binding entries to the binding database:

```
Switch(config)# ip dhcp snooping database flash:/database1
Switch(config)# ip dhcp snooping database timeout 30
Switch(config)# ip dhcp snooping database write-delay 30
Switch# ip dhcp snooping binding 0001.0200.0004 vlan 100 172.16.22.44 interface
gigabitethernet2/0/1 expiry 5000
Switch# ip dhcp snooping binding 0022.0300.0008 vlan 100 172.16.24.44 interface
gigabitethernet2/0/1 expiry 5000
Switch(config)# ip dhcp snooping binding 0004.0070.0012 vlan 100 172.16.26.44 interface
gigabitethernet2/0/1 expiry 5000
Switch(config)# show ip dhcp snooping database
Agent URL : flash:/database1
Write delay Timer : 30 seconds
Abort Timer : 30 seconds

Agent Running : No
Delay Timer Expiry : 19 (00:00:19)
Abort Timer Expiry : Not Running

Last Succeded Time : 17:06:10 pst Tue Mar 2 1993
Last Failed Time : None
Last Failed Reason : No failure recorded.

Total Attempts       :        4   Startup Failures :        0
Successful Transfers :        4   Failed Transfers :        0
Successful Reads     :        0   Failed Reads     :        0
Successful Writes    :        4   Failed Writes    :        0
Media Failures       :        0
Switch(config)# copy running-config startup-config
```

Displaying DHCP Snooping Information

This section describes how to display configuration information for all interfaces on a switch and the configuration information, status, and statistics for the DHCP snooping binding database, also referred to as a binding table.

- Displaying the DHCP Snooping Configuration, page 21-14
- Displaying the DHCP Snooping Binding Database, page 21-14

Displaying the DHCP Snooping Configuration

This example shows how to display the DHCP snooping configuration for a switch:

```
Switch# show ip dhcp snooping
Switch DHCP snooping is enabled
DHCP snooping is configured on following VLANs:
40-42
Insertion of option 82 is enabled
Verification of hwaddr field is enabled
Interface                            Trusted     Rate limit (pps)
------------------------             -------     ----------------
gigabitethernet1/0/1                  yes         unlimited
gigabitethernet2/0/2                  no          100
gigabitethernet2/0/3                  yes         unlimited
gigabitethernet2/0/4                  yes         unlimited
```

Displaying the DHCP Snooping Binding Database

The DHCP snooping binding database for each switch has binding entries that correspond to untrusted ports. The database does not have information about hosts interconnected with a trusted port.

Use the **show ip dhcp snooping binding** privileged EXEC command to display only the dynamically configured bindings in the DHCP snooping binding database. Use the **show ip source binding** privileged EXEC command to display the dynamically and statically configured bindings.

If DHCP snooping is enabled and an interface changes to the down state, the switch does not delete the statically configured bindings.

This example shows how to display the dynamically configured DHCP snooping binding entries for a switch:

```
Switch# show ip dhcp snooping binding
MacAddress          IpAddress        Lease(sec)  Type           VLAN  Interface
------------------  ---------------  ----------  -------------  ----  --------------------
01:02:03:04:05:06   10.1.2.150       9837        dhcp-snooping  20    GigabitEthernet2/0/1
00:D0:B7:1B:35:DE   10.1.2.151       237         dhcp-snooping  20    GigabitEthernet2/0/1
00:00:00:00:00:01   40.0.0.46        286         dhcp-snooping  20    GigabitEthernet2/0/2
00:00:00:00:00:03   42.0.0.33        286         dhcp-snooping  22    GigabitEthernet2/0/2
00:00:00:00:00:02   41.0.0.53        286         dhcp-snooping  21    GigabitEthernet2/0/2
```

Table 21-2 describes the fields in the **show ip dhcp snooping binding** command output.

Table 21-2 show ip dhcp snooping binding Command Output

Field	Description
MacAddress	Client hardware MAC address
IpAddress	Client IP address assigned from the DHCP server
Lease(sec)	Remaining lease time for the IP address
Type	Binding type
VLAN	VLAN number of the client interface
Interface	Interface that connects to the DHCP client host

This example shows how to display the DHCP snooping binding database status and statistics:

```
Switch# show ip dhcp snooping database
Agent URL :
Write delay Timer : 300 seconds
Abort Timer : 300 seconds

Agent Running : No
Delay Timer Expiry : Not Running
Abort Timer Expiry : Not Running

Last Succeded Time : None
Last Failed Time : None
Last Failed Reason : No failure recorded.

Total Attempts       :        0   Startup Failures :        0
Successful Transfers :        0   Failed Transfers :        0
Successful Reads     :        0   Failed Reads     :        0
Successful Writes    :        0   Failed Writes    :        0
Media Failures       :        0
```

Understanding IP Source Guard

IP source guard is a security feature that restricts IP traffic on nonrouted, Layer 2 interfaces by filtering traffic based on the DHCP snooping binding database and on manually configured IP source bindings. You can use IP source guard to prevent traffic attacks caused when a host tries to use the IP address of its neighbor.

You can enable IP source guard when DHCP snooping is enabled on an untrusted interface. After IP source guard is enabled on an interface, the switch blocks all IP traffic received on the interface, except for DHCP packets allowed by DHCP snooping. A port access control list (ACL) is applied to the interface. The port ACL allows only IP traffic with s a source IP address in the IP source binding table and denies all other traffic.

The IP source binding table has bindings that are learned by DHCP snooping or are manually configured (static IP source bindings). An entry in this table has an IP address, its associated MAC address, and its associated VLAN number. The switch uses the IP source binding table only when IP source guard is enabled.

IP source guard is supported only on Layer 2 ports, including access and trunk ports.You can configure IP source guard with source IP address filtering or with source IP and MAC address filtering.

To use this feature, you must have the enhanced multilayer image (EMI) installed on your switch.

Source IP Address Filtering

When IP source guard is enabled with this option, IP traffic is filtered based on the source IP address. The switch forwards IP traffic when the source IP address matches an entry in the DHCP snooping binding database or a binding in the IP source binding table.

When a DHCP snooping binding or static IP source binding is added, changed, or deleted on an interface, the switch modifies the port ACL with the IP source binding changes and re-applies the port ACL to the interface.

If you enable IP source guard on an interface on which IP source bindings (dynamically learned by DHCP snooping or manually configured) are not configured, the switch creates and applies a port ACL that denies all IP traffic on the interface. If you disable IP source guard, the switch removes the port ACL from the interface.

Source IP and MAC Address Filtering

When IP source guard is enabled with this option, IP traffic is filtered based on the source IP and MAC addresses. The switch forwards traffic only when the source IP and MAC addresses match an entry in the IP source binding table.

When IP source guard with source IP and MAC address filtering is enabled, the switch filters IP and non-IP traffic. If the source MAC address of an IP or non-IP packet matches a valid IP source binding, the switch forwards the packet. The switch drops all other types of packets except DHCP packets.

The switch uses port security to filter source MAC addresses. The interface can shut down when a port-security violation occurs.

Configuring IP Source Guard

This section describes how to configure IP source guard on your switch.

- Default IP Source Guard Configuration, page 21-16
- Configuration Guidelines, page 21-17
- Enabling IP Source Guard, page 21-17
- Displaying IP Source Guard Information, page 21-19

Default IP Source Guard Configuration

By default, IP source guard is disabled.

Configuration Guidelines

These are the configuration guides for IP source guard:

- You can configure static IP bindings only on nonrouted ports. If you enter the **ip source binding** *ip-address mac-address* **vlan** *vlan-id* **interface** *interface-id* global configuration command on a routed interface, this error message appears:

  ```
  Static IP source binding can only be configured on switch port.
  ```

- When IP source guard with source IP filtering is enabled on a VLAN, DHCP snooping must be enabled on the access VLAN to which the interface belongs.
- If you are enabling IP source guard on a trunk interface with multiple VLANs and DHCP snooping is enabled on all the VLANs, the source IP address filter is applied on all the VLANs.

  Note If IP source guard is enabled and you enable or disable DHCP snooping on a VLAN on the trunk interface, the switch might not properly filter traffic.

- When IP source guard with source IP and MAC address filtering is enabled, DHCP snooping and port security must be enabled on the interface.
- IP source guard is not supported on EtherChannels.
- You can enable this feature when Virtual Routing Function (VRF) Lite or 802.1x port-based authentication is enabled.
- If the number of ternary content addressable memory (TCAM) entries exceeds the maximum available, the CPU usage increases.

Enabling IP Source Guard

Beginning in privileged EXEC mode, follow these steps to enable and configure IP source guard on an interface.

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface-id*	Enter interface configuration mode, and specify the interface to be configured.
Step 3	**ip verify source** or **ip verify source port-security**	Enable IP source guard with source IP address filtering. Enable IP source guard with source IP and MAC address filtering.
Step 4	**exit**	Return to global configuration mode.
Step 5	**ip source binding** *mac-address* **vlan** *vlan-id ip-address* **inteface** *interface-id*	Add a static IP source binding. Enter this command for each static binding.
Step 6	**end**	Return to privileged EXEC mode.
Step 7	**show ip verify source** [**interface** *interface-id*]	Display the IP source guard configuration for all interfaces or for a specific interface.

	Command	Purpose
Step 8	**show ip source binding** [*ip-address*] [*mac-address*] [**dhcp-snooping** | **static**] [**inteface** *interface-id*] [**vlan** *vlan-id*]	Display the IP source bindings on the switch, on a specific VLAN, or on a specific interface.
Step 9	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

To disable IP source guard with source IP address filtering, use the **no ip verify source** interface configuration command.

To delete a static IP source binding entry, use the **no ip source binding** *ip-address mac-address* **vlan** *vlan-id* **inteface** *interface-id* interface configuration command.

This example shows how to enable IP source guard with source IP and MAC filtering on VLANs 10 and 11:

```
Switch# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)# interface gigabitethernet1/0/1
Switch(config-if)# ip verify source port-security
Switch(config-if)# exit
Switch(config)# ip source binding 0100.0022.0010 vlan 10 10.0.0.2 interface
gigabitethernet1/0/2
Switch(config)# ip source binding 0100.0230.0002 vlan 11 10.0.0.4 interface
gigabitethernet1/0/2
Switch(config)# end
Switch# show ip verify source
Interface  Filter-type  Filter-mode  IP-address       Mac-address     Vlan
---------  -----------  -----------  ---------------  --------------  ---------
gi1/0/2      ip-mac       active       10.0.0.2         0100.0022.0010  10
gi1/0/2      ip-mac       active       10.0.0.4         0100.0230.0002  11

Switch# show ip source binding
MacAddress          IpAddress        Lease(sec)  Type           VLAN  Interface
--------------      ---------------  ----------  -------------  ----  --------------------
01:00:00:22:00:10   10.0.0.2         infinite    static         10    GigabitEthernet1/0/2
01:00:00:22:00:10   10.0.0.2         infinite    static         10    GigabitEthernet1/0/2
01:00:02:30:00:02   10.0.0.9         10000       dhcp-snooping  10    GigabitEthernet1/0/3
Switch(config)# copy running-config startup-config
```

Displaying IP Source Guard Information

This section describes how to display the IP source guard configuration and the IP source bindings on the switch.

This example shows how to display the IP source guard configuration for a switch:

```
Switch# show ip verify source
Interface  Filter-type  Filter-mode  IP-address       Mac-address     Vlan
---------  -----------  -----------  ---------------  --------------  ---------
gi1/0/1      ip           active       10.0.0.1                       10
gi1/0/1      ip           active       deny-all                       11-20
gi1/0/2      ip           inactive-trust-port
gi1/0/3      ip           inactive-no-snooping-vlan
gi1/0/4      ip-mac       active       10.0.0.2         aaaa.bbbb.cccc  10
gi1/0/4      ip-mac       active       11.0.0.1         aaaa.bbbb.cccd  11
gi1/0/4      ip-mac       active       deny-all         deny-all        12-20
gi1/0/5      ip-mac       active       10.0.0.3         permit-all      10
gi1/0/5      ip-mac       active       deny-all         permit-all      11-20
```

This example shows how to display the IP source bindings on a switch:

```
Switch# show ip source binding
MacAddress          IpAddress        Lease(sec)  Type           VLAN  Interface
--------------      ---------------  ----------  -------------  ----  --------------------
00:00:00:0A:00:0B   11.0.0.1         infinite    static         10    FastEthernet6/10
00:00:00:0A:00:0A   11.0.0.2         10000       dhcp-snooping  10    FastEthernet6/11
```