



System Management Configuration Guide, Cisco IOS XE Everest 16.5.1a (Catalyst 9300 Switches)

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CHAPTER 1

Administering the Device

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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 at the end of this module.

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

Restrictions for Administering the Switch

Do not use switches running the Cisco IOS XE release images as VPN termination points. Use a router or Cisco Adaptive Security Appliance (ASA) as a VPN termination point .

Information About Administering the Device

System Time and Date Management

You can manage the system time and date on your device using automatic configuration methods (RTC and NTP), or manual configuration methods.



Note For complete syntax and usage information for the commands used in this section, see the *Cisco IOS Configuration Fundamentals Command Reference* on Cisco.com.

System Clock

The basis of the time service is the system clock. This clock runs from the moment the system starts up and keeps track of the date and time.

The system clock can then be set from these sources:

- NTP
- Manual configuration

The system clock can provide time to these services:

- User **show** commands
- Logging and debugging messages

The system clock keeps track of time internally based on Coordinated Universal Time (UTC), also known as Greenwich Mean Time (GMT). You can configure information about the local time zone and summer time (daylight saving time) so that the time appears correctly for the local time zone.

The system clock keeps track of whether the time is *authoritative* or not (that is, whether it has been set by a time source considered to be authoritative). If it is not authoritative, the time is available only for display purposes and is not redistributed.

Network Time Protocol

The NTP is designed to time-synchronize a network of devices. NTP runs over User Datagram Protocol (UDP), which runs over IP. NTP is documented in RFC 1305.

An NTP network usually gets its time from an authoritative time source, such as a radio clock or an atomic clock attached to a time server. NTP then distributes this time across the network. NTP is extremely efficient; no more than one packet per minute is necessary to synchronize two devices to within a millisecond of one another.

NTP uses the concept of a *stratum* to describe how many NTP hops away a device is from an authoritative time source. A stratum 1 time server has a radio or atomic clock directly attached, a stratum 2 time server receives its time through NTP from a stratum 1 time server, and so on. A device running NTP automatically chooses as its time source the device with the lowest stratum number with which it communicates through NTP. This strategy effectively builds a self-organizing tree of NTP speakers.

NTP avoids synchronizing to a device whose time might not be accurate by never synchronizing to a device that is not synchronized. NTP also compares the time reported by several devices and does not synchronize to a device whose time is significantly different than the others, even if its stratum is lower.

The communications between devices running NTP (known as associations) are usually statically configured; each device is given the IP address of all devices with which it should form associations. Accurate timekeeping is possible by exchanging NTP messages between each pair of devices with an association. However, in a LAN environment, NTP can be configured to use IP broadcast messages instead. This alternative reduces

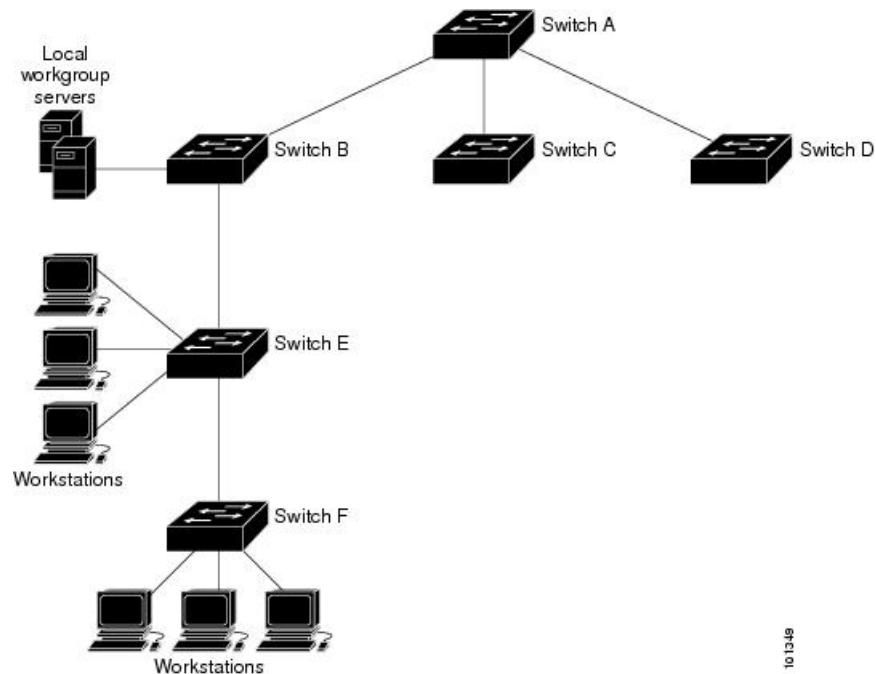
configuration complexity because each device can simply be configured to send or receive broadcast messages. However, in that case, information flow is one-way only.

The time kept on a device is a critical resource; you should use the security features of NTP to avoid the accidental or malicious setting of an incorrect time. Two mechanisms are available: an access list-based restriction scheme and an encrypted authentication mechanism.

Cisco's implementation of NTP does not support stratum 1 service; it is not possible to connect to a radio or atomic clock. We recommend that the time service for your network be derived from the public NTP servers available on the IP Internet.

The figure below shows a typical network example using NTP. Device A is the NTP primary (formerly known as NTP primary), with the **Device B, C, and D** configured in NTP server mode, in server association with Device A. Device E is configured as an NTP peer to the upstream and downstream Device, Device B and Device F, respectively.

Figure 1: Typical NTP Network Configuration



If the network is isolated from the Internet, Cisco's implementation of NTP allows a device to act as if it is synchronized through NTP, when in fact it has learned the time by using other means. Other devices then synchronize to that device through NTP.

When multiple sources of time are available, NTP is always considered to be more authoritative. NTP time overrides the time set by any other method.

Several manufacturers include NTP software for their host systems, and a publicly available version for systems running UNIX and its various derivatives is also available. This software allows host systems to be time-synchronized as well.

NTP Stratum

NTP uses the concept of a *stratum* to describe how many NTP hops away a device is from an authoritative time source. A stratum 1 time server has a radio or atomic clock directly attached, a stratum 2 time server

receives its time through NTP from a stratum 1 time server, and so on. A device running NTP automatically chooses as its time source the device with the lowest stratum number with which it communicates through NTP. This strategy effectively builds a self-organizing tree of NTP speakers.

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NTP Associations

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Poll-Based NTP Associations

Networking devices running NTP can be configured to operate in variety of association modes when synchronizing time with reference time sources. A networking device can obtain time information on a network in two ways—by polling host servers and by listening to NTP broadcasts. This section focuses on the poll-based association modes. Broadcast-based NTP associations are discussed in the *Broadcast-Based NTP Associations* section.

The following are the two most commonly used poll-based association modes:

- Client mode
- Symmetric active mode

The client and the symmetric active modes should be used when NTP is required to provide a high level of time accuracy and reliability.

When a networking device is operating in the client mode, it polls its assigned time-serving hosts for the current time. The networking device will then pick a host from among all the polled time servers to synchronize with. Because the relationship that is established in this case is a client-host relationship, the host will not capture or use any time information sent by the local client device. This mode is most suited for file-server and workstation clients that are not required to provide any form of time synchronization to other local clients. Use the **ntp server** command to individually specify the time server that you want your networking device to consider synchronizing with and to set your networking device to operate in the client mode.

When a networking device is operating in the symmetric active mode, it polls its assigned time-serving hosts for the current time and it responds to polls by its hosts. Because this is a peer-to-peer relationship, the host will also retain time-related information of the local networking device that it is communicating with. This mode should be used when a number of mutually redundant servers are interconnected via diverse network paths. Most stratum 1 and stratum 2 servers on the Internet adopt this form of network setup. Use the **ntp peer** command to individually specify the time serving hosts that you want your networking device to consider synchronizing with and to set your networking device to operate in the symmetric active mode.

The specific mode that you should set for each of your networking devices depends primarily on the role that you want them to assume as a timekeeping device (server or client) and the device's proximity to a stratum 1 timekeeping server.

A networking device engages in polling when it is operating as a client or a host in the client mode or when it is acting as a peer in the symmetric active mode. Although polling does not usually place a burden on

memory and CPU resources such as bandwidth, an exceedingly large number of ongoing and simultaneous polls on a system can seriously impact the performance of a system or slow the performance of a given network. To avoid having an excessive number of ongoing polls on a network, you should limit the number of direct, peer-to-peer or client-to-server associations. Instead, you should consider using NTP broadcasts to propagate time information within a localized network.

Broadcast-Based NTP Associations

Broadcast-based NTP associations should be used when time accuracy and reliability requirements are modest and if your network is localized and has more than 20 clients. Broadcast-based NTP associations are also recommended for use on networks that have limited bandwidth, system memory, or CPU resources.

A networking device operating in the broadcast client mode does not engage in any polling. Instead, it listens for NTP broadcast packets that are transmitted by broadcast time servers. Consequently, time accuracy can be marginally reduced because time information flows only one way.

Use the **ntp broadcast client** command to set your networking device to listen for NTP broadcast packets propagated through a network. For broadcast client mode to work, the broadcast server and its clients must be located on the same subnet. You must enable the time server that transmits NTP broadcast packets on the interface of the given device by using the **ntp broadcast** command.

NTP Security

The time kept on a device is a critical resource; you should use the security features of NTP to avoid the accidental or malicious setting of an incorrect time. Two mechanisms are available: an access list-based restriction scheme and an encrypted authentication mechanism.

NTP Access Group

The access list-based restriction scheme allows you to grant or deny certain access privileges to an entire network, a subnet within a network, or a host within a subnet. To define an NTP access group, use the `ntp access-group` command in global configuration mode.

The access group options are scanned in the following order, from least restrictive to the most restrictive:

1. `ipv4` —Configures IPv4 access lists.
2. `ipv6` —Configures IPv6 access lists.
3. `peer` —Allows time requests and NTP control queries, and allows the system to synchronize itself to a system whose address passes the access list criteria.
4. `serve` —Allows time requests and NTP control queries, but does not allow the system to synchronize itself to a system whose address passes the access list criteria.
5. `serve-only` —Allows only time requests from a system whose address passes the access list criteria.
6. `query-only` —Allows only NTP control queries from a system whose address passes the access list criteria.

If the source IP address matches the access lists for more than one access type, the first type is granted access. If no access groups are specified, all access types are granted access to all systems. If any access groups are specified, only the specified access types will be granted access.

For details on NTP control queries, see RFC 1305 (NTP Version 3).

The encrypted NTP authentication scheme should be used when a reliable form of access control is required. Unlike the access list-based restriction scheme that is based on IP addresses, the encrypted authentication

scheme uses authentication keys and an authentication process to determine if NTP synchronization packets sent by designated peers or servers on a local network are deemed as trusted before the time information that they carry along with them is accepted.

The authentication process begins from the moment an NTP packet is created. Cryptographic checksum keys are generated using the message digest algorithm 5 (MD5) and are embedded into the NTP synchronization packet that is sent to a receiving client. Once a packet is received by a client, its cryptographic checksum key is decrypted and checked against a list of trusted keys. If the packet contains a matching authentication key, the time-stamp information that is contained within the packet is accepted by the receiving client. NTP synchronization packets that do not contain a matching authenticator key are ignored.



Note In large networks, where many trusted keys must be configured, the Range of Trusted Key Configuration feature enables configuring multiple keys simultaneously.

It is important to note that the encryption and decryption processes used in NTP authentication can be very CPU-intensive and can seriously degrade the accuracy of the time that is propagated within a network. If your network setup permits a more comprehensive model of access control, you should consider the use of the access list-based form of control.

After NTP authentication is properly configured, your networking device will synchronize with and provide synchronization only to trusted time sources.

NTP Services on a Specific Interface

Network Time Protocol (NTP) services are disabled on all interfaces by default. NTP is enabled globally when any NTP commands are entered. You can selectively prevent NTP packets from being received through a specific interface by using the **ntp disable** command in interface configuration mode.

Source IP Address for NTP Packets

When the system sends an NTP packet, the source IP address is normally set to the address of the interface through which the NTP packet is sent. Use the **ntp source interface** command in global configuration mode to configure a specific interface from which the IP source address will be taken.

This interface will be used for the source address for all packets sent to all destinations. If a source address is to be used for a specific association, use the **source** keyword in the **ntp peer** or **ntp server** command.

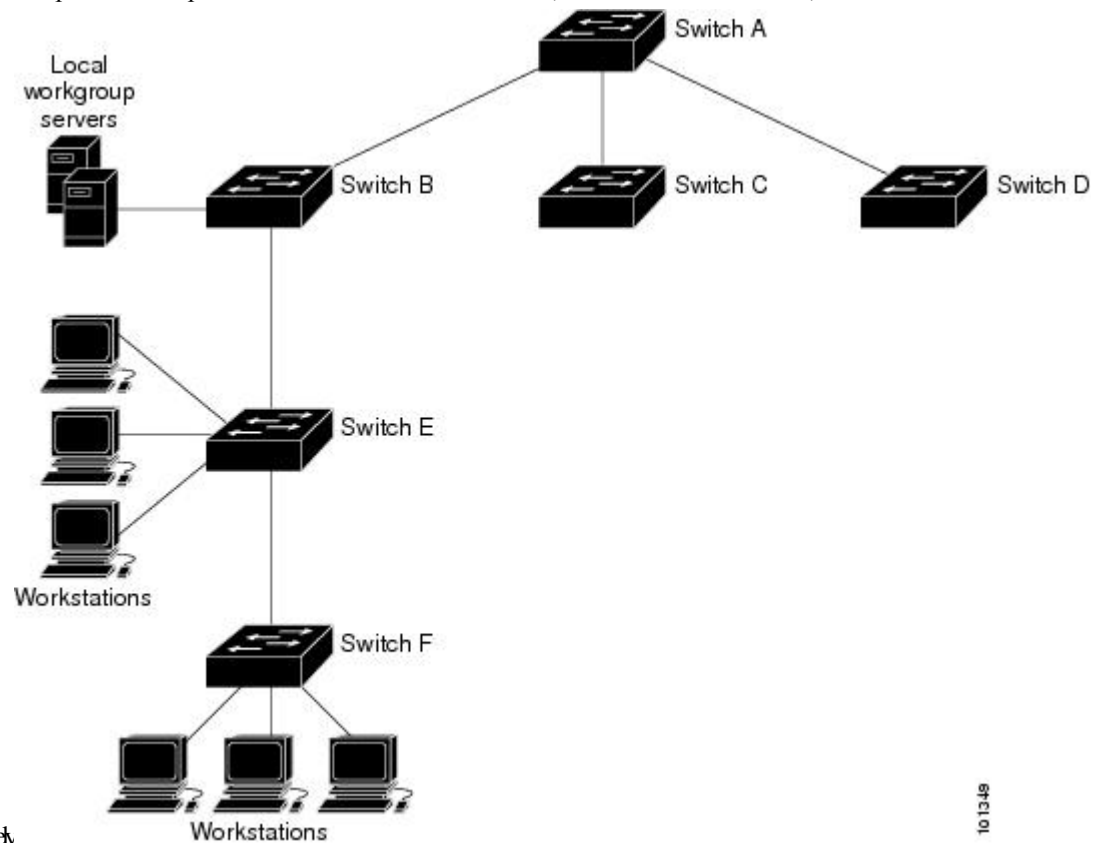
NTP Implementation

Implementation of NTP does not support stratum 1 service; it is not possible to connect to a radio or atomic clock. We recommend that the time service for your network be derived from the public NTP servers available on the IP Internet.

Figure 2: Typical NTP Network Configuration

The following figure shows a typical network example using NTP. Switch A is the NTP primary, with the Switch B, C, and D configured in NTP server mode, in server association with Switch A. Switch E is configured

as an NTP peer to the upstream and downstream switches, Switch B and Switch F,



respectively.

If the network is isolated from the Internet, NTP allows a device to act as if it is synchronized through NTP, when in fact it has learned the time by using other means. Other devices then synchronize to that device through NTP.

When multiple sources of time are available, NTP is always considered to be more authoritative. NTP time overrides the time set by any other method.

Several manufacturers include NTP software for their host systems, and a publicly available version for systems running UNIX and its various derivatives is also available. This software allows host systems to be time-synchronized as well.

System Name and Prompt

You configure the system name on the Device to identify it. By default, the system name and prompt are *Switch*.

If you have not configured a system prompt, the first 20 characters of the system name are used as the system prompt. A greater-than symbol [`>`] is appended. The prompt is updated whenever the system name changes.

For complete syntax and usage information for the commands used in this section, see the *Cisco IOS Configuration Fundamentals Command Reference, Release 12.4* and the *Cisco IOS IP Command Reference, Volume 2 of 3: Routing Protocols, Release 12.4*.

Stack System Name and Prompt

If you are accessing a stack member through the active stack, you must use the **session** *stack-member-number* privileged EXEC command. The stack member number range is from 1 through 8. When you use this command, the stack member number is appended to the system prompt. For example, Switch-2# is the prompt in privileged EXEC mode for stack member 2, and the system prompt for the switch stack is Switch.

Default System Name and Prompt Configuration

The default switch system name and prompt is *Switch*.

DNS

The DNS protocol controls the Domain Name System (DNS), a distributed database with which you can map hostnames to IP addresses. When you configure DNS on your device, you can substitute the hostname for the IP address with all IP commands, such as **ping**, **telnet**, **connect**, and related Telnet support operations.

IP defines a hierarchical naming scheme that allows a device to be identified by its location or domain. Domain names are pieced together with periods (.) as the delimiting characters. For example, Cisco Systems is a commercial organization that IP identifies by a *com* domain name, so its domain name is *cisco.com*. A specific device in this domain, for example, the File Transfer Protocol (FTP) system is identified as *ftp.cisco.com*.

To keep track of domain names, IP has defined the concept of a domain name server, which holds a cache (or database) of names mapped to IP addresses. To map domain names to IP addresses, you must first identify the hostnames, specify the name server that is present on your network, and enable the DNS.

Default DNS Settings

Table 1: Default DNS Settings

Feature	Default Setting
DNS enable state	Enabled.
DNS default domain name	None configured.
DNS servers	No name server addresses are configured.

Login Banners

You can configure a message-of-the-day (MOTD) and a login banner. The MOTD banner is displayed on all connected terminals at login and is useful for sending messages that affect all network users (such as impending system shutdowns).

The login banner is also displayed on all connected terminals. It appears after the MOTD banner and before the login prompts.



Note For complete syntax and usage information for the commands used in this section, see the *Cisco IOS Configuration Fundamentals Command Reference, Release 12.4*.

Default Banner Configuration

The MOTD and login banners are not configured.

MAC Address Table

The MAC address table contains address information that the device uses to forward traffic between ports. All MAC addresses in the address table are associated with one or more ports. The address table includes these types of addresses:

- Dynamic address—A source MAC address that the device learns and then ages when it is not in use.
- Static address—A manually entered unicast address that does not age and that is not lost when the device resets.

The address table lists the destination MAC address, the associated VLAN ID, and port number associated with the address and the type (static or dynamic).



Note For complete syntax and usage information for the commands used in this section, see the command reference for this release.

MAC Address Table Creation

With multiple MAC addresses supported on all ports, you can connect any port on the device to other network devices. The device provides dynamic addressing by learning the source address of packets it receives on each port and adding the address and its associated port number to the address table. As devices are added or removed from the network, the device updates the address table, adding new dynamic addresses and aging out those that are not in use.

The aging interval is globally configured. However, the device maintains an address table for each VLAN, and STP can accelerate the aging interval on a per-VLAN basis.

The device sends packets between any combination of ports, based on the destination address of the received packet. Using the MAC address table, the device forwards the packet only to the port associated with the destination address. If the destination address is on the port that sent the packet, the packet is filtered and not forwarded. The device always uses the store-and-forward method: complete packets are stored and checked for errors before transmission.

MAC Addresses and VLANs

All addresses are associated with a VLAN. An address can exist in more than one VLAN and have different destinations in each. Unicast addresses, for example, could be forwarded to port 1 in VLAN 1 and ports 9, 10, and 1 in VLAN 5.

Each VLAN maintains its own logical address table. A known address in one VLAN is unknown in another until it is learned or statically associated with a port in the other VLAN.

MAC Addresses and Device Stacks

The MAC address tables on all stack members are synchronized. At any given time, each stack member has the same copy of the address tables for each VLAN. When an address ages out, the address is removed from

the address tables on all stack members. When a Device joins a switch stack, that Device receives the addresses for each VLAN learned on the other stack members. When a stack member leaves the switch stack, the remaining stack members age out or remove all addresses learned by the former stack member.

Default MAC Address Table Settings

The following table shows the default settings for the MAC address table.

Table 2: Default Settings for the MAC Address

Feature	Default Setting
Aging time	300 seconds
Dynamic addresses	Automatically learned
Static addresses	None configured

ARP Table Management

To communicate with a device (over Ethernet, for example), the software first must learn the 48-bit MAC address or the local data link address of that device. The process of learning the local data link address from an IP address is called *address resolution*.

The Address Resolution Protocol (ARP) associates a host IP address with the corresponding media or MAC addresses and the VLAN ID. Using an IP address, ARP finds the associated MAC address. When a MAC address is found, the IP-MAC address association is stored in an ARP cache for rapid retrieval. Then the IP datagram is encapsulated in a link-layer frame and sent over the network. Encapsulation of IP datagrams and ARP requests and replies on IEEE 802 networks other than Ethernet is specified by the Subnetwork Access Protocol (SNAP). By default, standard Ethernet-style ARP encapsulation (represented by the **arpa** keyword) is enabled on the IP interface.

ARP entries added manually to the table do not age and must be manually removed.

For CLI procedures, see the Cisco IOS Release 12.4 documentation on *Cisco.com*.

How to Administer the Device

Configuring the Time and Date Manually

System time remains accurate through restarts and reboot, however, you can manually configure the time and date after the system is restarted.

We recommend that you use manual configuration only when necessary. If you have an outside source to which the device can synchronize, you do not need to manually set the system clock.



Note You must reconfigure this setting if you have manually configured the system clock before the active switch fails and a different stack member assumes the role of active switch.

Setting the System Clock

If you have an outside source on the network that provides time services, such as an NTP server, you do not need to manually set the system clock.

Follow these steps to set the system clock:

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	Use one of the following: <ul style="list-style-type: none"> • clock set <i>hh:mm:ss day month year</i> • clock set <i>hh:mm:ss month day year</i> Example: Device# clock set 13:32:00 23 March 2013	Manually set the system clock using one of these formats: <ul style="list-style-type: none"> • <i>hh:mm:ss</i>—Specifies the time in hours (24-hour format), minutes, and seconds. The time specified is relative to the configured time zone. • <i>day</i>—Specifies the day by date in the month. • <i>month</i>—Specifies the month by name. • <i>year</i>—Specifies the year (no abbreviation).

Configuring the Time Zone

Follow these steps to manually configure the time zone:

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.

	Command or Action	Purpose
Step 3	<p>clock timezone <i>zone hours-offset</i> [<i>minutes-offset</i>]</p> <p>Example:</p> <pre>Device(config)# clock timezone AST -3 30</pre>	<p>Sets the time zone.</p> <p>Internal time is kept in Coordinated Universal Time (UTC), so this command is used only for display purposes and when the time is manually set.</p> <ul style="list-style-type: none"> • <i>zone</i>—Enters the name of the time zone to be displayed when standard time is in effect. The default is UTC. • <i>hours-offset</i>—Enters the hours offset from UTC. • (Optional) <i>minutes-offset</i>—Enters the minutes offset from UTC. This available where the local time zone is a percentage of an hour different from UTC.
Step 4	<p>end</p> <p>Example:</p> <pre>Device(config)# end</pre>	Returns to privileged EXEC mode.
Step 5	<p>show running-config</p> <p>Example:</p> <pre>Device# show running-config</pre>	Verifies your entries.
Step 6	<p>copy running-config startup-config</p> <p>Example:</p> <pre>Device# copy running-config startup-config</pre>	(Optional) Saves your entries in the configuration file.

Configuring Summer Time (Daylight Saving Time)

To configure summer time (daylight saving time) in areas where it starts and ends on a particular day of the week each year, perform this task:

Procedure

	Command or Action	Purpose
Step 1	<p>enable</p> <p>Example:</p>	<p>Enables privileged EXEC mode.</p> <ul style="list-style-type: none"> • Enter your password if prompted.

	Command or Action	Purpose
	Device> enable	
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 3	clock summer-time zone date date month year hh:mm date month year hh:mm [offset] Example: Device(config)# clock summer-time PDT date 10 March 2013 2:00 3 November 2013 2:00	Configures summer time to start and end on specified days every year.
Step 4	clock summer-time zone recurring [week day month hh:mm week day month hh:mm [offset]] Example: Device(config)# clock summer-time PDT recurring 10 March 2013 2:00 3 November 2013 2:00	<p>Configures summer time to start and end on the specified days every year. All times are relative to the local time zone. The start time is relative to standard time.</p> <p>The end time is relative to summer time. Summer time is disabled by default. If you specify clock summer-time zone recurring without parameters, the summer time rules default to the United States rules.</p> <p>If the starting month is after the ending month, the system assumes that you are in the southern hemisphere.</p> <ul style="list-style-type: none"> • <i>zone</i>—Specifies the name of the time zone (for example, PDT) to be displayed when summer time is in effect. • (Optional) <i>week</i>— Specifies the week of the month (1 to 4, first, or last). • (Optional) <i>day</i>—Specifies the day of the week (Sunday, Monday...). • (Optional) <i>month</i>—Specifies the month (January, February...). • (Optional) <i>hh:mm</i>—Specifies the time (24-hour format) in hours and minutes. • (Optional) <i>offset</i>—Specifies the number of minutes to add during summer time. The default is 60.

	Command or Action	Purpose
Step 5	end Example: Device(config)# end	Returns to privileged EXEC mode.
Step 6	show running-config Example: Device# show running-config	Verifies your entries.
Step 7	copy running-config startup-config Example: Device# copy running-config startup-config	(Optional) Saves your entries in the configuration file.

Follow these steps if summer time in your area does not follow a recurring pattern (configure the exact date and time of the next summer time events):

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 3	clock summer-time zone date [<i>month date year hh:mm month date year hh:mm</i> [<i>offset</i>]] or clock summer-time zone date [<i>date month year hh:mm date month year hh:mm</i> [<i>offset</i>]]	Configures summer time to start on the first date and end on the second date. Summer time is disabled by default. <ul style="list-style-type: none"> • For <i>zone</i>, specify the name of the time zone (for example, PDT) to be displayed when summer time is in effect. • (Optional) For <i>week</i>, specify the week of the month (1 to 5 or last).

	Command or Action	Purpose
		<ul style="list-style-type: none"> • (Optional) For <i>day</i>, specify the day of the week (Sunday, Monday...). • (Optional) For <i>month</i>, specify the month (January, February...). • (Optional) For <i>hh:mm</i>, specify the time (24-hour format) in hours and minutes. • (Optional) For <i>offset</i>, specify the number of minutes to add during summer time. The default is 60.
Step 4	end Example: <pre>Device(config)# end</pre>	Returns to privileged EXEC mode.
Step 5	show running-config Example: <pre>Device# show running-config</pre>	Verifies your entries.
Step 6	copy running-config startup-config Example: <pre>Device# copy running-config startup-config</pre>	(Optional) Saves your entries in the configuration file.

Configuring NTP

The device does not have a hardware-supported clock and cannot function as an NTP primary clock to which peers synchronize themselves when an external NTP source is not available. The device also has no hardware support for a calendar. As a result, the **ntp update-calendar** and the **ntp master** commands in global configuration mode are not available.

These following sections provide configuration information on NTP:

Default NTP Configuration

shows the default NTP configuration.

Table 3: Default NTP Configuration

Feature	Default Setting
NTP authentication	Disabled. No authentication key is specified.

Feature	Default Setting
NTP peer or server associations	None configured.
NTP broadcast service	Disabled; no interface sends or receives NTP broadcast packets.
NTP access restrictions	No access control is specified.
NTP packet source IP address	The source address is set by the outgoing interface.

NTP is enabled on all interfaces by default. All interfaces receive NTP packets.

Configuring NTP Authentication

To configure NTP authentication, perform this procedure:

Procedure

	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	ntp authenticate Example: Device(config)# ntp authenticate	Enables NTP authentication. Use the no form of this command to disable NTP authentication
Step 4	ntp authentication-key <i>number md5 value</i> Example: Device(config)# ntp authentication-key 42 md5 aNiceKey	Defines the authentication keys. <ul style="list-style-type: none"> Each key has a key number, a type, and a value. Use the no form of this command to remove authentication key.
Step 5	ntp trusted-key <i>key-number</i> Example: Device(config)# ntp trusted-key 42	Defines trusted authentication keys that a peer NTP device must provide in its NTP packets for this device to synchronize to it. Use the no form of this command to disable trusted authentication.

	Command or Action	Purpose
Step 6	<p>ntp server <i>ip-address</i> key <i>key-id</i> [prefer]</p> <p>Example:</p> <pre>Device(config)# ntp server 172.16.22.44 key 42</pre>	<p>Allows the software clock to be synchronized by an NTP time server.</p> <ul style="list-style-type: none"> • <i>ip-address</i>: The IP address of the time server providing the clock synchronization. • <i>key-id</i>: Authentication key defined with the ntp authentication-key command. • prefer: Sets this peer as the preferred one that provides synchronization. This keyword reduces clock hop among peers. <p>Use the no form of this command to remove a server association.</p>
Step 7	<p>end</p> <p>Example:</p> <pre>Device(config)# end</pre>	Returns to privileged EXEC mode.

Configuring Poll-Based NTP Associations

To configure poll-based NTP associations, perform this procedure:

Procedure

	Command or Action	Purpose
Step 1	<p>enable</p> <p>Example:</p> <pre>Device> enable</pre>	<p>Enables privileged EXEC mode.</p> <p>Enter your password if prompted.</p>
Step 2	<p>configure terminal</p> <p>Example:</p> <pre>Device# configure terminal</pre>	Enters global configuration mode.
Step 3	<p>[no] ntp peer <i>ip-address</i> [version <i>number</i>] [key <i>key-id</i>] [source <i>interface</i>] [prefer]</p> <p>Example:</p> <pre>Device(config)# ntp peer 172.16.22.44 version 2</pre>	<p>Configures the device system clock to synchronize a peer or to be synchronized by a peer (peer association).</p> <ul style="list-style-type: none"> • <i>ip-address</i>: The IP address of the peer providing or being provided, the clock synchronization.

	Command or Action	Purpose
		<ul style="list-style-type: none"> • <i>number</i>: NTP version number. The range is 1 to 3. By default, version 3 is selected. • <i>key-id</i>: Authentication key defined with the ntp authentication-key command. • <i>interface</i>: The interface from which to pick the IP source address. By default, the source IP address is taken from the outgoing interface. • prefer: Sets this peer as the preferred one that provides synchronization. This keyword reduces switching back and forth between peers. <p>Use the no form of this command to remove a peer association.</p>
Step 4	<p>[no] ntp server ip-address [version number] [key key-id] [source interface] [prefer]</p> <p>Example:</p> <pre>Device(config)# ntp server 172.16.22.44 version 2</pre>	<p>Configures the device's system clock to be synchronized by a time server (server association).</p> <ul style="list-style-type: none"> • <i>ip-address</i>: The IP address of the time server providing the clock synchronization. • <i>number</i>: NTP version number. The range is 1 to 3. By default, version 3 is selected. • <i>key-id</i>: Authentication key defined with the ntp authentication-key command. • <i>interface</i>: The interface from which to pick the IP source address. By default, the source IP address is taken from the outgoing interface. • prefer: Sets this peer as the preferred one that provides synchronization. This keyword reduces clock hop among peers. <p>Use the no form of this command to remove a server association.</p>
Step 5	<p>end</p> <p>Example:</p> <pre>Device(config)# end</pre>	<p>Returns to privileged EXEC mode.</p>

Configuring Broadcast-Based NTP Associations

To configure broadcast-based NTP associations, perform this procedure:

Procedure

	Command or Action	Purpose
Step 1	enable Example: <pre>Device> enable</pre>	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: <pre>Device# configure terminal</pre>	Enters global configuration mode.
Step 3	interface <i>interface-id</i> Example: <pre>Device(config)# interface gigabitethernet1/0/1</pre>	Configures an interface and enters interface configuration mode.
Step 4	[no] ntp broadcast [version <i>number</i>] [key <i>key-id</i>] [<i>destination-address</i>] Example: <pre>Device(config-if)# ntp broadcast version 2</pre>	Enables the interface to send NTP broadcast packets to a peer. <ul style="list-style-type: none"> • <i>number</i>: NTP version number. The range is 1 to 3. By default, version 3 is used. • <i>key-id</i>: Authentication key. • <i>destination-address</i>: IP address of the peer that is synchronizing its clock to this switch. Use the no form of this command to disable the interface from sending NTP broadcast packets.
Step 5	[no] ntp broadcast client Example: <pre>Device(config-if)# ntp broadcast client</pre>	Enables the interface to receive NTP broadcast packets. Use the no form of this command to disable the interface from receiving NTP broadcast packets.
Step 6	exit Example: <pre>Device(config-if)# exit</pre>	Returns to privileged EXEC mode.

	Command or Action	Purpose
Step 7	<p>[no] ntp broadcastdelay <i>microseconds</i></p> <p>Example:</p> <pre>Device(config)# ntp broadcastdelay 100</pre>	<p>(Optional) Change the estimated round-trip delay between the device and the NTP broadcast server</p> <p>The default is 3000 microseconds. The range is from 1 to 999999.</p> <p>Use the no form of this command to disable the interface from receiving NTP broadcast packets.</p>
Step 8	<p>end</p> <p>Example:</p> <pre>Device(config)# end</pre>	Returns to privileged EXEC mode.

Configuring NTP Access Restrictions

You can control NTP access on two levels as described in these sections:

Creating an Access Group and Assigning a Basic IP Access List

To create an access group and assign a basic IP access list, perform this procedure:

Procedure

	Command or Action	Purpose
Step 1	<p>enable</p> <p>Example:</p> <pre>Device> enable</pre>	<p>Enables privileged EXEC mode.</p> <p>Enter your password if prompted.</p>
Step 2	<p>configure terminal</p> <p>Example:</p> <pre>Device# configure terminal</pre>	Enters global configuration mode.
Step 3	<p>[no] ntp access-group {query-only | serve-only | serve | peer} <i>access-list-number</i></p> <p>Example:</p> <pre>Device(config)# ntp access-group peer 99</pre>	<p>Create an access group, and apply a basic IP access list..</p> <ul style="list-style-type: none"> • query-only: NTP control queries. • serve-only: Time requests. • serve: Allows time requests and NTP control queries, but does not allow the device to synchronize to the remote device.

	Command or Action	Purpose
		<ul style="list-style-type: none"> • peer: Allows time requests and NTP control queries and allows the device to synchronize to the remote device. • access-list-number: IP access list number. The range is from 1 to 99. <p>Use the no form of this command to remove access control to the switch NTP services.</p>
Step 4	<p>access-list <i>access-list-number</i> permit <i>source</i> [<i>source-wildcard</i>]</p> <p>Example:</p> <pre>Device(config)# access-list 99 permit 172.20.130.5</pre>	<p>Create the access list.</p> <ul style="list-style-type: none"> • access-list-number: IP access list number. The range is from 1 to 99. • permit: Permits access if the conditions are matched. • source: IP address of the device that is permitted access to the device. • source-wildcard: Wildcard bits to be applied to the source. <p>Note When creating an access list, remember that, by default, the end of the access list contains an implicit deny statement for everything if it did not find a match before reaching the end.</p> <p>Use the no form of this command to remove authentication key.</p>
Step 5	<p>end</p> <p>Example:</p> <pre>Device(config)# end</pre>	<p>Returns to privileged EXEC mode.</p>

Disabling NTP Services on a Specific Interface

To disable NTP packets from being received on an interface, perform this procedure:

Procedure

	Command or Action	Purpose
Step 1	<p>enable</p> <p>Example:</p> <pre>Device> enable</pre>	<p>Enables privileged EXEC mode.</p> <p>Enter your password if prompted.</p>

	Command or Action	Purpose
Step 2	configure terminal Example: Device# <code>configure terminal</code>	Enters global configuration mode.
Step 3	interface <i>interface-id</i> Example: Device(config)# <code>interface gigabitethernet1/0/1</code>	Enters global configuration mode.
Step 4	[no] ntp disable Example: Device(config-if)# <code>ntp disable</code>	Disables NTP packets from being received on the interface. Use the no form of this command to re-enable receipt of NTP packets on an interface.
Step 5	end Example: Device(config-if)# <code>end</code>	Returns to privileged EXEC mode.

Configuring a System Name

Follow these steps to manually configure a system name:

Procedure

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

	Command or Action	Purpose
Step 3	hostname <i>name</i> Example: <pre>Device(config) # hostname remote-users</pre>	<p>Configures a system name. When you set the system name, it is also used as the system prompt.</p> <p>The default setting is Switch.</p> <p>The name must follow the rules for ARPANET hostnames. They must start with a letter, end with a letter or digit, and have as interior characters only letters, digits, and hyphens. Names can be up to 63 characters.</p>
Step 4	end Example: <pre>remote-users(config) #end remote-users#</pre>	Returns to privileged EXEC mode.
Step 5	show running-config Example: <pre>Device# show running-config</pre>	Verifies your entries.
Step 6	copy running-config startup-config Example: <pre>Device# copy running-config startup-config</pre>	(Optional) Saves your entries in the configuration file.

Setting Up DNS

If you use the device IP address as its hostname, the IP address is used and no DNS query occurs. If you configure a hostname that contains no periods (.), a period followed by the default domain name is appended to the hostname before the DNS query is made to map the name to an IP address. The default domain name is the value set by the **ip domain-name** global configuration command. If there is a period (.) in the hostname, the Cisco IOS software looks up the IP address without appending any default domain name to the hostname.

Follow these steps to set up your switch to use the DNS:

Procedure

	Command or Action	Purpose
Step 1	enable Example: <pre>Device> enable</pre>	<p>Enables privileged EXEC mode.</p> <ul style="list-style-type: none"> • Enter your password if prompted.

	Command or Action	Purpose
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 3	ip domain-name <i>name</i> Example: Device(config)# ip domain-name Cisco.com	<p>Defines a default domain name that the software uses to complete unqualified hostnames (names without a dotted-decimal domain name).</p> <p>Do not include the initial period that separates an unqualified name from the domain name.</p> <p>At boot time, no domain name is configured; however, if the device configuration comes from a BOOTP or Dynamic Host Configuration Protocol (DHCP) server, then the default domain name might be set by the BOOTP or DHCP server (if the servers were configured with this information).</p>
Step 4	ip name-server <i>server-address1</i> [<i>server-address2 ... server-address6</i>] Example: Device(config)# ip name-server 192.168.1.100 192.168.1.200 192.168.1.300	<p>Specifies the address of one or more name servers to use for name and address resolution.</p> <p>You can specify up to six name servers. Separate each server address with a space. The first server specified is the primary server. The device sends DNS queries to the primary server first. If that query fails, the backup servers are queried.</p>
Step 5	ip domain-lookup [<i>nsap</i> | <i>source-interface interface</i>] Example: Device(config)# ip domain-lookup	<p>(Optional) Enables DNS-based hostname-to-address translation on your device. This feature is enabled by default.</p> <p>If your network devices require connectivity with devices in networks for which you do not control name assignment, you can dynamically assign device names that uniquely identify your devices by using the global Internet naming scheme (DNS).</p>
Step 6	end Example: Device(config)# end	Returns to privileged EXEC mode.
Step 7	show running-config Example:	Verifies your entries.

	Command or Action	Purpose
	Device# <code>show running-config</code>	
Step 8	copy running-config startup-config Example: Device# <code>copy running-config startup-config</code>	(Optional) Saves your entries in the configuration file.

Configuring a Message-of-the-Day Login Banner

You can create a single or multiline message banner that appears on the screen when someone logs in to the device.

Follow these steps to configure a MOTD login banner:

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> <code>enable</code>	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Device# <code>configure terminal</code>	Enters global configuration mode.
Step 3	banner motd c message c Example: Device(config)# <code>banner motd #</code> This is a secure site. Only authorized users are allowed. For access, contact technical support. #	Specifies the message of the day. <p><i>c</i>—Enters the delimiting character of your choice, for example, a pound sign (#), and press the Return key. The delimiting character signifies the beginning and end of the banner text. Characters after the ending delimiter are discarded.</p> <p><i>message</i>—Enters a banner message up to 255 characters. You cannot use the delimiting character in the message.</p>
Step 4	end Example:	Returns to privileged EXEC mode.

	Command or Action	Purpose
	Device(config)# end	
Step 5	show running-config Example: Device# show running-config	Verifies your entries.
Step 6	copy running-config startup-config Example: Device# copy running-config startup-config	(Optional) Saves your entries in the configuration file.

Configuring a Login Banner

You can configure a login banner to be displayed on all connected terminals. This banner appears after the MOTD banner and before the login prompt.

Follow these steps to configure a login banner:

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 3	banner login c message c Example: Device(config)# banner login \$ Access for authorized users only. Please enter your username and password. \$	Specifies the login message. <i>c</i> — Enters the delimiting character of your choice, for example, a pound sign (#), and press the Return key. The delimiting character signifies the beginning and end of the banner text. Characters after the ending delimiter are discarded.

	Command or Action	Purpose
		<i>message</i> —Enters a login message up to 255 characters. You cannot use the delimiting character in the message.
Step 4	end Example: Device(config)# end	Returns to privileged EXEC mode.
Step 5	show running-config Example: Device# show running-config	Verifies your entries.
Step 6	copy running-config startup-config Example: Device# copy running-config startup-config	(Optional) Saves your entries in the configuration file.

Managing the MAC Address Table

Changing the Address Aging Time

Follow these steps to configure the dynamic address table aging time:

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 3	mac address-table aging-time [0 | 10-1000000] [routed-mac | vlan <i>vlan-id</i>] Example:	Sets the length of time that a dynamic entry remains in the MAC address table after the entry is used or updated.

	Command or Action	Purpose
	<pre>Device(config)# mac address-table aging-time 500 vlan 2</pre>	<p>The range is 10 to 1000000 seconds. The default is 300. You can also enter 0, which disables aging. Static address entries are never aged or removed from the table.</p> <p><i>vlan-id</i>—Valid IDs are 1 to 4094.</p>
Step 4	<p>end</p> <p>Example:</p> <pre>Device(config)# end</pre>	Returns to privileged EXEC mode.
Step 5	<p>show running-config</p> <p>Example:</p> <pre>Device# show running-config</pre>	Verifies your entries.
Step 6	<p>copy running-config startup-config</p> <p>Example:</p> <pre>Device# copy running-config startup-config</pre>	(Optional) Saves your entries in the configuration file.

Configuring MAC Address Change Notification Traps

Follow these steps to configure the switch to send MAC address change notification traps to an NMS host:

Procedure

	Command or Action	Purpose
Step 1	<p>enable</p> <p>Example:</p> <pre>Device> enable</pre>	<p>Enables privileged EXEC mode.</p> <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	<p>configure terminal</p> <p>Example:</p> <pre>Device# configure terminal</pre>	Enters global configuration mode.
Step 3	<p>snmp-server host <i>host-addr</i> <i>community-string</i> <i>notification-type</i> { <i>informs</i> | <i>traps</i> } { <i>version</i> { <i>1</i> | <i>2c</i> | <i>3</i> } } { <i>vrf vrf instance name</i> }</p> <p>Example:</p>	<p>Specifies the recipient of the trap message.</p> <ul style="list-style-type: none"> • <i>host-addr</i>—Specifies the name or address of the NMS.

	Command or Action	Purpose
	<pre>Device (config)# snmp-server host 172.20.10.10 traps private mac-notification</pre>	<ul style="list-style-type: none"> • traps (the default)—Sends SNMP traps to the host. • informs—Sends SNMP informs to the host. • version—Specifies the SNMP version to support. Version 1, the default, is not available with informs. • <i>community-string</i>—Specifies the string to send with the notification operation. Though you can set this string by using the snmp-server host command, we recommend that you define this string by using the snmp-server community command before using the snmp-server host command. • <i>notification-type</i>—Uses the mac-notification keyword. • vrf vrf instance name—Specifies the VPN routing/forwarding instance for this host.
Step 4	<p>snmp-server enable traps mac-notification change</p> <p>Example:</p> <pre>Device (config)# snmp-server enable traps mac-notification change</pre>	Enables the device to send MAC address change notification traps to the NMS.
Step 5	<p>mac address-table notification change</p> <p>Example:</p> <pre>Device (config)# mac address-table notification change</pre>	Enables the MAC address change notification feature.
Step 6	<p>mac address-table notification change [interval value] [history-size value]</p> <p>Example:</p> <pre>Device (config)# mac address-table notification change interval 123 Device (config)# mac address-table notification change history-size 100</pre>	<p>Enters the trap interval time and the history table size.</p> <ul style="list-style-type: none"> • (Optional) interval value—Specifies the notification trap interval in seconds between each set of traps that are generated to the NMS. The range is 0 to 2147483647 seconds; the default is 1 second. • (Optional) history-size value—Specifies the maximum number of entries in the

	Command or Action	Purpose
		MAC notification history table. The range is 0 to 500; the default is 1.
Step 7	interface <i>interface-id</i> Example: Device (config) # interface gigabitethernet 1/0/2	Enters interface configuration mode, and specifies the Layer 2 interface on which to enable the SNMP MAC address notification trap.
Step 8	snmp trap mac-notification change {added | removed} Example: Device (config-if) # snmp trap mac-notification change added	Enables the MAC address change notification trap on the interface. <ul style="list-style-type: none"> • Enables the trap when a MAC address is added on this interface. • Enables the trap when a MAC address is removed from this interface.
Step 9	end Example: Device (config) # end	Returns to privileged EXEC mode.
Step 10	show running-config Example: Device# show running-config	Verifies your entries.
Step 11	copy running-config startup-config Example: Device# copy running-config startup-config	(Optional) Saves your entries in the configuration file.

Configuring MAC Address Move Notification Traps

When you configure MAC-move notification, an SNMP notification is generated and sent to the network management system whenever a MAC address moves from one port to another within the same VLAN.

Follow these steps to configure the device to send MAC address-move notification traps to an NMS host:

Procedure

	Command or Action	Purpose
Step 1	enable Example:	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.

	Command or Action	Purpose
	Device> enable	
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 3	snmp-server host <i>host-addr</i> { traps | informs } { version { 1 | 2c | 3 }} <i>community-string</i> <i>notification-type</i> Example: Device(config)# snmp-server host 172.20.10.10 traps private mac-notification	Specifies the recipient of the trap message. <ul style="list-style-type: none"> • <i>host-addr</i>—Specifies the name or address of the NMS. • traps (the default)—Sends SNMP traps to the host. • informs—Sends SNMP informs to the host. • version—Specifies the SNMP version to support. Version 1, the default, is not available with informs. • <i>community-string</i>—Specifies the string to send with the notification operation. Though you can set this string by using the snmp-server host command, we recommend that you define this string by using the snmp-server community command before using the snmp-server host command. • <i>notification-type</i>—Uses the mac-notification keyword.
Step 4	snmp-server enable traps mac-notification move Example: Device(config)# snmp-server enable traps mac-notification move	Enables the device to send MAC address move notification traps to the NMS.
Step 5	mac address-table notification mac-move Example: Device(config)# mac address-table notification mac-move	Enables the MAC address move notification feature.

	Command or Action	Purpose
Step 6	end Example: Device (config) # end	Returns to privileged EXEC mode.
Step 7	show running-config Example: Device# show running-config	Verifies your entries.
Step 8	copy running-config startup-config Example: Device# copy running-config startup-config	(Optional) Saves your entries in the configuration file.

What to do next

To disable MAC address-move notification traps, use the **no snmp-server enable traps mac-notification move** global configuration command. To disable the MAC address-move notification feature, use the **no mac address-table notification mac-move** global configuration command.

You can verify your settings by entering the **show mac address-table notification mac-move** privileged EXEC commands.

Configuring MAC Threshold Notification Traps

When you configure MAC threshold notification, an SNMP notification is generated and sent to the network management system when a MAC address table threshold limit is reached or exceeded.

Procedure

	Command or Action	Purpose
Step 1	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 2	snmp-server host <i>host-addr</i> {traps / informs} {version {1 | 2c | 3}} <i>community-string notification-type</i> Example: Device (config) # snmp-server host 172.20.10.10 traps private	Specifies the recipient of the trap message. <ul style="list-style-type: none"> • <i>host-addr</i>—Specifies the name or address of the NMS. • traps (the default)—Sends SNMP traps to the host.

	Command or Action	Purpose
	<code>mac-notification</code>	<ul style="list-style-type: none"> • informs—Sends SNMP informs to the host. • version—Specifies the SNMP version to support. Version 1, the default, is not available with informs. • <i>community-string</i>—Specifies the string to send with the notification operation. You can set this string by using the snmp-server host command, but we recommend that you define this string by using the snmp-server community command before using the snmp-server host command. • <i>notification-type</i>—Uses the mac-notification keyword.
Step 3	snmp-server enable traps mac-notification threshold Example: <pre>Device(config)# snmp-server enable traps mac-notification threshold</pre>	Enables MAC threshold notification traps to the NMS.
Step 4	mac address-table notification threshold Example: <pre>Device(config)# mac address-table notification threshold</pre>	Enables the MAC address threshold notification feature.
Step 5	mac address-table notification threshold [limit <i>percentage</i>] | [interval <i>time</i>] Example: <pre>Device(config)# mac address-table notification threshold interval 123 Device(config)# mac address-table notification threshold limit 78</pre>	<p>Enters the threshold value for the MAC address threshold usage monitoring.</p> <ul style="list-style-type: none"> • (Optional) limit <i>percentage</i>—Specifies the percentage of the MAC address table use; valid values are from 1 to 100 percent. The default is 50 percent. • (Optional) interval <i>time</i>—Specifies the time between notifications; valid values are greater than or equal to 120 seconds. The default is 120 seconds.
Step 6	end Example:	Returns to privileged EXEC mode.

	Command or Action	Purpose
	Device(config)# end	

Adding and Removing Static Address Entries

Follow these steps to add a static address:

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 3	mac address-table static <i>mac-addr</i> vlan <i>vlan-id</i> interface <i>interface-id</i> Example: Device(config)# mac address-table static c2f3.220a.12f4 vlan 4 interface gigabitethernet 1/0/1	Adds a static address to the MAC address table. <ul style="list-style-type: none"> • <i>mac-addr</i>—Specifies the destination MAC unicast address to add to the address table. Packets with this destination address received in the specified VLAN are forwarded to the specified interface. • <i>vlan-id</i>—Specifies the VLAN for which the packet with the specified MAC address is received. Valid VLAN IDs are 1 to 4094. • <i>interface-id</i>—Specifies the interface to which the received packet is forwarded. Valid interfaces include physical ports or port channels. For static multicast addresses, you can enter multiple interface IDs. For static unicast addresses, you can enter only one interface at a time, but you can enter the command multiple times with the same MAC address and VLAN ID.
Step 4	end Example: Device(config)# end	Returns to privileged EXEC mode. Alternatively, you can also press Ctrl-Z to exit global configuration mode.

	Command or Action	Purpose
Step 5	show running-config Example: Device# <code>show running-config</code>	Verifies your entries.
Step 6	copy running-config startup-config Example: Device# <code>copy running-config startup-config</code>	(Optional) Saves your entries in the configuration file.

Configuring Unicast MAC Address Filtering

Follow these steps to configure the Device to drop a source or destination unicast static address:

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> <code>enable</code>	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Device# <code>configure terminal</code>	Enters global configuration mode.
Step 3	mac address-table static <i>mac-addr</i> vlan <i>vlan-id</i> drop Example: Device(config)# <code>mac address-table static c2f3.220a.12f4 vlan 4 drop</code>	Enables unicast MAC address filtering and configure the device to drop a packet with the specified source or destination unicast static address. <ul style="list-style-type: none"> • <i>mac-addr</i>—Specifies a source or destination unicast MAC address (48-bit). Packets with this MAC address are dropped. • <i>vlan-id</i>—Specifies the VLAN for which the packet with the specified MAC address is received. Valid VLAN IDs are 1 to 4094.

	Command or Action	Purpose
Step 4	end Example: Device (config) # end	Returns to privileged EXEC mode.
Step 5	show running-config Example: Device# show running-config	Verifies your entries.
Step 6	copy running-config startup-config Example: Device# copy running-config startup-config	(Optional) Saves your entries in the configuration file.

Monitoring and Maintaining Administration of the Device

Command	Purpose
clear mac address-table dynamic	Removes all dynamic entries.
clear mac address-table dynamic address <i>mac-address</i>	Removes a specific MAC address.
clear mac address-table dynamic interface <i>interface-id</i>	Removes all addresses on the specified physical port or port channel.
clear mac address-table dynamic vlan <i>vlan-id</i>	Removes all addresses on a specified VLAN.
show clock [<i>detail</i>]	Displays the time and date configuration.
show ip igmp snooping groups	Displays the Layer 2 multicast entries for all VLANs or the specified VLAN.
show mac address-table address <i>mac-address</i>	Displays MAC address table information for the specified MAC address.
show mac address-table aging-time	Displays the aging time in all VLANs or the specified VLAN.
show mac address-table count	Displays the number of addresses present in all VLANs or the specified VLAN.
show mac address-table dynamic	Displays only dynamic MAC address table entries.

Command	Purpose
<code>show mac address-table interface <i>interface-name</i></code>	Displays the MAC address table information for the specified interface.
<code>show mac address-table move update</code>	Displays the MAC address table move update information.
<code>show mac address-table multicast</code>	Displays a list of multicast MAC addresses.
<code>show mac address-table notification {change | mac-move | threshold}</code>	Displays the MAC notification parameters and history table.
<code>show mac address-table secure</code>	Displays the secure MAC addresses.
<code>show mac address-table static</code>	Displays only static MAC address table entries.
<code>show mac address-table vlan <i>vlan-id</i></code>	Displays the MAC address table information for the specified VLAN.

Configuration Examples for Device Administration

Example: Setting the System Clock

This example shows how to manually set the system clock:

```
Device# clock set 13:32:00 23 July 2013
```

Examples: Configuring Summer Time

This example (for daylight savings time) shows how to specify that summer time starts on March 10 at 02:00 and ends on November 3 at 02:00:

```
Device(config)# clock summer-time PDT recurring PST date
10 March 2013 2:00 3 November 2013 2:00
```

This example shows how to set summer time start and end dates:

```
Device(config)#clock summer-time PST date
20 March 2013 2:00 20 November 2013 2:00
```

Example: Configuring a MOTD Banner

This example shows how to configure a MOTD banner by using the pound sign (#) symbol as the beginning and ending delimiter:

```
Device(config)# banner motd #

This is a secure site. Only authorized users are allowed.
For access, contact technical support.

#

Device(config)#
```

This example shows the banner that appears from the previous configuration:

```
Unix> telnet 192.0.2.15

Trying 192.0.2.15...

Connected to 192.0.2.15.

Escape character is '^]'.

This is a secure site. Only authorized users are allowed.

For access, contact technical support.

User Access Verification

Password:
```

Example: Configuring a Login Banner

This example shows how to configure a login banner by using the dollar sign (\$) symbol as the beginning and ending delimiter:

```
Device(config)# banner login $

Access for authorized users only. Please enter your username and password.

$

Device(config)#
```

Example: Configuring MAC Address Change Notification Traps

This example shows how to specify 172.20.10.10 as the NMS, enable MAC address notification traps to the NMS, enable the MAC address-change notification feature, set the interval time to 123 seconds, set the history-size to 100 entries, and enable traps whenever a MAC address is added on the specified port:

```
Device(config)# snmp-server host 172.20.10.10 traps private mac-notification
Device(config)# snmp-server enable traps mac-notification change
Device(config)# mac address-table notification change
Device(config)# mac address-table notification change interval 123
Device(config)# mac address-table notification change history-size 100
Device(config)# interface gigabitethernet 1/2/1
Device(config-if)# snmp trap mac-notification change added
```

Example: Configuring MAC Threshold Notification Traps

This example shows how to specify 172.20.10.10 as the NMS, enable the MAC address threshold notification feature, set the interval time to 123 seconds, and set the limit to 78 per cent:

```
Device(config)# snmp-server host 172.20.10.10 traps private mac-notification
Device(config)# snmp-server enable traps mac-notification threshold
Device(config)# mac address-table notification threshold
Device(config)# mac address-table notification threshold interval 123
Device(config)# mac address-table notification threshold limit 78
```

Example: Adding the Static Address to the MAC Address Table

This example shows how to add the static address c2f3.220a.12f4 to the MAC address table. When a packet is received in VLAN 4 with this MAC address as its destination address, the packet is forwarded to the specified port:



Note You cannot associate the same static MAC address to multiple interfaces. If the command is executed again with a different interface, the static MAC address is overwritten on the new interface.

```
Device(config)# mac address-table static c2f3.220a.12f4 vlan 4 interface gigabitethernet
1/1/1
```

Example: Configuring Unicast MAC Address Filtering

This example shows how to enable unicast MAC address filtering and how to configure drop packets that have a source or destination address of c2f3.220a.12f4. When a packet is received in VLAN 4 with this MAC address as its source or destination, the packet is dropped:

```
Device(config)# mac address-table static c2f3.220a.12f4 vlan 4 drop
```

Additional References for Device Administration

Related Documents

Related Topic	Document Title
For complete syntax and usage information for the commands used in this chapter, see the command reference for this release.	<i>Command Reference (Catalyst 9300 Series Switches)</i>

MIBs

MIB	MIBs Link
All supported MIBs for this release.	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
<p>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies.</p> <p>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.</p> <p>Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</p>	http://www.cisco.com/support

Feature History and Information for Device Administration

Release	Modification
Cisco IOS XE Everest 16.5.1a	This feature was introduced.



CHAPTER 2

Performing Device Setup Configuration

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- [Information About Performing Device Setup Configuration, on page 41](#)
- [How to Perform Device Setup Configuration, on page 52](#)
- [Monitoring Device Setup Configuration, on page 65](#)
- [Configuration Examples for Performing Device Setup, on page 70](#)
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- [Feature History and Information For Performing Device Setup Configuration, on page 72](#)

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 at the end of this module.

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

Information About Performing Device Setup Configuration

Review the sections in this module before performing your initial device configuration tasks that include IP address assignments and DHCP autoconfiguration.

Device Boot Process

To start your device, you need to follow the procedures in the hardware installation guide for installing and powering on the device.

The normal boot process involves the operation of the boot loader software and includes these activities:

- Performs low-level CPU initialization. It initializes the CPU registers, which control where physical memory is mapped, its quantity, its speed, and so forth.
- Performs power-on self-test (POST) for the CPU subsystem and tests the system DRAM.

- Initializes the file systems on the system board.
- Loads a default operating system software image into memory and boots up the device.

The boot loader provides access to the file systems before the operating system is loaded. Normally, the boot loader is used only to load, decompress, and start the operating system. After the boot loader gives the operating system control of the CPU, the boot loader is not active until the next system reset or power-on.

Before you can assign device information, make sure you have connected a PC or terminal to the console port or a PC to the Ethernet management port, and make sure you have configured the PC or terminal-emulation software baud rate and character format to match these of the device console port:

- Baud rate default is 9600.
- Data bits default is 8.



Note If the data bits option is set to 8, set the parity option to none.

- Stop bits default is 2 (minor).
- Parity settings default is none.

Software Installer Features

The following software installer features are supported on your switch:

- Software bundle installation on a standalone switch, a switch stack, or a subset of switches in a stack. The default is installation on all the switches if a switch stack is configured.
- In a stack of switches, Cisco recommends all switches in install mode.
- Software rollback to a previously installed package set.
- Emergency installation in the event that no valid installed packages reside on the boot flash.
- Auto-upgrade of a switch that joins the switch stack with incompatible software.
- Installation using packages on one switch as the source for installing packages on another switch in the switch stack.



Note Software installation and rollback must be performed while running only in installed mode. You can use the **request platform software package expand EXEC** command to convert bundle boot mode to install mode.

Software Boot Modes

Your device supports two modes to boot the software packages:

- Installed mode
- Bundle mode

Installed Boot Mode

You can boot your device in installed mode by booting the software package provisioning file that resides in flash:

```
Switch: boot flash:packages.conf
```

The provisioning file contains a list of software packages to boot, mount, and run. The ISO file system in each installed package is mounted to the root file system directly from flash.



Note The packages and provisioning file used to boot in installed mode must reside in flash. Booting in installed mode from usbflash0: or tftp: is not supported.

Bundle Boot Mode

You can boot your device in bundle boot mode by booting the bundle (.bin) file:

```
switch: boot flash:cat9k_iosxe.16.05.01a.SPA.bin
```

The provisioning file contained in a bundle is used to decide which packages to boot, mount, and run. Packages are extracted from the bundle and copied to RAM. The ISO file system in each package is mounted to the root file system.

Unlike install boot mode, additional memory that is equivalent to the size of the bundle is used when booting in bundle mode.

Unlike install boot mode, bundle boot mode is available from several locations:

- flash:
- usbflash0:
- tftp:

Boot Mode for a Switch Stack

All the switches in a stack must be running in installed mode or bundle boot mode. A mixed mode stack is not supported. If a new switch tries to join the stack in a different boot mode than the active switch, the new switch is given a V-mismatch state.

If a mixed mode switch stack is booted at the same time, then only those switches that boot up in a different mode than the active go to the V-mismatch state. If the boot mode does not support auto-upgrade, then the switch stack members must be re-booted in the same boot mode as the active switch.

If the stack is running in installed mode, the auto-upgrade feature can be used to automatically upgrade the new switch that is attempting to join the switch stack.

The auto-upgrade feature changes the boot mode of the new switch to installed mode. If the stack is running in bundle boot mode, the auto-upgrade feature is not available. You will be required to use the bundle mode to boot the new switch so that it can join the switch stack.

This is an example of the state of a switch that attempts to join the switch stack when the boot mode is not compatible with the active switch:

```

Device# show switch

Switch/Stack Mac Address : 6400.f125.1100 - Local Mac Address
Mac persistency wait time: Indefinite
H/W Current
Switch#   Role   Mac Address      Priority Version   State
-----
 1       Member 6400 f125.1a00    1         0         V-Mismatch
*2       Active 6400.f125.1100   1         V01       Ready
Device

```

Devices Information Assignment

You can assign IP information through the device setup program, through a DHCP server, or manually.

Use the device setup program if you want to be prompted for specific IP information. With this program, you can also configure a hostname and an enable secret password.

It gives you the option of assigning a Telnet password (to provide security during remote management) and configuring your switch as a command or member switch of a cluster or as a standalone switch.

Use a DHCP server for centralized control and automatic assignment of IP information after the server is configured.



Note If you are using DHCP, do not respond to any of the questions in the setup program until the device receives the dynamically assigned IP address and reads the configuration file.

If you are an experienced user familiar with the device configuration steps, manually configure the device. Otherwise, use the setup program described in the *Boot Process* section.

Default Switch Information

DHCP-Based Autoconfiguration Overview

DHCP provides configuration information to Internet hosts and internetworking devices. This protocol consists of two components: one for delivering configuration parameters from a DHCP server to a device and an operation for allocating network addresses to devices. DHCP is built on a client-server model, in which designated DHCP servers allocate network addresses and deliver configuration parameters to dynamically configured devices. The device can act as both a DHCP client and a DHCP server.

During DHCP-based autoconfiguration, your device (DHCP client) is automatically configured at startup with IP address information and a configuration file.

With DHCP-based autoconfiguration, no DHCP client-side configuration is needed on your device. However, you need to configure the DHCP server for various lease options associated with IP addresses.

If you want to use DHCP to relay the configuration file location on the network, you might also need to configure a Trivial File Transfer Protocol (TFTP) server and a Domain Name System (DNS) server.



Note We recommend a redundant connection between a switch stack and the DHCP, DNS, and TFTP servers. This is to help ensure that these servers remain accessible in case one of the connected stack members is removed from the switch stack.

The DHCP server for your device can be on the same LAN or on a different LAN than the device. If the DHCP server is running on a different LAN, you should configure a DHCP relay device between your device and the DHCP server. A relay device forwards broadcast traffic between two directly connected LANs. A router does not forward broadcast packets, but it forwards packets based on the destination IP address in the received packet.

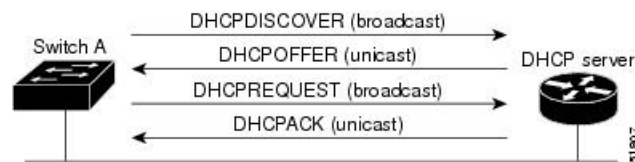
DHCP-based autoconfiguration replaces the BOOTP client functionality on your device.

DHCP Client Request Process

When you boot up your device, the DHCP client is invoked and requests configuration information from a DHCP server when the configuration file is not present on the device. If the configuration file is present and the configuration includes the **ip address dhcp** interface configuration command on specific routed interfaces, the DHCP client is invoked and requests the IP address information for those interfaces.

This is the sequence of messages that are exchanged between the DHCP client and the DHCP server.

Figure 3: DHCP Client and Server Message Exchange



The client, Device A, broadcasts a DHCPDISCOVER message to locate a DHCP server. The DHCP server offers configuration parameters (such as an IP address, subnet mask, gateway IP address, DNS IP address, a lease for the IP address, and so forth) to the client in a DHCPOFFER unicast message.

In a DHCPREQUEST broadcast message, the client returns a formal request for the offered configuration information to the DHCP server. The formal request 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.

The DHCP server confirms that the IP address has been allocated to the client by returning a DHCPACK unicast message to the client. With this message, the client and server are bound, and the client uses configuration information received from the server. The amount of information the device receives depends on how you configure the DHCP server.

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

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

A DHCP client might receive offers from multiple DHCP or BOOTP servers and can accept any 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 is allocated to the client; however, the server usually reserves the address until the client

has had a chance to formally request the address. If the device accepts replies from a BOOTP server and configures itself, the device broadcasts, instead of unicasts, TFTP requests to obtain the device configuration file.

The DHCP hostname option allows a group of devices to obtain hostnames and a standard configuration from the central management DHCP server. A client (device) includes in its DHCPDISCOVER message an option 12 field used to request a hostname and other configuration parameters from the DHCP server. The configuration files on all clients are identical except for their DHCP-obtained hostnames.

If a client has a default hostname (the **hostname name** global configuration command is not configured or the **no hostname** global configuration command is entered to remove the hostname), the DHCP hostname option is not included in the packet when you enter the **ip address dhcp** interface configuration command. In this case, if the client receives the DHCP hostname option from the DHCP interaction while acquiring an IP address for an interface, the client accepts the DHCP hostname option and sets the flag to show that the system now has a hostname configured.

DHCP-based Autoconfiguration and Image Update

You can use the DHCP image upgrade features to configure a DHCP server to download both a new image and a new configuration file to one or more devices in a network. Simultaneous image and configuration upgrade for all switches in the network helps ensure that each new device added to a network receives the same image and configuration.

There are two types of DHCP image upgrades: DHCP autoconfiguration and DHCP auto-image update.

Restrictions for DHCP-based Autoconfiguration

- The DHCP-based autoconfiguration with a saved configuration process stops if there is not at least one Layer 3 interface in an up state without an assigned IP address in the network.
- Unless you configure a timeout, the DHCP-based autoconfiguration with a saved configuration feature tries indefinitely to download an IP address.
- The auto-install process stops if a configuration file cannot be downloaded or if the configuration file is corrupted.
- The configuration file that is downloaded from TFTP is merged with the existing configuration in the running configuration but is not saved in the NVRAM unless you enter the **write memory** or **copy running-configuration startup-configuration** privileged EXEC command. If the downloaded configuration is saved to the startup configuration, the feature is not triggered during subsequent system restarts.

DHCP Autoconfiguration

DHCP autoconfiguration downloads a configuration file to one or more devices in your network from a DHCP server. The downloaded configuration file becomes the running configuration of the device. It does not overwrite the bootup configuration saved in the flash, until you reload the device.

DHCP Auto-Image Update

You can use DHCP auto-image upgrade with DHCP autoconfiguration to download both a configuration and a new image to one or more devices in your network. The device (or devices) downloading the new configuration and the new image can be blank (or only have a default factory configuration loaded).

If the new configuration is downloaded to a switch that already has a configuration, the downloaded configuration is appended to the configuration file stored on the switch. (Any existing configuration is not overwritten by the downloaded one.)

To enable a DHCP auto-image update on the device, the TFTP server where the image and configuration files are located must be configured with the correct option 67 (the configuration filename), option 66 (the DHCP server hostname) option 150 (the TFTP server address), and option 125 (description of the Cisco IOS image file) settings.

After you install the device in your network, the auto-image update feature starts. The downloaded configuration file is saved in the running configuration of the device, and the new image is downloaded and installed on the device. When you reboot the device, the configuration is stored in the saved configuration on the device.

DHCP Server Configuration Guidelines

Follow these guidelines if you are configuring a device as a DHCP server:

- You should configure the DHCP server with reserved leases that are bound to each device by the device hardware address.
- If you want the device to receive IP address information, you must configure the DHCP server with these lease options:
 - IP address of the client (required)
 - Subnet mask of the client (required)
 - DNS server IP address (optional)
 - Router IP address (default gateway address to be used by the device) (required)
- If you want the device to receive the configuration file from a TFTP server, you must configure the DHCP server with these lease options:
 - TFTP server name (required)
 - Boot filename (the name of the configuration file that the client needs) (recommended)
 - Hostname (optional)
- Depending on the settings of the DHCP server, the device can receive IP address information, the configuration file, or both.
- If you do not configure the DHCP server with the lease options described previously, it replies to client requests with only those parameters that are configured. If the IP address and the subnet mask are not in the reply, the device is not configured. If the router IP address or the TFTP server name are not found, the device might send broadcast, instead of unicast, TFTP requests. Unavailability of other lease options does not affect autoconfiguration.
- The device can act as a DHCP server. By default, the Cisco IOS DHCP server and relay agent features are enabled on your device but are not configured. (These features are not operational.)

Purpose of the TFTP Server

Based on the DHCP server configuration, the device attempts to download one or more configuration files from the TFTP server. If you configured the DHCP server to respond to the device with all the options required

for IP connectivity to the TFTP server, and if you configured the DHCP server with a TFTP server name, address, and configuration filename, the device attempts to download the specified configuration file from the specified TFTP server.

If you did not specify the configuration filename, the TFTP server, or if the configuration file could not be downloaded, the device attempts to download a configuration file by using various combinations of filenames and TFTP server addresses. The files include the specified configuration filename (if any) and these files: `network-config`, `cisconet.cfg`, `hostname.config`, or `hostname.cfg`, where *hostname* is the device's current hostname. The TFTP server addresses used include the specified TFTP server address (if any) and the broadcast address (255.255.255.255).

For the device to successfully download a configuration file, the TFTP server must contain one or more configuration files in its base directory. The files can include these files:

- The configuration file named in the DHCP reply (the actual device configuration file).
- The `network-config` or the `cisconet.cfg` file (known as the default configuration files).
- The `router-config` or the `ciscotr.cfg` file (These files contain commands common to all devices. Normally, if the DHCP and TFTP servers are properly configured, these files are not accessed.)

If you specify the TFTP server name in the DHCP server-lease database, you must also configure the TFTP server name-to-IP-address mapping in the DNS-server database.

If the TFTP server to be used is on a different LAN from the device, or if it is to be accessed by the device through the broadcast address (which occurs if the DHCP server response does not contain all the required information described previously), a relay must be configured to forward the TFTP packets to the TFTP server. The preferred solution is to configure the DHCP server with all the required information.

Purpose of the DNS Server

The DHCP server uses the DNS server to resolve the TFTP server name to an IP address. You must configure the TFTP server name-to-IP address map on the DNS server. The TFTP server contains the configuration files for the device.

You can configure the IP addresses of the DNS servers in the lease database of the DHCP server from where the DHCP replies will retrieve them. You can enter up to two DNS server IP addresses in the lease database.

The DNS server can be on the same LAN or on a different LAN from the device. If it is on a different LAN, the device must be able to access it through a router.

How to Obtain Configuration Files

Depending on the availability of the IP address and the configuration filename in the DHCP reserved lease, the device obtains its configuration information in these ways:

- The IP address and the configuration filename is reserved for the device and provided in the DHCP reply (one-file read method).

The device receives its IP address, subnet mask, TFTP server address, and the configuration filename from the DHCP server. The device sends a unicast message to the TFTP server to retrieve the named configuration file from the base directory of the server and upon receipt, it completes its boot up process.

- The IP address and the configuration filename is reserved for the device, but the TFTP server address is not provided in the DHCP reply (one-file read method).

The device receives its IP address, subnet mask, and the configuration filename from the DHCP server. The device sends a broadcast message to a TFTP server to retrieve the named configuration file from the base directory of the server, and upon receipt, it completes its boot-up process.

- Only the IP address is reserved for the device and provided in the DHCP reply. The configuration filename is not provided (two-file read method).

The device receives its IP address, subnet mask, and the TFTP server address from the DHCP server. The device sends a unicast message to the TFTP server to retrieve the network-config or cisco.net.cfg default configuration file. (If the network-config file cannot be read, the device reads the cisco.net.cfg file.)

The default configuration file contains the hostnames-to-IP-address mapping for the device. The device fills its host table with the information in the file and obtains its hostname. If the hostname is not found in the file, the device uses the hostname in the DHCP reply. If the hostname is not specified in the DHCP reply, the device uses the default *Switch* as its hostname.

After obtaining its hostname from the default configuration file or the DHCP reply, the device reads the configuration file that has the same name as its hostname (*hostname-config* or *hostname.cfg*, depending on whether network-config or cisco.net.cfg was read earlier) from the TFTP server. If the cisco.net.cfg file is read, the filename of the host is truncated to eight characters.

If the device cannot read the network-config, cisco.net.cfg, or the hostname file, it reads the router-config file. If the device cannot read the router-config file, it reads the ciscotr.cfg file.



Note The device broadcasts TFTP server requests if the TFTP server is not obtained from the DHCP replies, if all attempts to read the configuration file through unicast transmissions fail, or if the TFTP server name cannot be resolved to an IP address.

How to Control Environment Variables

With a normally operating device, you enter the boot loader mode only through the console connection configured for 9600 bps. Unplug the device power cord, and press the **Mode** button while reconnecting the power cord. You can release the **Mode** button after the system LED begins flashing green and remains solid. The boot loader device prompt then appears.

The device boot loader software provides support for nonvolatile environment variables, which can be used to control how the boot loader, or any other software running on the system, operates. Boot loader environment variables are similar to environment variables that can be set on UNIX or DOS systems.

Environment variables that have values are stored in flash memory outside of the flash file system.

Each line in these files contains an environment variable name and an equal sign followed by the value of the variable. A variable has no value if it is not present; it has a value if it is listed even if the value is a null string. A variable that is set to a null string (for example, “”) is a variable with a value. Many environment variables are predefined and have default values.

You can change the settings of the environment variables by accessing the boot loader or by using Cisco IOS commands. Under normal circumstances, it is not necessary to alter the setting of the environment variables.

Common Environment Variables

This table describes the function of the most common environment variables.

Table 4: Common Environment Variables

Variable	Boot Loader Command	Cisco IOS Global Configuration Command
BOOT	<p>set BOOT <i>filesystem :/file-url ...</i></p> <p>A semicolon-separated list of executable files to try to load and execute when automatically booting.</p>	<p>boot system <i>{filesystem : /file-url ... | switch {number | all}}</i></p> <p>Specifies the Cisco IOS image to load during the next boot cycle and the stack members on which the image is loaded. This command changes the setting of the BOOT environment variable.</p> <p>The package provisioning file, also referred to as the <i>packages.conf</i> file, is used by the system to determine which software packages to activate during boot up.</p> <ul style="list-style-type: none"> • When booting in installed mode, the package provisioning file specified in the boot command is used to determine which packages to activate. For example boot flash:packages.conf. • When booting in bundle mode, the package provisioning file contained in the booted bundle is used to activate the packages included in the bundle. For example, boot flash:image.bin.
MANUAL_BOOT	<p>set MANUAL_BOOT <i>yes</i></p> <p>Decides whether the switch automatically or manually boots.</p> <p>Valid values are 1, yes, 0, and no. If it is set to no or 0, the boot loader attempts to automatically boot up the system. If it is set to anything else, you must manually boot up the switch from the boot loader mode.</p>	<p>boot manual</p> <p>Enables manually booting the switch during the next boot cycle and changes the setting of the MANUAL_BOOT environment variable.</p> <p>The next time you reboot the system, the switch is in boot loader mode. To boot up the system, use the boot flash:filesystem :/file-url boot loader command, and specify the name of the bootable image.</p>

Variable	Boot Loader Command	Cisco IOS Global Configuration Command
CONFIG_FILE	set CONFIG_FILE flash:/<i>file-url</i> Changes the filename that Cisco IOS uses to read and write a nonvolatile copy of the system configuration.	boot config-file flash:/<i>file-url</i> Specifies the filename that Cisco IOS uses to read and write a nonvolatile copy of the system configuration. This command changes the CONFIG_FILE environment variable.
SWITCH_NUMBER	set SWITCH_NUMBER stack-member-number Changes the member number of a stack member.	switch <i>current-stack-member-number</i> renumber <i>new-stack-member-number</i> Changes the member number of a stack member.
SWITCH_PRIORITY	set SWITCH_PRIORITY stack-member-number Changes the priority value of a stack member.	switch <i>stack-member-number</i> priority <i>priority-number</i> Changes the priority value of a stack member.
BAUD	set BAUD <i>baud-rate</i>	line console 0 speed <i>speed-value</i> Configures the baud rate.
ENABLE_BREAK	set ENABLE_BREAK yes/no	boot enable-break switch yes/no Enables a break to the auto-boot cycle. You have 5 seconds to enter the break command.

Environment Variables for TFTP

When the switch is connected to a PC through the Ethernet management port, you can download or upload a configuration file to the boot loader by using TFTP. Make sure the environment variables in this table are configured.

Table 5: Environment Variables for TFTP

Variable	Description
MAC_ADDR	Specifies the MAC address of the switch. Note We recommend that you do not modify this variable. However, if you modify this variable after the boot loader is up or the value is different from the saved value, enter this command before using TFTP. A reset is required for the new value to take effect.
IP_ADDRESS	Specifies the IP address and the subnet mask for the associated IP subnet of the switch.

Variable	Description
DEFAULT_GATEWAY	Specifies the IP address and subnet mask of the default gateway.

Scheduled Reload of the Software Image

You can schedule a reload of the software image to occur on the device at a later time (for example, late at night or during the weekend when the device is used less), or you can synchronize a reload network-wide (for example, to perform a software upgrade on all devices in the network).



Note A scheduled reload must take place within approximately 24 days.

You have these reload options:

- Reload of the software to take affect in the specified minutes or hours and minutes. The reload must take place within approximately 24 hours. You can specify the reason for the reload in a string up to 255 characters in length.
- Reload of the software to take place at the specified time (using a 24-hour clock). If you specify the month and day, the reload is scheduled to take place at the specified time and date. If you do not specify the month and day, the reload takes place at the specified time on the current day (if the specified time is later than the current time) or on the next day (if the specified time is earlier than the current time). Specifying 00:00 schedules the reload for midnight.

The **reload** command halts the system. If the system is not set to manually boot up, it reboots itself.

If your device is configured for manual booting, do not reload it from a virtual terminal. This restriction prevents the device from entering the boot loader mode and then taking it from the remote user's control.

If you modify your configuration file, the device prompts you to save the configuration before reloading. During the save operation, the system requests whether you want to proceed with the save if the CONFIG_FILE environment variable points to a startup configuration file that no longer exists. If you proceed in this situation, the system enters setup mode upon reload.

To cancel a previously scheduled reload, use the **reload cancel** privileged EXEC command.

How to Perform Device Setup Configuration

Using DHCP to download a new image and a new configuration to a device requires that you configure at least two devices. One device acts as a DHCP and TFTP server and the second device (client) is configured to download either a new configuration file or a new configuration file and a new image file.

Configuring DHCP Autoconfiguration (Only Configuration File)

This task describes how to configure DHCP autoconfiguration of the TFTP and DHCP settings on an existing device in the network so that it can support the autoconfiguration of a new device.

Procedure

	Command or Action	Purpose
Step 1	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 2	ip dhcp pool <i>poolname</i> Example: Device(config)# ip dhcp pool pool	Creates a name for the DHCP server address pool, and enters DHCP pool configuration mode.
Step 3	boot <i>filename</i> Example: Device(dhcp-config)# boot config-boot.text	Specifies the name of the configuration file that is used as a boot image.
Step 4	network <i>network-number mask prefix-length</i> Example: Device(dhcp-config)# network 10.10.10.0 255.255.255.0	Specifies the subnet network number and mask of the DHCP address pool. Note The prefix length specifies 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	default-router <i>address</i> Example: Device(dhcp-config)# default-router 10.10.10.1	Specifies the IP address of the default router for a DHCP client.
Step 6	option 150 <i>address</i> Example: Device(dhcp-config)# option 150 10.10.10.1	Specifies the IP address of the TFTP server.
Step 7	exit Example: Device(dhcp-config)# exit	Returns to global configuration mode.

	Command or Action	Purpose
Step 8	tftp-server flash:filename.text Example: <pre>Device(config)# tftp-server flash:config-boot.text</pre>	Specifies the configuration file on the TFTP server.
Step 9	interface interface-id Example: <pre>Device(config)# interface gigabitethernet 1/0/4</pre>	Specifies the address of the client that will receive the configuration file.
Step 10	no switchport Example: <pre>Device(config-if)# no switchport</pre>	Puts the interface into Layer 3 mode.
Step 11	ip address address mask Example: <pre>Device(config-if)# ip address 10.10.10.1 255.255.255.0</pre>	Specifies the IP address and mask for the interface.
Step 12	end Example: <pre>Device(config-if)# end</pre>	Returns to privileged EXEC mode.

Configuring DHCP Auto-Image Update (Configuration File and Image)

This task describes DHCP autoconfiguration to configure TFTP and DHCP settings on an existing device to support the installation of a new switch.

Before you begin

You must first create a text file (for example, `autoinstall_dhcp`) that will be uploaded to the device. In the text file, put the name of the image that you want to download (for example, `cat9k_iosxe.16.xx.xx.SPA.bin`).

Procedure

	Command or Action	Purpose
Step 1	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 2	ip dhcp pool <i>poolname</i> Example: Device(config)# ip dhcp pool pool1	Creates a name for the DHCP server address pool and enter DHCP pool configuration mode.
Step 3	boot <i>filename</i> Example: Device(dhcp-config)# boot config-boot.text	Specifies the name of the file that is used as a boot image.
Step 4	network <i>network-number mask prefix-length</i> Example: Device(dhcp-config)# network 10.10.10.0 255.255.255.0	Specifies the subnet network number and mask of the DHCP address pool. Note The prefix length specifies 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	default-router <i>address</i> Example: Device(dhcp-config)# default-router 10.10.10.1	Specifies the IP address of the default router for a DHCP client.
Step 6	option 150 <i>address</i> Example: Device(dhcp-config)# option 150 10.10.10.1	Specifies the IP address of the TFTP server.
Step 7	option 125 <i>hex</i> Example: Device(dhcp-config)# option 125 hex 0000.0009.0a05.08661.7574.6f69.6e73.7461.6c6c.5f64.686370	Specifies the path to the text file that describes the path to the image file.

	Command or Action	Purpose
Step 8	copy tftp flash <i>filename.txt</i> Example: <pre>Device(config)# copy tftp flash image.bin</pre>	Uploads the text file to the device.
Step 9	copy tftp flash <i>imagename.bin</i> Example: <pre>Device(config)# copy tftp flash image.bin</pre>	Uploads the tar file for the new image to the device.
Step 10	exit Example: <pre>Device(dhcp-config)# exit</pre>	Returns to global configuration mode.
Step 11	tftp-server flash: <i>config.txt</i> Example: <pre>Device(config)# tftp-server flash:config-boot.txt</pre>	Specifies the Cisco IOS configuration file on the TFTP server.
Step 12	tftp-server flash: <i>imagename.bin</i> Example: <pre>Device(config)# tftp-server flash:image.bin</pre>	Specifies the image name on the TFTP server.
Step 13	tftp-server flash: <i>filename.txt</i> Example: <pre>Device(config)# tftp-server flash:boot-config.txt</pre>	Specifies the text file that contains the name of the image file to download
Step 14	interface <i>interface-id</i> Example: <pre>Device(config)# interface gigabitethernet 1/0/4</pre>	Specifies the address of the client that will receive the configuration file.

	Command or Action	Purpose
Step 15	no switchport Example: Device (config-if) # no switchport	Puts the interface into Layer 3 mode.
Step 16	ip address address mask Example: Device (config-if) # ip address 10.10.10.1 255.255.255.0	Specifies the IP address and mask for the interface.
Step 17	end Example: Device (config-if) # end	Returns to privileged EXEC mode.
Step 18	copy running-config startup-config Example: Device (config-if) # end	(Optional) Saves your entries in the configuration file.

Configuring the Client to Download Files from DHCP Server



Note You should only configure and enable the Layer 3 interface. Do not assign an IP address or DHCP-based autoconfiguration with a saved configuration.

Procedure

	Command or Action	Purpose
Step 1	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 2	boot host dhcp Example: Device (conf) # boot host dhcp	Enables autoconfiguration with a saved configuration.

	Command or Action	Purpose
Step 3	boot host retry timeout <i>timeout-value</i> Example: <pre>Device(conf)# boot host retry timeout 300</pre>	(Optional) Sets the amount of time the system tries to download a configuration file. Note If you do not set a timeout, the system will try indefinitely to obtain an IP address from the DHCP server.
Step 4	banner config-save ^C <i>warning-message</i> ^C Example: <pre>Device(conf)# banner config-save ^C Caution - Saving Configuration File to NVRAM May Cause You to No longer Automatically Download Configuration Files at Reboot^C</pre>	(Optional) Creates warning messages to be displayed when you try to save the configuration file to NVRAM.
Step 5	end Example: <pre>Device(config-if)# end</pre>	Returns to privileged EXEC mode.
Step 6	show boot Example: <pre>Device# show boot</pre>	Verifies the configuration.

Manually Assigning IP Information to Multiple SVIs

This task describes how to manually assign IP information to multiple switched virtual interfaces (SVIs):

Procedure

	Command or Action	Purpose
Step 1	configure terminal Example: <pre>Device# configure terminal</pre>	Enters global configuration mode.
Step 2	interface vlan <i>vlan-id</i> Example: <pre>Device(config)# interface vlan 99</pre>	Enters interface configuration mode, and enters the VLAN to which the IP information is assigned. The range is 1 to 4094.

	Command or Action	Purpose
Step 3	ip address <i>ip-address subnet-mask</i> Example: <pre>Device(config-vlan) # ip address 10.10.10.2 255.255.255.0</pre>	Enters the IP address and subnet mask.
Step 4	exit Example: <pre>Device(config-vlan) # exit</pre>	Returns to global configuration mode.
Step 5	ip default-gateway <i>ip-address</i> Example: <pre>Device(config) # ip default-gateway 10.10.10.1</pre>	<p>Enters the IP address of the next-hop router interface that is directly connected to the device where a default gateway is being configured. The default gateway receives IP packets with unresolved destination IP addresses from the device.</p> <p>Once the default gateway is configured, the device has connectivity to the remote networks with which a host needs to communicate.</p> <p>Note When your device is configured to route with IP, it does not need to have a default gateway set.</p> <p>Note The device capwap relays on default-gateway configuration to support routed access point join the device.</p>
Step 6	end Example: <pre>Device(config) # end</pre>	Returns to privileged EXEC mode.
Step 7	show interfaces vlan <i>vlan-id</i> Example: <pre>Device# show interfaces vlan 99</pre>	Verifies the configured IP address.
Step 8	show ip redirects Example: <pre>Device# show ip redirects</pre>	Verifies the configured default gateway.

Modifying the Device Startup Configuration

Specifying the Filename to Read and Write the System Configuration

By default, the Cisco IOS software uses the `config.text` file to read and write a nonvolatile copy of the system configuration. However, you can specify a different filename, which will be loaded during the next boot cycle.

Before you begin

Use a standalone device for this task.

Procedure

	Command or Action	Purpose
Step 1	configure terminal Example: <pre>Switch# configure terminal</pre>	Enters global configuration mode.
Step 2	boot flash:/file-url Example: <pre>Switch(config)# boot flash:config.text</pre>	Specifies the configuration file to load during the next boot cycle. <i>file-url</i> —The path (directory) and the configuration filename. Filenames and directory names are case-sensitive.
Step 3	end Example: <pre>Switch(config)# end</pre>	Returns to privileged EXEC mode.
Step 4	show boot Example: <pre>Switch# show boot</pre>	Verifies your entries. The boot global configuration command changes the setting of the <code>CONFIG_FILE</code> environment variable.
Step 5	copy running-config startup-config Example: <pre>Switch# copy running-config startup-config</pre>	(Optional) Saves your entries in the configuration file.

Manually Booting the Switch

By default, the switch automatically boots up; however, you can configure it to manually boot up.

Before you begin

Use a standalone switch for this task.

Procedure

	Command or Action	Purpose
Step 1	configure terminal Example: Device# <code>configure terminal</code>	Enters global configuration mode.
Step 2	boot manual Example: Device(config)# <code>boot manual</code>	Enables the switch to manually boot up during the next boot cycle.
Step 3	end Example: Device(config)# <code>end</code>	Returns to privileged EXEC mode.
Step 4	show boot Example: Device# <code>show boot</code>	<p>Verifies your entries.</p> <p>The boot manual global command changes the setting of the MANUAL_BOOT environment variable.</p> <p>The next time you reboot the system, the switch is in boot loader mode, shown by the <i>switch:</i> prompt. To boot up the system, use the boot filesystem:/file-url boot loader command.</p> <ul style="list-style-type: none"> • <i>filesystem:</i>—Uses flash: for the system board flash device. Switch: <code>boot flash:</code> • For <i>file-url</i>—Specifies the path (directory) and the name of the bootable image. <p>Filenames and directory names are case-sensitive.</p>
Step 5	copy running-config startup-config Example: Device# <code>copy running-config startup-config</code>	(Optional) Saves your entries in the configuration file.

Booting the Device in Installed Mode

Procedure

	Command or Action	Purpose
Step 1	cp <i>source_file_path destination_file_path</i> Example: Switch# copy tftp://10.0.0.6/cat9k_iosxe.16.05.01a.SPA.bin usbflash0:	(Optional) Copies the bin file (<i>image.bin</i>) from the FTP or TFTP server to USB flash.
Step 2	request platform software package expand switch all file <i>source_file_path to flash</i> Example: Switch# request platform software package expand switch all file tftp://10.0.0.2/cat9k_iosxe.16.5.01a.SPA.bin to flash:	Expands the bin file stored in flash, FTP, TFTP, HTTP, or HTTPS server on the booted device. Note Ensure that the <i>packages.conf</i> file is available in the expanded list.
Step 3	reload Example: Switch# reload	Reloads the device. Note You can boot the device manually or automatically using the <i>packages.conf</i> file. If you are booting manually, you can proceed to Step 4. Otherwise, the device boots up automatically.
Step 4	boot flash:packages.conf Example: Switch: boot flash:packages.conf	Boots the device with the <i>packages.conf</i> file.
Step 5	show version Example:	Verifies that the device is in the INSTALL mode.

Booting the Device in Bundle Mode

There are several methods by which you can boot the device—either by copying the bin file from the TFTP server and then boot the device, or by booting the device straight from flash or USB flash using the commands **boot flash:<image.bin>** or **boot usbflash0:<image.bin>**.

The following procedure explains how to boot the device from the TFTP server in the bundle mode.

Procedure

	Command or Action	Purpose
Step 1	switch:BOOT=<source path of .bin file> Example:	Sets the boot parameters.

	Command or Action	Purpose
	<code>switch:BOOT=ftp://10.0.0.2/cat9k_iosxe.16.05.01a.SPA.bin</code>	
Step 2	boot Example: <code>switch: boot</code>	Boots the device.
Step 3	show version Example: <code>switch# show version</code>	Verifies that the device is in the BUNDLE mode.

Booting a Specific Software Image On a Switch Stack

By default, the switch attempts to automatically boot up the system using information in the BOOT environment variable. If this variable is not set, the switch attempts to load and execute the first executable image it can by performing a recursive, depth-first search throughout the flash file system. In a depth-first search of a directory, each encountered subdirectory is completely searched before continuing the search in the original directory. However, you can specify a specific image to boot up.

Procedure

	Command or Action	Purpose
Step 1	configure terminal Example: <code>Switch# configure terminal</code>	Enters global configuration mode.
Step 2	boot system switch {number | all} Example: <code>Switch(config)# boot system switch all flash:cat9k_iosxe.16.05.01a.SPA.bin</code>	(Optional) For switches in a stack, specifies the switch members on which the system image is loaded during the next boot cycle: <ul style="list-style-type: none"> • Use <i>number</i> to specify a stack member. (Specify only one stack member.) • Use all to specify all stack members.
Step 3	end Example: <code>Switch(config)# end</code>	Returns to privileged EXEC mode.
Step 4	show boot system Example: <code>Switch# show boot system</code>	Verifies your entries. The boot system global command changes the setting of the BOOT environment variable.

	Command or Action	Purpose
		During the next boot cycle, the switch attempts to automatically boot up the system using information in the BOOT environment variable.
Step 5	copy running-config startup-config Example: <pre>Switch# copy running-config startup-config</pre>	(Optional) Saves your entries in the configuration file.

Configuring a Scheduled Software Image Reload

This task describes how to configure your device to reload the software image at a later time.

Procedure

	Command or Action	Purpose
Step 1	configure terminal Example: <pre>Device# configure terminal</pre>	Enters global configuration mode.
Step 2	copy running-config startup-config Example: <pre>copy running-config startup-config</pre>	Saves your device configuration information to the startup configuration before you use the reload command.
Step 3	reload in [hh:]mm [text] Example: <pre>Device(config)# reload in 12</pre> <p>System configuration has been modified. Save? [yes/no]: y</p>	Schedules a reload of the software to take affect in the specified minutes or hours and minutes. The reload must take place within approximately 24 days. You can specify the reason for the reload in a string up to 255 characters in length.
Step 4	reload at hh: mm [month day | day month] [text] Example: <pre>Device(config)# reload at 14:00</pre>	Specifies the time in hours and minutes for the reload to occur. Note Use the at keyword only if the device system clock has been set (through Network Time Protocol (NTP), the hardware calendar, or manually). The time is relative to the configured time zone on the device. To schedule reloads across several devices to occur simultaneously, the time on each device must be synchronized with NTP.

	Command or Action	Purpose
Step 5	reload cancel Example: Device(config)# reload cancel	Cancels a previously scheduled reload.
Step 6	show reload Example: show reload	Displays information about a previously scheduled reload or identifies if a reload has been scheduled on the device.

Monitoring Device Setup Configuration

Example: Verifying the Device Running Configuration

```

Device# show running-config
Building configuration...

Current configuration: 1363 bytes
!
version 12.4
no service pad
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname Stack1
!
enable secret 5 $1$ej9.$DMUvAUnZOAmvmgqBEzIxEO
!
.
<output truncated>
.
interface gigabitethernet6/0/2
mvr type source

<output truncated>

...!
interface VLAN1
 ip address 172.20.137.50 255.255.255.0
 no ip directed-broadcast
 !
ip default-gateway 172.20.137.1 !
!
snmp-server community private RW
snmp-server community public RO
snmp-server community private@es0 RW
snmp-server community public@es0 RO
snmp-server chassis-id 0x12
!
end

```

Examples: Displaying Software Bootup in Install Mode

This example displays software bootup in install mode:

```
switch: boot flash:packages.conf
Attempting to boot from [flash:packages.conf]
Located packages.conf
#

validate_package: SHA-1 hash:
    expected 340D5091:2872A0DD:03E9068C:3FDBECAB:69786462
    calculated 340D5091:2872A0DD:03E9068C:3FDBECAB:69786462
Image parsed from conf file is cat9k-rpboot.16.05.01a.SPA.pkg
#####

Waiting for 120 seconds for other switches to boot
#####
Switch number is 1

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                San Jose, California 95134-1706

Cisco IOS Software [Everest], Catalyst L3 Switch Software (CAT9K_IOSXE), Version 16.5.1a,
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FIPS: Flash Key Check : Begin
FIPS: Flash Key Check : End, Not Found, FIPS Mode Not Enabled

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```
cisco C9300-48P (X86) processor with 818597K/6147K bytes of memory.
Processor board ID FCW2049G03S
2048K bytes of non-volatile configuration memory.
8388608K bytes of physical memory.
1638400K bytes of Crash Files at crashinfo:.
11264000K bytes of Flash at flash:.
0K bytes of WebUI ODM Files at webui:.
```

```
Base Ethernet MAC Address       : 04:6c:9d:01:3b:80
Motherboard Assembly Number    : 73-17956-04
Motherboard Serial Number     : FOC20465ABU
Model Revision Number         : P4B
Motherboard Revision Number   : 04
Model Number                  : C9300-48P
System Serial Number          : FCW2049G03S
```

```
%INIT: waited 0 seconds for NVRAM to be available
```

```
Defaulting CPP : Policer rate for all classes will be set to their defaults
```

```
Press RETURN to get started!
```

This example displays software bootup in bundle mode:

```
switch: boot flash:cat9k_iosxe.16.05.01a.SPA.bin
```

```
Attempting to boot from [flash:cat9k_iosxe.16.05.01a.SPA.bin]
```

```
Located cat9k_iosxe.16.05.01a.SPA.bin
```

```
#####
Warning: ignoring ROMMON var "BOOT_PARAM"
```

```
Waiting for 120 seconds for other switches to boot
```

```
#####
Switch number is 3
```

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cisco Systems, Inc.
170 West Tasman Drive
San Jose, California 95134-1706

Cisco IOS Software [Everest], Catalyst L3 Switch Software (CAT9K_IOSXE), Version 16.5.1a,

```

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```

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```

FIPS: Flash Key Check : Begin
FIPS: Flash Key Check : End, Not Found, FIPS Mode Not Enabled

```

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```

cisco C9300-24U (X86) processor with 818597K/6147K bytes of memory.
Processor board ID FCW2111G00X
2048K bytes of non-volatile configuration memory.
8388608K bytes of physical memory.
1638400K bytes of Crash Files at crashinfo:.
11264000K bytes of Flash at flash:.
15633392K bytes of USB Flash at usbflash0:.
0K bytes of WebUI ODM Files at webui:.

```

```

Base Ethernet MAC Address       : 04:6c:9d:1e:2a:80
Motherboard Assembly Number    : 73-17954-05
Motherboard Serial Number      : FOC21094MWL
Model Revision Number          : PP
Motherboard Revision Number    : 05
Model Number                   : C9300-24U
System Serial Number           : FCW2111G00X

```

```
%INIT: waited 0 seconds for NVRAM to be available
```

```
Defaulting CPP : Policer rate for all classes will be set to their defaults
```

```
Press RETURN to get started!
```

Example: Emergency Installation

This sample output is an example when the **emergency-install** boot command is initiated:

```
switch: emergency-install
tftp://223.255.254.254/auto/tftpboot/X86/cat9k_iosxe.16.05.01a.SPA.bin
WARNING: The system partition (bootflash:) will be erased during the system recovery install
process.
Are you sure you want to proceed? [y] y/n [n]: y
Starting system recovery
(tftp://223.255.254.254/auto/tftpboot/X86/cat9k_iosxe.16.05.01a.SPA.bin) ...
Attempting to boot from [sda9:cat9k-recovery.SSA.bin]
Located cat9k-recovery.SSA.bin
#####

Warning: ignoring ROMMON var "BOOT_PARAM"

PLATFORM_TYPE C9300 speed 9600

Booting Recovery Image 16.5.1a

Initiating Emergency Installation of bundle
tftp://223.255.254.254/auto/tftpboot/X86/cat9k_iosxe.16.05.01a.SPA.bin

Downloading bundle tftp://223.255.254.254/auto/tftpboot/X86/cat9k_iosxe.16.05.01a.SPA.bin...
curl_vrf=2
  % Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
                                 Dload  Upload   Total   Spent    Left   Speed
100 485M  100 485M    0     0 5143k      0  0:01:36  0:01:36 ---:---: 5256k
100 485M  100 485M    0     0 5143k      0  0:01:36  0:01:36 ---:---: 5143k

Validating bundle tftp://223.255.254.254/auto/tftpboot/X86/cat9k_iosxe.16.05.01a.SPA.bin...
Installing bundle tftp://223.255.254.254/auto/tftpboot/X86/cat9k_iosxe.16.05.01a.SPA.bin...
Verifying bundle tftp://223.255.254.254/auto/tftpboot/X86/cat9k_iosxe.16.05.01a.SPA.bin...
Package cat9k-cc_srdriver.16.05.01a.SPA.pkg /temp//stage/cat9k-cc_srdriver.16.05.01a.SPA.pkg
is Digitally Signed
Package cat9k-espbase.16.05.01a.SPA.pkg /temp//stage/cat9k-espbase.16.05.01a.SPA.pkg is
Digitally Signed
Package cat9k-guestshell.16.05.01a.SPA.pkg /temp//stage/cat9k-guestshell.16.05.01a.SPA.pkg
is Digitally Signed
Package cat9k-rpbase.16.05.01a.SPA.pkg /temp//stage/cat9k-rpbase.16.05.01a.SPA.pkg is
Digitally Signed
Package cat9k-sipbase.16.05.01a.SPA.pkg /temp//stage/cat9k-sipbase.16.05.01a.SPA.pkg is
Digitally Signed
Package cat9k-sipspace.16.05.01a.SPA.pkg /temp//stage/cat9k-sipspace.16.05.01a.SPA.pkg is
Digitally Signed
Package cat9k-srdriver.16.05.01a.SPA.pkg /temp//stage/cat9k-srdriver.16.05.01a.SPA.pkg is
Digitally Signed
Package cat9k-webui.16.05.01a.SPA.pkg /temp//stage/cat9k-webui.16.05.01a.SPA.pkg is Digitally
Signed
Package cat9k-wlc.16.05.01a.SPA.pkg /temp//stage/cat9k-wlc.16.05.01a.SPA.pkg is Digitally
Signed
Package /cat9k-rpboot.16.05.01a.SPA.pkg /temp//rpboot/cat9k-rpboot.16.05.01a.SPA.pkg is
Digitally Signed
Preparing flash....
Flash filesystem unmounted successfully /dev/sdb3
```

```

Syncing device...
Emergency Install successful... Rebooting
Will reboot now

Initializing Hardware...

System Bootstrap, Version 16.5.2r, RELEASE SOFTWARE (P)
Compiled Wed 05/31/2017 15:58:35.22 by rel

Current image running:
Primary Rommon Image

Last reset cause: SoftwareReload
C9300-24U platform with 8388608 Kbytes of main memory

```

Configuration Examples for Performing Device Setup

Example: Configuring a Device as a DHCP Server

```

Device# configure terminal
Device(config)# ip dhcp pool pool1
Device(dhcp-config)# network 10.10.10.0 255.255.255.0
Device(dhcp-config)# boot config-boot.text
Device(dhcp-config)# default-router 10.10.10.1
Device(dhcp-config)# option 150 10.10.10.1
Device(dhcp-config)# exit
Device(config)# tftp-server flash:config-boot.text
Device(config)# interface gigabitethernet 1/0/4
Device(config-if)# no switchport
Device(config-if)# ip address 10.10.10.1 255.255.255.0
Device(config-if)# end

```

Example: Configuring DHCP Auto-Image Update

Example: Configuring a Device to Download Configurations from a DHCP Server

This example uses a Layer 3 SVI interface on VLAN 99 to enable DHCP-based autoconfiguration with a saved configuration:

```

Device# configure terminal
Device(config)# boot host dhcp
Device(config)# boot host retry timeout 300
Device(config)# banner config-save ^C Caution - Saving Configuration File to NVRAM May Cause
You to No longer Automatically Download Configuration Files at Reboot^C
Device(config)# vlan 99
Device(config-vlan)# interface vlan 99
Device(config-if)# no shutdown
Device(config-if)# end
Device# show boot
BOOT path-list:

```

```

Config file:          flash:/config.text
Private Config file: flash:/private-config.text
Enable Break:        no
Manual Boot:         no
HELPER path-list:
NVRAM/Config file
    buffer size:     32768
Timeout for Config
    Download:        300 seconds
Config Download
    via DHCP:        enabled (next boot: enabled)
Device#

```

Examples: Scheduling Software Image Reload

This example shows how to reload the software on the device on the current day at 7:30 p.m:

```

Device# reload at 19:30
Reload scheduled for 19:30:00 UTC Wed Jun 5 2013 (in 2 hours and 25 minutes)
Proceed with reload? [confirm]

```

This example shows how to reload the software on the device at a future time:

```

Device# reload at 02:00 jun 20
Reload scheduled for 02:00:00 UTC Thu Jun 20 2013 (in 344 hours and 53 minutes)
Proceed with reload? [confirm]

```

Additional References For Performing Device Setup

Related Documents

Related Topic	Document Title
Device setup commands Boot loader commands	<i>Command Reference (Catalyst 9300 Series Switches)</i>
Hardware installation	<i>Cisco Catalyst 9300 Series Switches Hardware Installation Guide</i>

Standards and RFCs

Standard/RFC	Title
None	—

MIBs

MIB	MIBs Link
All supported MIBs for this release.	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
<p>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies.</p> <p>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.</p> <p>Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</p>	http://www.cisco.com/support

Feature History and Information For Performing Device Setup Configuration

Command History

Release	Modification
Cisco IOS XE Everest 16.5.1a	This feature was introduced.



CHAPTER 3

Configuring Right-To-Use Licenses

- [Finding Feature Information, on page 73](#)
- [Restrictions for Configuring RTU Licenses, on page 73](#)
- [Information About Configuring RTU Licenses, on page 74](#)
- [How to Configure RTU Licenses, on page 75](#)
- [CLI for Permissible License Combinations, on page 80](#)
- [Monitoring and Maintaining RTU Licenses, on page 81](#)
- [Configuration Examples for RTU Licensing, on page 82](#)
- [Additional References for RTU Licensing, on page 85](#)
- [Feature History and Information for RTU Licensing, on page 86](#)

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 at the end of this module.

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

Restrictions for Configuring RTU Licenses

The following are the restrictions for configuring and using RTU licenses.

- To activate a license, you must reboot your switch after configuring the new license level.
- An expired evaluation license can not be reactivated after reboot.
- Stack members of a switch stack must run the same license level. If the license level is different, the switch will not join the stack until it is changed and rebooted from the active switch of the stack.

Information About Configuring RTU Licenses

Right-To-Use Licensing

The software features available with Right-to-use (RTU) licensing falls under the base or add-on license levels. The license types available are:

- Base licenses—These can be ordered as a permanent license.
 - Network Essentials
 - Network Advantage (Contains Network Essentials plus more)
- Add-on licenses—These can be subscribed for a fixed term of 3, 5, and 7 years.
 - Digital Networking Architecture (DNA) Essentials
 - DNA Advantage (Contains DNA Essentials plus more)

After the initial term of the add-on license expires, you will be able to continue using the base license by deactivating the add-on license and reloading the device.

To activate a license, you must accept the End-User License Agreement (EULA) and reboot the device.

Cisco Smart Software Manager (CSSM) simplifies the licensing experience across the enterprise making it easier to purchase, deploy, track and renew Cisco software. It provides visibility into license ownership and consumption through a single user interface.

To find info about platform support and to know which license levels a feature is available with, use Cisco Feature Navigator. To access Cisco Feature Navigator, go to <http://www.cisco.com/go/cfn>. An account on Cisco.com is not required.

RTU licenses are available as per the following durations:

- Permanent licenses—Purchased with a specific feature set with no expiration date. It can be transferred from one device to another.
- Term licenses—Purchased with a feature set for a specific subscription period. You can verify the expiration date from Cisco Smart Software Manager (CSSM).
- Evaluation licenses—Pre-installed on the device and valid for a 90-day trial period. They cannot be ordered or transferred to another device. Once activated, this type of license cannot be deactivated until it expires. Warning system messages about the evaluation license expiry are generated 10 and 5 days before the 90-day period and everyday after that. After your evaluation period expires, at the next reload, the device returns to its default license and network operations are not impacted.

When ordering an add-on license with a base license, note the combinations that are permitted and those that are not permitted.

Table 6: License Combinations

Combinations	License Level
Permitted License Combinations	Network Essentials + DNA Essentials
	Network Advantage + DNA Essentials
	Network Advantage + DNA Advantage



Note You cannot add a DNA Advantage license to Network Essentials base license.

License Activation for Switch Stacks

Right-to-use licensing is supported on switch stacks. A switch is a set of up to nine stacking-capable switches connected through StackWise-480 ports. One switch in the stack is identified as the active switch and the remaining switches are standby switches. The active switch is the switch that is activated with an RTU license and from its active console, the license level for the standby switches in the stack can be activated at the same time.

To change the license level on a new stack member, use the console of the active switch to set the same license level on the new stack member and reboot it.



Note A switch stack cannot contain mixed license levels.

How to Configure RTU Licenses

Activating a License

Procedure

	Command or Action	Purpose
Step 1	<p><code>license right-to-use [activate | deactivate] [network-essentials | network-advantage] [all | evaluation {all | slot slot-number <1-8>}] [acceptEULA]</code></p> <p>Example:</p> <pre>Device# license right-to-use activate network-essentials all acceptEULA</pre>	<p>Activates the license level. Activation can happen on all switches and also include the EULA acceptance.</p> <p>Note If you do not accept EULA, the modified configuration will not take effect after reload. The default license (or a license that was not deactivated) becomes active after reload.</p>

	Command or Action	Purpose
Step 2	<p>license right-to-use [activate | deactivate] addon [dna-essentials | dna-advantage] [all | evaluation | subscription {all | slot slot-number <1-8>}] [acceptEULA]</p> <p>Example:</p> <pre>Device# license right-to-use activate addon dna-essentials subscription all acceptEULA</pre>	<p>Activates the license level. Activation can happen on all switches and also include the EULA acceptance.</p> <p>Note If you do not accept EULA, the modified configuration will not take effect after reload. The default license (or a license that was not deactivated) becomes active after reload.</p>
Step 3	<p>reload [LINE | at | cancel | in | slot device-member-number | standby-cpu]</p> <p>Example:</p> <pre>Device# reload slot 1 Proceed with reload? [confirm] y</pre>	<p>Reloads a specific device member to complete the activation process.</p> <p>When changing license level, you are not required to save the configuration. But, it is a good practice to ensure all the configuration is stored properly before reload. Changing from a higher license level to a lower license level on reboot will remove CLIs that are not applicable. Ensure that all features in the lower license level that are actively used are not removed.</p>
Step 4	<p>show license right-to-use usage [slot slot-number]</p> <p>Example:</p> <pre>Device# show license right-to-use usage Slot# License Name Type usage-duration(y:m:d) In-Use EULA 1 network-essentials Permanent 0 :0 :3 no yes 1 network-essentials Evaluation 0 :0 :0 no no 1 network-essentials Subscription 0 :0 :0 no no 1 network-advantage Permanent 0 :0 :6 yes yes 1 network-advantage Evaluation 0 :0 :0 no no 1 network-advantage Subscription 0 :0 :0 no no 1 dna-essentials Evaluation 0 :0 :0 no no 1 dna-essentials Subscription 0 :0 :0 no no 1 dna-advantage Evaluation 0 :0 :0 no no 1 dna-advantage Subscription 0 :0 :6 yes yes</pre>	<p>Displays detailed usage information.</p>

	Command or Action	Purpose
	Device#	

Rehosting a License

To rehost a license, you have to deactivate the license from one device and then activate the same license on another.

Procedure

	Command or Action	Purpose
Step 1	license right-to-use deactivate [license-level] slot <i>slot-num</i> Example: Device# <code>license right-to-use deactivate network-essentials slot 1</code>	Deactivates the license on one device. The network-essentials license is considered for the example.
Step 2	license right-to-use activate [license-level] slot <i>slot-num</i> [acceptEULA] Example: Device# <code>license right-to-use activate network-essentials slot 2 acceptEULA</code>	Activates the license on another device. The network-essentials license is considered for the example.

Upgrading a Network Essentials License to Network Advantage

Procedure

	Command or Action	Purpose
Step 1	license right-to-use activate network-advantage slot <i>switch-ID</i> acceptEULA	Activates Network Advantage license. Enter the switch ID. Enter acceptEULA to indicate acceptance.
Step 2	show license right-to-use summary	Check the reboot license level is Network Advantage.
Step 3	reload	Reboots the switch to boot with Network Advantage.

Activating DNA Essentials License on a SKU with a Network Essentials License

Procedure

	Command or Action	Purpose
Step 1	<code>license right-to-use activate addon dna-essentials subscription slot <i>switch-ID</i> acceptEULA</code>	Activates DNA Essentials license. Enter the switch ID. Enter acceptEULA to indicate acceptance.
Step 2	<code>show license right-to-use summary</code>	Check the reboot license level is DNA Essentials.
Step 3	<code>reload</code>	Reboots the switch to boot with DNA Essentials.

Evaluating a Network Advantage License on a SKU with a Network Essentials License

Procedure

	Command or Action	Purpose
Step 1	<code>license right-to-use activate network-advantage evaluation slot <i>switch-ID</i> acceptEULA</code>	Activates the Network Advantage evaluation license. Enter the switch ID. Enter acceptEULA to indicate acceptance.
Step 2	<code>show license right-to-use summary</code>	Check the reboot license level is Network Advantage evaluation.
Step 3	<code>reload</code>	Reboots the switch to boot with Network Advantage evaluation license.

Deactivating an Evaluation Network Advantage License on a Network Essentials SKU

Procedure

	Command or Action	Purpose
Step 1	<code>license right-to-use deactivate network-advantage evaluation slot <i>switch-ID</i> acceptEULA</code>	Deactivates the Network Advantage evaluation license. Enter the switch ID.

	Command or Action	Purpose
Step 2	<code>show license right-to-use summary</code>	Check the reboot license level is Network Essentials.
Step 3	<code>reload</code>	Reboots the switch to boot with Network Essentials.

Upgrading a Network Essentials Stack to a Network Advantage Stack

Procedure

	Command or Action	Purpose
Step 1	<code>license right-to-use activate network-advantage all acceptEULA</code>	Activates the Network Advantage license on all the switches in the stack. Enter <code>acceptEULA</code> to indicate acceptance.
Step 2	<code>show license right-to-use summary</code>	Check the reboot license level is Network Advantage for all the switches.
Step 3	<code>reload</code>	Reboots all the switches to boot with Network Advantage.

Changing the License Level of License Mismatch Switch from Active's Console

If the license mismatch switch has a lower license level than other switches in the stack, and the stack is running at Network Advantage and the mismatch switch is booted with Network Essentials license:

Procedure

	Command or Action	Purpose
Step 1	<code>show switch</code>	Get the switch number in license mismatch state.
Step 2	<code>show license right-to-use mismatch</code>	Check the license level of the license mismatch switch.
Step 3	<code>license right-to-use activate network-advantage slot switch-ID</code>	Activates Network Advantage license on all the mismatched switches in the stack. Enter <code>acceptEULA</code> to indicate acceptance. If the license mismatch switch has a higher license level than other switches in the stack, and the stack is running at Network Essentials and the mismatch switch is booted with Network Advantage license, use network-essentials instead of network advantage .

	Command or Action	Purpose
Step 4	<code>reload slot <i>switch-ID</i></code>	Reboots the switch to boot with Network Advantage.

CLI for Permissible License Combinations

Table 7: Base Licenses

Network Essentials
Network Essentials (Single Device)
license right-to-use [activate | deactivate] network-essentials [acceptEULA] license right-to-use [activate | deactivate] network-essentials evaluation [acceptEULA]
Network Essentials (Stack: all)
license right-to-use [activate | deactivate] network-essentials all [acceptEULA] license right-to-use [activate | deactivate] network-essentials evaluation all [acceptEULA]
Network Essentials (Stack: slot)
license right-to-use [activate | deactivate] network-essentials slot <switch id> [acceptEULA] license right-to-use [activate | deactivate] network-essentials evaluation slot <switch id> [acceptEULA]
Network Advantage
Network Advantage (Single Device)
license right-to-use [activate | deactivate] network-advantage [acceptEULA] license right-to-use [activate | deactivate] network-advantage evaluation [acceptEULA]
Network Advantage (Stack: all)
license right-to-use [activate | deactivate] network-advantage all [acceptEULA] license right-to-use [activate | deactivate] network-advantage evaluation all [acceptEULA]
Network Advantage (Stack: slot)
license right-to-use [activate | deactivate] network-advantage slot <switch id> [acceptEULA] license right-to-use [activate | deactivate] network-advantage evaluation slot <switch id> [acceptEULA]

Table 8: Add-on Licenses

DNA Essentials
DNA Essentials (Single Device)

DNA Essentials
license right-to-use [activate | deactivate] addon dna-essentials subscription [acceptEULA] license right-to-use [activate | deactivate] addon dna-essentials evaluation [acceptEULA]
DNA Essentials (Stack: all)
license right-to-use [activate | deactivate] addon dna-essentials subscription all [acceptEULA] license right-to-use [activate | deactivate] addon dna-essentials evaluation all [acceptEULA]
DNA Essentials (Stack: slot)
license right-to-use [activate | deactivate] addon dna-essentials subscription slot <switch id> [acceptEULA] license right-to-use [activate | deactivate] addon dna-essentials evaluation slot <switch id> [acceptEULA]
DNA Advantage
DNA Advantage (Single Device)
license right-to-use [activate | deactivate] addon dna-advantage subscription [acceptEULA] license right-to-use [activate | deactivate] addon dna-advantage evaluation [acceptEULA]
DNA Advantage (Stack: all)
license right-to-use [activate | deactivate] addon dna-advantage subscription all [acceptEULA] license right-to-use [activate | deactivate] addon dna-advantage evaluation all [acceptEULA]
DNA Advantage (Stack: slot)
license right-to-use [activate | deactivate] addon dna-advantage subscription slot <switch id> [acceptEULA] license right-to-use [activate | deactivate] addon dna-advantage evaluation slot <switch id> [acceptEULA]

Monitoring and Maintaining RTU Licenses

Command	Purpose
show license right-to-use default	Displays the default license information.
show license right-to-use detail	Displays detailed information of the licenses on the device.
show license right-to-use eula {evaluation | permanent | subscription}	Displays the end user license agreement.
show license right-to-use mismatch	Displays the license information that does not match.
show license right-to-use summary	Displays a summary of the license information on the device.

Command	Purpose
<code>show license right-to-use slot <i>slot-number</i></code>	Displays the license information for a specific slot in a switch stack.
<code>show license right-to-use usage [slot <i>slot-number</i>]</code>	Displays detailed information about usage for all licenses in the switch stack.
<code>show switch</code>	Displays detailed information of every member in a switch stack including the state of the license.

Configuration Examples for RTU Licensing

Example: Displaying RTU Licensing Information

This example shows the RTU licensing information on the device.

Example Output with Base (Permanent) License

```
Switch# show license right-to-use summary

      License Name          Type      Period left
-----
network-essentials        Permanent  Lifetime
-----

License Level In Use: network-essentials
License Level on Reboot: network-essentials
```

Example Output with Add-on (Term) License

```
Switch# show license right-to-use summary

Switch#show license right-to-use summary
      License Name          Type      Period left
-----
network-advantage        Permanent  Lifetime
dna-advantage            Subscription  CSSM Managed
-----

License Level In Use: network-advantage+dna-advantage Subscription
License Level on Reboot: network-advantage+dna-advantage Subscription
```

Example Output with Evaluation License

```
Switch# show license right-to-use summary

Switch#show license right-to-use summary
      License Name          Type      Period left
-----
network-advantage        Evaluation  90
```



```

          dna-advantage      Evaluation          90
-----

```

```

License Level In Use: network-advantage Evaluation+dna-advantage Evaluation
License Level on Reboot: network-advantage Evaluation+dna-advantage Evaluation

```

Example: Displaying RTU License Details

This example shows all the detailed information for the RTU licenses on slot 1:

```

Switch# show license right-to-use detail slot 1
Index 1
License Name      : network-essentials
Period left      : Lifetime
License Type     : Permanent
License State    : Not Activated
License Location: Slot 1
Index 2
License Name      : network-essentials
Period left      : 90
License Type     : Evaluation
License State    : Not Activated
License Location: Slot 1
Index 3
License Name      : network-essentials
Period left      : CSSM Managed
License Type     : Subscription
License State    : Active, Not In use
License Location: Slot 1
Index 4
License Name      : network-advantage
Period left      : Lifetime
License Type     : Permanent
License State    : Not Activated
License Location: Slot 1
Index 5
License Name      : network-advantage
Period left      : 90
License Type     : Evaluation
License State    : Not Activated
License Location: Slot 1
Index 6
License Name      : network-advantage
Period left      : CSSM Managed
License Type     : Subscription
License State    : Active, In use
License Location: Slot 1
Index 7
License Name      : dna-essentials
Period left      : 90
License Type     : Evaluation
License State    : Not Activated
License Location: Slot 1
Index 8
License Name      : dna-essentials
Period left      : CSSM Managed
License Type     : Subscription
License State    : Active, Not In use
License Location: Slot 1
Index 9

```

Example: Displaying RTU License Mismatch

```

License Name      : dna-advantage
Period left      : 90
License Type     : Evaluation
License State    : Not Activated
License Location : Slot 1
Index 10
License Name      : dna-advantage
Period left      : CSSM Managed
License Type     : Subscription
License State    : Active, In use
License Location : Slot 1

```

Example: Displaying RTU License Mismatch

This example shows the license information of the switches in a stack and a mismatch state of a member switch. The member must match the active.

```
Switch# show switch
```

```

Switch/Stack Mac Address : 1c1d.8625.7700 - Local Mac Address
                                     H/W   Current
Switch#  Role      Mac Address      Priority Version  State
-----
 1      Standby  046c.9d01.b580   1       V01     Ready
 2      Member   046c.9d01.be00   1       V01     Lic-Mismatch
 *3     Active   046c.9d01.b180   1       V01     Ready

```



Note To resolve the license mismatch, first check the RTU license summary:

```
Switch# show license right-to-use
```

Then change the license level of the mismatched switched so that it is the same license level of the active switch. This example shows that the Network Advantage license was activated for the member switch to match the active switch.

```
Switch# license right-to-use activate network-advantage slot 2 acceptEULA
```

Example: Displaying RTU Licensing Usage

This example shows the detailed licensing usage on your switch. EULA was accepted and stateshows in use, but afterreboot the evaluation license will be deactivated.

```

Switch# show license right-to-use usage
Slot#      License Name      Type  usage-duration(y:m:d)  In-Use  EULA
-----
 1 network-essentials  Permanent          0 :0 :0                no       no
 1 network-essentials  Evaluation         0 :0 :0                no       no
 1 network-essentials  Subscription       0 :0 :0                no       yes
 1 network-advantage   Permanent          0 :0 :0                no       no

```

```

1 network-advantage Evaluation 0 :0 :0 no no
1 network-advantage Subscription 0 :0 :0 yes yes
1 dna-essentials Evaluation 0 :0 :0 no no
1 dna-essentials Subscription 0 :0 :0 no yes
1 dna-advantage Evaluation 0 :0 :0 no no
1 dna-advantage Subscription 0 :0 :0 yes yes
-----
    
```

Additional References for RTU Licensing

Related Documents

Related Topic	Document Title
For complete syntax and usage information for the commands used in this chapter.	

Standards and RFCs

Standard/RFC	Title
None	—

MIBs

MIB	MIBs Link
Object ciscoLicenseMIB OID 1.3.6.1.4.1.9.9.359 CISCO-LICENSE-MGMT-MIB ; - View Supporting Images	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
<p>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies.</p> <p>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.</p> <p>Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</p>	http://www.cisco.com/support

Feature History and Information for RTU Licensing

Release	Feature Information
Cisco IOS XE 16.5.1a	This feature is introduced.



CHAPTER 4

Configuring Application Visibility and Control in a Wired Network

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Finding Feature Information

Your software release may not support all of the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release.

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

Information About Application Visibility and Control in a Wired Network

Application Visibility and Control (AVC) is a critical part of Cisco's efforts to evolve its Branch and Campus solutions from being strictly packet and connection based to being application-aware and application-intelligent. Application Visibility and Control (AVC) classifies applications using deep packet inspection techniques with the Network-Based Application Recognition (NBAR2) engine. AVC can be configured on wired access ports for standalone switches as well as for a switch stack. NBAR2 can be activated either explicitly on the interface by enabling protocol-discovery or implicitly by attaching a QoS policy that contains **match protocol** classifier. Wired AVC Flexible NetFlow (FNF) can be configured on an interface to provide client, server and application

statistics per interface. The record is similar to **application-client-server-stats** traffic monitor which is available in **application-statistics** and **application-performance** profiles in Easy Performance Monitor (Easy perf-mon or ezPM).

Supported AVC Class Map and Policy Map Formats

Supported AVC Class Map Format

Class Map Format	Class Map Example	Direction
match protocol <i>protocol name</i>	<code>class-map match-any NBAR-VOICE match protocol ms-lync-audio</code>	Both ingress and egress
Combination filters	<code>class-map match-any NBAR-VOICE match protocol ms-lync-audio match dscp ef</code>	Both ingress and egress

Supported AVC Policy Format

Policy Format	QoS Action
Egress policy based on match protocol filter	Mark and police
Ingress policy based on match protocol filter	Mark and police

The following table describes the detailed AVC policy format with an example:

AVC Policy Format	AVC Policy Example	Direction
Basic set	<code>policy-map MARKING-IN class NBAR-MM_CONFERENCING set dscp af41</code>	Ingress and egress
Basic police	<code>policy-map POLICING-IN class NBAR-MM_CONFERENCING police cir 600000 set dscp af41</code>	Ingress and egress
Basic set and police	<code>policy-map webex-policy class webex-class set dscp ef cos police 5000000</code>	Ingress and egress
Multiple set and police including default	<code>policy-map webex-policy class webex-class set dscp af31 cos police 4000000 class class-webex-category set dscp ef cos police 6000000 class class-default set dscp <></code>	Ingress and egress

AVC Policy Format	AVC Policy Example	Direction
Hierarchical police	<pre> policy-map webex-policy class webex-class police 5000000 service-policy client-in-police-only policy-map client-in-police-only class webex-class police 100000 class class-webex-category set dscp ef cos police 200000 </pre>	Ingress and egress
Hierarchical set and police	<pre> policy-map webex-policy class class-default police 1500000 service policy client-up-child policy-map webex-policy class webex-class police 100000 set dscp ef class class-webex-category police 200000 set dscp af31 </pre>	

Restrictions for Wired Application Visibility and Control

- NBAR based QoS policy configuration is allowed only on wired physical ports. Policy configuration is not supported on virtual interfaces, for example, VLAN, Port-Channel and other logical interfaces.
- Only one of the NBAR based QoS mechanisms are allowed to be attached to any port at the same time, either protocol based or attributes based. Only the following two attributes are supported :
 - traffic-class
 - business-relevance
- The legacy WDAVC QoS limitations are still applicable:
 - Only marking and policing are supported.
 - Supports only physical interfaces.
 - There is a delay in the QoS classification since the application classification is done offline (while the initial packet/s of the flow are meanwhile forwarded before the correct QoS classification).
- NBAR2 based match criteria **match protocol** will be allowed only with marking or policing actions. NBAR2 match criteria will not be allowed in a policy that has queuing features configured.
- ‘Match Protocol’: up to 255 concurrent different protocols in all policies (8 bits HW limitation).
- AVC is not supported on management port (Gig 0/0).
- IPv6 packet classification is not supported.

- Only IPv4 unicast(TCP/UDP) is supported.
- Web UI: You can configure application visibility and perform application monitoring from the Web UI. Application Control can only be done using the CLI. It is not supported on the Web UI.
To manage and check wired AVC traffic on the Web UI, you must first configure **ip http authentication local** and **ip nbar http-service** commands using the CLI.
- NBAR and ACL logging cannot be configured together on the same switch.
- Protocol-discovery, application-based QoS, and wired AVC FNF cannot be configured together at the same time on the same interface with the non-application-based FNF. However, these wired AVC features can be configured with each other. For example, protocol-discovery, application-based QoS and wired AVC FNF can be configured together on the same interface at the same time.
- AVC and Encrypted Traffic Analytics (ETA) cannot be configured together at the same time on the same interface.
- Up to two wired AVC monitors with different records can be attached to an interface at the same time. Prior to Cisco IOS XE Fuji 16.9.1, only a single predefined record was supported with wired AVC FNF.
- Attachment should be done only on physical Layer2 (Access/Trunk) and Layer3 ports. Uplink can be attached as long as it is a single uplink and is not part of a port channel.
- Performance: Each switch member is able to handle 500 connections per second (CPS) at less than 50% CPU utilization.
- Scale: Able to handle up to 10,000 bi-directional flows per 48 access ports and 5000 bi-directional flows per 24 access ports. (~200 flows per access port).
- Wired AVC allows only the fixed set of fields listed in the procedures of this chapter. Other combinations are not allowed. For a regular FNF flow monitor, other combinations are allowed (for the list of supported FNF fields, refer the "Configuring Flexible NetFlow" chapter of the *Network Management Configuration Guide*).

How to Configure Application Visibility and Control

Configuring Application Visibility and Control in a Wired Network

To configure application visibility and control on wired ports, follow these steps:

Configuring Visibility :

- Activate NBAR2 engine by enabling protocol-discovery on the interface using the **ip nbar protocol-discovery** command in the interface configuration mode. See the *Enabling Application Recognition on an Interface* section.

Configuring Control : Configure QoS policies based on application by

1. Creating an AVC QoS policy.
2. Applying AVC QoS policy to the interface.

Configuring application-based Flexible Netflow :

- Create a flow record by specifying key and non-key fields to the flow.
- Create a flow exporter to export the flow record.
- Create a flow monitor based on the flow record and the flow exporter.
- Attach the flow monitor to the interface.

Protocol-Discovery, application-based QoS and application-based FNF are all independent features. They can be configured independently or together on the same interface at the same time.

Enabling Application Recognition on an interface

To enable application recognition on an interface, follow these steps:

Procedure

	Command or Action	Purpose
Step 1	configure terminal Example: Device# <code>configure terminal</code>	Enters global configuration mode.
Step 2	interface <i>interface-id</i> Example: Device(config)# <code>interface gigabitethernet 1/0/1</code>	Specifies the interface for which you are enabling protocol-discovery and enters interface configuration mode.
Step 3	ip nbar protocol-discovery Example: Device(config-if)# <code>ip nbar protocol-discovery</code>	Enables application recognition on the interface by activating NBAR2 engine.
Step 4	end Example: Device(config-if)# <code>end</code>	Returns to privileged EXEC mode.

Creating AVC QoS Policy

To create AVC QoS policy, perform these general steps:

1. Create a class map with match protocol filters.
2. Create a policy map.
3. Apply the policy map to the interface.

Creating a Class Map

You need to create a class map before configuring any match protocol filter. The QoS actions such as marking and policing can be applied to the traffic. The AVC match protocol filters are applied to the wired access ports. For more information about the protocols that are supported, see http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/qos_nbar/prot_lib/config_library/nbar-prot-pack-library.html.

Procedure

	Command or Action	Purpose
Step 1	configure terminal Example: Device# <code>configure terminal</code>	Enters global configuration mode.
Step 2	class-map <i>class-map-name</i> Example: Device(config)# <code>class-map webex-class</code>	Creates a class map.
Step 3	match protocol <i>application-name</i> Example: Device(config)# <code>class-map webex-class</code> Device(config-cmap)# <code>match protocol webex-media</code>	Specifies match to the application name.
Step 4	end Example: Device(config)# <code>end</code>	Returns to privileged EXEC mode. Alternatively, you can also press Ctrl-Z to exit global configuration mode.

Creating a Policy Map

Procedure

	Command or Action	Purpose
Step 1	configure terminal Example: Device# <code>configure terminal</code>	Enters global configuration mode.
Step 2	policy-map <i>policy-map-name</i> Example: Device(config)# <code>policy-map webex-policy</code>	Creates a policy map by entering the policy map name, and enters policy-map configuration mode. By default, no policy maps are defined. The default behavior of a policy map is to set the DSCP to 0 if the packet is an IP packet and to set the CoS to 0 if the packet is tagged. No policing is performed.

	Command or Action	Purpose
		<p>Note To delete an existing policy map, use the no policy-map <i>policy-map-name</i> global configuration command.</p>
Step 3	<p>class [<i>class-map-name</i> | class-default]</p> <p>Example:</p> <pre>Device(config-pmap) # class webex-class</pre>	<p>Defines a traffic classification, and enters policy-map class configuration mode.</p> <p>By default, no policy map and class maps are defined.</p> <p>If a traffic class has already been defined by using the class-map global configuration command, specify its name for <i>class-map-name</i> in this command.</p> <p>A class-default traffic class is predefined and can be added to any policy. It is always placed at the end of a policy map. With an implied match any is included in the class-default class, all packets that have not already matched the other traffic classes will match class-default.</p> <p>Note To delete an existing class map, use the no class <i>class-map-name</i> policy-map configuration command.</p>
Step 4	<p>police <i>rate-bps burst-byte</i></p> <p>Example:</p> <pre>Device(config-pmap-c) # police 100000 80000</pre>	<p>Defines a policer for the classified traffic.</p> <p>By default, no policer is defined.</p> <ul style="list-style-type: none"> For <i>rate-bps</i>, specify an average traffic rate in bits per second (b/s). The range is 8000 to 10000000000. For <i>burst-byte</i>, specify the normal burst size in bytes. The range is 8000 to 1000000.
Step 5	<p>set { dscp <i>new-dscp</i> | cos <i>cos-value</i> }</p> <p>Example:</p> <pre>Device(config-pmap-c) # set dscp 45</pre>	<p>Classifies IP traffic by setting a new value in the packet.</p> <ul style="list-style-type: none"> For dscp <i>new-dscp</i>, enter a new DSCP value to be assigned to the classified traffic. The range is 0 to 63.
Step 6	<p>end</p> <p>Example:</p> <pre>Device(config) # end</pre>	<p>Returns to privileged EXEC mode.</p> <p>Alternatively, you can also press Ctrl-Z to exit global configuration mode.</p>

Applying a QoS Policy to the switch port

Procedure

	Command or Action	Purpose
Step 1	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 2	interface <i>interface-id</i> Example: Device (config)# interface GigabitEthernet 1/0/1	Enters the interface configuration mode.
Step 3	service-policy input <i>polycymapname</i> Example: Device (config-if)# service-policy input MARKING_IN	Applies local policy to interface.
Step 4	end Example: Device (config)# end	Returns to privileged EXEC mode. Alternatively, you can also press Ctrl-Z to exit global configuration mode.

Configuring Wired AVC Flexible Netflow

Creating a Flow Record

A single flow record can be configured and associated with a flow monitor.

Procedure

	Command or Action	Purpose
Step 1	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 2	flow record <i>flow_record_name</i> Example: Device (config)# flow record flow-record-1	Enters flow record configuration mode.
Step 3	description <i>description</i> Example: Device (config-flow-record)# description flow-record-1	(Optional) Creates a description for the flow record.

	Command or Action	Purpose
Step 4	match ipv4 version Example: Device (config-flow-record)# match ipv4 version	Specifies a match to the IP version from the IPv4 header.
Step 5	match ipv4 protocol Example: Device (config-flow-record)# match ipv4 protocol	Specifies a match to the IPv4 protocol.
Step 6	match application name Example: Device (config-flow-record)# match application name	Specifies a match to the application name. Note This action is mandatory for AVC support, as this allows the flow to be matched against the application.
Step 7	match connection client ipv4 address Example: Device (config-flow-record)# match connection client ipv4 address	Specifies a match to the IPv4 address of the client (flow initiator).
Step 8	match connection server ipv4 address Example: Device (config-flow-record)# match connection server ipv4 address	Specifies a match to the IPv4 address of the server (flow responder).
Step 9	match connection server transport port Example: Device (config-flow-record)# match connection server transport port	Specifies a match to the transport port of the server.
Step 10	match flow observation point Example: Device (config-flow-record)# match flow observation point	Specifies a match to the observation point ID for flow observation metrics.
Step 11	collect flow direction Example: Device (config-flow-record)# collect flow direction	Specifies to collect the direction — Ingress or Egress — of the relevant side — Initiator or Responder — of the bi-directional flow that is specified by the initiator keyword in the collect connection initiator command in the step below. Depending on the value specified by the initiator keyword, the flow direction keyword takes the following values : <ul style="list-style-type: none"> • 0x01 = Ingress Flow • 0x02 = Egress Flow

	Command or Action	Purpose
		When the initiator keyword is set to initiator, the flow direction is specified from the initiator side of the flow. When the initiator keyword is set to responder, the flow direction is specified from the responder side of the flow. For wired AVC, the initiator keyword is always set to initiator.
Step 12	collect connection initiator Example: <pre>Device (config-flow-record)# collect connection initiator</pre>	<p>Specifies to collect the side of the flow — Initiator or Responder — relevant to the direction of the flow specified by the collect flow direction command. The initiator keyword provides the following information about the direction of the flow :</p> <ul style="list-style-type: none"> • 0x01 = Initiator - the flow source is the initiator of the connection <p>For wired AVC, the initiator keyword is always set to initiator.</p>
Step 13	collect connection client counter packets long Example: <pre>Device (config-flow-record)# collect connection client counter packets long</pre>	Specifies to collect the number of packets sent by the client.
Step 14	collect connection client counter bytes network long Example: <pre>Device (config-flow-record)# collect connection client counter bytes network long</pre>	Specifies to collect the total number of bytes transmitted by the client.
Step 15	collect connection server counter packets long Example: <pre>Device (config-flow-record)# collect connection server counter packets long</pre>	Specifies to collect the number of packets sent by the server.
Step 16	collect connection server counter bytes network long Example: <pre>Device (config-flow-record)# collect connection server counter bytes network long</pre>	Specifies to collect the total number of bytes transmitted by the server.
Step 17	collect timestamp absolute first Example:	Specifies to collect the time, in milliseconds, when the first packet was seen in the flow.

	Command or Action	Purpose
	Device (config-flow-record)# collect timestamp absolute first	
Step 18	collect timestamp absolute last Example: Device (config-flow-record)# collect timestamp absolute last	Specifies to collect the time, in milliseconds, when the most recent packet was seen in the flow.
Step 19	collect connection new-connections Example: Device (config-flow-record)# collect connection new-connections	Specifies to collect the number of connection initiations observed.
Step 20	end Example: Device(config)# end	Returns to privileged EXEC mode. Alternatively, you can also press Ctrl-Z to exit global configuration mode.
Step 21	show flow record Example: Device # show flow record	Displays information about all the flow records.

Creating a Flow Exporter

You can create a flow exporter to define the export parameters for a flow.

Procedure

	Command or Action	Purpose
Step 1	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 2	flow exporter <i>flow_exporter_name</i> Example: Device(config)# flow exporter flow-exporter-1	Enters flow exporter configuration mode.
Step 3	description <i>description</i> Example: Device(config-flow-exporter)# description flow-exporter-1	(Optional) Creates a description for the flow exporter.
Step 4	destination { <i>hostname</i> | <i>ipv4-address</i> | <i>ipv6-address</i> } Example:	Specifies the hostname, IPv4 or IPv6 address of the system to which the exporter sends data.

	Command or Action	Purpose
	Device (config-flow-exporter)# destination 10.10.1.1	
Step 5	option application-table [timeout <i>seconds</i>] Example: Device (config-flow-exporter)# option application-table timeout 500	(Optional) Configures the application table option for the flow exporter. The timeout option configures the resend time in seconds for the flow exporter. The valid range is from 1 to 86400 seconds.
Step 6	end Example: Device(config)# end	Returns to privileged EXEC mode. Alternatively, you can also press Ctrl-Z to exit global configuration mode.
Step 7	show flow exporter Example: Device # show flow exporter	Displays information about all the flow exporters.
Step 8	show flow exporter statistics Example: Device # show flow exporter statistics	Displays flow exporter statistics.

Creating a Flow Monitor

You can create a flow monitor and associate it with a flow record.

Procedure

	Command or Action	Purpose
Step 1	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 2	flow monitor <i>monitor-name</i> Example: Device (config)# flow monitor flow-monitor-1	Creates a flow monitor and enters flow monitor configuration mode.
Step 3	description <i>description</i> Example: Device (config-flow-monitor)# description flow-monitor-1	(Optional) Creates a description for the flow monitor.
Step 4	record <i>record-name</i> Example: Device (config-flow-monitor)# record flow-record-1	Specifies the name of a record that was created previously.

	Command or Action	Purpose
Step 5	exporter <i>exporter-name</i> Example: Device (config-flow-monitor)# exporter flow-exporter-1	Specifies the name of an exporter that was created previously.
Step 6	cache { entries <i>number-of-entries</i> | timeout { active | inactive} | type normal } Example: Device (config-flow-monitor)# cache timeout active 1800 Example: Device (config-flow-monitor)# cache timeout inactive 200 Example: Device (config-flow-monitor)# cache type normal	(Optional) Specifies to configure flow cache parameters. <ul style="list-style-type: none"> • entries <i>number-of-entries</i> — Specifies the maximum number of flow entries in the flow cache in the range from 16 to 65536. Note Only normal cache type is supported.
Step 7	end Example: Device (config)# end	Returns to privileged EXEC mode. Alternatively, you can also press Ctrl-Z to exit global configuration mode.
Step 8	show flow monitor Example: Device # show flow monitor	Displays information about all the flow monitors.
Step 9	show flow monitor <i>flow-monitor-name</i> Example: Device # show flow monitor flow-monitor-1	Displays information about the specified wired AVC flow monitor.
Step 10	show flow monitor <i>flow-monitor-name</i> statistics Example: Device# show flow monitor flow-monitor-1 statistics	Displays statistics for wired AVC flow monitor.
Step 11	clear flow monitor <i>flow-monitor-name</i> statistics Example: Device# clear flow monitor flow-monitor-1 statistics	Clears the statistics of the specified flow monitor. Use the show flow monitor flow-monitor-1 statistics command after using the clear flow monitor flow-monitor-1 statistics to verify that all the statistics have been reset.

	Command or Action	Purpose
Step 12	show flow monitor <i>flow-monitor-name</i> cache format table Example: Device# <code>show flow monitor flow-monitor-1 cache format table</code>	Displays flow cache contents in a tabular format.
Step 13	show flow monitor <i>flow-monitor-name</i> cache format record Example: Device# <code>show flow monitor flow-monitor-1 cache format record</code>	Displays flow cache contents in similar format as the flow record.
Step 14	show flow monitor <i>flow-monitor-name</i> cache format csv Example: Device# <code>show flow monitor flow-monitor-1 cache format csv</code>	Displays flow cache contents in CSV format.

Associating Flow Monitor to an interface

Procedure

	Command or Action	Purpose
Step 1	configure terminal Example: Device# <code>configure terminal</code>	Enters global configuration mode.
Step 2	interface <i>interface-id</i> Example: Device(config)# <code>interface GigabitEthernet 1/0/1</code>	Enters the interface configuration mode.
Step 3	ip flow monitor <i>monitor-name</i> { input | output } Example: Device (config-if) # <code>ip flow monitor flow-monitor-1 input</code>	Associates a flow monitor to the interface for input and/or output packets.
Step 4	end Example: Device(config)# <code>end</code>	Returns to privileged EXEC mode. Alternatively, you can also press Ctrl-Z to exit global configuration mode.

NBAR2 Custom Applications

NBAR2 supports the use of custom protocols to identify custom applications. Custom protocols support protocols and applications that NBAR2 does not currently support.

In every deployment, there are local and specific applications which are not covered by the NBAR2 protocol pack provided by Cisco. Local applications are mainly categorized as:

- Specific applications to an organization
- Applications specific to a geography

NBAR2 provides a way to manually customize such local applications. You can manually customize applications using the command **ip nbar custom *myappname*** in global configuration mode. Custom applications take precedence over built-in protocols. For each custom protocol, user can define a selector ID that can be used for reporting purposes.

There are various types of application customization:

Generic protocol customization

- HTTP
- SSL
- DNS

Composite : Customization based on multiple underlying protocols – **server-name**

Layer3/Layer4 customization

- IPv4 address
- DSCP values
- TCP/UDP ports
- Flow source or destination direction

Byte Offset : Customization based on specific byte values in the payload

HTTP Customization

HTTP customization could be based on a combination of HTTP fields from:

- **cookie** - HTTP Cookie
- **host** - Host name of Origin Server containing resource
- **method** - HTTP method
- **referrer** - Address the resource request was obtained from
- **url** - Uniform Resource Locator path
- **user-agent** - Software used by agent sending the request
- **version** - HTTP version
- **via** - HTTP via field

HTTP Customization

Custom application called MYHTTP using the HTTP host “*mydomain.com” with Selector ID 10.

```
Device# configure terminal
Device(config)# ip nbar custom MYHTTP http host *mydomain.com id 10
```

SSL Customization

Customization can be done for SSL encrypted traffic using information extracted from the SSL Server Name Indication (SNI) or Common Name (CN).

SSL Customization

Custom application called MYSSL using SSL unique-name “mydomain.com” with selector ID 11.

```
Device# configure terminal
Device(config)# ip nbar custom MYSSL ssl unique-name *mydomain.com id 11
```

DNS Customization

NBAR2 examines DNS request and response traffic, and can correlate the DNS response to an application. The IP address returned from the DNS response is cached and used for later packet flows associated with that specific application.

The command **ip nbar custom *application-name* dns *domain-name* id *application-id*** is used for DNS customization. To extend an existing application, use the command **ip nbar custom *application-name* dns *domain-name* *domain-name* extends *existing-application***.

For more information on DNS based customization, see http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/qos_nbar/configuration/xs-3s/asr1000/qos-nbar-xe-3s-asr-1000-book/nbar-custapp-dns-xe.html.

DNS Customization

Custom application called MYDNS using the DNS domain name “mydomain.com” with selector ID 12.

```
Device# configure terminal
Device(config)# ip nbar custom MYDNS dns domain-name *mydomain.com id 12
```

Composite Customization

NBAR2 provides a way to customize applications based on domain names appearing in HTTP, SSL or DNS.

Composite Customization

Custom application called MYDOMAIN using HTTP, SSL or DNS domain name “mydomain.com” with selector ID 13.

```
Device# configure terminal
Device(config)# ip nbar custom MYDOMAIN composite server-name *mydomain.com id 13
```

L3/L4 Customization

Layer3/Layer4 customization is based on the packet tuple and is always matched on the first packet of a flow.

L3/L4 Customization

Custom application called LAYER4CUSTOM matching IP addresses 10.56.1.10 and 10.56.1.11, TCP and DSCP ef with selector ID 14.

```
Device# configure terminal
Device(config)# ip nbar custom LAYER4CUSTOM transport tcp id 14
Device(config-custom)# ip address 10.56.1.10 10.56.1.11
Device(config-custom)# dscp ef
```

Examples: Monitoring Custom Applications

Show Commands for Monitoring Custom Applications

show ip nbar protocol-id | inc Custom

```
Device# show ip nbar protocol-id | inc Custom
LAYER4CUSTOM          14          Custom
MYDNS                 12          Custom
MYDOMAIN              13          Custom
MYHTTP                10          Custom
MYSSL                 11          Custom
```

show ip nbar protocol-discovery protocol CUSTOM_APP

```
WSW-157# show ip nbar protocol-id MYSSL
Protocol Name          id          type
-----
MYSSL                  11          Custom
```

NBAR2 Dynamic Hitless Protocol Pack Upgrade

Protocol packs are software packages that update the NBAR2 protocol support on a device without replacing the Cisco software on the device. A protocol pack contains information on applications officially supported by NBAR2 which are compiled and packed together. For each application, the protocol-pack includes information on application signatures and application attributes. Each software release has a built-in protocol-pack bundled with it.

Protocol packs provide the following features:

- They are easy and fast to load.
- They are easy to upgrade to a higher version protocol pack or revert to a lower version protocol pack.
- They do not require the switch to be reloaded.

NBAR2 protocol packs are available for download on Cisco Software Center from this URL:

<https://software.cisco.com/download/navigator.html> .

Prerequisites for the NBAR2 Protocol Pack

Before loading a new protocol pack, you must copy the protocol pack to the flash on all the switch members.
To load a protocol pack, see [Examples: Loading the NBAR2 Protocol Pack, on page 105](#).

Loading the NBAR2 Protocol Pack

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 3	ip nbar protocol-pack <i>protocol-pack</i> [force] Example: Device(config)# ip nbar protocol-pack flash:defProtoPack Example: Device(config)# default ip nbar protocol-pack	Loads the protocol pack. <ul style="list-style-type: none"> • Use the force keyword to specify and load a protocol pack of a lower version, which is different from the base protocol pack version. This also removes the configuration that is not supported by the current protocol pack on the switch. For reverting to the built-in protocol pack, use the following command:
Step 4	exit Example: Device(config)# exit	Returns to privileged EXEC mode.
Step 5	show ip nbar protocol-pack {protocol-pack | active} [detail] Example: Device# show ip nbar protocol-pack active	Displays the protocol pack information. <ul style="list-style-type: none"> • Verify the loaded protocol pack version, publisher, and other details using this command. • Use the <i>protocol-pack</i> argument to display information about the specified protocol pack. • Use the active keyword to display active protocol pack information. • Use the detail keyword to display detailed protocol pack information.

Examples: Loading the NBAR2 Protocol Pack

The following example shows how to load a new protocol pack:

```
Device> enable
Device# configure terminal
Device(config)# ip nbar protocol-pack flash:newDefProtoPack
Device(config)# exit
```

The following example shows how to use the **force** keyword to load a protocol pack of a lower version:

```
Device> enable
Device# configure terminal
Device(config)# ip nbar protocol-pack flash:OldDefProtoPack force
Device(config)# exit
```

The following example shows how to revert to the built-in protocol pack:

```
Device> enable
Device# configure terminal
Device(config)# default ip nbar protocol-pack
Device(config)# exit
```

Monitoring Application Visibility and Control

Monitoring Application Visibility and Control (CLI)

This section describes the new commands for application visibility.

The following commands can be used to monitor application visibility on the and access ports.

Table 9: Monitoring Application Visibility Commands on the

Command	Purpose
show ip nbar protocol-discovery [<i>interface interface-type interface-number</i>] [<i>stats {byte-count | bit-rate | packet-count | max-bit-rate}</i>] [<i>protocol protocol-name | top-n number</i>]	Displays the statistics gathered by the NBAR Protocol Discovery feature. • (Optional) Enter keywords and arguments to fine-tune the statistics displayed. For more information on each of the keywords, refer to the show ip nbar protocol-discovery command in Cisco IOS Quality of Service Solutions Command Reference.
show policy-map interface <i>interface-type interface-number</i>	Displays information about policy map applied to the interface.
show platform software fed switch <i>switch id</i> wdavc flows	Displays statistics about all flows on the specified switch.

Examples: Application Visibility and Control

Examples: Application Visibility and Control Configuration

This example shows how to create class maps with apply match protocol filters for application name:

```
Device# configure terminal
Device(config)# class-map match-any NBAR-VOICE
Device(config-cmap)# match protocol ms-lync-audio
Device(config-cmap)#end
```

This example shows how to create policy maps and define existing class maps for egress QoS:

```
Device# configure terminal
Device(config)# policy-map test-avc-up
Device(config-pmap)# class cat-browsing
Device(config-pmap-c)# police 150000
Device(config-pmap-c)# set dscp 12
Device(config-pmap-c)#end
```

This example shows how to create policy maps and define existing class maps for ingress QoS:

```
Device# configure terminal
Device(config)# policy-map test-avc-down
Device(config-pmap)# class cat-browsing
Device(config-pmap-c)# police 200000
Device(config-pmap-c)# set dscp 10
Device(config-pmap-c)#end
```

This example shows how to apply policy maps to a switch port:

```
Device# configure terminal
Device(config)# interface GigabitEthernet 1/0/1
Device(config-if)# switchport mode access
Device(config-if)# switchport access vlan 20
Device(config-if)# service-policy input POLICING_IN
Device(config-if)#end
```

This example shows how to create class maps based on NBAR attributes.

```
Device# configure terminal
Device(config)# class-map match-all rel-relevant
Device(config-cmap)# match protocol attribute business-relevance business-relevant

Device(config)# class-map match-all rel-irrelevant
Device(config-cmap)# match protocol attribute business-relevance business-irrelevant

Device(config)# class-map match-all rel-default
Device(config-cmap)# match protocol attribute business-relevance default

Device(config)# class-map match-all class--ops-admin-and-rel
Device(config-cmap)# match protocol attribute traffic-class ops-admin-mgmt
Device(config-cmap)# match protocol attribute business-relevance business-relevant
```

This example shows how to create policy maps based on class maps based on NBAR attributes.

```
Device# configure terminal
Device(config)# policy-map attrib--rel-types
Device(config-pmap)# class rel-relevant
Device(config-pmap-c)# set dscp ef
Device(config-pmap-c)# class rel-irrelevant
```



```

Device(config-pmap-c) # set dscp af11
Device(config-pmap-c) # class rel-default
Device(config-pmap-c) # set dscp default

Device(config)# policy-map attrib--ops-admin-and-rel
Device(config-pmap)# class class--ops-admin-and-rel
Device(config-pmap-c) # set dscp cs5

```

This example shows how to attach a policy map based on NBAR attributes to a wired port:

```

Device# configure terminal
Device(config)# interface GigabitEthernet1/0/2
Device(config-if)# service-policy input attrib--rel-types

```

Show Commands for Viewing the Configuration

show ip nbar protocol-discovery

Displays a report of the Protocol Discovery statistics per interface.

The following is a sample output for the statistics per interface:

```
Deviceqos-cat9k-reg2-r1# show ip nbar protocol-discovery int GigabitEthernet1/0/1
```

```
GigabitEthernet1/0/1
```

```
Last clearing of "show ip nbar protocol-discovery" counters 00:03:16
```

	Input
Output	-----

Protocol	Packet Count
Packet Count	Byte Count
Byte Count	30sec Bit Rate (bps)
30sec Bit Rate (bps)	30sec Max Bit Rate (bps)
30sec Max Bit Rate (bps)	-----
-----	-----
ms-lync	60580
55911	
	31174777
28774864	
	3613000
93000	
	3613000
3437000	
Total	60580
55911	
	31174777
28774864	
	3613000
93000	

```

3437000
3613000

```

show policy-map interface

Displays the QoS statistics and the configured policy maps on all interfaces.

The following is a sample output for the policy-maps configured on all the interfaces:

```

Deviceqos-cat9k-reg2-r1# show policy-map int

GigabitEthernet1/0/1
  Service-policy input: MARKING-IN

    Class-map: NBAR-VOICE (match-any)
      718 packets
      Match: protocol ms-lync-audio
        0 packets, 0 bytes
        30 second rate 0 bps
      QoS Set
        dscp ef

    Class-map: NBAR-MM_CONFERENCING (match-any)
      6451 packets
      Match: protocol ms-lync
        0 packets, 0 bytes
        30 second rate 0 bps
      Match: protocol ms-lync-video
        0 packets, 0 bytes
        30 second rate 0 bps
      QoS Set
        dscp af41

    Class-map: class-default (match-any)
      34 packets
      Match: any

```

Show Commands for Viewing Attributes-based QoS Configuration

show policy-map interface

Displays the attribute-based QoS statistics and the configured policy maps on all interfaces.

The following is a sample output for the policy-maps configured on all the interfaces:

```

Device# show policy-map interface gigabitEthernet 1/0/2
GigabitEthernet1/0/2

  Service-policy input: attrib--rel-types

    Class-map: rel-relevant (match-all)
      20 packets
      Match: protocol attribute business-relevance business-relevant
      QoS Set
        dscp ef

```

```

Class-map: rel-irrelevant (match-all)
  0 packets
  Match: protocol attribute business-relevance business-irrelevant
  QoS Set
    dscp af11

Class-map: rel-default (match-all)
  14 packets
  Match: protocol attribute business-relevance default
  QoS Set
    dscp default

Class-map: class-default (match-any)
  0 packets
  Match: any

```

show ip nbar protocol-attribute

Displays all the protocol attributes used by NBAR.

The following shows sample output for some of the attributes:

```

Device# show ip nbar protocol-attribute cisco-jabber-im
  Protocol Name : cisco-jabber-im
    encrypted : encrypted-yes
    tunnel : tunnel-no
    category : voice-and-video
    sub-category : enterprise-media-conferencing
  application-group : cisco-jabber-group
  p2p-technology : p2p-tech-no
  traffic-class : transactional-data
  business-relevance : business-relevant
  application-set : collaboration-apps

Device# show ip nbar protocol-attribute google-services
  Protocol Name : google-services
    encrypted : encrypted-yes
    tunnel : tunnel-no
    category : other
    sub-category : other
  application-group : google-group
  p2p-technology : p2p-tech-yes
  traffic-class : transactional-data
  business-relevance : default
  application-set : general-browsing

Device# show ip nbar protocol-attribute dns
  Protocol Name : google-services
    encrypted : encrypted-yes
    tunnel : tunnel-no
    category : other
    sub-category : other
  application-group : google-group
  p2p-technology : p2p-tech-yes

```

```

        traffic-class : transactional-data
    business-relevance : default
    application-set : general-browsing
Device# show ip nbar protocol-attribute unknown
    Protocol Name : unknown
        encrypted : encrypted-no
            tunnel : tunnel-no
                category : other
                    sub-category : other
                        application-group : other
                            p2p-technology : p2p-tech-no
                                traffic-class : bulk-data
                                    business-relevance : default
                                        application-set : general-misc

```

Show Commands for Viewing Flow Monitor Configuration

show flow monitor wdavc

Displays information about the specified wired AVC flow monitor.

```

Device # show flow monitor wdavc

Flow Monitor wdavc:
  Description:      User defined
  Flow Record:     wdavc
  Flow Exporter:   wdavc-exp (inactive)
  Cache:
    Type:           normal (Platform cache)
    Status:         not allocated
    Size:           12000 entries
    Inactive Timeout: 15 secs
    Active Timeout: 1800 secs

```

show flow monitor wdavc statistics

Displays statistics for wired AVC flow monitor.

```

Device# show flow monitor wdavc statistics
Cache type:                Normal (Platform cache)
Cache size:                12000
Current entries:           13

Flows added:               26
Flows aged:                13
  - Active timeout        ( 1800 secs)    1
  - Inactive timeout      (   15 secs)    12

```

clear flow monitor wdavc statistics

Clears the statistics of the specified flow monitor. Use the **show flow monitor wdavc statistics** command after using the **clear flow monitor wdavc statistics** to verify that all the statistics have been reset. The following is a sample output of the **show flow monitor wdavc statistics** command after clearing flow monitor statistics.

```
Device# show flow monitor wдавc statistics
Cache type: Normal (Platform cache)
Cache size: 12000
Current entries: 0

Flows added: 0
Flows aged: 0
```

Show Commands for Viewing Cache Contents

show flow monitor wдавc cache format table

Displays flow cache contents in a tabular format.

```
Device# show flow monitor wдавc cache format table
Cache type: Normal (Platform cache)
Cache size: 12000
Current entries: 13

Flows added: 26
Flows aged: 13
- Active timeout ( 1800 secs) 1
- Inactive timeout ( 15 secs) 12
```

CONN	IPV4 INITIATOR ADDR	CONN	IPV4 RESPONDER ADDR	CONN	RESPONDER	PORT
FLOW	OBSPOINT ID	IP	VERSION	IP	PROT	APP NAME
dirn	.....	.....	.....	.....	.....	flow
64.103.125.147	4294967305	144.254.71.184	4	17	port dns	53
.....	.....	.....	.....	.....	.....	Input
64.103.121.103	4294967305	10.1.1.2	4	17	layer7 dhcp	67
....contd.....	.....	.....	.....	.....	.....	Input
64.103.125.3	4294967305	64.103.125.97	4	17	layer7 dhcp	68
.....	.....	.....	.....	.....	.....	Input
10.0.2.6	4294967305	157.55.40.149	4	6	layer7 ms-lync	443
.....	.....	.....	.....	.....	.....	Input
64.103.126.28	4294967305	66.163.36.139	4	6	layer7 cisco-jabber-im	443
....contd.....	.....	.....	.....	.....	.....	Input
64.103.125.2	4294967305	64.103.125.29	4	17	layer7 dhcp	68
.....	.....	.....	.....	.....	.....	Input
64.103.125.97	4294967305	64.103.101.181	4	17	layer7 dhcp	67
.....	.....	.....	.....	.....	.....	Input
192.168.100.6	4294967305	10.10.20.1	4	17	layer7 cisco-jabber-control	5060
.....	.....	.....	.....	.....	.....	Input

```

.....contd.....
64.103.125.3          64.103.125.29          68
      4294967305      4      17 layer7 dhcp      Input
.....
10.80.101.18         10.80.101.6           5060
      4294967305      4      6 layer7 cisco-collab-control Input
.....
10.1.11.4           66.102.11.99          80
      4294967305      4      6 layer7 google-services Input
.....contd.....
64.103.125.2         64.103.125.97          68
      4294967305      4      17 layer7 dhcp      Input
.....
64.103.125.29       64.103.101.181        67
      4294967305      4      17 layer7 dhcp      Input
.....

```

show flow monitor wdavc cache format record

Displays flow cache contents in similar format as the flow record.

```

Device# show flow monitor wdavc cache format record
Cache type:                Normal (Platform cache)
Cache size:                 12000
Current entries:           13

Flows added:                26
Flows aged:                 13
  - Active timeout          ( 1800 secs)  1
  - Inactive timeout        (   15 secs)  12

CONNECTION IPV4 INITIATOR ADDRESS: 64.103.125.147
CONNECTION IPV4 RESPONDER ADDRESS: 144.254.71.184
CONNECTION RESPONDER PORT:        53
FLOW OBSPOINT ID:                4294967305
IP VERSION:                      4
IP PROTOCOL:                     17
APPLICATION NAME:                 port dns
flow direction:                  Input
timestamp abs first:              08:55:46.917
timestamp abs last:               08:55:46.917
connection initiator:              Initiator
connection count new:              2
connection server packets counter: 1
connection client packets counter: 1
connection server network bytes counter: 190
connection client network bytes counter: 106

CONNECTION IPV4 INITIATOR ADDRESS: 64.103.121.103
CONNECTION IPV4 RESPONDER ADDRESS: 10.1.1.2
CONNECTION RESPONDER PORT:        67
FLOW OBSPOINT ID:                4294967305
IP VERSION:                      4

```

```

IP PROTOCOL: 17
APPLICATION NAME: layer7 dhcp
flow direction: Input
timestamp abs first: 08:55:47.917
timestamp abs last: 08:55:47.917
connection initiator: Initiator
connection count new: 1
connection server packets counter: 0
connection client packets counter: 1
connection server network bytes counter: 0
connection client network bytes counter: 350

CONNECTION IPV4 INITIATOR ADDRESS: 64.103.125.3
CONNECTION IPV4 RESPONDER ADDRESS: 64.103.125.97
CONNECTION RESPONDER PORT: 68
FLOW OBSPOINT ID: 4294967305
IP VERSION: 4
IP PROTOCOL: 17
APPLICATION NAME: layer7 dhcp
flow direction: Input
timestamp abs first: 08:55:47.917
timestamp abs last: 08:55:53.917
connection initiator: Initiator
connection count new: 1
connection server packets counter: 0
connection client packets counter: 4
connection server network bytes counter: 0
connection client network bytes counter: 1412

CONNECTION IPV4 INITIATOR ADDRESS: 10.0.2.6
CONNECTION IPV4 RESPONDER ADDRESS: 157.55.40.149
CONNECTION RESPONDER PORT: 443
FLOW OBSPOINT ID: 4294967305
IP VERSION: 4
IP PROTOCOL: 6
APPLICATION NAME: layer7 ms-lync
flow direction: Input
timestamp abs first: 08:55:46.917
timestamp abs last: 08:55:46.917
connection initiator: Initiator
connection count new: 2
connection server packets counter: 10
connection client packets counter: 14
connection server network bytes counter: 6490
connection client network bytes counter: 1639

CONNECTION IPV4 INITIATOR ADDRESS: 64.103.126.28
CONNECTION IPV4 RESPONDER ADDRESS: 66.163.36.139
CONNECTION RESPONDER PORT: 443
FLOW OBSPOINT ID: 4294967305
IP VERSION: 4

```

```

IP PROTOCOL: 6
APPLICATION NAME: layer7 cisco-jabber-im
flow direction: Input
timestamp abs first: 08:55:46.917
timestamp abs last: 08:55:46.917
connection initiator: Initiator
connection count new: 2
connection server packets counter: 12
connection client packets counter: 10
connection server network bytes counter: 5871
connection client network bytes counter: 2088

CONNECTION IPV4 INITIATOR ADDRESS: 64.103.125.2
CONNECTION IPV4 RESPONDER ADDRESS: 64.103.125.29
CONNECTION RESPONDER PORT: 68
FLOW OBSPOINT ID: 4294967305
IP VERSION: 4
IP PROTOCOL: 17
APPLICATION NAME: layer7 dhcp
flow direction: Input
timestamp abs first: 08:55:47.917
timestamp abs last: 08:55:47.917
connection initiator: Initiator
connection count new: 1
connection server packets counter: 0
connection client packets counter: 2
connection server network bytes counter: 0
connection client network bytes counter: 712

CONNECTION IPV4 INITIATOR ADDRESS: 64.103.125.97
CONNECTION IPV4 RESPONDER ADDRESS: 64.103.101.181
CONNECTION RESPONDER PORT: 67
FLOW OBSPOINT ID: 4294967305
IP VERSION: 4
IP PROTOCOL: 17
APPLICATION NAME: layer7 dhcp
flow direction: Input
timestamp abs first: 08:55:47.917
timestamp abs last: 08:55:47.917
connection initiator: Initiator
connection count new: 1
connection server packets counter: 0
connection client packets counter: 1
connection server network bytes counter: 0
connection client network bytes counter: 350

CONNECTION IPV4 INITIATOR ADDRESS: 192.168.100.6
CONNECTION IPV4 RESPONDER ADDRESS: 10.10.20.1
CONNECTION RESPONDER PORT: 5060
FLOW OBSPOINT ID: 4294967305
IP VERSION: 4

```



```

IP PROTOCOL: 17
APPLICATION NAME: layer7 cisco-jabber-control
flow direction: Input
timestamp abs first: 08:55:46.917
timestamp abs last: 08:55:46.917
connection initiator: Initiator
connection count new: 1
connection server packets counter: 0
connection client packets counter: 2
connection server network bytes counter: 0
connection client network bytes counter: 2046

CONNECTION IPV4 INITIATOR ADDRESS: 64.103.125.3
CONNECTION IPV4 RESPONDER ADDRESS: 64.103.125.29
CONNECTION RESPONDER PORT: 68
FLOW OBSPOINT ID: 4294967305
IP VERSION: 4
IP PROTOCOL: 17
APPLICATION NAME: layer7 dhcp
flow direction: Input
timestamp abs first: 08:55:47.917
timestamp abs last: 08:55:47.917
connection initiator: Initiator
connection count new: 1
connection server packets counter: 0
connection client packets counter: 2
connection server network bytes counter: 0
connection client network bytes counter: 712

CONNECTION IPV4 INITIATOR ADDRESS: 10.80.101.18
CONNECTION IPV4 RESPONDER ADDRESS: 10.80.101.6
CONNECTION RESPONDER PORT: 5060
FLOW OBSPOINT ID: 4294967305
IP VERSION: 4
IP PROTOCOL: 6
APPLICATION NAME: layer7 cisco-collab-control
flow direction: Input
timestamp abs first: 08:55:46.917
timestamp abs last: 08:55:47.917
connection initiator: Initiator
connection count new: 2
connection server packets counter: 23
connection client packets counter: 27
connection server network bytes counter: 12752
connection client network bytes counter: 8773

CONNECTION IPV4 INITIATOR ADDRESS: 10.1.11.4
CONNECTION IPV4 RESPONDER ADDRESS: 66.102.11.99
CONNECTION RESPONDER PORT: 80
FLOW OBSPOINT ID: 4294967305
IP VERSION: 4

```

```

IP PROTOCOL: 6
APPLICATION NAME: layer7 google-services
flow direction: Input
timestamp abs first: 08:55:46.917
timestamp abs last: 08:55:46.917
connection initiator: Initiator
connection count new: 2
connection server packets counter: 3
connection client packets counter: 5
connection server network bytes counter: 1733
connection client network bytes counter: 663

```

```

CONNECTION IPV4 INITIATOR ADDRESS: 64.103.125.2
CONNECTION IPV4 RESPONDER ADDRESS: 64.103.125.97
CONNECTION RESPONDER PORT: 68
FLOW OBSPOINT ID: 4294967305
IP VERSION: 4
IP PROTOCOL: 17
APPLICATION NAME: layer7 dhcp
flow direction: Input
timestamp abs first: 08:55:47.917
timestamp abs last: 08:55:53.917
connection initiator: Initiator
connection count new: 1
connection server packets counter: 0
connection client packets counter: 4
connection server network bytes counter: 0
connection client network bytes counter: 1412

```

```

CONNECTION IPV4 INITIATOR ADDRESS: 64.103.125.29
CONNECTION IPV4 RESPONDER ADDRESS: 64.103.101.181
CONNECTION RESPONDER PORT: 67
FLOW OBSPOINT ID: 4294967305
IP VERSION: 4
IP PROTOCOL: 17
APPLICATION NAME: layer7 dhcp
flow direction: Input
timestamp abs first: 08:55:47.917
timestamp abs last: 08:55:47.917
connection initiator: Initiator
connection count new: 1
connection server packets counter: 0
connection client packets counter: 1
connection server network bytes counter: 0
connection client network bytes counter: 350

```

show flow monitor wdavc cache format csv

Displays flow cache contents in CSV format.

```

Device# show flow monitor wdavc cache format csv
Cache type: Normal (Platform cache)
Cache size: 12000

```

```

Current entries:                               13

Flows added:                                  26
Flows aged:                                   13
  - Active timeout      ( 1800 secs)         1
  - Inactive timeout    (   15 secs)         12

CONN IPV4 INITIATOR ADDR,CONN IPV4 RESPONDER ADDR,CONN RESPONDER PORT,FLOW
OBSPOINT ID,IP VERSION,IP
PROT,APP NAME,flow dirn,time abs first,time abs last,conn initiator,conn
count new,conn server packets
cnt,conn client packets cnt,conn server network bytes cnt,conn client
network bytes cnt
64.103.125.147,144.254.71.184,53,4294967305,4,17,port
dns,Input,08:55:46.917,08:55:46.917,Initiator,2,1,1,190,106
64.103.121.103,10.1.1.2,67,4294967305,4,17,layer7
dhcp,Input,08:55:47.917,08:55:47.917,Initiator,1,0,1,0,350
64.103.125.3,64.103.125.97,68,4294967305,4,17,layer7
dhcp,Input,08:55:47.917,08:55:53.917,Initiator,1,0,4,0,1412
10.0.2.6,157.55.40.149,443,4294967305,4,6,layer7 ms-
lync,Input,08:55:46.917,08:55:46.917,Initiator,2,10,14,6490,1639
64.103.126.28,66.163.36.139,443,4294967305,4,6,layer7 cisco-jabber-
im,Input,08:55:46.917,08:55:46.917,Initiator,2,12,10,5871,2088
64.103.125.2,64.103.125.29,68,4294967305,4,17,layer7
dhcp,Input,08:55:47.917,08:55:47.917,Initiator,1,0,2,0,712
64.103.125.97,64.103.101.181,67,4294967305,4,17,layer7
dhcp,Input,08:55:47.917,08:55:47.917,Initiator,1,0,1,0,350
192.168.100.6,10.10.20.1,5060,4294967305,4,17,layer7 cisco-jabber-
control,Input,08:55:46.917,08:55:46.917,Initiator,1,0,2,0,2046
64.103.125.3,64.103.125.29,68,4294967305,4,17,layer7
dhcp,Input,08:55:47.917,08:55:47.917,Initiator,1,0,2,0,712
10.80.101.18,10.80.101.6,5060,4294967305,4,6,layer7 cisco-collab-
control,Input,08:55:46.917,08:55:47.917,Initiator,2,23,27,12752,8773
10.1.11.4,66.102.11.99,80,4294967305,4,6,layer7 google-
services,Input,08:55:46.917,08:55:46.917,Initiator,2,3,5,1733,663
64.103.125.2,64.103.125.97,68,4294967305,4,17,layer7
dhcp,Input,08:55:47.917,08:55:53.917,Initiator,1,0,4,0,1412
64.103.125.29,64.103.101.181,67,4294967305,4,17,layer7
dhcp,Input,08:55:47.917,08:55:47.917,Initiator,1,0,1,0,350

```

Basic Troubleshooting(Questions and Answers)

Following are the basic questions and answers for troubleshooting wired Application Visibility and Control:

- Question:** My IPv6 traffic is not being classified.

Answer: Currently only IPv4 traffic is supported.
- Question:** My multicast traffic is not being classified

Answer: Currently only unicast traffic is supported

3. **Question:** I send ping but I don't see them being classified
Answer: Only TCP/UDP protocols are supported
4. **Question:** Why can't I attach NBAR to an SVI?
Answer: NBAR is only supported on physical interfaces.
5. **Question:** I see that most of my traffic is CAPWAP traffic, why?
Answer: Make sure that you have enabled NBAR on an access port that is not connected to a wireless access port. All traffic coming from APs will be classified as capwap. Actual classification in this case happens either on the AP or WLC.
6. **Question:** In protocol-discovery, I see traffic only on one side. Along with that, there are a lot of unknown traffic.
Answer: This usually indicates that NBAR sees asymmetric traffic: one side of the traffic is classified in one switch member and the other on a different member. The recommendation is to attach NBAR only on access ports where we see both sides of the traffic. If you have multiple uplinks, you can't attach NBAR on them due to this issue. Similar issue happens if you configure NBAR on an interface that is part of a port channel.
7. **Question:** With protocol-discovery, I see an aggregate view of all application. How can I see traffic distribution over time?
Answer: WebUI will give you view of traffic over time for the last 48 hours.
8. **Question:** I can't configure queue-based egress policy with **match protocol protocol-name** command.
Answer: Only **shape** and **set DSCP** are supported in a policy with NBAR2 based classifiers. Common practice is to set DSCP on ingress and perform shaping on egress based on DSCP.
9. **Question:** I don't have NBAR2 attached to any interface but I still see that NBAR2 is activated.
Answer: If you have any class-map with **match protocol protocol-name**, NBAR will be globally activated on the stack but no traffic will be subjected to NBAR classification. This is an expected behavior and it does not consume any resources.
10. **Question:** I see some traffic under the default QoS queue. Why?
Answer: For each new flow, it takes a few packets to classify it and install the result in the hardware. During this time, the classification would be 'unknown' and traffic will fall under the default queue.

Additional References for Application Visibility and Control

Related Documents

Related Topic	Document Title
QoS	<i>NBAR Configuration Guide, Cisco IOS XE Release 16.x</i>
NBAR2 Protocol Pack Hitless Upgrade	<i>NBAR Configuration Guide, Cisco IOS XE Release 16.x</i>

Technical Assistance

Description	Link
<p>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies.</p> <p>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.</p> <p>Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</p>	<p>http://www.cisco.com/support</p>

Feature History and Information For Application Visibility and Control in a Wired Network

Release	Feature Information
Cisco IOS XE Denali 16.3.2	Wired AVC Flexible NetFlow (FNF) — The feature uses a flow record with an application name as the key, to provide client, server and application statistics, per interface.
Cisco IOS XE Denali 16.3.1	This feature was introduced.



CHAPTER 5

Configuring SDM Templates

- [Finding Feature Information, on page 121](#)
- [Information About SDM Templates, on page 121](#)
- [SDM Templates and Switch Stacks, on page 122](#)
- [How to Configure SDM Templates, on page 122](#)
- [Monitoring and Maintaining SDM Templates, on page 123](#)
- [Configuration Examples for SDM Templates, on page 123](#)
- [Additional References for SDM Templates, on page 124](#)
- [Feature History and Information for Configuring SDM Templates, on page 125](#)

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 at the end of this module.

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

Information About SDM Templates

You can use SDM templates to configure system resources to optimize support for specific features, depending on how your device is used in the network. You can select a template to provide maximum system usage for some functions.

Cisco Catalyst 9300 Series Switches support Access template.

After you change the template and the system reboots, you can use the **show sdm prefer** privileged EXEC command to verify the new template configuration. If you enter the **show sdm prefer** command before you enter the **reload** privileged EXEC command, the **show sdm prefer** command shows the template currently in use and the template that will become active after a reload.

SDM Templates and Switch Stacks

In a switch stack, all stack members must use the same SDM template that is stored on the active switch. When a new switch is added to a stack, the SDM configuration that is stored on the active switch overrides the template configured on an individual switch.

You can use the **show switch** privileged EXEC command to see if any stack members are in SDM mismatch mode.

How to Configure SDM Templates

Setting the SDM Template

Follow these steps to use the SDM template to maximize feature usage:

Procedure

	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	sdm prefer access Example: Device(config)# sdm prefer access	Sets the switch to the access template.
Step 4	end Example: Device(config)# end	Returns to privileged EXEC mode.
Step 5	reload Example:	Reloads the operating system. After the system reboots, you can use the show sdm prefer privileged EXEC command to

	Command or Action	Purpose
	Device# reload	verify the new template configuration. If you enter the show sdm prefer command before you enter the reload privileged EXEC command, the show sdm prefer command shows the template currently in use and the template that will become active after a reload.

Monitoring and Maintaining SDM Templates

Command	Purpose
show sdm prefer	Displays the SDM template in use.
reload	Reloads the switch to activate the newly configured SDM template.
no sdm prefer	Sets the default SDM template.



Note The SDM templates contain only those commands that are defined as part of the templates. If a template enables another related command that is not defined in the template, then this other command will be visible when the **show running config** command is entered. For example, if the SDM template enables the **switchport voice vlan** command, then the **spanning-tree portfast edge** command may also be enabled (although it is not defined on the SDM template).

If the SDM template is removed, then other such related commands are also removed and have to be reconfigured explicitly.

Configuration Examples for SDM Templates

Examples: Configuring SDM Templates

```
Device(config)# sdm prefer access
Device(config)# exit
Device# reload
Proceed with reload? [confirm]
```

Examples: Displaying SDM Templates

The following example output shows the Access template information on Cisco Catalyst 9300 Series Switches:

```

Device# show sdm prefer access
This is the Access template.
Number of VLANs: 4094
Unicast MAC addresses: 32768
Overflow Unicast MAC addresses: 1024
L2 Multicast entries: 8192
Overflow L2 Multicast entries: 512
L3 Multicast entries: 8192
Overflow L3 Multicast entries: 512
Directly connected routes: 24576
Indirect routes: 8192
STP Instances: 1024
Security Access Control Entries: 5120
QoS Access Control Entries: 5120
Policy Based Routing ACEs: 1024
Netflow Input ACEs: 256
Netflow Output ACEs: 768
Ingress Netflow ACEs: 256
Egress Netflow ACEs: 768
Flow SPAN ACEs: 1024
Tunnels: 512
LISP Instance Mapping Entries: 512
Control Plane Entries: 512
Input Netflow flows: 32768
Output Netflow flows: 32768
SGT/DGT (or) MPLS VPN entries: 8192
SGT/DGT (or) MPLS VPN Overflow entries: 512
Wired clients: 2048
MACSec SPD Entries: 256
MPLS L3 VPN VRF: 255
MPLS Labels: 2048
MPLS L3 VPN Routes VRF Mode: 7168
MPLS L3 VPN Routes Prefix Mode: 3072
MVPN MDT Tunnels: 256
L2 VPN EOMPLS Attachment Circuit: 256
MAX VPLS Bridge Domains : 128
MAX VPLS Peers Per Bridge Domain: 32
MAX VPLS/VPWS Pseudowires : 1024

```

These numbers are typical for L2 and IPv4 features.
Some features such as IPv6, use up double the entry size;
so only half as many entries can be created.
* values can be modified by sdm cli.

Additional References for SDM Templates

Related Documents

Related Topic	Document Title
Command Reference	<i>Command Reference (Catalyst 9300 Series Switches)</i>

Standards and RFCs

Standard/RFC	Title
None	—

MIBs

MIB	MIBs Link
All the supported MIBs for this release.	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
<p>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies.</p> <p>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.</p> <p>Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</p>	http://www.cisco.com/support

Feature History and Information for Configuring SDM Templates

Release	Modification
Cisco IOS XE Everest 16.5.1a	This feature was introduced.



CHAPTER 6

Configuring System Message Logs

- [Finding Feature Information, on page 127](#)
- [Information About Configuring System Message Logs, on page 127](#)
- [How to Configure System Message Logs, on page 130](#)
- [Monitoring and Maintaining System Message Logs, on page 138](#)
- [Configuration Examples for System Message Logs, on page 138](#)
- [Feature History and Information For System Message Logs, on page 139](#)

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 at the end of this module.

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

Information About Configuring System Message Logs

System Message Logging

By default, a switch sends the output from system messages and **debug** privileged EXEC commands to a logging process. Stack members can trigger system messages. A stack member that generates a system message appends its hostname in the form of hostname-n, where n is a switch range from 1 to 8, and redirects the output to the logging process on the active switch. Though the active switch is a stack member, it does not append its hostname to system messages. The logging process controls the distribution of logging messages to various destinations, such as the logging buffer, terminal lines, or a UNIX syslog server, depending on your configuration. The process also sends messages to the console.

When the logging process is disabled, messages are sent only to the console. The messages are sent as they are generated, so message and debug output are interspersed with prompts or output from other commands. Messages appear on the active consoles after the process that generated them has finished.

You can set the severity level of the messages to control the type of messages displayed on the consoles and each of the destinations. You can time-stamp log messages or set the syslog source address to enhance real-time debugging and management. For information on possible messages, see the system message guide for this release.

You can access logged system messages by using the switch command-line interface (CLI) or by saving them to a properly configured syslog server. The switch software saves syslog messages in an internal buffer on a standalone switch, and in the case of a switch stack, on the active switch. If a standalone switch or the stack's active switch fails, the log is lost unless you had saved it to flash memory.

You can remotely monitor system messages by viewing the logs on a syslog server or by accessing the switch through Telnet, through the console port, or through the Ethernet management port. In a switch stack, all stack member consoles provide the same console output.



Note The syslog format is compatible with 4.3 BSD UNIX.

System Log Message Format

System log messages can contain up to 80 characters and a percent sign (%), which follows the optional sequence number or time-stamp information, if configured. Depending on the switch, messages appear in one of these formats:

- *seq no:timestamp: %facility-severity-MNEMONIC:description (hostname-n)*
- *seq no:timestamp: %facility-severity-MNEMONIC:description*

The part of the message preceding the percent sign depends on the setting of these global configuration commands:

- **service sequence-numbers**
- **service timestamps log datetime**
- **service timestamps log datetime [localtime] [msec] [show-timezone]**
- **service timestamps log uptime**

Table 10: System Log Message Elements

Element	Description
<i>seq no:</i>	Stamps log messages with a sequence number only if the service sequence-numbers global configuration command is configured.

Element	Description
<i>timestamp</i> formats: <i>mm/dd h h:mm:ss</i> or <i>hh:mm:ss</i> (short uptime) or <i>d h</i> (long uptime)	Date and time of the message or event. This information appears only if the service timestamps log [datetime | log] global configuration command is configured.
<i>facility</i>	The facility to which the message refers (for example, SNMP, SYS, and so forth).
<i>severity</i>	Single-digit code from 0 to 7 that is the severity of the message.
<i>MNEMONIC</i>	Text string that uniquely describes the message.
<i>description</i>	Text string containing detailed information about the event being reported.
<i>hostname-n</i>	Hostname of a stack member and its switch number in the stack. Though the active switch is a stack member, it does <i>not</i> append its hostname to system messages.

Default System Message Logging Settings

Table 11: Default System Message Logging Settings

Feature	Default Setting
System message logging to the console	Enabled.
Console severity	Debugging.
Logging file configuration	No filename specified.
Logging buffer size	4096 bytes.
Logging history size	1 message.
Time stamps	Disabled.
Synchronous logging	Disabled.
Logging server	Disabled.
Syslog server IP address	None configured.
Server facility	Local7
Server severity	Informational.

Syslog Message Limits

If you enabled syslog message traps to be sent to an SNMP network management station by using the **snmp-server enable trap** global configuration command, you can change the level of messages sent and stored in the switch history table. You also can change the number of messages that are stored in the history table.

Messages are stored in the history table because SNMP traps are not guaranteed to reach their destination. By default, one message of the level **warning** and numerically lower levels are stored in the history table even if syslog traps are not enabled.

When the history table is full (it contains the maximum number of message entries specified with the **logging history size** global configuration command), the oldest message entry is deleted from the table to allow the new message entry to be stored.

The history table lists the level keywords and severity level. For SNMP usage, the severity level values increase by 1. For example, *emergencies* equal 1, not 0, and *critical* equals 3, not 2.

How to Configure System Message Logs

Setting the Message Display Destination Device

If message logging is enabled, you can send messages to specific locations in addition to the console.

This task is optional.

Procedure

	Command or Action	Purpose
Step 1	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 2	logging buffered <i>[size]</i> Example: Device(config)# logging buffered 8192	Logs messages to an internal buffer on the switch or on a standalone switch or, in the case of a switch stack, on the active switch. The range is 4096 to 2147483647 bytes. The default buffer size is 4096 bytes. If a standalone switch or the active switch fails, the log file is lost unless you previously saved it to flash memory. See Step 4.

	Command or Action	Purpose
		<p>Note Do not make the buffer size too large because the switch could run out of memory for other tasks. Use the show memory privileged EXEC command to view the free processor memory on the switch. However, this value is the maximum available, and the buffer size should <i>not</i> be set to this amount.</p>
Step 3	<p>logging host</p> <p>Example:</p> <pre>Device(config)# logging 125.1.1.100</pre>	<p>Logs messages to a UNIX syslog server host. <i>host</i> specifies the name or IP address of the host to be used as the syslog server.</p> <p>To build a list of syslog servers that receive logging messages, enter this command more than once.</p>
Step 4	<p>logging file flash: filename [max-file-size [min-file-size]] [severity-level-number | type]</p> <p>Example:</p> <pre>Device(config)# logging file flash:log_msg.txt 40960 4096 3</pre>	<p>Stores log messages in a file in flash memory on a standalone switch or, in the case of a switch stack, on the active switch.</p> <ul style="list-style-type: none"> • <i>filename</i>—Enters the log message filename. • (Optional) max-file-size —Specifies the maximum logging file size. The range is 4096 to 2147483647. The default is 4096 bytes. • (Optional) <i>min-file-size</i>—Specifies the minimum logging file size. The range is 1024 to 2147483647. The default is 2048 bytes. • (Optional) <i>severity-level-number | type</i>—Specifies either the logging severity level or the logging type. The severity range is 0 to 7.
Step 5	<p>end</p> <p>Example:</p> <pre>Device(config)# end</pre>	<p>Returns to privileged EXEC mode.</p>
Step 6	<p>terminal monitor</p> <p>Example:</p> <pre>Device# terminal monitor</pre>	<p>Logs messages to a nonconsole terminal during the current session.</p> <p>Terminal parameter-setting commands are set locally and do not remain in effect after the</p>

	Command or Action	Purpose
		session has ended. You must perform this step for each session to see the debugging messages.

Synchronizing Log Messages

You can synchronize unsolicited messages and **debug** privileged EXEC command output with solicited device output and prompts for a specific console port line or virtual terminal line. You can identify the types of messages to be output asynchronously based on the level of severity. You can also configure the maximum number of buffers for storing asynchronous messages for the terminal after which messages are dropped.

When synchronous logging of unsolicited messages and **debug** command output is enabled, unsolicited device output appears on the console or printed after solicited device output appears or is printed. Unsolicited messages and **debug** command output appears on the console after the prompt for user input is returned. Therefore, unsolicited messages and **debug** command output are not interspersed with solicited device output and prompts. After the unsolicited messages appear, the console again displays the user prompt.

This task is optional.

Procedure

	Command or Action	Purpose
Step 1	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 2	line [console | vty] line-number [ending-line-number] Example: Device(config)# line console	Specifies the line to be configured for synchronous logging of messages. <ul style="list-style-type: none"> • console—Specifies configurations that occur through the switch console port or the Ethernet management port. • line vty line-number—Specifies which vty lines are to have synchronous logging enabled. You use a vty connection for configurations that occur through a Telnet session. The range of line numbers is from 0 to 15. You can change the setting of all 16 vty lines at once by entering: line vty 0 15 You can also change the setting of the single vty line being used for your current connection. For example, to change the setting for vty line 2, enter:

	Command or Action	Purpose
		line vty 2 When you enter this command, the mode changes to line configuration.
Step 3	logging synchronous [level [<i>severity-level</i> | all] | limit <i>number-of-buffers</i>] Example: <pre>Device(config)# logging synchronous level 3 limit 1000</pre>	Enables synchronous logging of messages. <ul style="list-style-type: none"> • (Optional) level <i>severity-level</i>—Specifies the message severity level. Messages with a severity level equal to or higher than this value are printed asynchronously. Low numbers mean greater severity and high numbers mean lesser severity. The default is 2. • (Optional) level all—Specifies that all messages are printed asynchronously regardless of the severity level. • (Optional) limit <i>number-of-buffers</i>—Specifies the number of buffers to be queued for the terminal after which new messages are dropped. The range is 0 to 2147483647. The default is 20.
Step 4	end Example: <pre>Device(config)# end</pre>	Returns to privileged EXEC mode.

Disabling Message Logging

Message logging is enabled by default. It must be enabled to send messages to any destination other than the console. When enabled, log messages are sent to a logging process, which logs messages to designated locations asynchronously to the processes that generated the messages.

Disabling the logging process can slow down the switch because a process must wait until the messages are written to the console before continuing. When the logging process is disabled, messages appear on the console as soon as they are produced, often appearing in the middle of command output.

The **logging synchronous** global configuration command also affects the display of messages to the console. When this command is enabled, messages appear only after you press **Return**.

To reenable message logging after it has been disabled, use the **logging on** global configuration command.

This task is optional.

Procedure

	Command or Action	Purpose
Step 1	configure terminal Example: Device# <code>configure terminal</code>	Enters global configuration mode.
Step 2	no logging console Example: Device(config)# <code>no logging console</code>	Disables message logging.
Step 3	end Example: Device(config)# <code>end</code>	Returns to privileged EXEC mode.

Enabling and Disabling Time Stamps on Log Messages

By default, log messages are not time-stamped.

This task is optional.

Procedure

	Command or Action	Purpose
Step 1	configure terminal Example: Device# <code>configure terminal</code>	Enters global configuration mode.
Step 2	Use one of these commands: <ul style="list-style-type: none"> • <code>service timestamps log uptime</code> • <code>service timestamps log datetime[msec | localtime | show-timezone]</code> Example: Device(config)# <code>service timestamps log uptime</code> or Device(config)# <code>service timestamps log datetime</code>	Enables log time stamps. <ul style="list-style-type: none"> • log uptime—Enables time stamps on log messages, showing the time since the system was rebooted. • log datetime—Enables time stamps on log messages. Depending on the options selected, the time stamp can include the date, time in milliseconds relative to the local time zone, and the time zone name.

	Command or Action	Purpose
Step 3	end Example: Device (config) # end	Returns to privileged EXEC mode.

Enabling and Disabling Sequence Numbers in Log Messages

If there is more than one log message with the same time stamp, you can display messages with sequence numbers to view these messages. By default, sequence numbers in log messages are not displayed.

This task is optional.

Procedure

	Command or Action	Purpose
Step 1	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 2	service sequence-numbers Example: Device (config) # service sequence-numbers	Enables sequence numbers.
Step 3	end Example: Device (config) # end	Returns to privileged EXEC mode.

Defining the Message Severity Level

Limit messages displayed to the selected device by specifying the severity level of the message.

This task is optional.

Procedure

	Command or Action	Purpose
Step 1	configure terminal Example:	Enters global configuration mode.

	Command or Action	Purpose
	Device# <code>configure terminal</code>	
Step 2	logging console <i>level</i> Example: Device(config)# <code>logging console 3</code>	Limits messages logged to the console. By default, the console receives debugging messages and numerically lower levels.
Step 3	logging monitor <i>level</i> Example: Device(config)# <code>logging monitor 3</code>	Limits messages logged to the terminal lines. By default, the terminal receives debugging messages and numerically lower levels.
Step 4	logging trap <i>level</i> Example: Device(config)# <code>logging trap 3</code>	Limits messages logged to the syslog servers. By default, syslog servers receive informational messages and numerically lower levels.
Step 5	end Example: Device(config)# <code>end</code>	Returns to privileged EXEC mode.

Limiting Syslog Messages Sent to the History Table and to SNMP

This task explains how to limit syslog messages that are sent to the history table and to SNMP.

This task is optional.

Procedure

	Command or Action	Purpose
Step 1	configure terminal Example: Device# <code>configure terminal</code>	Enters global configuration mode.
Step 2	logging history <i>level</i> Example: Device(config)# <code>logging history 3</code>	Changes the default level of syslog messages stored in the history file and sent to the SNMP server. By default, warnings , errors , critical , alerts , and emergencies messages are sent.

	Command or Action	Purpose
Step 3	logging history size <i>number</i> Example: Device(config)# logging history size 200	Specifies the number of syslog messages that can be stored in the history table. The default is to store one message. The range is 0 to 500 messages.
Step 4	end Example: Device(config)# end	Returns to privileged EXEC mode.

Logging Messages to a UNIX Syslog Daemon

This task is optional.



Note Some recent versions of UNIX syslog daemons no longer accept by default syslog packets from the network. If this is the case with your system, use the UNIX **man syslogd** command to decide what options must be added to or removed from the syslog command line to enable logging of remote syslog messages.

Before you begin

- Log in as root.
- Before you can send system log messages to a UNIX syslog server, you must configure the syslog daemon on a UNIX server.

Procedure

	Command or Action	Purpose
Step 1	Add a line to the file /etc/syslog.conf. Example: <pre>local7.debug /usr/adm/logs/cisco.log</pre>	<ul style="list-style-type: none"> • local7—Specifies the logging facility. • debug—Specifies the syslog level. The file must already exist, and the syslog daemon must have permission to write to it.
Step 2	Enter these commands at the UNIX shell prompt. Example: <pre>\$ touch /var/log/cisco.log \$ chmod 666 /var/log/cisco.log</pre>	Creates the log file. The syslog daemon sends messages at this level or at a more severe level to this file.

	Command or Action	Purpose
Step 3	<p>Make sure the syslog daemon reads the new changes.</p> <p>Example:</p> <pre>\$ kill -HUP `cat /etc/syslog.pid`</pre>	For more information, see the man syslog.conf and man syslogd commands on your UNIX system.

Monitoring and Maintaining System Message Logs

Monitoring Configuration Archive Logs

Command	Purpose
<pre>show archive log config {all | number [<i>end-number</i>] | user <i>username</i> [session number] number [<i>end-number</i>] | statistics} [provisioning]</pre>	Displays the entire configuration log or the log for specified parameters.

Configuration Examples for System Message Logs

Example: Stacking System Message

This example shows a partial switch system message for active stack and a stack member (hostname *Switch-2*):

```
00:00:46: %LINK-3-UPDOWN: Interface Port-channel1, changed state to up
00:00:47: %LINK-3-UPDOWN: Interface GigabitEthernet1/0/1, changed state to up
00:00:47: %LINK-3-UPDOWN: Interface GigabitEthernet1/0/2, changed state to up
00:00:48: %LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan1, changed state to down
00:00:48: %LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet1/0/1, changed
state to down 2
*Mar  1 18:46:11: %SYS-5-CONFIG_I: Configured from console by vty2 (10.34.195.36)
18:47:02: %SYS-5-CONFIG_I: Configured from console by vty2 (10.34.195.36)
*Mar  1 18:48:50.483 UTC: %SYS-5-CONFIG_I: Configured from console by vty2 (10.34.195.36)

00:00:46: %LINK-3-UPDOWN: Interface Port-channel1, changed state to up (Switch-2)
00:00:47: %LINK-3-UPDOWN: Interface GigabitEthernet2/0/1, changed state to up (Switch-2)
00:00:47: %LINK-3-UPDOWN: Interface GigabitEthernet2/0/2, changed state to up (Switch-2)
00:00:48: %LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan1, changed state to down
(Switch-2)
00:00:48: %LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet2/0/1, changed
state to down 2 (Switch-2)
```


Example: Switch System Message

This example shows a partial switch system message on a switch:

```
00:00:46: %LINK-3-UPDOWN: Interface Port-channel1, changed state to up
00:00:47: %LINK-3-UPDOWN: Interface GigabitEthernet0/1, changed state to up
00:00:47: %LINK-3-UPDOWN: Interface GigabitEthernet0/2, changed state to up
00:00:48: %LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan1, changed state to down
00:00:48: %LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/1, changed state
to down 2
*Mar  1 18:46:11: %SYS-5-CONFIG_I: Configured from console by vty2 (10.34.195.36)
18:47:02: %SYS-5-CONFIG_I: Configured from console by vty2 (10.34.195.36)
*Mar  1 18:48:50.483 UTC: %SYS-5-CONFIG_I: Configured from console by vty2 (10.34.195.36)
```

Feature History and Information For System Message Logs

Release	Modification
Cisco IOS XE Everest 16.5.1a	This feature was introduced.



CHAPTER 7

Configuring Online Diagnostics

- [Finding Feature Information, on page 141](#)
- [Information About Configuring Online Diagnostics, on page 141](#)
- [How to Configure Online Diagnostics, on page 142](#)
- [Monitoring and Maintaining Online Diagnostics, on page 147](#)
- [Configuration Examples for Online Diagnostic Tests, on page 147](#)
- [Additional References for Online Diagnostics, on page 149](#)
- [Feature History and Information for Configuring Online Diagnostics, on page 150](#)

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 at the end of this module.

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

Information About Configuring Online Diagnostics

Online Diagnostics

With online diagnostics, you can test and verify the hardware functionality of the Device while the Device is connected to a live network.

The online diagnostics contain packet switching tests that check different hardware components and verify the data path and the control signals.

The online diagnostics detect problems in these areas:

- Hardware components
- Interfaces (Ethernet ports and so forth)
- Solder joints

Online diagnostics are categorized as on-demand, scheduled, or health-monitoring diagnostics. On-demand diagnostics run from the CLI; scheduled diagnostics run at user-designated intervals or at specified times when the Device is connected to a live network; and health-monitoring runs in the background with user-defined intervals. By default, the health-monitoring test runs for every 30 seconds.

After you configure online diagnostics, you can manually start diagnostic tests or display the test results. You can also see which tests are configured for the Device or switch stack and the diagnostic tests that have already run.

How to Configure Online Diagnostics

Starting Online Diagnostic Tests

After you configure diagnostic tests to run on the Device, use the **diagnostic start** privileged EXEC command to begin diagnostic testing.

After starting the tests, you cannot stop the testing process.

Use this privileged EXEC command to manually start online diagnostic testing:

Procedure

	Command or Action	Purpose
Step 1	<p>diagnostic start switch <i>number</i> test {<i>name</i> | <i>test-id</i> | <i>test-id-range</i> | all | basic | complete | minimal | non-disruptive | per-port}</p> <p>Example:</p> <pre>Device# diagnostic start switch 2 test basic</pre>	<p>Starts the diagnostic tests.</p> <p>The switch <i>number</i> keyword is supported only on stacking Device. The range is from 1 to 8.</p> <p>You can specify the tests by using one of these options:</p> <ul style="list-style-type: none"> • <i>name</i>—Enters the name of the test. • <i>test-id</i>—Enters the ID number of the test. • <i>test-id-range</i>—Enters the range of test IDs by using integers separated by a comma and a hyphen. • all—Starts all of the tests. • basic— Starts the basic test suite. • complete—Starts the complete test suite. • minimal—Starts the minimal bootup test suite. • non-disruptive—Starts the non-disruptive test suite. • per-port—Starts the per-port test suite.

Configuring Online Diagnostics

You must configure the failure threshold and the interval between tests before enabling diagnostic monitoring.

Scheduling Online Diagnostics

You can schedule online diagnostics to run at a designated time of day or on a daily, weekly, or monthly basis for a Device. Use the **no** form of this command to remove the scheduling.

Procedure

	Command or Action	Purpose
Step 1	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 2	diagnostic schedule switch number test {name | test-id | test-id-range | all | basic | complete | minimal | non-disruptive | per-port} {daily | on mm dd yyyy hh:mm | port inter-port-number port-number-list | weekly day-of-week hh:mm} Example: Device(config)# diagnostic schedule switch 3 test 1-5 on July 3 2013 23:10	Schedules on-demand diagnostic tests for a specific day and time. The switch number keyword is supported only on stacking switches. The range is from 1 to 8 When specifying the tests to be scheduled, use these options: <ul style="list-style-type: none"> • name—Name of the test that appears in the show diagnostic content command output. • test-id—ID number of the test that appears in the show diagnostic content command output. • test-id-range—ID numbers of the tests that appear in the show diagnostic content command output. • all—All test IDs. • basic—Starts the basic on-demand diagnostic tests. • complete—Starts the complete test suite. • minimal—Starts the minimal bootup test suite. • non-disruptive—Starts the non-disruptive test suite. • per-port—Starts the per-port test suite.

	Command or Action	Purpose
		<p>You can schedule the tests as follows:</p> <ul style="list-style-type: none"> • Daily—Use the daily <i>hh:mm</i> parameter. • Specific day and time—Use the on <i>mm dd yyyy hh:mm</i> parameter. • Weekly—Use the weekly <i>day-of-week hh:mm</i> parameter.

Configuring Health-Monitoring Diagnostics

You can configure health-monitoring diagnostic testing on a Device while it is connected to a live network. You can configure the execution interval for each health-monitoring test, enable the Device to generate a syslog message because of a test failure, and enable a specific test.

Use the **no** form of this command to disable testing.

By default, health monitoring is disabled, but the Device generates a syslog message when a test fails.

Follow these steps to configure and enable the health-monitoring diagnostic tests:

Procedure

	Command or Action	Purpose
Step 1	<p>enable</p> <p>Example:</p> <pre>Device> enable</pre>	<p>Enables privileged EXEC mode.</p> <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	<p>configure terminal</p> <p>Example:</p> <pre>Device# configure terminal</pre>	<p>Enters global configuration mode.</p>
Step 3	<p>diagnostic monitor interval switch <i>number</i> test {<i>name</i> | <i>test-id</i> | <i>test-id-range</i> | all} <i>hh:mm:ss</i> <i>milliseconds</i> <i>day</i></p> <p>Example:</p> <pre>Device(config)# diagnostic monitor interval switch 2 test 1 12:30:00 750 5</pre>	<p>Configures the health-monitoring interval of the specified tests.</p> <p>The switch <i>number</i> keyword is supported only on stacking switches. The range is from 1 to 8.</p> <p>When specifying the tests, use one of these parameters:</p> <ul style="list-style-type: none"> • <i>name</i>—Name of the test that appears in the show diagnostic content command output.

	Command or Action	Purpose
		<ul style="list-style-type: none"> • <i>test-id</i>—ID number of the test that appears in the show diagnostic content command output. • <i>test-id-range</i>—ID numbers of the tests that appear in the show diagnostic content command output. • all—All of the diagnostic tests. <p>When specifying the interval, set these parameters:</p> <ul style="list-style-type: none"> • <i>hh:mm:ss</i>—Monitoring interval in hours, minutes, and seconds. The range for <i>hh</i> is 0 to 24, and the range for <i>mm</i> and <i>ss</i> is 0 to 60. • <i>milliseconds</i>—Monitoring interval in milliseconds (ms). The range is from 0 to 999. • <i>day</i>—Monitoring interval in the number of days. The range is from 0 to 20.
<p>Step 4</p>	<p>diagnostic monitor syslog</p> <p>Example:</p> <pre>Device(config)# diagnostic monitor syslog</pre>	<p>(Optional) Configures the switch to generate a syslog message when a health-monitoring test fails.</p>
<p>Step 5</p>	<p>diagnostic monitor threshold switch <i>number number test {name | test-id | test-id-range | all} failure count count</i></p> <p>Example:</p> <pre>Device(config)# diagnostic monitor threshold switch 2 test 1 failure count 20</pre>	<p>(Optional) Sets the failure threshold for the health-monitoring tests.</p> <p>The switch <i>number</i> keyword is supported only on stacking switches. The range is from 1 to 8.</p> <p>When specifying the tests, use one of these parameters:</p> <ul style="list-style-type: none"> • <i>name</i>—Name of the test that appears in the show diagnostic content command output. • <i>test-id</i>—ID number of the test that appears in the show diagnostic content command output. • <i>test-id-range</i>—ID numbers of the tests that appear in the show diagnostic content command output. • all—All of the diagnostic tests.

	Command or Action	Purpose
		The range for the failure threshold <i>count</i> is 0 to 99.
Step 6	<p>diagnostic monitor switch <i>number</i> test {<i>name</i> | <i>test-id</i> | <i>test-id-range</i> | all}</p> <p>Example:</p> <pre>Device(config)# diagnostic monitor switch 2 test 1</pre>	<p>Enables the specified health-monitoring tests.</p> <p>The switch <i>number</i> keyword is supported only on stacking switches. The range is from 1 to 8.</p> <p>When specifying the tests, use one of these parameters:</p> <ul style="list-style-type: none"> • <i>name</i>—Name of the test that appears in the show diagnostic content command output. • <i>test-id</i>—ID number of the test that appears in the show diagnostic content command output. • <i>test-id-range</i>—ID numbers of the tests that appear in the show diagnostic content command output. • all—All of the diagnostic tests.
Step 7	<p>end</p> <p>Example:</p> <pre>Device(config)# end</pre>	Returns to privileged EXEC mode.
Step 8	<p>show running-config</p> <p>Example:</p> <pre>Device# show running-config</pre>	Verifies your entries.
Step 9	<p>copy running-config startup-config</p> <p>Example:</p> <pre>Device# copy running-config startup-config</pre>	(Optional) Saves your entries in the configuration file.

What to do next

Use the **no diagnostic monitor interval test***test-id* | *test-id-range* } global configuration command to change the interval to the default value or to zero. Use the **no diagnostic monitor syslog** command to disable generation of syslog messages when a health-monitoring test fails. Use the **diagnostic monitor threshold test***test-id* | *test-id-range* } **failure count** command to remove the failure threshold.

Monitoring and Maintaining Online Diagnostics

Displaying Online Diagnostic Tests and Test Results

You can display the online diagnostic tests that are configured for the Device or Device stack and check the test results by using the privileged EXEC **show** commands in this table:

Table 12: Commands for Diagnostic Test Configuration and Results

Command	Purpose
show diagnostic content switch [<i>number</i> | all]	Displays the online diagnostics configured for a switch. The switch [<i>number</i> | all] parameter is supported only on stacking switches.
show diagnostic status	Displays the currently running diagnostic tests.
show diagnostic result switch [<i>number</i> | all] [detail | test { <i>name</i> | <i>test-id</i> | <i>test-id-range</i> | all } [detail]]	Displays the online diagnostics test results. The switch [<i>number</i> | all] parameter is supported only on stacking switches.
show diagnostic switch [<i>number</i> | all] [detail]	Displays the online diagnostics test results. The switch [<i>number</i> | all] parameter is supported only on stacking switches.
show diagnostic schedule switch [<i>number</i> | all]	Displays the online diagnostics test schedule. The switch [<i>number</i> | all] parameter is supported only on stacking switches.
show diagnostic post	Displays the POST results. (The output is the same as the show post command output.)

Configuration Examples for Online Diagnostic Tests

Examples: Start Diagnostic Tests

This example shows how to start a diagnostic test by using the test name:

```
Device# diagnostic start switch 2 test DiagPOETest
```

This example shows how to start all of the basic diagnostic tests:

```
Device# diagnostic start switch 1 test all
```

Example: Configure a Health Monitoring Test

This example shows how to configure a health-monitoring test:

```
Device(config)# diagnostic monitor threshold switch 1 test 1 failure count 50
Device(config)# diagnostic monitor interval switch 1 test TestPortAsicStackPortLoopback
```

Examples: Schedule Diagnostic Test

This example shows how to schedule diagnostic testing for a specific day and time on a specific switch:

```
Device(config)# diagnostic schedule test DiagThermalTest on June 3 2013 22:25
```

This example shows how to schedule diagnostic testing to occur weekly at a certain time on a specific switch:

```
Device(config)# diagnostic schedule switch 1 test 1,2,4-6 weekly saturday 10:30
```

Examples: Displaying Online Diagnostics

This example shows how to display on demand diagnostic settings:

```
Device# show diagnostic ondemand settings

Test iterations = 1
Action on test failure = continue
```

This example shows how to display diagnostic events for errors:

```
Device# show diagnostic events event-type error

Diagnostic events (storage for 500 events, 0 events recorded)
Number of events matching above criteria = 0

No diagnostic log entry exists.
```

This example shows how to display the description for a diagnostic test:

```
Device# show diagnostic description switch 1 test all

DiagGoldPktTest :
  The GOLD packet Loopback test verifies the MAC level loopback
  functionality. In this test, a GOLD packet, for which doppler
  provides the support in hardware, is sent. The packet loops back
  at MAC level and is matched against the stored packet. It is a non
  -disruptive test.

DiagThermalTest :
  This test verifies the temperature reading from the sensor is below the yellow
  temperature threshold. It is a non-disruptive test and can be run as a health
  monitoring test.
```

```

DiagFanTest :
    This test verifies all fan modules have been inserted and working properly on the
board
    It is a non-disruptive test and can be run as a health monitoring test.

DiagPhyLoopbackTest :
    The PHY Loopback test verifies the PHY level loopback
    functionality. In this test, a packet is sent which loops back
    at PHY level and is matched against the stored packet. It is a
    disruptive test and cannot be run as a health monitoring test.

DiagScratchRegisterTest :
    The Scratch Register test monitors the health of application-specific
    integrated circuits (ASICs) by writing values into registers and reading
    back the values from these registers. It is a non-disruptive test and can
    be run as a health monitoring test.

DiagPoETest :
    This test checks the PoE controller functionality. This is a disruptive test
    and should not be performed during normal switch operation.

DiagStackCableTest :
    This test verifies the stack ring loopback functionality
    in the stacking environment. It is a disruptive test and
    cannot be run as a health monitoring test.

DiagMemoryTest :
    This test runs the exhaustive ASIC memory test during normal switch operation
    NG3K utilizes mbist for this test. Memory test is very disruptive
    in nature and requires switch reboot after the test.

Device#

```

This example shows how to display the boot up level:

```

Device# show diagnostic bootup level

Current bootup diagnostic level: minimal

Device#

```

Additional References for Online Diagnostics

Related Documents

Related Topic	Document Title
System management commands	System Management Command Reference (Cisco Catalyst 9300 Switches)

Standards and RFCs

Standard/RFC	Title
None	—

MIBs

MIB	MIBs Link
All supported MIBs for this release.	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
<p>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies.</p> <p>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.</p> <p>Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</p>	http://www.cisco.com/support

Feature History and Information for Configuring Online Diagnostics

Release	Modification
Cisco IOS XE Everest 16.5.1a	This feature was introduced.



CHAPTER 8

Managing Configuration Files

- [Prerequisites for Managing Configuration Files, on page 151](#)
- [Restrictions for Managing Configuration Files, on page 151](#)
- [Information About Managing Configuration Files, on page 151](#)
- [How to Manage Configuration File Information, on page 158](#)
- [Additional References, on page 185](#)

Prerequisites for Managing Configuration Files

- You should have at least a basic familiarity with the Cisco IOS environment and the command-line interface.
- You should have at least a minimal configuration running on your system. You can create a basic configuration file using the **setup** command.

Restrictions for Managing Configuration Files

- Many of the Cisco IOS commands described in this document are available and function only in certain configuration modes on the device.
- Some of the Cisco IOS configuration commands are only available on certain device platforms, and the command syntax may vary on different platforms.

Information About Managing Configuration Files

Types of Configuration Files

Configuration files contain the Cisco IOS software commands used to customize the functionality of your Cisco device. Commands are parsed (translated and executed) by the Cisco IOS software when the system is booted (from the startup-config file) or when you enter commands at the CLI in a configuration mode.

Startup configuration files (startup-config) are used during system startup to configure the software. Running configuration files (running-config) contain the current configuration of the software. The two configuration

files can be different. For example, you may want to change the configuration for a short time period rather than permanently. In this case, you would change the running configuration using the **configure terminal** EXEC command but not save the configuration using the **copy running-config startup-config** EXEC command.

To change the running configuration, use the **configure terminal** command, as described in the [Modifying the Configuration File \(CLI\)](#) section. As you use the Cisco IOS configuration modes, commands generally are executed immediately and are saved to the running configuration file either immediately after you enter them or when you exit a configuration mode.

To change the startup configuration file, you can either save the running configuration file to the startup configuration using the **copy running-config startup-config** EXEC command or copy a configuration file from a file server to the startup configuration (see the [Copying a Configuration File from a TFTP Server to the Device \(CLI\)](#) section for more information).

Configuration Mode and Selecting a Configuration Source

To enter configuration mode on the device, enter the **configure** command at the privileged EXEC prompt. The Cisco IOS software responds with the following prompt asking you to specify the terminal, memory, or a file stored on a network server (network) as the source of configuration commands:

```
Configuring from terminal, memory, or network [terminal]?
```

Configuring from the terminal allows you to enter configuration commands at the command line, as described in the following section. See the [Re-executing the Configuration Commands in the Startup Configuration File \(CLI\)](#) section for more information.

Configuring from the network allows you to load and execute configuration commands over the network. See the [Copying a Configuration File from a TFTP Server to the Device \(CLI\)](#) section for more information.

Configuration File Changes Using the CLI

The Cisco IOS software accepts one configuration command per line. You can enter as many configuration commands as you want. You can add comments to a configuration file describing the commands you have entered. Precede a comment with an exclamation point (!). Because comments are *not* stored in NVRAM or in the active copy of the configuration file, comments do not appear when you list the active configuration with the **show running-config** or **more system:running-config** EXEC command. Comments are not displayed when you list the startup configuration with the **show startup-config** or **more nvram:startup-config** EXEC mode command. Comments are stripped out of the configuration file when it is loaded onto the device. However, you can list the comments in configuration files stored on a File Transfer Protocol (FTP), Remote Copy Protocol (RCP), or Trivial File Transfer Protocol (TFTP) server. When you configure the software using the CLI, the software executes the commands as you enter them.

Location of Configuration Files

Configuration files are stored in the following locations:

- The running configuration is stored in RAM.
- On all platforms except the Class A Flash file system platforms, the startup configuration is stored in nonvolatile random-access memory (NVRAM).

- On Class A Flash file system platforms, the startup configuration is stored in the location specified by the CONFIG_FILE environment variable (see the [Specifying the CONFIG_FILE Environment Variable on Class A Flash File Systems \(CLI\)](#) section). The CONFIG_FILE variable defaults to NVRAM and can be a file in the following file systems:
 - **nvr**am: (NVRAM)
 - **flash**: (internal flash memory)
 - **usbflash0**: (external usbflash file system)

Copy Configuration Files from a Network Server to the Device

You can copy configuration files from a TFTP, rcp, or FTP server to the running configuration or startup configuration of the device. You may want to perform this function for one of the following reasons:

- To restore a backed-up configuration file.
- To use the configuration file for another device. For example, you may add another device to your network and want it to have a similar configuration to the original device. By copying the file to the new device, you can change the relevant parts rather than recreating the whole file.
- To load the same configuration commands on to all of the devices in your network so that all of the devices have similar configurations.

The **copy {ftp: | rcp: | tftp:system:running-config}** EXEC command loads the configuration files into the device as if you were typing the commands on the command line. The device does not erase the existing running configuration before adding the commands. If a command in the copied configuration file replaces a command in the existing configuration file, the existing command is erased. For example, if the copied configuration file contains a different IP address in a particular command than the existing configuration, the IP address in the copied configuration is used. However, some commands in the existing configuration may not be replaced or negated. In this case, the resulting configuration file is a mixture of the existing configuration file and the copied configuration file, with the copied configuration file having precedence.

To restore a configuration file to an exact copy of a file stored on a server, you need to copy the configuration file directly to the startup configuration (using the **copy ftp: | rcp: | tftp:} nvram:startup-config** command) and reload the device.

To copy configuration files from a server to a device, perform the tasks described in the following sections.

The protocol that you use depends on which type of server you are using. The FTP and rcp transport mechanisms provide faster performance and more reliable delivery of data than TFTP. These improvements are possible because the FTP and rcp transport mechanisms are built on and use the TCP/IP stack, which is connection-oriented.

Copying a Configuration File from the Device to a TFTP Server

In some implementations of TFTP, you must create a dummy file on the TFTP server and give it read, write, and execute permissions before copying a file over it. Refer to your TFTP documentation for more information.

Copying a Configuration File from the Device to an RCP Server

You can copy a configuration file from the device to an RCP server.

One of the first attempts to use the network as a resource in the UNIX community resulted in the design and implementation of the remote shell protocol, which included the remote shell (rsh) and remote copy (rcp) functions. Rsh and rcp give users the ability to execute commands remotely and copy files to and from a file system residing on a remote host or server on the network. The Cisco implementation of rsh and rcp interoperates with standard implementations.

The rcp **copy** commands rely on the rsh server (or daemon) on the remote system. To copy files using rcp, you need not create a server for file distribution, as you do with TFTP. You need only have access to a server that supports the remote shell (rsh). (Most UNIX systems support rsh.) Because you are copying a file from one place to another, you must have read permission on the source file and write permission on the destination file. If the destination file does not exist, rcp creates it for you.

Although the Cisco rcp implementation emulates the functions of the UNIX rcp implementation—copying files among systems on the network—the Cisco command syntax differs from the UNIX rcp command syntax. The Cisco rcp support offers a set of **copy** commands that use rcp as the transport mechanism. These rcp **copy** commands are similar in style to the Cisco TFTP **copy** commands, but they offer an alternative that provides faster performance and reliable delivery of data. These improvements are possible because the rcp transport mechanism is built on and uses the TCP/IP stack, which is connection-oriented. You can use rcp commands to copy system images and configuration files from the device to a network server and vice versa.

You also can enable rcp support to allow users on remote systems to copy files to and from the device.

To configure the Cisco IOS software to allow remote users to copy files to and from the device, use the **ip rcmd rcp-enable** global configuration command.

Restrictions

The RCP protocol requires a client to send a remote username on each RCP request to a server. When you copy a configuration file from the device to a server using RCP, the Cisco IOS software sends the first valid username it encounters in the following sequence:

1. The username specified in the **copy EXEC** command, if a username is specified.
2. The username set by the **ip rcmd remote-username** global configuration command, if the command is configured.
3. The remote username associated with the current tty (terminal) process. For example, if the user is connected to the device through Telnet and was authenticated through the **username** command, the device software sends the Telnet username as the remote username.
4. The device host name.

For the RCP copy request to execute successfully, an account must be defined on the network server for the remote username. If the server has a directory structure, the configuration file or image is written to or copied from the directory associated with the remote username on the server. For example, if the system image resides in the home directory of a user on the server, you can specify that user name as the remote username.

Use the **ip rcmd remote-username** command to specify a username for all copies. (Rcmd is a UNIX routine used at the super-user level to execute commands on a remote machine using an authentication scheme based on reserved port numbers. Rcmd stands for “remote command”). Include the username in the **copy** command if you want to specify a username for that copy operation only.

If you are writing to the server, the RCP server must be properly configured to accept the RCP write request from the user on the device. For UNIX systems, you must add an entry to the .rhosts file for the remote user on the RCP server. For example, suppose the device contains the following configuration lines:


```
hostname Device1
ip rcmd remote-username User0
```

If the device IP address translates to device1.example.com, then the .rhosts file for User0 on the RCP server should contain the following line:

```
Device1.example.com Device1
```

Requirements for the RCP Username

The RCP protocol requires a client to send a remote username on each RCP request to a server. When you copy a configuration file from the device to a server using RCP, the Cisco IOS software sends the first valid username it encounters in the following sequence:

1. The username specified in the **copy EXEC** command, if a username is specified.
2. The username set by the **ip rcmd remote-username** global configuration command, if the command is configured.
3. The remote username associated with the current tty (terminal) process. For example, if the user is connected to the device through Telnet and is authenticated through the **username** command, the device software sends the Telnet username as the remote username.
4. The device host name.

For the RCP copy request to execute, an account must be defined on the network server for the remote username. If the server has a directory structure, the configuration file or image is written to or copied from the directory associated with the remote username on the server. For example, if the system image resides in the home directory of a user on the server, specify that user name as the remote username.

Refer to the documentation for your RCP server for more information.

Copying a Configuration File from the Device to an FTP Server

You can copy a configuration file from the device to an FTP server.

Understanding the FTP Username and Password



Note The password must not contain the special character '@'. If the character '@' is used, the copy fails to parse the IP address of the server.

The FTP protocol requires a client to send a remote username and password on each FTP request to a server. When you copy a configuration file from the device to a server using FTP, the Cisco IOS software sends the first valid username it encounters in the following sequence:

1. The username specified in the **copy EXEC** command, if a username is specified.
2. The username set by the **ip ftp username** global configuration command, if the command is configured.
3. Anonymous.

The device sends the first valid password it encounters in the following sequence:

1. The password specified in the **copy** command, if a password is specified.
2. The password set by the **ip ftp password** command, if the command is configured.
3. The device forms a password *username @devicename.domain* . The variable *username* is the username associated with the current session, *devicename* is the configured host name, and *domain* is the domain of the device.

The username and password must be associated with an account on the FTP server. If you are writing to the server, the FTP server must be properly configured to accept the FTP write request from the user on the device.

If the server has a directory structure, the configuration file or image is written to or copied from the directory associated with the username on the server. For example, if the system image resides in the home directory of a user on the server, specify that user name as the remote username.

Refer to the documentation for your FTP server for more information.

Use the **ip ftp username** and **ip ftp password** global configuration commands to specify a username and password for all copies. Include the username in the **copy EXEC** command if you want to specify a username for that copy operation only.

Copying files through a VRF

You can copy files through a VRF interface specified in the **copy** command. Specifying the VRF in the **copy** command is easier and more efficient as you can directly change the source interface without using a change request for the configuration.

Example

The following example shows how to copy files through a VRF, using the **copy** command:

```
Device# copy scp: flash-1: vrf test-vrf
Address or name of remote host [10.1.2.3]?
Source username [ScpUser]?
Source filename [/auto/tftp-server/ScpUser/vrf_test.txt]?
Destination filename [vrf_test.txt]?
Getting the vrf name as test-vrf
Password:
Sending file modes: C0644 10 vrf_test.txt
!
223 bytes copied in 22.740 secs (10 bytes/sec)
```

Copy Configuration Files from a Switch to Another Switch

You can copy the configurations from one switch to another. This is a 2-step process - Copy the configurations from the switch to the TFTP server, and then from TFTP to another switch.

To copy your current configurations from the switch, run the command **copy startup-config tftp:** and follow the instructions. The configurations are copied onto the TFTP server.

Then, login to another switch and run the command **copy tftp: startup-config** and follow the instructions. The configurations are now copied onto the other switch.

After the configurations are copied, to save your configurations, use **write memory** command and then either reload the switch or run the **copy startup-config running-config** command

Configuration Files Larger than NVRAM

To maintain a configuration file that exceeds the size of NVRAM, you should be aware of the information in the following sections.

Compressing the Configuration File

The **service compress-config** global configuration command specifies that the configuration file be stored compressed in NVRAM. Once the configuration file has been compressed, the device functions normally. When the system is booted, it recognizes that the configuration file is compressed, expands it, and proceeds normally. The **more nvram:startup-config EXEC** command expands the configuration before displaying it.

Before you compress configuration files, refer to the appropriate hardware installation and maintenance publication. Verify that your system's ROMs support file compression. If not, you can install new ROMs that support file compression.

The size of the configuration must not exceed three times the NVRAM size. For a 128-KB size NVRAM, the largest expanded configuration file size is 384 KB.

The **service compress-config** global configuration command works only if you have Cisco IOS software Release 10.0 or later release boot ROMs. Installing new ROMs is a one-time operation and is necessary only if you do not already have Cisco IOS Release 10.0 in ROM. If the boot ROMs do not recognize a compressed configuration, the following message is displayed:

```
Boot ROMs do not support NVRAM compression Config NOT written to NVRAM
```

Storing the Configuration in Flash Memory on Class A Flash File Systems

On class A Flash file system devices, you can store the startup configuration in flash memory by setting the **CONFIG_FILE** environment variable to a file in internal flash memory or flash memory in a PCMCIA slot.

See the [Specifying the CONFIG_FILE Environment Variable on Class A Flash File Systems \(CLI\)](#) section for more information.

Care must be taken when editing or changing a large configuration. Flash memory space is used every time a **copy system:running-config nvram:startup-config EXEC** command is issued. Because file management for flash memory (such as optimizing free space) is not done automatically, you must pay close attention to available flash memory. Use the **squeeze** command to reclaim used space. We recommend that you use a large-capacity Flash card of at least 20 MB.

Loading the Configuration Commands from the Network

You can also store large configurations on FTP, RCP, or TFTP servers and download them at system startup. To use a network server to store large configurations, see the [Copying a Configuration File from the Device to a TFTP Server \(CLI\)](#) and [Configuring the Device to Download Configuration Files](#) sections for more information on these commands.

Configuring the Device to Download Configuration Files

You can configure the device to load one or two configuration files at system startup. The configuration files are loaded into memory and read in as if you were typing the commands at the command line. Thus, the

configuration for the device is a mixture of the original startup configuration and the one or two downloaded configuration files.

Network Versus Host Configuration Files

For historical reasons, the first file the device downloads is called the network configuration file. The second file the device downloads is called the host configuration file. Two configuration files can be used when all of the devices on a network use many of the same commands. The network configuration file contains the standard commands used to configure all of the devices. The host configuration files contain the commands specific to one particular host. If you are loading two configuration files, the host configuration file should be the configuration file you want to have precedence over the other file. Both the network and host configuration files must reside on a network server reachable via TFTP, RCP, or FTP, and must be readable.

How to Manage Configuration File Information

Displaying Configuration File Information (CLI)

To display information about configuration files, complete the tasks in this section:

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	show boot Example: Device# show boot	Lists the contents of the BOOT environment variable (if set), the name of the configuration file pointed to by the CONFIG_FILE environment variable, and the contents of the BOOTLDR environment variable.
Step 3	more <i>file-url</i> Example: Device# more 10.1.1.1	Displays the contents of a specified file.
Step 4	show running-config Example: Device# show running-config	Displays the contents of the running configuration file. (Command alias for the more system:running-config command.)
Step 5	show startup-config Example: Device# show startup-config	Displays the contents of the startup configuration file. (Command alias for the more nvram:startup-config command.)

	Command or Action	Purpose
		<p>On all platforms except the Class A Flash file system platforms, the default startup-config file usually is stored in NVRAM.</p> <p>On the Class A Flash file system platforms, the CONFIG_FILE environment variable points to the default startup-config file.</p> <p>The CONFIG_FILE variable defaults to NVRAM.</p>

Modifying the Configuration File (CLI)

The Cisco IOS software accepts one configuration command per line. You can enter as many configuration commands as you want. You can add comments to a configuration file describing the commands you have entered. Precede a comment with an exclamation point (!). Because comments are *not* stored in NVRAM or in the active copy of the configuration file, comments do not appear when you list the active configuration with the **show running-config** or **more system:running-config EXEC** commands. Comments do not display when you list the startup configuration with the **show startup-config** or **more nvram:startup-config EXEC** mode commands. Comments are stripped out of the configuration file when it is loaded onto the device. However, you can list the comments in configuration files stored on a File Transfer Protocol (FTP), Remote Copy Protocol (RCP), or Trivial File Transfer Protocol (TFTP) server. When you configure the software using the CLI, the software executes the commands as you enter them. To configure the software using the CLI, use the following commands in privileged EXEC mode:

Procedure

	Command or Action	Purpose
Step 1	enable Example: <pre>Device> enable</pre>	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: <pre>Device# configure terminal</pre>	Enters global configuration mode.
Step 3	configuration command Example: <pre>Device(config)# configuration command</pre>	Enter the necessary configuration commands. The Cisco IOS documentation set describes configuration commands organized by technology.
Step 4	Do one of the following: <ul style="list-style-type: none"> • end • ^Z Example:	Ends the configuration session and exits to EXEC mode. Note When you press the Ctrl and Z keys simultaneously, ^Z is displayed to the screen.

	Command or Action	Purpose
	Device(config)# end	
Step 5	copy system:running-config nvram:startup-config Example: Device# copy system:running-config nvram:startup-config	Saves the running configuration file as the startup configuration file. You may also use the copy running-config startup-config command alias, but you should be aware that this command is less precise. On most platforms, this command saves the configuration to NVRAM. On the Class A Flash file system platforms, this step saves the configuration to the location specified by the CONFIG_FILE environment variable (the default CONFIG_FILE variable specifies that the file should be saved to NVRAM).

Examples

In the following example, the device prompt name of the device is configured. The comment line, indicated by the exclamation mark (!), does not execute any command. The **hostname** command is used to change the device name from device to new_name. By pressing Ctrl-Z (^Z) or entering the **end** command, the user quits configuration mode. The **copy system:running-config nvram:startup-config** command saves the current configuration to the startup configuration.

```
Device# configure terminal
Device(config)# !The following command provides the switch host name.
Device(config)# hostname new_name
new_name(config)# end
new_name# copy system:running-config nvram:startup-config
```

When the startup configuration is NVRAM, it stores the current configuration information in text format as configuration commands, recording only non-default settings. The memory is checksummed to guard against corrupted data.



Note Some specific commands might not get saved to NVRAM. You need to enter these commands again if you reboot the machine. These commands are noted in the documentation. We recommend that you keep a list of these settings so that you can quickly reconfigure your device after rebooting.

Copying a Configuration File from the Device to a TFTP Server (CLI)

To copy configuration information on a TFTP network server, complete the tasks in this section:

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	copy system:running-config tftp: [[[//location]/directory]/filename] Example: Device# copy system:running-config tftp: //server1/topdir/file10	Copies the running configuration file to a TFTP server.
Step 3	copy nvram:startup-config tftp: [[[//location]/directory]/filename] Example: Device# copy nvram:startup-config tftp: //server1/1stidir/file10	Copies the startup configuration file to a TFTP server.

Examples

The following example copies a configuration file from a device to a TFTP server:

```
Device# copy system:running-config tftp://172.16.2.155/tokyo-config
Write file tokyo-config on host 172.16.2.155? [confirm] Y
Writing tokyo-config!!! [OK]
```

What to Do Next

After you have issued the **copy** command, you may be prompted for additional information or for confirmation of the action. The prompt displayed depends on how much information you provide in the **copy** command and the current setting of the **file prompt** global configuration command.

Copying a Configuration File from the Device to an RCP Server (CLI)

To copy a startup configuration file or a running configuration file from the device to an RCP server, use the following commands beginning in privileged EXEC mode:

Procedure

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

	Command or Action	Purpose
	Device> enable	
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 3	ip rcmd remote-username <i>username</i> Example: Device(config)# ip rcmd remote-username NetAdmin1	(Optional) Changes the default remote username.
Step 4	end Example: Device(config)# end	(Optional) Exits global configuration mode.
Step 5	Do one of the following: <ul style="list-style-type: none"> • copy system:running-config rcp: [[[/<i>username@</i>]<i>location</i>]/<i>directory</i>]/<i>filename</i>] • copy nvram:startup-config rcp: [[[/<i>username@</i>]<i>location</i>]/<i>directory</i>]/<i>filename</i>] Example: Device# copy system:running-config rcp: //NetAdmin1@example.com/dir-files/file1	<ul style="list-style-type: none"> • Specifies that the device running configuration file is to be stored on an RCP server or • Specifies that the device startup configuration file is to be stored on an RCP server

Examples

Storing a Running Configuration File on an RCP Server

The following example copies the running configuration file named runfile2-confg to the netadmin1 directory on the remote host with an IP address of 172.16.101.101:

```
Device# copy system:running-config rcp://netadmin1@172.16.101.101/runfile2-confg
Write file runfile2-confg on host 172.16.101.101?[confirm]
Building configuration...[OK]
Connected to 172.16.101.101
Device#
```

Storing a Startup Configuration File on an RCP Server

The following example shows how to store a startup configuration file on a server by using RCP to copy the file:


```

Device# configure terminal

Device(config)# ip rcmd remote-username netadmin2

Device(config)# end

Device# copy nvram:startup-config rcp:

Remote host[]? 172.16.101.101

Name of configuration file to write [start-config]?
Write file start-config on host 172.16.101.101?[confirm]
![OK]

```

What to Do Next

After you have issued the **copy** EXEC command, you may be prompted for additional information or for confirmation of the action. The prompt displayed depends on how much information you provide in the **copy** command and the current setting of the **file prompt** global configuration command.

Copying a Configuration File from the Device to the FTP Server (CLI)

To copy a startup configuration file or a running configuration file from the device to an FTP server, complete the following tasks:

Procedure

	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 on the device.
Step 3	ip ftp username <i>username</i> Example: Device(config)# ip ftp username NetAdmin1	(Optional) Specifies the default remote username.
Step 4	ip ftp password <i>password</i> Example: Device(config)# ip ftp password adminpassword	(Optional) Specifies the default password.
Step 5	end Example:	(Optional) Exits global configuration mode. This step is required only if you override the

	Command or Action	Purpose
	Device(config)# end	default remote username or password (see Steps 2 and 3).
Step 6	Do one of the following: <ul style="list-style-type: none"> • copy system:running-config ftp: [[[/[username [:password]@]location]/directory]/filename] or • copy nvram:startup-config ftp: [[[/[username [:password]@]location]/directory]/filename] Example: Device# copy system:running-config ftp:	Copies the running configuration or startup configuration file to the specified location on the FTP server.

Examples

Storing a Running Configuration File on an FTP Server

The following example copies the running configuration file named runfile-config to the netadmin1 directory on the remote host with an IP address of 172.16.101.101:

```
Device# copy system:running-config ftp://netadmin1:mypass@172.16.101.101/runfile-config
Write file runfile-config on host 172.16.101.101?[confirm]
Building configuration...[OK]
Connected to 172.16.101.101
Device#
```

Storing a Startup Configuration File on an FTP Server

The following example shows how to store a startup configuration file on a server by using FTP to copy the file:

```
Device# configure terminal

Device(config)# ip ftp username netadmin2

Device(config)# ip ftp password mypass

Device(config)# end

Device# copy nvram:startup-config ftp:

Remote host[]? 172.16.101.101

Name of configuration file to write [start-config]?
Write file start-config on host 172.16.101.101?[confirm]
![OK]
```

What to Do Next

After you have issued the **copy EXEC** command, you may be prompted for additional information or for confirmation of the action. The prompt displayed depends on how much information you provide in the **copy** command and the current setting of the **file prompt** global configuration command.

Copying a Configuration File from a TFTP Server to the Device (CLI)

To copy a configuration file from a TFTP server to the device, complete the tasks in this section:

Procedure

	Command or Action	Purpose
Step 1	enable Example: <pre>Device> enable</pre>	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	copy tftp: [[[//location]/directory]/filename] system:running-config Example: <pre>Device# copy tftp://server1/dir10/datasource system:running-config</pre>	Copies a configuration file from a TFTP server to the running configuration.
Step 3	copy tftp: [[[//location]/directory]/filename] nvrnram:startup-config Example: <pre>Device# copy tftp://server1/dir10/datasource nvrnram:startup-config</pre>	Copies a configuration file from a TFTP server to the startup configuration.
Step 4	copy tftp: [[[//location]/directory]/filename] flash-[n]/directory/startup-config Example: <pre>Device# copy tftp://server1/dir10/datasource flash:startup-config</pre>	Copies a configuration file from a TFTP server to the startup configuration.

Examples

In the following example, the software is configured from the file named **tokyo-config** at IP address 172.16.2.155:

```
Device# copy tftp://172.16.2.155/tokyo-config system:running-config
```

```
Configure using tokyo-config from 172.16.2.155? [confirm] Y
Booting tokyo-config from 172.16.2.155:!!! [OK - 874/16000 bytes]
```

What to Do Next

After you have issued the **copy EXEC** command, you may be prompted for additional information or for confirmation of the action. The prompt displayed depends on how much information you provide in the **copy** command and the current setting of the **file prompt** global configuration command.

Copying a Configuration File from the rcp Server to the Device (CLI)

To copy a configuration file from an rcp server to the running configuration or startup configuration, complete the following tasks:

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Device# configure terminal	(Optional) Enters configuration mode from the terminal. This step is required only if you override the default remote username (see Step 3).
Step 3	ip rcmd remote-username <i>username</i> Example: Device(config)# ip rcmd remote-username NetAdmin1	(Optional) Specifies the remote username.
Step 4	end Example: Device(config)# end	(Optional) Exits global configuration mode. This step is required only if you override the default remote username (see Step 2).
Step 5	Do one of the following: <ul style="list-style-type: none"> • copy rp|||username@|cat||dev||name|sysrunningconf • copy rp|||username@|cat||dev||name|sysstartupconf Example: Device# copy	Copies the configuration file from an rcp server to the running configuration or startup configuration.

	Command or Action	Purpose
	<code>rcp://[user1@example.com/dir10/fileone] nvram:startup-config</code>	

Examples

Copy RCP Running-Config

The following example copies a configuration file named `host1-config` from the `netadmin1` directory on the remote server with an IP address of `172.16.101.101`, and loads and runs the commands on the device:

```
Device# copy rcp://netadmin1@172.16.101.101/host1-config system:running-config
Configure using host1-config from 172.16.101.101? [confirm]
Connected to 172.16.101.101
Loading 1112 byte file host1-config:[OK]
Device#
%SYS-5-CONFIG: Configured from host1-config by rcp from 172.16.101.101
```

Copy RCP Startup-Config

The following example specifies a remote username of `netadmin1`. Then it copies the configuration file named `host2-config` from the `netadmin1` directory on the remote server with an IP address of `172.16.101.101` to the startup configuration.

```
Device# configure terminal
Device(config)# ip rcmd remote-username netadmin1
Device(config)# end
Device# copy rcp: nvram:startup-config
Address of remote host [255.255.255.255]? 172.16.101.101
Name of configuration file[rtr2-config]? host2-config
Configure using host2-config from 172.16.101.101?[confirm]
Connected to 172.16.101.101
Loading 1112 byte file host2-config:[OK]
[OK]
Device#
%SYS-5-CONFIG_NV:Non-volatile store configured from host2-config by rcp from 172.16.101.101
```

What to Do Next

After you have issued the **copy EXEC** command, you may be prompted for additional information or for confirmation of the action. The prompt displayed depends on how much information you provide in the **copy** command and the current setting of the **file prompt** global configuration command.

Copying a Configuration File from an FTP Server to the Device (CLI)

To copy a configuration file from an FTP server to the running configuration or startup configuration, complete the tasks in this section:

Procedure

	Command or Action	Purpose
Step 1	<code>enable</code>	Enables privileged EXEC mode.

	Command or Action	Purpose
	Example: Device> enable	<ul style="list-style-type: none"> Enter your password if prompted.
Step 2	configure terminal Example: Device# configure terminal	(Optional) Allows you to enter global configuration mode. This step is required only if you want to override the default remote username or password (see Steps 3 and 4).
Step 3	ip ftp username <i>username</i> Example: Device(config)# ip ftp username NetAdmin1	(Optional) Specifies the default remote username.
Step 4	ip ftp password <i>password</i> Example: Device(config)# ip ftp password adminpassword	(Optional) Specifies the default password.
Step 5	end Example: Device(config)# end	(Optional) Exits global configuration mode. This step is required only if you override the default remote username or password (see Steps 3 and 4).
Step 6	Do one of the following: <ul style="list-style-type: none"> copy ftp: [[[/[<i>username</i>[:<i>password</i>]@]<i>location</i>] /<i>directory</i>]/<i>filename</i>]system:running-config copy ftp: [[/[<i>username</i>[:<i>password</i>]@]<i>location</i>]<i>filename</i>]system:startup-config Example: Device# copy ftp:nvram:startup-config	Using FTP copies the configuration file from a network server to running memory or the startup configuration.

Examples

Copy FTP Running-Config

The following example copies a host configuration file named host1-config from the netadmin1 directory on the remote server with an IP address of 172.16.101.101, and loads and runs the commands on the device:

```
Device# copy ftp://netadmin1:mypass@172.16.101.101/host1-config system:running-config
Configure using host1-config from 172.16.101.101? [confirm]
Connected to 172.16.101.101
Loading 1112 byte file host1-config:![OK]
```

```
Device#
%SYS-5-CONFIG: Configured from host1-config by ftp from 172.16.101.101
```

Copy FTP Startup-Config

The following example specifies a remote username of netadmin1. Then it copies the configuration file named host2-config from the netadmin1 directory on the remote server with an IP address of 172.16.101.101 to the startup configuration:

```
Device# configure terminal
Device(config)# ip ftp username netadmin1
Device(config)# ip ftp password mypass
Device(config)# end
Device# copy ftp: nvram:startup-config
Address of remote host [255.255.255.255]? 172.16.101.101
Name of configuration file[host1-config]? host2-config
Configure using host2-config from 172.16.101.101?[confirm]
Connected to 172.16.101.101
Loading 1112 byte file host2-config:[OK]
[OK]
Device#
%SYS-5-CONFIG_NV:Non-volatile store configured from host2-config by ftp from 172.16.101.101
```

What to Do Next

After you have issued the **copy EXEC** command, you may be prompted for additional information or for confirmation of the action. The prompt displayed depends on how much information you provide in the **copy** command and the current setting of the **file prompt** global configuration command.

Maintaining Configuration Files Larger than NVRAM

To maintain a configuration file that exceeds the size of NVRAM, perform the tasks described in the following sections:

Compressing the Configuration File (CLI)

To compress configuration files, complete the tasks in this section:

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.

	Command or Action	Purpose
Step 3	service compress-config Example: <pre>Device(config)# service compress-config</pre>	Specifies that the configuration file be compressed.
Step 4	end Example: <pre>Device(config)# end</pre>	Exits global configuration mode.
Step 5	Do one of the following: <ul style="list-style-type: none"> • Use FTP, RCP, or TFTP to copy the new configuration. • configure terminal Example: <pre>Device# configure terminal</pre>	Enters the new configuration: <ul style="list-style-type: none"> • If you try to load a configuration that is more than three times larger than the NVRAM size, the following error message is displayed: <pre>“[buffer overflow - file-size /buffer-size bytes].”</pre>
Step 6	copy system:running-config nvrām:startup-config Example: <pre>Device(config)# copy system:running-config nvrām:startup-config</pre>	When you have finished changing the running-configuration, save the new configuration.

Examples

The following example compresses a 129-KB configuration file to 11 KB:

```
Device# configure terminal
Device(config)# service compress-config
Device(config)# end
Device# copy tftp://172.16.2.15/tokyo-config system:running-config
Configure using tokyo-config from 172.16.2.155? [confirm] y
Booting tokyo-config from 172.16.2.155:!!! [OK - 874/16000 bytes]
Device# copy system:running-config nvrām:startup-config
Building configuration...
Compressing configuration from 129648 bytes to 11077 bytes
[OK]
```


Storing the Configuration in Flash Memory on Class A Flash File Systems (CLI)

To store the startup configuration in flash memory, complete the tasks in this section:

Procedure

	Command or Action	Purpose
Step 1	enable Example: <pre>Device> enable</pre>	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	copy nvram:startup-config <i>flash-filesystem:filename</i> Example: <pre>Device# copy nvram:startup-config usbflash0:switch-config</pre>	Copies the current startup configuration to the new location to create the configuration file.
Step 3	configure terminal Example: <pre>Device# configure terminal</pre>	Enters global configuration mode.
Step 4	boot config flash-filesystem: filename Example: <pre>Device(config)# boot config usbflash0:switch-config</pre>	Specifies that the startup configuration file be stored in flash memory by setting the CONFIG_FILE variable.
Step 5	end Example: <pre>Device(config)# end</pre>	Exits global configuration mode.
Step 6	Do one of the following: <ul style="list-style-type: none"> • Use FTP, RCP, or TFTP to copy the new configuration. If you try to load a configuration that is more than three times larger than the NVRAM size, the following error message is displayed: “[buffer overflow - <i>file-size</i> /<i>buffer-size</i> bytes].” • configure terminal Example: <pre>Device# configure terminal</pre>	Enters the new configuration.

	Command or Action	Purpose
Step 7	copy system:running-config nvram:startup-config Example: <pre>Device(config)# copy system:running-config nvram:startup-config</pre>	When you have finished changing the running-configuration, save the new configuration.

Examples

The following example stores the configuration file in usbflash0:

```
Device# copy nvram:startup-config usbflash0:switch-config
Device# configure terminal
Device(config)# boot config usbflash0:switch-config
Device(config)# end
Device# copy system:running-config nvram:startup-config
```

Loading the Configuration Commands from the Network (CLI)

To use a network server to store large configurations, complete the tasks in this section:

Procedure

	Command or Action	Purpose
Step 1	enable Example: <pre>Device> enable</pre>	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	copy system:running-config {ftp: | rcp: | tftp:} Example: <pre>Device# copy system:running-config ftp:</pre>	Saves the running configuration to an FTP, RCP, or TFTP server.
Step 3	configure terminal Example: <pre>Device# configure terminal</pre>	Enters global configuration mode.
Step 4	boot network {ftp:[[[/[username [:password]@]location]/directory]/filename ] | rcp:[[[/[username@]location]/directory	Specifies that the startup configuration file be loaded from the network server at startup.

	Command or Action	Purpose
	<pre>]/filename ] | tftp:[[[//location]/directory]/filename]} Example: Device(config)# boot network ftp://user1:guessme@example.com/dir10/file1</pre>	
Step 5	<pre>service config Example: Device(config)# service config</pre>	Enables the switch to download configuration files at system startup.
Step 6	<pre>end Example: Device(config)# end</pre>	Exits global configuration mode.
Step 7	<pre>copy system:running-config nvram:startup-config Example: Device# copy system:running-config nvram:startup-config</pre>	Saves the configuration.

Copying Configuration Files from Flash Memory to the Startup or Running Configuration (CLI)

To copy a configuration file from flash memory directly to your startup configuration in NVRAM or your running configuration, enter one of the commands in Step 2:

Procedure

	Command or Action	Purpose
Step 1	<pre>enable Example: Device> enable</pre>	<p>Enables privileged EXEC mode.</p> <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	<p>Do one of the following:</p> <ul style="list-style-type: none"> • copy filesystem: [partition-number:][filename] nvram:startup-config • copy filesystem: [partition-number:][filename] system:running-config 	<ul style="list-style-type: none"> • Loads a configuration file directly into NVRAM or • Copies a configuration file to your running configuration

	Command or Action	Purpose
	Example: Device# copy usbflash0:4:ios-upgrade-1 nvram:startup-config	

Examples

The following example copies the file named ios-upgrade-1 from partition 4 of the flash memory PC Card in usbflash0 to the device startup configurations:

```
Device# copy usbflash0:4:ios-upgrade-1 nvram:startup-config
```

```
Copy 'ios-upgrade-1' from flash device as 'startup-config' ? [yes/no] yes
```

```
[OK]
```

Copying Configuration Files Between Flash Memory File Systems (CLI)

On platforms with multiple flash memory file systems, you can copy files from one flash memory file system, such as internal flash memory to another flash memory file system. Copying files to different flash memory file systems lets you create backup copies of working configurations and duplicate configurations for other devices. To copy a configuration file between flash memory file systems, use the following commands in EXEC mode:

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	show source-filesystem: Example: Device# show flash:	Displays the layout and contents of flash memory to verify the filename.
Step 3	copy source-filesystem: [partition-number:][filename] dest-filesystem:[partition-number:][filename] Example: Device# copy flash: usbflash0:	Copies a configuration file between flash memory devices. <ul style="list-style-type: none"> • The source device and the destination device cannot be the same. For example, the copy usbflash0: usbflash0: command is invalid.

	Command or Action	Purpose
Step 2	configure terminal Example: Device# configure terminal	(Optional) Enters global configuration mode. This step is required only if you override the default remote username or password (see Steps 3 and 4).
Step 3	ip ftp username <i>username</i> Example: Device(config)# ip ftp username Admin01	(Optional) Specifies the remote username.
Step 4	ip ftp password <i>password</i> Example: Device(config)# ip ftp password adminpassword	(Optional) Specifies the remote password.
Step 5	end Example: Device(config)# end	(Optional) Exits configuration mode. This step is required only if you override the default remote username (see Steps 3 and 4).
Step 6	copy ftp: [[//location]/directory]/bundle_name flash: Example: Device>copy ftp://cat3-ca-universal-9.SSA.03.12.02.EZF.150-12.02.EZF.150-12.02.EZF.bin flash:	Copies the configuration file from a network server to the flash memory device using FTP.

What to Do Next

After you have issued the **copy** EXEC command, you may be prompted for additional information or for confirmation of the action. The prompt displayed depends on how much information you provide in the **copy** command and the current setting of the **file prompt** global configuration command.

Copying a Configuration File from an RCP Server to Flash Memory Devices (CLI)

To copy a configuration file from an RCP server to a flash memory device, complete the tasks in this section:

Procedure

	Command or Action	Purpose
Step 1	enable Example:	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.

	Command or Action	Purpose
	Device> enable	
Step 2	configure terminal Example: Device# configure terminal	(Optional) Enters global configuration mode. This step is required only if you override the default remote username or password (see Step 3).
Step 3	ip rcmd remote-username <i>username</i> Example: Device(config)# ip rcmd remote-username Admin01	(Optional) Specifies the remote username.
Step 4	end Example: Device(config)# end	(Optional) Exits configuration mode. This step is required only if you override the default remote username or password (see Step 3).
Step 5	copy rcp: [[[//<i>username@</i>]<i>location</i>]/<i>directory</i>]/<i>bundle_name</i>] flash: Example: Device# copy rcp://netadmin@172.16.101.101/bundle1 flash:	Copies the configuration file from a network server to the flash memory device using RCP. Respond to any device prompts for additional information or confirmation. Prompting depends on how much information you provide in the copy command and the current setting of the file prompt command.

Copying a Configuration File from a TFTP Server to Flash Memory Devices (CLI)

To copy a configuration file from a TFTP server to a flash memory device, complete the tasks in this section:

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	copy tftp: [[[//<i>location</i>]/<i>directory</i>]/<i>bundle_name</i>] flash: Example: Device# copy	Copies the file from a TFTP server to the flash memory device. Reply to any device prompts for additional information or confirmation. Prompting depends on how much information you provide in the copy command and the current setting of the file prompt command.

	Command or Action	Purpose
	<code>tftp://cat3k-aaa-universall9.SSA.03.12.02.EZP.150-12.02.EZP.150-12.02.EZP.bin</code> flash:	

Examples

The following example shows the copying of the configuration file named switch-config from a TFTP server to the flash memory card inserted in usbflash0. The copied file is renamed new-config.

```
Device#
copy tftp:switch-config usbflash0:new-config
```

Re-executing the Configuration Commands in the Startup Configuration File (CLI)

To re-execute the commands located in the startup configuration file, complete the task in this section:

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	configure memory Example: Device# configure memory	Re-executes the configuration commands located in the startup configuration file.

Clearing the Startup Configuration (CLI)

You can clear the configuration information from the startup configuration. If you reboot the device with no startup configuration, the device enters the Setup command facility so that you can configure the device from scratch. To clear the contents of your startup configuration, complete the task in this section:

Procedure

	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	erase nvram Example: Device# erase nvram	Clears the contents of your startup configuration. Note For all platforms except the Class A Flash file system platforms, this command erases NVRAM. The startup configuration file cannot be restored once it has been deleted. On Class A Flash file system platforms, when you use the erase startup-config EXEC command, the device erases or deletes the configuration pointed to by the CONFIG_FILE environment variable. If this variable points to NVRAM, the device erases NVRAM. If the CONFIG_FILE environment variable specifies a flash memory device and configuration filename, the device deletes the configuration file. That is, the device marks the file as “deleted,” rather than erasing it. This feature allows you to recover a deleted file.

Deleting a Specified Configuration File (CLI)

To delete a specified configuration on a specific flash device, complete the task in this section:

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	delete <i>flash-filesystem:filename</i> Example:	Deletes the specified configuration file on the specified flash device.

	Command or Action	Purpose
	Device# delete usbflash0:myconfig	<p>Note On Class A and B Flash file systems, when you delete a specific file in flash memory, the system marks the file as deleted, allowing you to later recover a deleted file using the undelete EXEC command. Erased files cannot be recovered. To permanently erase the configuration file, use the squeeze EXEC command. On Class C Flash file systems, you cannot recover a file that has been deleted. If you attempt to erase or delete the configuration file specified by the CONFIG_FILE environment variable, the system prompts you to confirm the deletion.</p>

Specifying the CONFIG_FILE Environment Variable on Class A Flash File Systems (CLI)

On Class A flash file systems, you can configure the Cisco IOS software to load the startup configuration file specified by the CONFIG_FILE environment variable. The CONFIG_FILE variable defaults to NVRAM. To change the CONFIG_FILE environment variable, complete the tasks in this section:

Procedure

	Command or Action	Purpose
Step 1	<p>enable</p> <p>Example:</p> <pre>Device> enable</pre>	<p>Enables privileged EXEC mode.</p> <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	<p>copy <i>[flash-url | ftp-url | rcp-url | tftp-url | system:running-config | nvram:startup-config] dest-flash-url</i></p> <p>Example:</p> <pre>Device# copy system:running-config nvram:startup-config</pre>	<p>Copies the configuration file to the flash file system from which the device loads the file on restart.</p>
Step 3	<p>configure terminal</p> <p>Example:</p> <pre>Device# configure terminal</pre>	<p>Enters global configuration mode.</p>

	Command or Action	Purpose
Step 4	boot config <i>dest-flash-url</i> Example: Device(config)# boot config 172.16.1.1	Sets the CONFIG_FILE environment variable. This step modifies the runtime CONFIG_FILE environment variable.
Step 5	end Example: Device(config)# end	Exits global configuration mode.
Step 6	copy system:running-config nvrnram:startup-config Example: Device# copy system:running-config nvrnram:startup-config	Saves the configuration performed in Step 3 to the startup configuration.
Step 7	show boot Example: Device# show boot	(Optional) Allows you to verify the contents of the CONFIG_FILE environment variable.

Examples

The following example copies the running configuration file to the device. This configuration is then used as the startup configuration when the system is restarted:

```
Device# copy system:running-config usbflash0:config2
Device# configure terminal
Device(config)# boot config usbflash0:config2
Device(config)# end
Device# copy system:running-config nvrnram:startup-config
[ok]
Device# show boot
BOOT variable = usbflash0:rsp-boot-m
CONFIG_FILE variable = nvrnram:
Current CONFIG_FILE variable = usbflash0:config2
Configuration register is 0x010F
```

What to Do Next

After you specify a location for the startup configuration file, the **nvrnram:startup-config** command is aliased to the new location of the startup configuration file. The **more nvrnram:startup-config EXEC** command displays the startup configuration, regardless of its location. The **erase nvrnram:startup-config EXEC** command erases the contents of NVRAM and deletes the file pointed to by the CONFIG_FILE environment variable.

When you save the configuration using the **copy system:running-config nvrnram:startup-config** command, the device saves a complete version of the configuration file to the location specified by the CONFIG_FILE environment variable and a distilled version to NVRAM. A distilled version is one that does not contain access

list information. If NVRAM contains a complete configuration file, the device prompts you to confirm your overwrite of the complete version with the distilled version. If NVRAM contains a distilled configuration, the device does not prompt you for confirmation and proceeds with overwriting the existing distilled configuration file in NVRAM.



Note If you specify a file in a flash device as the CONFIG_FILE environment variable, every time you save your configuration file with the **copy system:running-config nvram:startup-config** command, the old configuration file is marked as “deleted,” and the new configuration file is saved to that device. Eventually, Flash memory fills up as the old configuration files still take up memory. Use the **squeeze EXEC** command to permanently delete the old configuration files and reclaim the space.

Configuring the Device to Download Configuration Files

You can specify an ordered list of network configuration and host configuration filenames. The Cisco IOS XE software scans this list until it loads the appropriate network or host configuration file.

To configure the device to download configuration files at system startup, perform at least one of the tasks described in the following sections:

- [Configuring the Device to Download the Network Configuration File \(CLI\)](#)
- [Configuring the Device to Download the Host Configuration File \(CLI\)](#)

If the device fails to load a configuration file during startup, it tries again every 10 minutes (the default setting) until a host provides the requested files. With each failed attempt, the device displays the following message on the console terminal:

```
Booting host-config... [timed out]
```

If there are any problems with the startup configuration file, or if the configuration register is set to ignore NVRAM, the device enters the Setup command facility.

Configuring the Device to Download the Network Configuration File (CLI)

To configure the Cisco IOS software to download a network configuration file from a server at startup, complete the tasks in this section:

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example:	Enters global configuration mode.

	Command or Action	Purpose
	Device# configure terminal	
Step 3	<p>boot network {ftp:[[[//[username [:password]@]location]/directory]/filename ] | rcp:[[[//[username@]location]/directory]/filename ] | tftp:[[[//[location]/directory]/filename]}]</p> <p>Example:</p> <pre>Device(config)# boot network tftp:hostfile1</pre>	<p>Specifies the network configuration file to download at startup, and the protocol to be used (TFTP, RCP, or FTP).</p> <ul style="list-style-type: none"> If you do not specify a network configuration filename, the Cisco IOS software uses the default filename network-config. If you omit the address, the device uses the broadcast address. You can specify more than one network configuration file. The software tries them in order entered until it loads one. This procedure can be useful for keeping files with different configuration information loaded on a network server.
Step 4	<p>service config</p> <p>Example:</p> <pre>Device(config)# service config</pre>	Enables the system to automatically load the network file on restart.
Step 5	<p>end</p> <p>Example:</p> <pre>Device(config)# end</pre>	Exits global configuration mode.
Step 6	<p>copy system:running-config nvram:startup-config</p> <p>Example:</p> <pre>Device# copy system:running-config nvram:startup-config</pre>	Saves the running configuration to the startup configuration file.

Configuring the Device to Download the Host Configuration File (CLI)

To configure the Cisco IOS software to download a host configuration file from a server at startup, complete the tasks in this section:

Procedure

	Command or Action	Purpose
Step 1	<p>enable</p> <p>Example:</p> <pre>Device> enable</pre>	<p>Enables privileged EXEC mode.</p> <ul style="list-style-type: none"> Enter your password if prompted.

	Command or Action	Purpose
Step 2	configure terminal Example: <pre>Device# configure terminal</pre>	Enters global configuration mode.
Step 3	boot host {ftp:[[/[username [:password]@]location]/directory]/filename ] | rcp:[[/[username@]location]/directory]/filename ] | tftp:[[/location]/directory]/filename] } Example: <pre>Device(config)# boot host tftp:hostfile1</pre>	<p>Specifies the host configuration file to download at startup, and the protocol to be used (FTP, RCP, or TFTP):</p> <ul style="list-style-type: none"> • If you do not specify a host configuration filename, the device uses its own name to form a host configuration filename by converting the name to all lowercase letters, removing all domain information, and appending “-cfg.” If no host name information is available, the software uses the default host configuration filename device-cfg. If you omit the address, the device uses the broadcast address. • You can specify more than one host configuration file. The Cisco IOS software tries them in order entered until it loads one. This procedure can be useful for keeping files with different configuration information loaded on a network server.
Step 4	service config Example: <pre>Device(config)# service config</pre>	Enables the system to automatically load the host file upon restart.
Step 5	end Example: <pre>Device(config)# end</pre>	Exits global configuration mode.
Step 6	copy system:running-config nvram:startup-config Example: <pre>Device# copy system:running-config nvram:startup-config</pre>	Saves the running configuration to the startup configuration file.

Example

In the following example, a device is configured to download the host configuration file named `hostfile1` and the network configuration file named `networkfile1`. The device uses TFTP and the broadcast address to obtain the file:

```
Device# configure terminal
Device(config)# boot host tftp:hostfile1
Device(config)# boot network tftp:networkfile1
Device(config)# service config
Device(config)# end
Device# copy system:running-config nvram:startup-config
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS configuration commands	<i>Cisco IOS Configuration Fundamentals Command Reference</i>

Error Message Decoder

Description	Link
To help you research and resolve system error messages in this release, use the Error Message Decoder tool.	https://www.cisco.com/cgi-bin/Support/Errordecoder/index.cgi

Standards

Standard	Title
No new or modified standards are supported, and support for existing standards has not been modified	--

MIBs

MIB	MIBs Link
<ul style="list-style-type: none"> No new or modified MIBs are supported, and support for existing MIBs has not been modified. 	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

RFCs

RFC	Title
No new or modified RFCs are supported, and support for existing RFCs has not been modified.	--

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



CHAPTER 9

Configuration Replace and Configuration Rollback

- [Prerequisites for Configuration Replace and Configuration Rollback, on page 187](#)
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Prerequisites for Configuration Replace and Configuration Rollback

The format of the configuration files used as input by the Configuration Replace and Configuration Rollback feature must comply with standard Cisco software configuration file indentation rules as follows:

- Start all commands on a new line with no indentation, unless the command is within a configuration submode.
- Indent commands within a first-level configuration submode one space.
- Indent commands within a second-level configuration submode two spaces.
- Indent commands within subsequent submodes accordingly.

These indentation rules describe how the software creates configuration files for such commands as **show running-config** or **copy running-config destination-url**. Any configuration file generated on a Cisco device complies with these rules.

Free memory larger than the combined size of the two configuration files (the current running configuration and the saved replacement configuration) is required.

Restrictions for Configuration Replace and Configuration Rollback

If the device does not have free memory larger than the combined size of the two configuration files (the current running configuration and the saved replacement configuration), the configuration replace operation is not performed.

Certain Cisco configuration commands such as those pertaining to physical components of a networking device (for example, physical interfaces) cannot be added or removed from the running configuration. For example, a configuration replace operation cannot remove the **interface ethernet 0** command line from the current running configuration if that interface is physically present on the device. Similarly, the **interface ethernet 1** command line cannot be added to the running configuration if no such interface is physically present on the device. A configuration replace operation that attempts to perform these types of changes results in error messages indicating that these specific command lines failed.

In very rare cases, certain Cisco configuration commands cannot be removed from the running configuration without reloading the device. A configuration replace operation that attempts to remove this type of command results in error messages indicating that these specific command lines failed.

Information About Configuration Replace and Configuration Rollback

Configuration Archive

The Cisco IOS configuration archive is intended to provide a mechanism to store, organize, and manage an archive of Cisco IOS configuration files to enhance the configuration rollback capability provided by the **configure replace** command. Before this feature was introduced, you could save copies of the running configuration using the **copy running-config destination-url** command, storing the replacement file either locally or remotely. However, this method lacked any automated file management. On the other hand, the Configuration Replace and Configuration Rollback feature provides the capability to automatically save copies of the running configuration to the Cisco IOS configuration archive. These archived files serve as checkpoint configuration references and can be used by the **configure replace** command to revert to previous configuration states.

The **archive config** command allows you to save Cisco IOS configurations in the configuration archive using a standard location and filename prefix that is automatically appended with an incremental version number (and optional timestamp) as each consecutive file is saved. This functionality provides a means for consistent identification of saved Cisco IOS configuration files. You can specify how many versions of the running configuration are kept in the archive. After the maximum number of files are saved in the archive, the oldest file is automatically deleted when the next, most recent file is saved. The **show archive** command displays information for all configuration files saved in the Cisco IOS configuration archive.

The Cisco IOS configuration archive, in which the configuration files are stored and available for use with the **configure replace** command, can be located on the following file systems: FTP, HTTP, RCP, TFTP.

Configuration Replace

The **configure replace** privileged EXEC command provides the capability to replace the current running configuration with any saved Cisco IOS configuration file. This functionality can be used to revert to a previous configuration state, effectively rolling back any configuration changes that were made since the previous configuration state was saved.

When using the **configure replace** command, you must specify a saved Cisco IOS configuration as the replacement configuration file for the current running configuration. The replacement file must be a complete configuration generated by a Cisco IOS device (for example, a configuration generated by the **copy running-config destination-url** command), or, if generated externally, the replacement file must comply with the format of files generated by Cisco IOS devices. When the **configure replace** command is entered, the current running configuration is compared with the specified replacement configuration and a set of diffs is generated. The algorithm used to compare the two files is the same as that employed by the **show archive config differences** command. The resulting diffs are then applied by the Cisco IOS parser to achieve the replacement configuration state. Only the diffs are applied, avoiding potential service disruption from reapplying configuration commands that already exist in the current running configuration. This algorithm effectively handles configuration changes to order-dependent commands (such as access lists) through a multiple pass process. Under normal circumstances, no more than three passes are needed to complete a configuration replace operation, and a limit of five passes is performed to preclude any looping behavior.

The Cisco IOS **copy source-url running-config** privileged EXEC command is often used to copy a stored Cisco IOS configuration file to the running configuration. When using the **copy source-url running-config** command as an alternative to the **configure replace target-url** privileged EXEC command, the following major differences should be noted:

- The **copy source-url running-config** command is a merge operation and preserves all of the commands from both the source file and the current running configuration. This command does not remove commands from the current running configuration that are not present in the source file. In contrast, the **configure replace target-url** command removes commands from the current running configuration that are not present in the replacement file and adds commands to the current running configuration that need to be added.
- The **copy source-url running-config** command applies every command in the source file, whether or not the command is already present in the current running configuration. This algorithm is inefficient and, in some cases, can result in service outages. In contrast, the **configure replace target-url** command only applies the commands that need to be applied—no existing commands in the current running configuration are reapplied.
- A partial configuration file may be used as the source file for the **copy source-url running-config** command, whereas a complete Cisco IOS configuration file must be used as the replacement file for the **configure replace target-url** command.

A locking feature for the configuration replace operation was introduced. When the **configure replace** command is used, the running configuration file is locked by default for the duration of the configuration replace operation. This locking mechanism prevents other users from changing the running configuration while the replacement operation is taking place, which might otherwise cause the replacement operation to terminate unsuccessfully. You can disable the locking of the running configuration by using the **no lock** keyword when issuing the **configure replace** command.

The running configuration lock is automatically cleared at the end of the configuration replace operation. You can display any locks that may be currently applied to the running configuration using the **show configuration lock** command.

Configuration Rollback

The concept of rollback comes from the transactional processing model common to database operations. In a database transaction, you might make a set of changes to a given database table. You then must choose whether to commit the changes (apply the changes permanently) or to roll back the changes (discard the changes and revert to the previous state of the table). In this context, rollback means that a journal file containing a log of the changes is discarded, and no changes are applied. The result of the rollback operation is to revert to the previous state, before any changes were applied.

The **configure replace** command allows you to revert to a previous configuration state, effectively rolling back changes that were made since the previous configuration state was saved. Instead of basing the rollback operation on a specific set of changes that were applied, the Cisco IOS configuration rollback capability uses the concept of reverting to a specific configuration state based on a saved Cisco IOS configuration file. This concept is similar to the database idea of saving a checkpoint (a saved version of the database) to preserve a specific state.

If the configuration rollback capability is desired, you must save the Cisco IOS running configuration before making any configuration changes. Then, after entering configuration changes, you can use that saved configuration file to roll back the changes (using the **configure replace target-url** command). Furthermore, because you can specify any saved Cisco IOS configuration file as the replacement configuration, you are not limited to a fixed number of rollbacks, as is the case in some rollback models.

Configuration Rollback Confirmed Change

The Configuration Rollback Confirmed Change feature allows configuration changes to be performed with an optional requirement that they be confirmed. If this confirmation is not received, the configuration is returned to the state prior to the changes being applied. The mechanism provides a safeguard against inadvertent loss of connectivity between a network device and the user or management application due to configuration changes.

Benefits of Configuration Replace and Configuration Rollback

- Allows you to revert to a previous configuration state, effectively rolling back configuration changes.
- Allows you to replace the current running configuration file with the startup configuration file without having to reload the device or manually undo CLI changes to the running configuration file, therefore reducing system downtime.
- Allows you to revert to any saved Cisco IOS configuration state.
- Simplifies configuration changes by allowing you to apply a complete configuration file to the device, where only the commands that need to be added or removed are affected.
- When using the **configure replace** command as an alternative to the **copy source-url running-config** command, increases efficiency and prevents risk of service outages by not reapplying existing commands in the current running configuration.

How to Use Configuration Replace and Configuration Rollback

Creating a Configuration Archive (CLI)

No prerequisite configuration is needed to use the **configure replace** command. Using the **configure replace** command in conjunction with the Cisco IOS configuration archive and the **archive config** command is optional but offers significant benefit for configuration rollback scenarios. Before using the **archive config** command, the configuration archive must be configured. Perform this task to configure the characteristics of the configuration archive.

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 3	archive Example: Device(config)# archive	Enters archive configuration mode.
Step 4	path <i>url</i> Example: Device(config-archive)# path flash:myconfiguration	Specifies the location and filename prefix for the files in the Cisco IOS configuration archive. <p>Note If a directory is specified in the path instead of file, the directory name must be followed by a forward slash as follows: path flash:/directory/. The forward slash is not necessary after a filename; it is only necessary when specifying a directory.</p>
Step 5	maximum <i>number</i> Example: Device(config-archive)# maximum 14	(Optional) Sets the maximum number of archive files of the running configuration to be saved in the Cisco IOS configuration archive. <ul style="list-style-type: none"> • The <i>number</i> argument is the maximum number of archive files of the running configuration to be saved in the Cisco IOS configuration archive. Valid values are from 1 to 14. The default is 10.

	Command or Action	Purpose
		<p>Note Before using this command, you must configure the path command to specify the location and filename prefix for the files in the Cisco IOS configuration archive.</p>
Step 6	<p>time-period <i>minutes</i></p> <p>Example:</p> <pre>Device(config-archive)# time-period 1440</pre>	<p>(Optional) Sets the time increment for automatically saving an archive file of the current running configuration in the Cisco IOS configuration archive.</p> <ul style="list-style-type: none"> The <i>minutes</i> argument specifies how often, in minutes, to automatically save an archive file of the current running configuration in the Cisco IOS configuration archive. <p>Note Before using this command, you must configure the path command to specify the location and filename prefix for the files in the Cisco IOS configuration archive.</p>
Step 7	<p>end</p> <p>Example:</p> <pre>Device(config-archive)# end</pre>	Exits to privileged EXEC mode.
Step 8	<p>archive config</p> <p>Example:</p> <pre>Device# archive config</pre>	<p>Saves the current running configuration file to the configuration archive.</p> <p>Note The path command must be configured before using this command.</p>

Performing a Configuration Replace or Configuration Rollback Operation (CLI)

Perform this task to replace the current running configuration file with a saved Cisco IOS configuration file.



Note You must create a configuration archive before performing this procedure. See [Creating a Configuration Archive \(CLI\)](#) for detailed steps. The following procedure details how to return to that archived configuration in the event of a problem with the current running configuration.

Procedure

	Command or Action	Purpose
Step 1	<p>enable</p> <p>Example:</p> <pre>Device> enable</pre>	<p>Enables privileged EXEC mode.</p> <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	<p>configure replace <i>target-url</i> [nolock] [list] [force] [ignore case] [revert trigger [error]] [timer <i>minutes</i>] | time <i>minutes</i>]</p> <p>Example:</p> <pre>Device# configure replace flash: startup-config time 120</pre>	<p>Replaces the current running configuration file with a saved Cisco IOS configuration file.</p> <ul style="list-style-type: none"> • The <i>target - url</i> argument is a URL (accessible by the Cisco IOS file system) of the saved Cisco IOS configuration file that is to replace the current running configuration, such as the configuration file created using the archive config command. • The list keyword displays a list of the command lines applied by the Cisco IOS software parser during each pass of the configuration replace operation. The total number of passes performed is also displayed. • The force keyword replaces the current running configuration file with the specified saved Cisco IOS configuration file without prompting you for confirmation. • The time <i>minutes</i> keyword and argument specify the time (in minutes) within which you must enter the configure confirm command to confirm replacement of the current running configuration file. If the configure confirm command is not entered within the specified time limit, the configuration replace operation is automatically reversed (in other words, the current running configuration file is restored to the configuration state that existed prior to entering the configure replace command). • The nolock keyword disables the locking of the running configuration file that prevents other users from changing the running configuration during a configuration replace operation.

	Command or Action	Purpose
		<ul style="list-style-type: none"> The revert trigger keywords set the following triggers for reverting to the original configuration: <ul style="list-style-type: none"> error —Reverts to the original configuration upon error. timer <i>minutes</i> —Reverts to the original configuration if specified time elapses. The ignore case keyword allows the configuration to ignore the case of the confirmation command.
Step 3	<p>configure revert { now | timer { <i>minutes</i> | idle <i>minutes</i> } }</p> <p>Example:</p> <pre>Device# configure revert now</pre>	<p>(Optional) To cancel the timed rollback and trigger the rollback immediately, or to reset parameters for the timed rollback, use the configure revert command in privileged EXEC mode.</p> <ul style="list-style-type: none"> now —Triggers the rollback immediately. timer —Resets the configuration revert timer. <ul style="list-style-type: none"> Use the <i>minutes</i> argument with the timer keyword to specify a new revert time in minutes. Use the idle keyword along with a time in minutes to set the maximum allowable time period of no activity before reverting to the saved configuration.
Step 4	<p>configure confirm</p> <p>Example:</p> <pre>Device# configure confirm</pre>	<p>(Optional) Confirms replacement of the current running configuration file with a saved Cisco IOS configuration file.</p> <p>Note Use this command only if the time seconds keyword and argument of the configure replace command are specified.</p>
Step 5	<p>exit</p> <p>Example:</p> <pre>Device# exit</pre>	Exits to user EXEC mode.

Monitoring and Troubleshooting the Feature (CLI)

Perform this task to monitor and troubleshoot the Configuration Replace and Configuration Rollback feature.

Procedure

Step 1 **enable**

Use this command to enable privileged EXEC mode. Enter your password if prompted.

Example:

```
Device> enable  
Device#
```

Step 2 **show archive**

Use this command to display information about the files saved in the Cisco IOS configuration archive.

Example:

```
Device# show archive  
There are currently 1 archive configurations saved.  
The next archive file will be named flash:myconfiguration-2  
Archive # Name  
0  
1 flash:myconfiguration-1 <- Most Recent  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14
```

The following is sample output from the **show archive** command after several archive files of the running configuration have been saved. In this example, the maximum number of archive files to be saved is set to three.

Example:

```
Device# show archive  
There are currently 3 archive configurations saved.  
The next archive file will be named flash:myconfiguration-8  
Archive # Name  
0  
1 :Deleted  
2 :Deleted  
3 :Deleted  
4 :Deleted  
5 flash:myconfiguration-5  
6 flash:myconfiguration-6  
7 flash:myconfiguration-7 <- Most Recent
```

```

8
9
10
11
12
13
14

```

Step 3 debug archive versioning

Use this command to enable debugging of the Cisco IOS configuration archive activities to help monitor and troubleshoot configuration replace and rollback.

Example:

```

Device# debug archive versioning
Jan  9 06:46:28.419:backup_running_config
Jan  9 06:46:28.419:Current = 7
Jan  9 06:46:28.443:Writing backup file flash:myconfiguration-7
Jan  9 06:46:29.547: backup worked

```

Step 4 debug archive config timestamp

Use this command to enable debugging of the processing time for each integral step of a configuration replace operation and the size of the configuration files being handled.

Example:

```

Device# debug archive config timestamp
Device# configure replace flash:myconfiguration force
Timing Debug Statistics for IOS Config Replace operation:
  Time to read file usbflash0:sample_2.cfg = 0 msec (0 sec)
  Number of lines read:55
  Size of file           :1054
Starting Pass 1
  Time to read file system:running-config = 0 msec (0 sec)
  Number of lines read:93
  Size of file           :2539
  Time taken for positive rollback pass = 320 msec (0 sec)
  Time taken for negative rollback pass = 0 msec (0 sec)
  Time taken for negative incremental diffs pass = 59 msec (0 sec)
  Time taken by PI to apply changes = 0 msec (0 sec)
  Time taken for Pass 1 = 380 msec (0 sec)
Starting Pass 2
  Time to read file system:running-config = 0 msec (0 sec)
  Number of lines read:55
  Size of file           :1054
  Time taken for positive rollback pass = 0 msec (0 sec)
  Time taken for negative rollback pass = 0 msec (0 sec)
  Time taken for Pass 2 = 0 msec (0 sec)
Total number of passes:1
Rollback Done

```

Step 5 exit

Use this command to exit to user EXEC mode.

Example:

```
Device# exit
Device>
```

Configuration Examples for Configuration Replace and Configuration Rollback

Creating a Configuration Archive

The following example shows how to perform the initial configuration of the Cisco IOS configuration archive. In this example, `flash:myconfiguration` is specified as the location and filename prefix for the files in the configuration archive and a value of 10 is set as the maximum number of archive files to be saved.

```
configure terminal
!
archive
 path flash:myconfiguration
 maximum 10
end
```

Replacing the Current Running Configuration with a Saved Cisco IOS Configuration File

The following example shows how to replace the current running configuration with a saved Cisco IOS configuration file named `flash:myconfiguration`. The **configure replace** command interactively prompts you to confirm the operation.

```
Device# configure replace flash:myconfiguration
This will apply all necessary additions and deletions
to replace the current running configuration with the
contents of the specified configuration file, which is
assumed to be a complete configuration, not a partial
configuration. Enter Y if you are sure you want to proceed. ? [no]: Y
Total number of passes: 1
Rollback Done
```

In the following example, the **list** keyword is specified in order to display the command lines that were applied during the configuration replace operation:

```
Device# configure replace flash:myconfiguration list
This will apply all necessary additions and deletions
to replace the current running configuration with the
contents of the specified configuration file, which is
assumed to be a complete configuration, not a partial
configuration. Enter Y if you are sure you want to proceed. ? [no]: Y
!Pass 1
!List of Commands:
no snmp-server community public ro
```

```
snmp-server community mystring ro

end
Total number of passes: 1
Rollback Done
```

Reverting to the Startup Configuration File

The following example shows how to revert to the Cisco IOS startup configuration file using the **configure replace** command. This example also shows the use of the optional **force** keyword to override the interactive user prompt:

```
Device# configure replace flash:startup-config force
Total number of passes: 1
Rollback Done
```

Performing a Configuration Replace Operation with the **configure confirm** Command

The following example shows the use of the **configure replace** command with the **time minutes** keyword and argument. You must enter the **configure confirm** command within the specified time limit to confirm replacement of the current running configuration file. If the **configure confirm** command is not entered within the specified time limit, the configuration replace operation is automatically reversed (in other words, the current running configuration file is restored to the configuration state that existed prior to entering the **configure replace** command).

```
Device# configure replace flash:startup-config time 120
This will apply all necessary additions and deletions
to replace the current running configuration with the
contents of the specified configuration file, which is
assumed to be a complete configuration, not a partial
configuration. Enter Y if you are sure you want to proceed. ? [no]: Y
Total number of passes: 1
Rollback Done
Device# configure confirm
```

The following example shows the use of the **configure revert** command with the **timer** keyword. You must enter the **configure revert** command to cancel the timed rollback and trigger the rollback immediately, or to reset parameters for the timed rollback.

```
Device# configure revert timer 100
```

Performing a Configuration Rollback Operation

The following example shows how to make changes to the current running configuration and then roll back the changes. As part of the configuration rollback operation, you must save the current running configuration before making changes to the file. In this example, the **archive config** command is used to save the current running configuration. The generated output of the **configure replace** command indicates that only one pass was performed to complete the rollback operation.



Note Before using the **archive config** command, you must configure the **path** command to specify the location and filename prefix for the files in the Cisco IOS configuration archive.

You first save the current running configuration in the configuration archive as follows:

```
archive config
```

You then enter configuration changes as shown in the following example:

```
configure terminal
!
user netops2 password rain
user netops3 password snow
exit
```

After having made changes to the running configuration file, assume you now want to roll back these changes and revert to the configuration that existed before the changes were made. The **show archive** command is used to verify the version of the configuration to be used as a replacement file. The **configure replace** command is then used to revert to the replacement configuration file as shown in the following example:

```
Device# show archive
There are currently 1 archive configurations saved.
The next archive file will be named flash:myconfiguration-2
Archive # Name
0
1 flash:myconfiguration-1 <- Most Recent
2
3
4
5
6
7
8
9
10
Device# configure replace flash:myconfiguration-1
Total number of passes: 1
Rollback Done
```

Additional References

Related Documents

Related Topic	Document Title
Configuration Locking	<i>Exclusive Configuration Change Access and Access Session Locking</i>
Commands for managing configuration files	<i>Cisco IOS Configuration Fundamentals Command Reference</i>

Related Topic	Document Title
Information about managing configuration files	<i>Managing Configuration Files</i>

Error Message Decoder

Description	Link
To help you research and resolve system error messages in this release, use the Error Message Decoder tool.	https://www.cisco.com/cgi-bin/Support/Errordecoder/index.cgi

Standards

Standards	Title
No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.	--

MIBs

MIBs	MIBs Link
No new or modified MIBs are supported by this feature, and support for existing MIBs has not been modified 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
No new or modified RFCs are supported by this feature, and support for existing RFCs has not been modified by this feature.	--

Technical Assistance

Description	Link
<p>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies.</p> <p>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.</p> <p>Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</p>	<p>http://www.cisco.com/cisco/web/support/index.html</p>



CHAPTER 10

Working with the Flash File System

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- [Displaying Available File Systems, on page 203](#)
- [Setting the Default File System, on page 205](#)
- [Displaying Information About Files on a File System, on page 206](#)
- [Changing Directories and Displaying the Working Directory \(CLI\), on page 206](#)
- [Creating Directories \(CLI\), on page 207](#)
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- [Creating, Displaying and Extracting Files \(CLI\), on page 210](#)
- [Additional References, on page 212](#)

Information About the Flash File System

The flash file system is a single flash device on which you can store files. It also provides several commands to help you manage software bundles and configuration files. The default flash file system on the device is named flash:

As viewed from the active device, flash: refers to the local flash device, which is the device attached to the same device on which the file system is being viewed. In a device stack, each of the flash devices from the various stack members can be viewed from the active device. The names of these flash file systems include the corresponding device member numbers. For example, flash-3:, as viewed from the active device, refers to the same file system as does flash: on stack member 3. Use the **show file systems** privileged EXEC command to list all file systems, including the flash file systems in the device stack.

Only one user at a time can manage the software bundles and configuration files for a device stack .

Displaying Available File Systems

To display the available file systems on your device, use the **show file systems** privileged EXEC command as shown in this example for a standalone device:

```
Device# show file systems
Size(b) Free(b) Type Flags Prefixes
- - opaque rw system:
- - opaque rw tmpsys:
1651314688 1559785472 disk rw crashinfo:
* 11353194496 9693396992 disk rw flash:
8049967104 7959392256 disk ro webui:
```

```

- - opaque rw null:
- - opaque ro tar:
- - network rw tftp:
2097152 2080848 nvram rw nvram:
- - opaque wo syslog:
- - network rw rcp:
- - network rw http:
- - network rw ftp:
- - network rw scp:
- - network rw https:
- - opaque ro cns:

```

This example shows a device stack. In this example, the active device is stack member 1; the file system on stack member 2 is displayed as flash-2:, the file system on stack member 3 is displayed as flash-3: and so on up to stack member 8, displayed as flash-8: for a 8-member stack. The example also shows the crashinfo directories and a USB flash drive plugged into the active device:

```

Device# show file systems
File Systems:

Size(b) Free(b) Type Flags Prefixes
- - opaque rw system:
- - opaque rw tmpsys:
1651314688 1520742400 disk rw crashinfo: crashinfo-1:
1651507200 1516240896 disk rw crashinfo-2: stby-crashinfo:
1651507200 1517289472 disk rw crashinfo-3:
1651507200 1519386624 disk rw crashinfo-4:
1651507200 1524629504 disk rw crashinfo-5:
1651507200 1523580928 disk rw crashinfo-6:
1651507200 1517289472 disk rw crashinfo-7:
1651507200 1526726656 disk rw crashinfo-8:
* 11353194496 7916576768 disk rw flash: flash-1:
11353980928 7944011776 disk rw flash-2: stby-flash:
11353980928 7876902912 disk rw flash-3:
11353980928 7944011776 disk rw flash-4:
11353980928 7939817472 disk rw flash-5:
11353980928 7944011776 disk rw flash-6:
11353980928 7944011776 disk rw flash-7:
11353980928 7944011776 disk rw flash-8:
3824013312 3756507136 disk ro webui:
- - opaque rw null:
- - opaque ro tar:
- - network rw tftp:
2097152 2052489 nvram rw nvram:
- - opaque wo syslog:
- - network rw rcp:
- - network rw http:
- - network rw ftp:
- - network rw scp:
- - network rw https:
- - opaque ro cns:
2097152 2052489 nvram rw stby-nvram:
- - nvram rw stby-rcsf:
- - opaque rw revrcsf:

```

Table 13: show file systems Field Descriptions

Field	Value
Size(b)	Amount of memory in the file system in bytes.
Free(b)	Amount of free memory in the file system in bytes.

Field	Value
Type	<p>Type of file system.</p> <p>disk—The file system is for a flash memory device, USB flash, and crashinfo file.</p> <p>network—The file system for network devices; for example, an FTP server or and HTTP server.</p> <p>nvram—The file system is for a NVRAM device.</p> <p>opaque—The file system is a locally generated pseudo file system (for example, the system) or a download interface, such as brimux.</p> <p>unknown—The file system is an unknown type.</p>
Flags	<p>Permission for file system.</p> <p>ro—read-only.</p> <p>rw—read/write.</p> <p>wo—write-only.</p>
Prefixes	<p>Alias for file system.</p> <p>crashinfo:—Crashinfo file.</p> <p>flash:—Flash file system.</p> <p>ftp:—FTP server.</p> <p>http:—HTTP server.</p> <p>https:—Secure HTTP server.</p> <p>nvram:—NVRAM.</p> <p>null:—Null destination for copies. You can copy a remote file to null to find its size.</p> <p>rcp:—Remote Copy Protocol (RCP) server.</p> <p>scp:—Session Control Protocol (SCP) server.</p> <p>system:—Contains the system memory, including the running configuration.</p> <p>tftp:—TFTP network server.</p> <p>usbflash0:—USB flash memory.</p> <p>ymodem:—Obtain the file from a network machine by using the Ymodem protocol.</p>

Setting the Default File System

You can specify the file system or directory that the system uses as the default file system by using the **cd filesystem:** privileged EXEC command. You can set the default file system to omit the *filesystem:* argument

from related commands. For example, for all privileged EXEC commands that have the optional *filesystem:* argument, the system uses the file system specified by the **cd** command.

By default, the default file system is *flash:*.

You can display the current default file system as specified by the **cd** command by using the **pwd** privileged EXEC command.

Displaying Information About Files on a File System

You can view a list of the contents of a file system before manipulating its contents. For example, before copying a new configuration file to flash memory, you might want to verify that the file system does not already contain a configuration file with the same name. Similarly, before copying a flash configuration file to another location, you might want to verify its filename for use in another command. To display information about files on a file system, use one of the privileged EXEC commands listed in the following table.

Table 14: Commands for Displaying Information About Files

Command	Description
dir [/all] [filesystem:filename]	Displays a list of files on a file system.
show file systems	Displays more information about each of the files on a file system.
show file information file-url	Displays information about a specific file.
show file descriptors	Displays a list of open file descriptors. File descriptors are the internal representations of open files. You can use this command to see if another user has a file open.

Changing Directories and Displaying the Working Directory (CLI)

Follow these steps to change directories and to display the working directory:

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	dir filesystem: Example:	Displays the directories on the specified file system.

	Command or Action	Purpose
	Device# dir flash:	For <i>filesystem:</i> , use flash: for the system board flash device. To access flash partitions of device members in a stack, use flash- <i>n</i> where <i>n</i> is the stack member number. For example, flash-4.
Step 3	cd <i>directory_name</i> Example: Device# cd new_configs	Navigates to the specified directory. The command example shows how to navigate to the directory named <i>new_configs</i> .
Step 4	pwd Example: Device# pwd	Displays the working directory.
Step 5	cd Example: Device# cd	Navigates to the default directory.

Creating Directories (CLI)

Beginning in privileged EXEC mode, follow these steps to create a directory:

Procedure

	Command or Action	Purpose
Step 1	dir <i>filesystem:</i> Example: Device# dir flash:	Displays the directories on the specified file system. For <i>filesystem:</i> , use flash: for the system board flash device.
Step 2	mkdir <i>directory_name</i> Example: Device# mkdir new_configs	Creates a new directory. Directory names are case sensitive and are limited to 45 characters between the slashes (/); the name cannot contain control characters, spaces, slashes, quotes, semicolons, or colons.
Step 3	dir <i>filesystem:</i> Example: Device# dir flash:	Verifies your entry.

Removing Directories

To remove a directory with all its files and subdirectories, use the **delete /force /recursive** *filesystem:/file-url* privileged EXEC command.

Use the **/recursive** keyword to delete the named directory and all subdirectories and the files contained in it. Use the **/force** keyword to suppress the prompting that confirms a deletion of each file in the directory. You are prompted only once at the beginning of this deletion process.

For *filesystem*, use **flash:** for the system board flash device. For *file-url*, enter the name of the directory to be deleted. All of the files in the directory and the directory are removed.



Caution When directories are deleted, their contents cannot be recovered.

Copying Files

To copy a file from a source to a destination, use the **copy source-url destination-url** privileged EXEC command. For the source and destination URLs, you can use **running-config** and **startup-config** keyword shortcuts. For example, the **copy running-config startup-config** command saves the currently running configuration file to the NVRAM section of flash memory to be used as the configuration during system initialization.

You can also copy from special file systems (**xmodem:**, **ymodem:**) as the source for the file from a network machine that uses the Xmodem or Ymodem protocol.

Network file system URLs include ftp:, rcp:, tftp:, scp:, http:, and https: and have these syntaxes:

- FTP—ftp:[[/username [:password]@location]/directory]/filename
- RCP—rcp:[[/username@location]/directory]/filename
- TFTP—tftp:[[/location]/directory]/filename
- SCP—scp:[[/username [:password]@location]/directory]/filename
- HTTP—http:[[/username [:password]@location]/directory]/filename
- HTTPS—https:[[/username [:password]@location]/directory]/filename



Note The password must not contain the special character '@'. If the character '@' is used, the copy fails to parse the IP address of the server.

Local writable file systems include flash:.

Some invalid combinations of source and destination exist. Specifically, you cannot copy these combinations:

- From a running configuration to a running configuration
- From a startup configuration to a startup configuration
- From a device to the same device (for example, the **copy flash: flash:** command is invalid)

Copying Files from One Device in a Stack to Another Device in the Same Stack

To copy a file from one device in a stack to another device in the same stack, use the **flash-X:** notation, where **X** is the device number.

To view all devices in a stack, use the **show switch** command in privileged EXEC mode, as in the following example of a 9-member device stack:

```
Switch#show switch
Switch/Stack Mac Address : 046c.9d01.3b80 - Local Mac Address
Mac persistency wait time: 4 mins
```

Switch#	Role	Mac Address	Priority	H/W Version	Current State
*1	Active	046c.9d01.3b80	15	P4B	Ready
2	Standby	046c.9d01.0f80	13	P3C	Ready
3	Member	046c.9d01.1180	11	P4B	Ready
4	Member	046c.9d01.0e80	9	P3C	Ready
5	Member	046c.9d01.4d00	7	P3C	Ready
6	Member	046c.9d01.2800	5	P3C	Ready
7	Member	046c.9d01.6e80	3	P4B	Ready
8	Member	046c.9d01.8180	1	P4B	Ready

To view all file systems available to copy on a specific device, use the **copy** command as in the following example of a 5-member stack:

```
switch#copy flash:?
flash:.installer
flash:.prst_sync
flash:.rollback_timer
flash:boothelper.log
flash:bootloader_evt_handle.log
flash:cat9k-cc_srdriver.16.05.01a.SPA.pkg
flash:cat9k-espbase.16.05.01a.SPA.pkg
flash:cat9k-guestshell.16.05.01a.SPA.pkg
flash:cat9k-rpbase.16.05.01a.SPA.pkg
flash:cat9k-rpboot.16.05.01a.SPA.pkg
flash:cat9k-sipbase.16.05.01a.SPA.pkg
flash:cat9k-sipspa.16.05.01a.SPA.pkg
flash:cat9k-srdriver.16.05.01a.SPA.pkg
flash:cat9k-webui.16.05.01a.SPA.pkg
flash:cat9k-wlc.16.05.01a.SPA.pkg
flash:core
flash:dc_profile_dir
flash:dc_stats.txt
flash:gs_script
flash:nvram_config
flash:packages.conf
```

This example shows how to copy a config file stored in the flash partition of device 2 to the flash partition of device 4. It assumes that device 2 and device 4 are in the same stack.

```
Device# copy flash-2:config.txt flash-4:config.txt
```

Deleting Files

When you no longer need a file on a flash memory device, you can permanently delete it. To delete a file or directory from a specified flash device, use the **delete** [**/force**] [**/recursive**] [*filesystem:*]/*file-url* privileged EXEC command.

Use the **/recursive** keyword for deleting a directory and all subdirectories and the files contained in it. Use the **/force** keyword to suppress the prompting that confirms a deletion of each file in the directory. You are prompted only once at the beginning of this deletion process. Use the **/force** and **/recursive** keywords for deleting old software images that were installed by using the **archive download-sw** command but are no longer needed.

If you omit the *filesystem:* option, the device uses the default device specified by the **cd** command. For *file-url*, you specify the path (directory) and the name of the file to be deleted.

When you attempt to delete any files, the system prompts you to confirm the deletion.



Caution When files are deleted, their contents cannot be recovered.

This example shows how to delete the file *myconfig* from the default flash memory device:

```
Device# delete myconfig
```

Creating, Displaying and Extracting Files (CLI)

You can create a file and write files into it, list the files in a file, and extract the files from a file as described in the next sections.

Beginning in privileged EXEC mode, follow these steps to create a file, display the contents, and extract it:

Procedure

	Command or Action	Purpose
Step 1	<p>archive tar /create destination-url flash: <i>/file-url</i></p> <p>Example:</p> <pre>device# archive tar /create tftp:172.20.10.30/saved. flash:/new-configs</pre>	<p>Creates a file and adds files to it.</p> <p>For <i>destination-url</i>, specify the destination URL alias for the local or network file system and the name of the file to create:</p> <ul style="list-style-type: none"> Local flash file system syntax: <p>flash:</p> FTP syntax: <p>ftp:<i>[//username[password]@location]directory/-filename.</i></p> RCP syntax: <p>rcp:<i>[//username@location]directory/-filename.</i></p> TFTP syntax: <p>tftp:<i>[//location]directory/-filename.</i></p>

	Command or Action	Purpose
		For flash:/file-url , specify the location on the local flash file system in which the new file is created. You can also specify an optional list of files or directories within the source directory to add to the new file. If none are specified, all files and directories at this level are written to the newly created file.
Step 2	<p>archive tar /table source-url</p> <p>Example:</p> <pre>device# archive tar /table flash: /new_configs</pre>	<p>Displays the contents of a file.</p> <p>For <i>source-url</i>, specify the source URL alias for the local or network file system. The <i>-filename</i> is the file to display. These options are supported:</p> <ul style="list-style-type: none"> Local flash file system syntax: <p>flash:</p> FTP syntax: <p>ftp:[[/username[:password]@location]/directory]/-filename.</p> RCP syntax: <p>rcp:[[/username@location]/directory]/-filename.</p> TFTP syntax: <p>tftp:[[/location]/directory]/-filename.</p> <p>You can also limit the file displays by specifying a list of files or directories after the file. Only those files appear. If none are specified, all files and directories appear.</p>
Step 3	<p>archive tar /xtract source-url flash:/file-url [dir/file...]</p> <p>Example:</p> <pre>device# archive tar /xtract tftp:/172.20.10.30/saved. flash:/new-configs</pre>	<p>Extracts a file into a directory on the flash file system.</p> <p>For <i>source-url</i>, specify the source URL alias for the local file system. The <i>-filename</i> is the file from which to extract files. These options are supported:</p> <ul style="list-style-type: none"> Local flash file system syntax: <p>flash:</p> FTP syntax: <p>ftp:[[/username[:password]@location]/directory]/-filename.</p> RCP syntax: <p>rcp:[[/username@location]/directory]/-filename.</p> TFTP syntax: <p>tftp:[[/location]/directory]/-filename.</p> <p>For flash:/file-url [dir/file...], specify the location on the local flash file system from</p>

	Command or Action	Purpose
		which the file is extracted. Use the <i>dir/file...</i> option to specify a list of files or directories within the file to be extracted. If none are specified, all files and directories are extracted.
Step 4	more [/ascii | /binary | /ebcdic] /file-url Example: <pre>device# more flash:/new-configs</pre>	Displays the contents of any readable file, including a file on a remote file system.

Additional References

Related Documents

Related Topic	Document Title
Commands for managing flash: file systems	<i>Cisco IOS Configuration Fundamentals Command Reference</i>

Error Message Decoder

Description	Link
To help you research and resolve system error messages in this release, use the Error Message Decoder tool.	https://www.cisco.com/cgi-bin/Support/Errordecoder/index.cgi

Standards

Standards	Title
No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.	--

MIBs

MIBs	MIBs Link
No new or modified MIBs are supported by this feature, and support for existing MIBs has not been modified 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
No new or modified RFCs are supported by this feature, and support for existing RFCs has not been modified by this feature.	--

Technical Assistance

Description	Link
<p>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies.</p> <p>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.</p> <p>Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</p>	http://www.cisco.com/cisco/web/support/index.html



CHAPTER 11

Conditional Debug and Radioactive Tracing

- [Finding Feature Information, on page 215](#)
- [Introduction to Conditional Debugging, on page 215](#)
- [Introduction to Radioactive Tracing, on page 216](#)
- [Conditional Debugging and Radioactive Tracing, on page 216](#)
- [Location of Tracefiles, on page 217](#)
- [Configuring Conditional Debugging, on page 217](#)
- [Radioactive Tracing for L2 Multicast, on page 219](#)
- [Recommended Workflow for Trace files, on page 219](#)
- [Copying tracefiles off the box, on page 219](#)
- [Configuration Examples for Conditional Debugging, on page 220](#)
- [Monitoring Conditional Debugging, on page 221](#)

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 at the end of this module.

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

Introduction to Conditional Debugging

The Conditional Debugging feature allows you to selectively enable debugging and logging for specific features based on the set of conditions you define. This feature is useful in systems where a large number of features are supported.



Note In Cisco IOS XE Denali 16.1.1, only Control Plane Tracing is supported.

The Conditional debug allows granular debugging in a network that is operating at a large scale with a large number of features. It allows you to observe detailed debugs for granular instances within the system. This is very useful when we need to debug only a particular session among thousands of sessions. It is also possible to specify multiple conditions.

A condition refers to a feature or identity, where identity could be an interface, IP Address, or a MAC address and so on.



Note In Cisco IOS XE Denali 16.1.1, MAC address is the only supported condition. The support for other features will be introduced in the releases that follow.

This is in contrast to the general debug command, that produces its output without discriminating on the feature objects that are being processed. General debug command consumes a lot of system resources and impacts the system performance.



Note To enable debug for wireless IPs, use the **debug platform condition feature wireless ip ip-address** command.

Introduction to Radioactive Tracing

Radioactive tracing provides the ability to stitch together a chain of execution for operations of interest across the system, at an increased verbosity level. This provides a way to conditionally print debug information (up to DEBUG Level or a specified level) across threads, processes and function calls.



Note In Cisco IOS XE Denali 16.1.1 the default level is **DEBUG**. The users cannot change this to another level. The support for other levels will be introduced in the releases that follow.



Note The radioactive tracing supports First-Hop Security (FHS).

For more information on First Hop Security features, see *System Management > Wireless Multicast > Information About Wireless Multicast > Information About IPv6 Snooping*.

Conditional Debugging and Radioactive Tracing

Radioactive Tracing when coupled with Conditional Debugging, enable us to have a single debug CLI to debug all execution contexts related to the condition. This can be done without being aware of the various control flow processes of the feature within the box and without having to issue debugs at these processes individually.

Location of Tracefiles

By default the tracefile logs will be generated for each process and saved into either the **/tmp/rp/trace** or **/tmp/fp/trace** directory. In this temp directory, the trace logs are written to files, which are of 1 MB size each. The directory can hold up to a maximum of 25 such files for a given process. When a tracefile in the **/tmp** directory reaches its 1MB limit or whatever size was configured for it during the boot time, it is rotated out to an archive location in the **/crashinfo** partition under **tracelogs** directory.

The **/tmp** directory holds only a single tracefile for a given process. Once the file reaches its file size limit it is rotated out to **/crashinfo/tracelogs**. In the archive directory, up to 25 files are accumulated, after which the oldest one is replaced by the newly rotated file from **/tmp**.

The tracefiles in the crashinfo directory are located in the following formats:

1. Process-name_Process-ID_running-counter.timestamp.gz
Example: IOSRP_R0-0.bin_0.14239.20151101234827.gz
2. Process-name_pmanlog_Process-ID_running-counter.timestamp.bin.gz
Example: wcm_pmanlog_R0-0.30360_0.20151028233007.bin.gz

Configuring Conditional Debugging

To configure conditional debugging, follow the steps given below:

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	debug platform condition mac {mac-address} Example: Device# debug platform condition mac bc16.6509.3314	Configures conditional debugging for the MAC Address specified.
Step 3	debug platform condition start Example: Device# debug platform condition start	Starts conditional debugging (this will start radioactive tracing if there is a match on one of the conditions above).
Step 4	show platform condition OR show debug Example: Device# show platform condition Device# show debug	Displays the current conditions set.

	Command or Action	Purpose
Step 5	debug platform condition stop Example: Device# <code>debug platform condition stop</code>	Stops conditional debugging (this will stop radioactive tracing).
Step 6	request platform software trace archive [last {number} days] [target {crashinfo: | flashinfo:}] Example: Device# <code>request platform software trace archive last 2 days</code>	(Optional) Displays historical logs of merged tracefiles on the system. Filter on any combination of number of days or location.
Step 7	show platform software trace [filter-binary | level | message] Example: Device# <code>show platform software trace message</code>	(Optional) Displays logs merged from the latest tracefile. Filter on any combination of application condition, trace module name, and trace level. <ul style="list-style-type: none"> • filter-binary - Filter the modules to be collated • level - Show trace levels • message - Show trace message ring contents <p>Note On Box:</p> <ul style="list-style-type: none"> • Available from IOS console in addition to linux shell. • Generates a file with merged logs on the box. • Displays merged logs only from staging area
Step 8	clear platform condition all Example: Device# <code>clear platform condition all</code>	Clears all conditions.

What to do next



Note The commands **request platform software trace filter-binary** and **show platform software trace filter-binary** work in a similar way. The only difference is:

- **request platform software trace filter-binary** - Sources the data from historical logs.
- **show platform software trace filter-binary** – Sources the data from the flash Temp directory.

Of these, `mac_log <..date..>` is the most important file, as it gives the messages for the MAC we are debugging. The command `show platform software trace filter-binary` also generates the same flash files, and also prints the `mac_log` on the screen.

Radioactive Tracing for L2 Multicast

To identify a specific multicast receiver, specify the MAC address of the joiner or the receiver client, Group Multicast IP address and Snooping VLAN. Additionally, enable the trace level for the debug. The debug level will provide detailed traces and better visibility into the system.

```
debug platform condition feature multicast controlplane mac client MAC address ip Group IP
address vlan id level debug level
```

Recommended Workflow for Trace files

The Recommended Workflow for Trace files is listed below:

1. To request the tracelogs for a specific time period.
EXAMPLE 1 day.
Use the command:
Device#**request platform software trace archive last 1 day**
2. The system generates a tar ball (.gz file) of the tracelogs in the location /flash:
3. Copy the file off the switch. By copying the file, the tracelogs can be used to work offline. For more details on copying files, see section below.
4. Delete the tracelog file (.gz) file from /flash: location. This will ensure enough space on the switch for other operations.

Copying tracefiles off the box

An example of the tracefile is shown below:

```
Device# dir crashinfo:/tracelogs
Directory of crashinfo:/tracelogs/

50664 -rwx 760 Sep 22 2015 11:12:21 +00:00 plogd_F0-0.bin_0.gz
50603 -rwx 991 Sep 22 2015 11:12:08 +00:00 fed_pmanlog_F0-0.bin_0.9558.20150922111208.gz
50610 -rw- 11 Nov 2 2015 00:15:59 +00:00 timestamp
50611 -rwx 1443 Sep 22 2015 11:11:31 +00:00
auto_upgrade_client_sh_pmanlog_R0-.bin_0.3817.20150922111130.gz
50669 -rwx 589 Sep 30 2015 03:59:04 +00:00 cfgwr-8021_R0-0.bin_0.gz
50612 -rwx 1136 Sep 22 2015 11:11:46 +00:00 reflector_803_R0-0.bin_0.1312.20150922111116.gz
50794 -rwx 4239 Nov 2 2015 00:04:32 +00:00 IOSRP_R0-0.bin_0.14239.20151101234827.gz
50615 -rwx 131072 Nov 2 2015 00:19:59 +00:00 linux_iosd_image_pmanlog_R0-0.bin_0
--More--
```

The trace files can be copied using one of the various options shown below:

```

Device# copy crashinfo:/tracelogs ?
crashinfo: Copy to crashinfo: file system
flash: Copy to flash: file system
ftp: Copy to ftp: file system
http: Copy to http: file system
https: Copy to https: file system
null: Copy to null: file system
nvram: Copy to nvram: file system
rcp: Copy to rcp: file system
running-config Update (merge with) current system configuration
scp: Copy to scp: file system
startup-config Copy to startup configuration
syslog: Copy to syslog: file system
system: Copy to system: file system
tftp: Copy to tftp: file system
tmpsys: Copy to tmpsys: file system

```

The general syntax for copying onto a TFTP server is as follows:

```

Device# copy source: tftp:
Device# copy crashinfo:/tracelogs/IOSRP_R0-0.bin_0.14239.20151101234827.gz tftp:
Address or name of remote host []? 2.2.2.2
Destination filename [IOSRP_R0-0.bin_0.14239.20151101234827.gz]?

```



Note It is important to clear the generated report or archive files off the switch in order to have flash space available for tracelog and other purposes.

Configuration Examples for Conditional Debugging

The following is an output example of the *show platform condition* command.

```

Device# show platform condition
Conditional Debug Global State: Stop
Conditions Direction
-----|-----
MAC Address 0024.D7C7.0054 N/A
Feature Condition Type Value
-----|-----|-----
Device#

```

The following is an output example of the *show debug* command.

```

Device# show debug
IOSXE Conditional Debug Configs:
Conditional Debug Global State: Start
Conditions Direction
-----|-----
MAC Address 0024.D7C7.0054 N/A
Feature Condition Type Value
-----|-----|-----
Packet Infra debugs:
Ip Address Port
-----|-----
Device#

```

The following is a sample of the *debug platform condition stop* command.

```
Device# debug platform condition stop
Conditional Debug Global State: Stop
```

Monitoring Conditional Debugging

The table shown below lists the various commands that can be used to monitor conditional debugging.

Command	Purpose
show platform condition	Displays the current conditions set.
show debug	Displays the current debug conditions set.
show platform software trace filter-binary	Displays logs merged from the latest tracefile.
request platform software trace filter-binary	Displays historical logs of merged tracefiles on the system.



CHAPTER 12

Troubleshooting the Software Configuration

This chapter describes how to identify and resolve software problems related to the Cisco IOS software on the switch. Depending on the nature of the problem, you can use the command-line interface (CLI), Device Manager, or Network Assistant to identify and solve problems.

Additional troubleshooting information, such as LED descriptions, is provided in the hardware installation guide.

- [Finding Feature Information, on page 223](#)
- [Information About Troubleshooting the Software Configuration, on page 223](#)
- [How to Troubleshoot the Software Configuration, on page 230](#)
- [Verifying Troubleshooting of the Software Configuration, on page 241](#)
- [Scenarios for Troubleshooting the Software Configuration, on page 244](#)
- [Configuration Examples for Troubleshooting Software, on page 246](#)
- [Feature History and Information for Troubleshooting Software Configuration, on page 248](#)

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 at the end of this module.

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Information About Troubleshooting the Software Configuration

Software Failure on a Switch

Switch software can be corrupted during an upgrade by downloading the incorrect file to the switch, and by deleting the image file. In all of these cases, the switch does not pass the power-on self-test (POST), and there is no connectivity.

Lost or Forgotten Password on a Device

The default configuration for the device allows an end user with physical access to the device to recover from a lost password by interrupting the boot process during power-on and by entering a new password. These recovery procedures require that you have physical access to the device.



Note On these devices, a system administrator can disable some of the functionality of this feature by allowing an end user to reset a password only by agreeing to return to the default configuration. If you are an end user trying to reset a password when password recovery has been disabled, a status message reminds you to return to the default configuration during the recovery process.



Note You cannot recover encryption password key, when Cisco WLC configuration is copied from one Cisco WLC to another (in case of an RMA).

Power over Ethernet Ports

A Power over Ethernet (PoE) switch port automatically supplies power to one of these connected devices if the switch detects that there is no power on the circuit:

- a Cisco pre-standard powered device (such as a Cisco IP Phone or a Cisco Aironet Access Point)
- an IEEE 802.3af-compliant powered device
- an IEEE 802.3at-compliant powered device

A powered device can receive redundant power when it is connected to a PoE switch port and to an AC power source. The device does not receive redundant power when it is only connected to the PoE port.

After the switch detects a powered device, the switch determines the device power requirements and then grants or denies power to the device. The switch can also detect the real-time power consumption of the device by monitoring and policing the power usage.

For more information, see the "Configuring PoE" chapter in the *Interface and Hardware Component Configuration Guide (Catalyst 9300 Switches)*.

Disabled Port Caused by Power Loss

If a powered device (such as a Cisco IP Phone 7910) that is connected to a PoE Device port and powered by an AC power source loses power from the AC power source, the device might enter an error-disabled state. To recover from an error-disabled state, enter the **shutdown** interface configuration command, and then enter the **no shutdown** interface command. You can also configure automatic recovery on the Device to recover from the error-disabled state.

On a Device, the **errdisable recovery cause loopback** and the **errdisable recovery interval seconds** global configuration commands automatically take the interface out of the error-disabled state after the specified period of time.

Disabled Port Caused by False Link-Up

If a Cisco powered device is connected to a port and you configure the port by using the **power inline never** interface configuration command, a false link-up can occur, placing the port into an error-disabled state. To take the port out of the error-disabled state, enter the **shutdown** and the **no shutdown** interface configuration commands.

You should not connect a Cisco powered device to a port that has been configured with the **power inline never** command.

Ping

The Device supports IP ping, which you can use to test connectivity to remote hosts. Ping sends an echo request packet to an address and waits for a reply. Ping returns one of these responses:

- Normal response—The normal response (*hostname is alive*) occurs in 1 to 10 seconds, depending on network traffic.
- Destination does not respond—If the host does not respond, a *no-answer* message is returned.
- Unknown host—If the host does not exist, an *unknown host* message is returned.
- Destination unreachable—If the default gateway cannot reach the specified network, a *destination-unreachable* message is returned.
- Network or host unreachable—If there is no entry in the route table for the host or network, a *network or host unreachable* message is returned.

Layer 2 Traceroute

The Layer 2 traceroute feature allows the switch to identify the physical path that a packet takes from a source device to a destination device. Layer 2 traceroute supports only unicast source and destination MAC addresses. Traceroute finds the path by using the MAC address tables of the Device in the path. When the Device detects a device in the path that does not support Layer 2 traceroute, the Device continues to send Layer 2 trace queries and lets them time out.

The Device can only identify the path from the source device to the destination device. It cannot identify the path that a packet takes from source host to the source device or from the destination device to the destination host.

Layer 2 Traceroute Guidelines

- Cisco Discovery Protocol (CDP) must be enabled on all the devices in the network. For Layer 2 traceroute to function properly, do not disable CDP.
If any devices in the physical path are transparent to CDP, the switch cannot identify the path through these devices.
- A Device is reachable from another Device when you can test connectivity by using the **ping** privileged EXEC command. All Device in the physical path must be reachable from each other.
- The maximum number of hops identified in the path is ten.

- You can enter the **traceroute mac** or the **traceroute mac ip** privileged EXEC command on a Device that is not in the physical path from the source device to the destination device. All Device in the path must be reachable from this switch.
- The **traceroute mac** command output shows the Layer 2 path only when the specified source and destination MAC addresses belong to the same VLAN. If you specify source and destination MAC addresses that belong to different VLANs, the Layer 2 path is not identified, and an error message appears.
- If you specify a multicast source or destination MAC address, the path is not identified, and an error message appears.
- If the source or destination MAC address belongs to multiple VLANs, you must specify the VLAN to which both the source and destination MAC addresses belong. If the VLAN is not specified, the path is not identified, and an error message appears.
- The **traceroute mac ip** command output shows the Layer 2 path when the specified source and destination IP addresses belong to the same subnet. When you specify the IP addresses, the Device uses the Address Resolution Protocol (ARP) to associate the IP addresses with the corresponding MAC addresses and the VLAN IDs.
 - If an ARP entry exists for the specified IP address, the Device uses the associated MAC address and identifies the physical path.
 - If an ARP entry does not exist, the Device sends an ARP query and tries to resolve the IP address. If the IP address is not resolved, the path is not identified, and an error message appears.
- When multiple devices are attached to one port through hubs (for example, multiple CDP neighbors are detected on a port), the Layer 2 traceroute feature is not supported. When more than one CDP neighbor is detected on a port, the Layer 2 path is not identified, and an error message appears.
- This feature is not supported in Token Ring VLANs.
- Layer 2 traceroute opens a listening socket on the User Datagram Protocol (UDP) port 2228 that can be accessed remotely with any IPv4 address, and does not require any authentication. This UDP socket allows to read VLAN information, links, presence of particular MAC addresses, and CDP neighbor information, from the device. This information can be used to eventually build a complete picture of the Layer 2 network topology.
- Layer 2 traceroute is enabled by default and can be disabled by running the **no l2 traceroute** command in global configuration mode. To re-enable Layer 2 traceroute, use the **l2 traceroute** command in global configuration mode.

IP Traceroute

You can use IP traceroute to identify the path that packets take through the network on a hop-by-hop basis. The command output displays all network layer (Layer 3) devices, such as routers, that the traffic passes through on the way to the destination.

Your Device can participate as the source or destination of the **traceroute** privileged EXEC command and might or might not appear as a hop in the **traceroute** command output. If the Device is the destination of the traceroute, it is displayed as the final destination in the traceroute output. Intermediate Device do not show up in the traceroute output if they are only bridging the packet from one port to another within the same VLAN. However, if the intermediate Device is a multilayer Device that is routing a particular packet, this Device shows up as a hop in the traceroute output.

The **tracert** privileged EXEC command uses the Time To Live (TTL) field in the IP header to cause routers and servers to generate specific return messages. Tracert starts by sending a User Datagram Protocol (UDP) datagram to the destination host with the TTL field set to 1. If a router finds a TTL value of 1 or 0, it drops the datagram and sends an Internet Control Message Protocol (ICMP) time-to-live-exceeded message to the sender. Tracert finds the address of the first hop by examining the source address field of the ICMP time-to-live-exceeded message.

To identify the next hop, tracert sends a UDP packet with a TTL value of 2. The first router decrements the TTL field by 1 and sends the datagram to the next router. The second router sees a TTL value of 1, discards the datagram, and returns the time-to-live-exceeded message to the source. This process continues until the TTL is incremented to a value large enough for the datagram to reach the destination host (or until the maximum TTL is reached).

To learn when a datagram reaches its destination, tracert sets the UDP destination port number in the datagram to a very large value that the destination host is unlikely to be using. When a host receives a datagram destined to itself containing a destination port number that is unused locally, it sends an ICMP *port-unreachable* error to the source. Because all errors except port-unreachable errors come from intermediate hops, the receipt of a port-unreachable error means that this message was sent by the destination port.

Debug Commands



Caution Because debugging output is assigned high priority in the CPU process, it can render the system unusable. For this reason, use **debug** commands only to troubleshoot specific problems or during troubleshooting sessions with Cisco technical support staff. It is best to use **debug** commands during periods of lower network traffic and fewer users. Debugging during these periods decreases the likelihood that increased **debug** command processing overhead will affect system use.

All **debug** commands are entered in privileged EXEC mode, and most **debug** commands take no arguments.

System Report

System reports or crashinfo files save information that helps Cisco technical support representatives to debug problems that caused the Cisco IOS image to fail (crash). It is necessary to quickly and reliably collect critical crash information with high fidelity and integrity. Further, it is necessary to collect this information and bundle it in a way that it can be associated or identified with a specific crash occurrence.

System reports are generated in these situations:

- In case of a switch failure—A system report is generated on the member that failed; reports are not generated on other members in the stack.
- In case of a switchover—System reports are generated only on high availability (HA) member switches. reports are not generated for non-HA members.

The system does not generate reports in case of a reload.

During a process crash, the following is collected locally from the switch:

1. Full process core
2. Tracelogs

3. IOS syslogs (not guaranteed in case of non-active crashes)
4. System process information
5. Bootup logs
6. Reload logs
7. Certain types of /proc information

This information is stored in separate files which are then archived and compressed into one bundle. This makes it convenient to get a crash snapshot in one place, and can be then moved off the box for analysis. This report is generated before the switch goes down to rommon/bootloader.

Except for the full core and tracelogs, everything else is a text file.

Crashinfo Files

By default the system report file will be generated and saved into the /crashinfo directory. If it cannot be saved to the crashinfo partition for lack of space, then it will be saved to the /flash directory.

To display the files, enter the **dir crashinfo:** command. The following is sample output of a crashinfo directory:

```
Switch#dir crashinfo:
Directory of crashinfo:/

23665 drwx 86016 Jun 9 2017 07:47:51 -07:00 tracelogs
11 -rw- 0 May 26 2017 15:32:44 -07:00 koops.dat
12 -rw- 4782675 May 29 2017 15:47:16 -07:00 system-report_1_20170529-154715-PDT.tar.gz
1651507200 bytes total (1519386624 bytes free)
```

System reports are located in the crashinfo directory in the following format:

```
system-report_[switch number]_[date]-[timestamp]-UTC.gz
```

After a switch crashes, check for a system report file. The name of the most recently generated system report file is stored in the last_systemreport file under the crashinfo directory. The system report and crashinfo files assist TAC while troubleshooting the issue.

The system report generated can be further copied using TFTP, HTTP and few other options.

```
Switch#copy crashinfo: ?
crashinfo:      Copy to crashinfo: file system
flash:         Copy to flash: file system
ftp:           Copy to ftp: file system
http:          Copy to http: file system
https:         Copy to https: file system
null:          Copy to null: file system
nvram:         Copy to nvram: file system
rcp:           Copy to rcp: file system
running-config Update (merge with) current system configuration
scp:           Copy to scp: file system
startup-config Copy to startup configuration
syslog:        Copy to syslog: file system
system:        Copy to system: file system
tftp:          Copy to tftp: file system
tmpsys:        Copy to tmpsys: file system
```

The general syntax for copying onto TFTP server is as follows:

```
Switch#copy crashinfo: tftp:
Source filename [system-report_1_20150909-092728-UTC.gz]?
```

```
Address or name of remote host []? 1.1.1.1
Destination filename [system-report_1_20150909-092728-UTC.gz]?
```

The tracelogs from all members in the stack can be collected by issuing a trace archive command. This command provides time period options. The command syntax is as follows:

```
Switch#request platform software trace archive ?
last      Archive trace files of last x days
target    Location and name for the archive file
```

The tracelogs stored in crashinfo: or flash: directory from within the last 3650 days can be collected.

```
Switch# request platform software trace archive last ?
<1-3650> Number of days (1-3650)
Switch#request platform software trace archive last 3650 days target ?
crashinfo: Archive file name and location
flash:      Archive file name and location
```



Note It is important to clear the system reports or trace archives from flash or crashinfo directory once they are copied out, in order to have space available for tracelogs and other purposes.

Onboard Failure Logging on the Switch

You can use the onboard failure logging (OBFL) feature to collect information about the device. The information includes uptime, temperature, and voltage information and helps Cisco technical support representatives to troubleshoot device problems. We recommend that you keep OBFL enabled and do not erase the data stored in the flash memory.

By default, OBFL is enabled. It collects information about the device and small form-factor pluggable (SFP) modules. The device stores this information in the flash memory:

- CLI commands—Record of the OBFL CLI commands that are entered on a standalone device or a switch stack member.
- Environment data—Unique device identifier (UDI) information for a standalone device or a switch stack member and for all the connected FRU devices: the product identification (PID), the version identification (VID), and the serial number.
- Message—Record of the hardware-related system messages generated by a standalone device or a switch stack member.
- Power over Ethernet (PoE)—Record of the power consumption of PoE ports on a standalone device or a switch stack member.
- Temperature—Temperature of a standalone device or a switch stack member.
- Uptime data—Time when a standalone device or a switch stack member starts, the reason the device restarts, and the length of time the device has been running since it last restarted.
- Voltage—System voltages of a standalone device or a switch stack member.

You should manually set the system clock or configure it by using Network Time Protocol (NTP).

When the device is running, you can retrieve the OBFL data by using the **show logging onboard** privileged EXEC commands. If the device fails, contact your Cisco technical support representative to find out how to retrieve the data.

When an OBFL-enabled device is restarted, there is a 10-minute delay before logging of new data begins.

Fan Failures

By default, the feature is disabled. When more than one of the fans fails in a field-replaceable unit (FRU) or in a power supply, the Device does not shut down, and this error message appears:

```
Multiple fan(FRU/PS) failure detected. System may get overheated. Change fan quickly.
```

The Device might overheat and shut down.

To enable the fan failures feature, enter the **system env fan-fail-action shut** privileged EXEC command. If more than one fan in the Device fails, the Device automatically shuts down, and this error message appears:

```
Faulty (FRU/PS) fans detected, shutting down system!
```

After the first fan shuts down, if the Device detects a second fan failure, the Device waits for 20 seconds before it shuts down.

To restart the Device, it must be power cycled.

Possible Symptoms of High CPU Utilization

Excessive CPU utilization might result in these symptoms, but the symptoms might also result from other causes:

- Spanning tree topology changes
- EtherChannel links brought down due to loss of communication
- Failure to respond to management requests (ICMP ping, SNMP timeouts, slow Telnet or SSH sessions)
- UDLD flapping
- IP SLAs failures because of SLAs responses beyond an acceptable threshold
- DHCP or IEEE 802.1x failures if the switch does not forward or respond to requests

How to Troubleshoot the Software Configuration

Recovering from a Software Failure

Before you begin

This recovery procedure requires that you have physical access to the switch.

This procedure uses boot loader commands and TFTP to recover from a corrupted or incorrect image file.

Procedure

- Step 1** From your PC, download the software image file (*image.bin*) from Cisco.com.
- Step 2** Load the software image to your TFTP server.
- Step 3** Connect your PC to the switch Ethernet management port.
- Step 4** Unplug the switch power cord.
- Step 5** Press the **Mode** button, and at the same time, reconnect the power cord to the switch.
- Step 6** From the bootloader (ROMMON) prompt, ensure that you can ping your TFTP server.

- a) Set the IP address **switch: set IP_ADDR ip_address subnet_mask**

Example:

```
switch: set IP_ADDR 192.0.2.123/255.255.255.0
```

- b) Set the default router IP address **switch: set DEFAULT_ROUTER ip_address**

Example:

```
switch: set DEFAULT_ROUTER 192.0.2.1
```

- c) Verify that you can ping the TFTP server **switch: ping ip_address_of_TFTP_server**

Example:

```
switch: ping 192.0.2.15
ping 192.0.2.1 with 32 bytes of data...
Host 192.0.2.1 is alive.
switch:
```

- Step 7** Verify that you have a recovery image in your recovery partition (sda9:).
This recovery image is required for recovery using the emergency-install feature.

Example:

```
switch: dir sda9:
Directory of sda9:/

   2  drwx  1024      .
   2  drwx  1024     ..
  11  -rw- 18923068  c3850-recovery.bin

36939776 bytes available (20830208 bytes used)
switch:
```

- Step 8** From the bootloader (ROMMON) prompt, initiate the emergency-install feature that assists you in recovering the software image on your switch.

WARNING: The emergency install command will erase your entire boot flash!

Example:

```
Switch#
emergency-install tftp://192.0.2.47/cat3k/cat3k_caa-universalk9.SPA.03.02.00.SE.150-1.EX.bin

The bootflash will be erased during install operation, continue (y/n)?y
Starting emergency recovery
```




Note On these switches, a system administrator can disable some of the functionality of this feature by allowing an end user to reset a password only by agreeing to return to the default configuration. If you are an end user trying to reset a password when password recovery has been disabled, a status message shows this during the recovery process.

Procedure

- Step 1** Connect a terminal or PC to the switch.
 - Connect a terminal or a PC with terminal-emulation software to the switch console port. If you are recovering the password for a switch stack, connect to the console port of the active switch.
 - Connect a PC to the Ethernet management port. If you are recovering the password for a switch stack, connect to the Ethernet management port of a stack member.
- Step 2** Set the line speed on the emulation software to 9600 baud.
- Step 3** Power off the standalone switch or the entire switch stack.
- Step 4** Reconnect the power cord to the switch or the active switch. As soon as the System LED blinks, press and release the Mode button 2-3 times. The switch enters the ROMMON mode.

The following console messages are displayed during the reload:

```

Initializing Hardware...

System Bootstrap, Version 16.6.1r [FC1], RELEASE SOFTWARE (P)
Compiled Sat 07/15/2017 8:31:57.39 by rel

Current image running:
Primary Rommon Image

Last reset cause: SoftwareReload          <---- Start pressing and releasing the mode button
C9300-24U platform with 8388608 Kbytes of main memory

attempting to boot from [flash:packages.conf]

Located file packages.conf
#
#####

Unable to load cat9k-rpboot.16.06.02b.SPA.pkg
Failed to boot file flash:user/packages.conf
ERROR: failed to boot from flash:packages.conf (Aborted) <--- will abort
switch:
switch: <---- ROMMON
    
```

Proceed to the *Procedure with Password Recovery Enabled* section, and follow the steps.

- Step 5** After recovering the password, reload the switch or the active switch.

On a switch:

```

Switch> reload
Proceed with reload? [confirm] y
            
```

On the active switch:

```
Switch> reload slot <stack-active-member-number>
Proceed with reload? [confirm] y
```

Step 6 Power on the remaining switches in the stack.

Procedure with Password Recovery Enabled

If the password-recovery operation is enabled, this message appears:

Procedure

Step 1 Ignore the startup configuration with the following command:

```
Switch: SWITCH_IGNORE_STARTUP_CFG=1
```

Step 2 Boot the switch with the *packages.conf* file from flash.

```
Switch: boot flash:packages.conf
```

Step 3 Terminate the initial configuration dialog by answering **No**.

```
Would you like to enter the initial configuration dialog? [yes/no]: No
```

Step 4 At the switch prompt, enter privileged EXEC mode.

```
Switch> enable
Switch#
```

Step 5 Copy the startup configuration to running configuration.

```
Switch# copy startup-config running-config Destination filename [running-config]?
```

Press Return in response to the confirmation prompts. The configuration file is now reloaded, and you can change the password.

Step 6 Enter global configuration mode and change the **enable** password.

```
Switch# configure terminal
Switch(config)#
```

Step 7 Write the running configuration to the startup configuration file.

```
Switch(config)# copy running-config startup-config
```


Step 8 Confirm that manual boot mode is enabled.

```
Switch# show boot

BOOT variable = flash:packages.conf;
Manual Boot = yes
Enable Break = yes
```

Step 9 Set the SWITCH_IGNORE_STARTUP_CFG parameter to 0.

```
Switch(config)# no system ignore startupconfig switch all
Switch(config)# end
Switch# write memory
```

Step 10 Boot the device with the *packages.conf* file from flash.

```
Switch: boot flash:packages.conf
```

Step 11 After the device boots up, disable manual boot on the device.

```
Switch(config)# no boot manual
```

Procedure with Password Recovery Disabled

If the password-recovery mechanism is disabled, this message appears:

```
The password-recovery mechanism has been triggered, but
is currently disabled. Access to the boot loader prompt
through the password-recovery mechanism is disallowed at
this point. However, if you agree to let the system be
reset back to the default system configuration, access
to the boot loader prompt can still be allowed.
```

```
Would you like to reset the system back to the default configuration (y/n)?
```



Caution Returning the device to the default configuration results in the loss of all existing configurations. We recommend that you contact your system administrator to verify if there are backup device and VLAN configuration files.

- If you enter **n** (no), the normal boot process continues as if the **Mode** button had not been pressed; you cannot access the boot loader prompt, and you cannot enter a new password. You see the message:

```
Press Enter to continue.....
```

- If you enter **y** (yes), the configuration file in flash memory and the VLAN database file are deleted. When the default configuration loads, you can reset the password.

Procedure

Step 1 Choose to continue with password recovery and delete the existing configuration:

```
Would you like to reset the system back to the default configuration (y/n)? Y
```

Step 2 Display the contents of flash memory:

```
Device: dir flash:
```

The device file system appears.

Step 3 Boot up the system:

```
Device: boot
```

You are prompted to start the setup program. To continue with password recovery, enter **N** at the prompt:

```
Continue with the configuration dialog? [yes/no]: N
```

Step 4 At the device prompt, enter privileged EXEC mode:

```
Device> enable
```

Step 5 Enter global configuration mode:

```
Device# configure terminal
```

Step 6 Change the password:

```
Device(config)# enable secret password
```

The secret password can be from 1 to 25 alphanumeric characters, can start with a number, is case sensitive, and allows spaces but ignores leading spaces.

Step 7 Return to privileged EXEC mode:

```
Device(config)# exit  
Device#
```

Note Before continuing to Step 9, power on any connected stack members and wait until they have completely initialized.

Step 8 Write the running configuration to the startup configuration file:

```
Device# copy running-config startup-config
```

The new password is now in the startup configuration.

- Step 9** You must now reconfigure the device. If the system administrator has the backup device and VLAN configuration files available, you should use those.
-

Preventing Switch Stack Problems

To prevent switch stack problems, you should do the following:

- Make sure that the Device that you add to or remove from the switch stack are powered off. For all powering considerations in switch stacks, see the “Switch Installation” chapter in the hardware installation guide.
- Press the **Mode** button on a stack member until the Stack mode LED is on. The last two port LEDs on the Device should be green. Depending on the Device model, the last two ports are either 10/100/1000 ports or small form-factor pluggable (SFP) module. If one or both of the last two port LEDs are not green, the stack is not operating at full bandwidth.
- We recommend using only one CLI session when managing the switch stack. Be careful when using multiple CLI sessions to the active stack. Commands that you enter in one session are not displayed in the other sessions. Therefore, it is possible that you might not be able to identify the session from which you entered a command.
- Manually assigning stack member numbers according to the placement of the Device in the stack can make it easier to remotely troubleshoot the switch stack. However, you need to remember that the Device have manually assigned numbers if you add, remove, or rearrange Device later. Use the **switch** *current-stack-member-number* **renumber** *new-stack-member-number* global configuration command to manually assign a stack member number.

If you replace a stack member with an identical model, the new Device functions with the exact same configuration as the replaced Device. This is also assuming the new Device is using the same member number as the replaced Device.

Removing powered-on stack members causes the switch stack to divide (partition) into two or more switch stacks, each with the same configuration. If you want the switch stacks to remain separate, change the IP address or addresses of the newly created switch stacks. To recover from a partitioned switch stack, follow these steps:

1. Power off the newly created switch stacks.
2. Reconnect them to the original switch stack through their StackWise Plus ports.
3. Power on the Device.

For the commands that you can use to monitor the switch stack and its members, see the *Displaying Switch Stack Information* section.

Preventing Autonegotiation Mismatches

The IEEE 802.3ab autonegotiation protocol manages the switch settings for speed (10 Mb/s, 100 Mb/s, and 1000 Mb/s, excluding SFP module ports) and duplex (half or full). There are situations when this protocol can incorrectly align these settings, reducing performance. A mismatch occurs under these circumstances:

- A manually set speed or duplex parameter is different from the manually set speed or duplex parameter on the connected port.

- A port is set to autonegotiate, and the connected port is set to full duplex with no autonegotiation.

To maximize switch performance and ensure a link, follow one of these guidelines when changing the settings for duplex and speed:

- Let both ports autonegotiate both speed and duplex.
- Manually set the speed and duplex parameters for the ports on both ends of the connection.



Note If a remote device does not autonegotiate, configure the duplex settings on the two ports to match. The speed parameter can adjust itself even if the connected port does not autonegotiate.

Troubleshooting SFP Module Security and Identification

Cisco small form-factor pluggable (SFP) modules have a serial EEPROM that contains the module serial number, the vendor name and ID, a unique security code, and cyclic redundancy check (CRC). When an SFP module is inserted in the Device, the Device software reads the EEPROM to verify the serial number, vendor name and vendor ID, and recompute the security code and CRC. If the serial number, the vendor name or vendor ID, the security code, or CRC is invalid, the software generates a security error message and places the interface in an error-disabled state.



Note The security error message references the `GBIC_SECURITY` facility. The Device supports SFP modules and does not support GBIC modules. Although the error message text refers to GBIC interfaces and modules, the security messages actually refer to the SFP modules and module interfaces.

If you are using a non-Cisco SFP module, remove the SFP module from the Device, and replace it with a Cisco module. After inserting a Cisco SFP module, use the **`errdisable recovery cause gbic-invalid`** global configuration command to verify the port status, and enter a time interval for recovering from the error-disabled state. After the elapsed interval, the Device brings the interface out of the error-disabled state and retries the operation. For more information about the **`errdisable recovery`** command, see the command reference for this release.

If the module is identified as a Cisco SFP module, but the system is unable to read vendor-data information to verify its accuracy, an SFP module error message is generated. In this case, you should remove and reinsert the SFP module. If it continues to fail, the SFP module might be defective.

Monitoring SFP Module Status

You can check the physical or operational status of an SFP module by using the **`show interfaces transceiver`** privileged EXEC command. This command shows the operational status, such as the temperature and the current for an SFP module on a specific interface and the alarm status. You can also use the command to check the speed and the duplex settings on an SFP module. For more information, see the **`show interfaces transceiver`** command in the command reference for this release.

Executing Ping

If you attempt to ping a host in a different IP subnetwork, you must define a static route to the network or have IP routing configured to route between those subnets.

IP routing is disabled by default on all Device.



Note Though other protocol keywords are available with the **ping** command, they are not supported in this release.

Use this command to ping another device on the network from the Device:

Command	Purpose
<p>ping ip <i>host</i> | <i>address</i></p> <p>Device# ping 172.20.52.3</p>	Pings a remote host through IP or by supplying the hostname or network address.

Monitoring Temperature

The Device monitors the temperature conditions and uses the temperature information to control the fans.

Use the **show env temperature status** privileged EXEC command to display the temperature value, state, and thresholds. The temperature value is the temperature in the Device (not the external temperature). You can configure only the yellow threshold level (in Celsius) by using the **system env temperature threshold yellow value** global configuration command to set the difference between the yellow and red thresholds. You cannot configure the green or red thresholds. For more information, see the command reference for this release.

Monitoring the Physical Path

You can monitor the physical path that a packet takes from a source device to a destination device by using one of these privileged EXEC commands:

Table 15: Monitoring the Physical Path

Command	Purpose
<p>tracetroute mac [interface <i>interface-id</i>] {<i>source-mac-address</i>} [interface <i>interface-id</i>] {<i>destination-mac-address</i>} [vlan <i>vlan-id</i>] [detail]</p>	Displays the Layer 2 path taken by the packets from the specified source MAC address to the specified destination MAC address.
<p>tracetroute mac ip {<i>source-ip-address</i> | <i>source-hostname</i>} {<i>destination-ip-address</i> | <i>destination-hostname</i>} [detail]</p>	Displays the Layer 2 path taken by the packets from the specified source IP address or hostname to the specified destination IP address or hostname.

Executing IP Traceroute



Note Though other protocol keywords are available with the **traceroute** privileged EXEC command, they are not supported in this release.

Command	Purpose
traceroute ip host Device# traceroute ip 192.51.100.1	Traces the path that packets take through the network.

Redirecting Debug and Error Message Output

By default, the network server sends the output from **debug** commands and system error messages to the console. If you use this default, you can use a virtual terminal connection to monitor debug output instead of connecting to the console port or the Ethernet management port.

Possible destinations include the console, virtual terminals, internal buffer, and UNIX hosts running a syslog server. The syslog format is compatible with 4.3 Berkeley Standard Distribution (BSD) UNIX and its derivatives.



Note Be aware that the debugging destination you use affects system overhead. When you log messages to the console, very high overhead occurs. When you log messages to a virtual terminal, less overhead occurs. Logging messages to a syslog server produces even less, and logging to an internal buffer produces the least overhead of any method.

For more information about system message logging, see *Configuring System Message Logging*.

Using the show platform forward Command

The output from the **show platform forward** privileged EXEC command provides some useful information about the forwarding results if a packet entering an interface is sent through the system. Depending upon the parameters entered about the packet, the output provides lookup table results and port maps used to calculate forwarding destinations, bitmaps, and egress information.

Most of the information in the output from the command is useful mainly for technical support personnel, who have access to detailed information about the Device application-specific integrated circuits (ASICs). However, packet forwarding information can also be helpful in troubleshooting.

Using the show debug command

The **show debug** command is entered in privileged EXEC mode. This command displays all debug options available on the switch.

To view all conditional debug options run the command **show debug condition**. The commands can be listed by selecting either a condition identifier *<1-1000>* or *all* conditions.

To disable debugging, use the **no debug all** command.



Caution Because debugging output is assigned high priority in the CPU process, it can render the system unusable. For this reason, use **debug** commands only to troubleshoot specific problems or during troubleshooting sessions with Cisco technical support staff. Moreover, it is best to use **debug** commands during periods of lower network traffic and fewer users. Debugging during these periods decreases the likelihood that increased **debug** command processing overhead will affect system use.

Configuring OBFL



Caution We recommend that you do not disable OBFL and that you do not remove the data stored in the flash memory.

- To enable OBFL, use the **hw-switch switch [switch-number] logging onboard [message]** global configuration command. On switches, the range for *switch-number* is from 1 to 9.
- To copy the OBFL data to the local network or a specific file system, use the **copy logging onboard switch switch-number url url-destination** privileged EXEC command.
- To disable OBFL, use the **no hw-switch switch [switch-number] logging onboard [message]** global configuration command.
- To clear all the OBFL data in the flash memory except for the uptime and CLI command information, use the **clear logging onboard switch switch-number** privileged EXEC command.

To clear all the OBFL data in the flash memory except for the uptime, use the **clear logging onboard RP active {application}** privileged EXEC command.

Verifying Troubleshooting of the Software Configuration

Displaying OBFL Information

Table 16: Commands for Displaying OBFL Information

Command	Purpose
show onboard switch switch-number clilog Device# show onboard switch 1 clilog	Displays the OBFL CLI commands that were entered on a standalone switch or the specified stack members.
show onboard switch switch-number environment Device# show onboard switch 1 environment	Displays the UDI information for a standalone switch or the specified stack members and for all the connected FRU devices: the PID, the VID, and the serial number.

Example: Verifying the Problem and Cause for High CPU Utilization

Command	Purpose
show onboard switch <i>switch-number</i> message Device# show onboard switch 1 message	Displays the hardware-related messages generated by a standalone switch or the specified stack members.
show onboard switch <i>switch-number</i> counter Device# show onboard switch 1 counter	Displays the counter information on a standalone switch or the specified stack members.
show onboard switch <i>switch-number</i> temperature Device# show onboard switch 1 temperature	Displays the temperature of a standalone switch or the specified switch stack members.
show onboard switch <i>switch-number</i> uptime Device# show onboard switch 1 uptime	Displays the time when a standalone switch or the specified stack members start, the reason the standalone switch or specified stack members restart, and the length of time that the standalone switch or specified stack members have been running since they last restarted.
show onboard switch <i>switch-number</i> voltage Device# show onboard switch 1 voltage	Displays the system voltages of a standalone switch or the specified stack members.
show onboard switch <i>switch-number</i> status Device# show onboard switch 1 status	Displays the status of a standalone switch or the specified stack members.

Example: Verifying the Problem and Cause for High CPU Utilization

To determine if high CPU utilization is a problem, enter the **show processes cpu sorted** privileged EXEC command. Note the underlined information in the first line of the output example.

```

Device# show processes cpu sorted
CPU utilization for five seconds: 8%/0%; one minute: 7%; five minutes: 8%
PID Runtime(ms) Invoked uSecs 5Sec 1Min 5Min TTY Process
309 42289103 752750 56180 1.75% 1.20% 1.22% 0 RIP Timers
140 8820183 4942081 1784 0.63% 0.37% 0.30% 0 HRPC qos request
100 3427318 16150534 212 0.47% 0.14% 0.11% 0 HRPC pm-counters
192 3093252 14081112 219 0.31% 0.14% 0.11% 0 Spanning Tree
143 8 37 216 0.15% 0.01% 0.00% 0 Exec
...
<output truncated>
    
```

This example shows normal CPU utilization. The output shows that utilization for the last 5 seconds is 8%/0%, which has this meaning:

- The total CPU utilization is 8 percent, including both time running Cisco IOS processes and time spent handling interrupts.
- The time spent handling interrupts is zero percent.

Table 17: Troubleshooting CPU Utilization Problems

Type of Problem	Cause	Corrective Action
Interrupt percentage value is almost as high as total CPU utilization value.	The CPU is receiving too many packets from the network.	Determine the source of the network packet. Stop the flow, or change the switch configuration. See the section on “Analyzing Network Traffic.”
Total CPU utilization is greater than 50% with minimal time spent on interrupts.	One or more Cisco IOS process is consuming too much CPU time. This is usually triggered by an event that activated the process.	Identify the unusual event, and troubleshoot the root cause. See the section on “Debugging Active Processes.”

Scenarios for Troubleshooting the Software Configuration

Scenarios to Troubleshoot Power over Ethernet (PoE)

Table 18: Power over Ethernet Troubleshooting Scenarios

Symptom or Problem	Possible Cause and Solution
<p>Only one port does not have PoE.</p> <p>Trouble is on only one switch port. PoE and non-PoE devices do not work on this port, but do on other ports.</p>	<p>Verify that the powered device works on another PoE port.</p> <p>Use the show run, or show interface status user EXEC commands to verify that the port is not shut down or error-disabled.</p> <p>Note Most switches turn off port power when the port is shut down, even though the IEEE specifications make this optional.</p> <p>Verify that power inline never is not configured on that interface or port.</p> <p>Verify that the Ethernet cable from the powered device to the switch port is good: Connect a known good non-PoE Ethernet device to the Ethernet cable, and make sure that the powered device establishes a link and exchanges traffic with another host.</p> <p>Note Cisco powered device works only with straight cable and not with crossover one.</p> <p>Verify that the total cable length from the switch front panel to the powered device is not more than 100 meters.</p> <p>Disconnect the Ethernet cable from the switch port. Use a short Ethernet cable to connect a known good Ethernet device directly to this port on the switch front panel (not on a patch panel). Verify that it can establish an Ethernet link and exchange traffic with another host, or ping the port VLAN SVI. Next, connect a powered device to this port, and verify that it powers on.</p> <p>If a powered device does not power on when connected with a patch cord to the switch port, compare the total number of connected powered devices to the switch power budget (available PoE). Use the show power inline command to verify the amount of available power.</p>

Symptom or Problem	Possible Cause and Solution
<p>No PoE on all ports or a group of ports. Trouble is on all switch ports. Nonpowered Ethernet devices cannot establish an Ethernet link on any port, and PoE devices do not power on.</p>	<p>If there is a continuous, intermittent, or reoccurring alarm related to power, replace the power supply if possible it is a field-replaceable unit. Otherwise, replace the switch.</p> <p>If the problem is on a consecutive group of ports but not all ports, the power supply is probably not defective, and the problem could be related to PoE regulators in the switch.</p> <p>Use the show log privileged EXEC command to review alarms or system messages that previously reported PoE conditions or status changes.</p> <p>If there are no alarms, use the show interface status command to verify that the ports are not shut down or error-disabled. If ports are error-disabled, use the shut and no shut interface configuration commands to reenable the ports.</p> <p>Use the show env power and show power inline privileged EXEC commands to review the PoE status and power budget (available PoE).</p> <p>Review the running configuration to verify that power inline never is not configured on the ports.</p> <p>Connect a nonpowered Ethernet device directly to a switch port. Use only a short patch cord. Do not use the existing distribution cables. Enter the shut and no shut interface configuration commands, and verify that an Ethernet link is established. If this connection is good, use a short patch cord to connect a powered device to this port and verify that it powers on. If the device powers on, verify that all intermediate patch panels are correctly connected.</p> <p>Disconnect all but one of the Ethernet cables from switch ports. Using a short patch cord, connect a powered device to only one PoE port. Verify the powered device does not require more power than can be delivered by the switch port.</p> <p>Use the show power inline privileged EXEC command to verify that the powered device can receive power when the port is not shut down. Alternatively, watch the powered device to verify that it powers on.</p> <p>If a powered device can power on when only one powered device is connected to the switch, enter the shut and no shut interface configuration commands on the remaining ports, and then reconnect the Ethernet cables one at a time to the switch PoE ports. Use the show interface status and show power inline privileged EXEC commands to monitor inline power statistics and port status.</p> <p>If there is still no PoE at any port, a fuse might be open in the PoE section of the power supply. This normally produces an alarm. Check the log again for alarms reported earlier by system messages.</p>

Symptom or Problem	Possible Cause and Solution
<p>Cisco pre-standard powered device disconnects or resets.</p> <p>After working normally, a Cisco phone or wireless access point intermittently reloads or disconnects from PoE.</p>	<p>Verify all electrical connections from the switch to the powered device. Any unreliable connection results in power interruptions and irregular powered device functioning such as erratic powered device disconnects and reloads.</p> <p>Verify that the cable length is not more than 100 meters from the switch port to the powered device.</p> <p>Notice what changes in the electrical environment at the switch location or what happens at the powered device when the disconnect occurs.</p> <p>Notice whether any error messages appear at the same time a disconnect occurs. Use the show log privileged EXEC command to review error messages.</p> <p>Verify that an IP phone is not losing access to the Call Manager immediately before the reload occurs. (It might be a network problem and not a PoE problem.)</p> <p>Replace the powered device with a non-PoE device, and verify that the device works correctly. If a non-PoE device has link problems or a high error rate, the problem might be an unreliable cable connection between the switch port and the powered device.</p>
<p>IEEE 802.3af-compliant or IEEE 802.3at-compliant powered devices do not work on Cisco PoE switch.</p> <p>A non-Cisco powered device is connected to a Cisco PoE switch, but never powers on or powers on and then quickly powers off. Non-PoE devices work normally.</p>	<p>Use the show power inline command to verify that the switch power budget (available PoE) is not depleted before or after the powered device is connected. Verify that sufficient power is available for the powered device type before you connect it.</p> <p>Use the show interface status command to verify that the switch detects the connected powered device.</p> <p>Use the show log command to review system messages that reported an overcurrent condition on the port. Identify the symptom precisely: Does the powered device initially power on, but then disconnect? If so, the problem might be an initial surge-in (or <i>inrush</i>) current that exceeds a current-limit threshold for the port.</p>

Configuration Examples for Troubleshooting Software

Example: Pinging an IP Host

This example shows how to ping an IP host:

```
Device# ping 172.20.52.3

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echoes to 172.20.52.3, timeout is 2 seconds:
!!!!
```

```
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/4 ms
Device#
```

Table 19: Ping Output Display Characters

Character	Description
!	Each exclamation point means receipt of a reply.
.	Each period means the network server timed out while waiting for a reply.
U	A destination unreachable error PDU was received.
C	A congestion experienced packet was received.
I	User interrupted test.
?	Unknown packet type.
&	Packet lifetime exceeded.

To end a ping session, enter the escape sequence (**Ctrl-^ X** by default). Simultaneously press and release the **Ctrl**, **Shift**, and **6** keys and then press the **X** key.

Example: Performing a Traceroute to an IP Host

This example shows how to perform a **traceroute** to an IP host:

```
Device# traceroute ip 192.0.2.10

Type escape sequence to abort.
Tracing the route to 192.0.2.10

 1 192.0.2.1 0 msec 0 msec 4 msec
 2 192.0.2.203 12 msec 8 msec 0 msec
 3 192.0.2.100 4 msec 0 msec 0 msec
 4 192.0.2.10 0 msec 4 msec 0 msec
```

The display shows the hop count, the IP address of the router, and the round-trip time in milliseconds for each of the three probes that are sent.

Table 20: Traceroute Output Display Characters

Character	Description
*	The probe timed out.
?	Unknown packet type.
A	Administratively unreachable. Usually, this output means that an access list is blocking traffic.
H	Host unreachable.
N	Network unreachable.

Character	Description
P	Protocol unreachable.
Q	Source quench.
U	Port unreachable.

To end a trace in progress, enter the escape sequence (**Ctrl-^ X** by default). Simultaneously press and release the **Ctrl**, **Shift**, and **6** keys and then press the **X** key.

Example: Enabling All System Diagnostics



Caution Because debugging output takes priority over other network traffic, and because the **debug all** privileged EXEC command generates more output than any other **debug** command, it can severely diminish switch performance or even render it unusable. In virtually all cases, it is best to use more specific **debug** commands.

This command disables all-system diagnostics:

```
Device# debug all
```

The **no debug all** privileged EXEC command disables all diagnostic output. Using the **no debug all** command is a convenient way to ensure that you have not accidentally left any **debug** commands enabled.

Feature History and Information for Troubleshooting Software Configuration

Release	Modification
Cisco IOS XE Everest 16.5.1a	This feature was introduced.



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