System Management Configuration Guide, Cisco IOS XE Release 3E (Cisco WLC 5700 Series)

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Preface

Document Conventions

This document uses the following conventions:

Convention	Description
^ or Ctrl	Both the ^ symbol and Ctrl represent the Control (Ctrl) key on a keyboard. For example, the key combination **^D** or **Ctrl-D** means that you hold down the Control key while you press the D key. (Keys are indicated in capital letters but are not case sensitive.)
bold font	Commands and keywords and user-entered text appear in **bold** font.
Italic font	Document titles, new or emphasized terms, and arguments for which you supply values are in *italic* font.
`Courier` font	Terminal sessions and information the system displays appear in `courier` font.
`Bold Courier` font	**`Bold Courier`** font indicates text that the user must enter.
[x]	Elements in square brackets are optional.
...	An ellipsis (three consecutive nonbolded periods without spaces) after a syntax element indicates that the element can be repeated.
|	A vertical line, called a pipe, indicates a choice within a set of keywords or arguments.
[x | y]	Optional alternative keywords are grouped in brackets and separated by vertical bars.

Convention	Description
{x | y}	Required alternative keywords are grouped in braces and separated by vertical bars.
[x {y | z}]	Nested set of square brackets or braces indicate optional or required choices within optional or required elements. Braces and a vertical bar within square brackets indicate a required choice within an optional element.
string	A nonquoted set of characters. Do not use quotation marks around the string or the string will include the quotation marks.
< >	Nonprinting characters such as passwords are in angle brackets.
[ ]	Default responses to system prompts are in square brackets.
!, #	An exclamation point (!) or a pound sign (#) at the beginning of a line of code indicates a comment line.

Reader Alert Conventions

This document may use the following conventions for reader alerts:

Note Means *reader take note*. Notes contain helpful suggestions or references to material not covered in the manual.

Tip Means *the following information will help you solve a problem.*

Caution Means *reader be careful*. In this situation, you might do something that could result in equipment damage or loss of data.

Timesaver Means *the described action saves time.* You can save time by performing the action described in the paragraph.

Warning IMPORTANT SAFETY INSTRUCTIONS

This warning symbol means danger. You are in a situation that could cause bodily injury. Before you work on any equipment, be aware of the hazards involved with electrical circuitry and be familiar with standard practices for preventing accidents. Use the statement number provided at the end of each warning to locate its translation in the translated safety warnings that accompanied this device. Statement 1071

SAVE THESE INSTRUCTIONS

Related Documentation

Note Before installing or upgrading the controller, refer to the controller release notes.

- Cisco Validated Designs documents, located at:

  http://www.cisco.com/go/designzone

- Error Message Decoder, located at:

  https://www.cisco.com/cgi-bin/Support/Errordecoder/index.cgi

Obtaining Documentation and Submitting a Service Request

For information on obtaining documentation, submitting a service request, and gathering additional information, see the monthly *What's New in Cisco Product Documentation*, which also lists all new and revised Cisco technical documentation, at:

http://www.cisco.com/c/en/us/td/docs/general/whatsnew/whatsnew.html

Subscribe to the *What's New in Cisco Product Documentation* as a Really Simple Syndication (RSS) feed and set content to be delivered directly to your desktop using a reader application. The RSS feeds are a free service and Cisco currently supports RSS version 2.0.

CHAPTER 1

Using the Command-Line Interface

This chapter contains the following topics:

Information About Using the Command-Line Interface

Command Modes

The Cisco IOS user interface is divided into many different modes. The commands available to you depend on which mode you are currently in. Enter a question mark (?) at the system prompt to obtain a list of commands available for each command mode.

You can start a CLI session through a console connection, through Telnet, a SSH, or by using the browser.

When you start a session, you begin in user mode, often called user EXEC mode. Only a limited subset of the commands are available in user EXEC mode. For example, most of the user EXEC commands are one-time commands, such as **show** commands, which show the current configuration status, and **clear** commands, which clear counters or interfaces. The user EXEC commands are not saved when the controller reboots.

To have access to all commands, you must enter privileged EXEC mode. Normally, you must enter a password to enter privileged EXEC mode. From this mode, you can enter any privileged EXEC command or enter global configuration mode.

Using the configuration modes (global, interface, and line), you can make changes to the running configuration. If you save the configuration, these commands are stored and used when the controller reboots. To access the various configuration modes, you must start at global configuration mode. From global configuration mode, you can enter interface configuration mode and line configuration mode.

This table describes the main command modes, how to access each one, the prompt you see in that mode, and how to exit the mode.

Table 1: Command Mode Summary

Mode	Access Method	Prompt	Exit Method	About This Mode
User EXEC	Begin a session using Telnet, SSH, or console.	`Controller>`	Enter **logout** or **quit**.	Use this mode to • Change terminal settings. • Perform basic tests. • Display system information.
Privileged EXEC	While in user EXEC mode, enter the **enable** command.	`Controller#`	Enter **disable** to exit.	Use this mode to verify commands that you have entered. Use a password to protect access to this mode. Use this mode to execute privilege EXEC commands for access points. These commands are not part of the running config of the controller, they are sent to the IOS config of the access point.
Global configuration	While in privileged EXEC mode, enter the **configure** command.	`Controller(config)#`	To exit to privileged EXEC mode, enter **exit** or **end**, or press **Ctrl-Z**.	Use this mode to configure parameters that apply to the entire controller. Use this mode to configure access point commands that are part of the running config of the controller.
VLAN configuration	While in global configuration mode, enter the **vlan** *vlan-id* command.	`Controller(config-vlan)#`		

Mode	Access Method	Prompt	Exit Method	About This Mode
			To exit to global configuration mode, enter the **exit** command. To return to privileged EXEC mode, press **Ctrl-Z** or enter **end**.	Use this mode to configure VLAN parameters. When VTP mode is transparent, you can create extended-range VLANs (VLAN IDs greater than 1005) and save configurations in the controller startup configuration file.
Interface configuration	While in global configuration mode, enter the **interface** command (with a specific interface).	`Controller(config-if)#`	To exit to global configuration mode, enter **exit**. To return to privileged EXEC mode, press **Ctrl-Z** or enter **end**.	Use this mode to configure parameters for the Ethernet ports.
Line configuration	While in global configuration mode, specify a line with the **line vty** or **line console** command.	`Controller(config-line)#`	To exit to global configuration mode, enter **exit**. To return to privileged EXEC mode, press **Ctrl-Z** or enter **end**.	Use this mode to configure parameters for the terminal line.

Using the Help System

You can enter a question mark (?) at the system prompt to display a list of commands available for each command mode. You can also obtain a list of associated keywords and arguments for any command.

SUMMARY STEPS

1. **help**
2. *abbreviated-command-entry* **?**
3. *abbreviated-command-entry* <Tab>
4. **?**
5. *command* **?**
6. *command keyword* **?**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**help** **Example:** `Controller# help`	Obtains a brief description of the help system in any command mode.

Step 2	*abbreviated-command-entry* **?**
	
	Example:
	`Controller# di?`
	`dir disable disconnect`
		Obtains a list of commands that begin with a particular character string.

Step 3	*abbreviated-command-entry* <Tab>
	
	Example:
	`Controller# sh conf<tab>`
	`Controller# show configuration`
		Completes a partial command name.

Step 4	**?** **Example:** `Controller> ?`	Lists all commands available for a particular command mode.
Step 5	*command* **?** **Example:** `Controller> show ?`	Lists the associated keywords for a command.

Step 6	*command keyword* **?**
	
	Example:
	`Controller(config)# cdp holdtime ?`
	`  <10-255> Length of time (in sec) that receiver must keep this packet`
		Lists the associated arguments for a keyword.

Understanding Abbreviated Commands

You need to enter only enough characters for the controller to recognize the command as unique.

This example shows how to enter the **show configuration** privileged EXEC command in an abbreviated form:

```
Controller# show conf
```

No and Default Forms of Commands

Almost every configuration command also has a **no** form. In general, use the **no** form to disable a feature or function or reverse the action of a command. For example, the **no shutdown** interface configuration command reverses the shutdown of an interface. Use the command without the keyword **no** to reenable a disabled feature or to enable a feature that is disabled by default.

Configuration commands can also have a **default** form. The **default** form of a command returns the command setting to its default. Most commands are disabled by default, so the **default** form is the same as the **no** form. However, some commands are enabled by default and have variables set to certain default values. In these cases, the **default** command enables the command and sets variables to their default values.

CLI Error Messages

This table lists some error messages that you might encounter while using the CLI to configure your controller.

Table 2: Common CLI Error Messages

Error Message	Meaning	How to Get Help
`% Ambiguous command: "show con"`	You did not enter enough characters for your controller to recognize the command.	Reenter the command followed by a question mark (?) without any space between the command and the question mark. The possible keywords that you can enter with the command appear.
`% Incomplete command.`	You did not enter all of the keywords or values required by this command.	Reenter the command followed by a question mark (?) with a space between the command and the question mark. The possible keywords that you can enter with the command appear.
`% Invalid input detected at '^' marker.`	You entered the command incorrectly. The caret (^) marks the point of the error.	Enter a question mark (?) to display all of the commands that are available in this command mode. The possible keywords that you can enter with the command appear.

Configuration Logging

You can log and view changes to the controller configuration. You can use the Configuration Change Logging and Notification feature to track changes on a per-session and per-user basis. The logger tracks each configuration command that is applied, the user who entered the command, the time that the command was entered, and the parser return code for the command. This feature includes a mechanism for asynchronous notification to registered applications whenever the configuration changes. You can choose to have the notifications sent to the syslog.

Note Only CLI or HTTP changes are logged.

How to Use the CLI to Configure Features

Configuring the Command History

The software provides a history or record of commands that you have entered. The command history feature is particularly useful for recalling long or complex commands or entries, including access lists. You can customize this feature to suit your needs.

Changing the Command History Buffer Size

By default, the controller records ten command lines in its history buffer. You can alter this number for a current terminal session or for all sessions on a particular line. This procedure is optional.

SUMMARY STEPS

1. **terminal history** [**size** *number-of-lines*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**terminal history** [**size** *number-of-lines*] **Example:** `Controller# terminal history size 200`	Changes the number of command lines that the controller records during the current terminal session in privileged EXEC mode. You can configure the size from 0 to 256.

Recalling Commands

To recall commands from the history buffer, perform one of the actions listed in this table. These actions are optional.

Note The arrow keys function only on ANSI-compatible terminals such as VT100s.

SUMMARY STEPS

1. **Ctrl-P** or use the **up arrow** key
2. **Ctrl-N** or use the **down arrow** key
3. **show history**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**Ctrl-P** or use the **up arrow** key	Recalls commands in the history buffer, beginning with the most recent command. Repeat the key sequence to recall successively older commands.
Step 2	**Ctrl-N** or use the **down arrow** key	Returns to more recent commands in the history buffer after recalling commands with **Ctrl-P** or the up arrow key. Repeat the key sequence to recall successively more recent commands.
Step 3	**show history** **Example:** `Controller# show history`	Lists the last several commands that you just entered in privileged EXEC mode. The number of commands that appear is controlled by the setting of the **terminal history** global configuration command and the **history** line configuration command.

Disabling the Command History Feature

The command history feature is automatically enabled. You can disable it for the current terminal session or for the command line. This procedure is optional.

SUMMARY STEPS

1. **terminal no history**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**terminal no history** **Example:** `Controller# terminal no history`	Disables the feature during the current terminal session in privileged EXEC mode.

Enabling and Disabling Editing Features

Although enhanced editing mode is automatically enabled, you can disable it and reenable it.

SUMMARY STEPS

1. **terminal editing**
2. **terminal no editing**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**terminal editing** **Example:** `Controller# terminal editing`	Reenables the enhanced editing mode for the current terminal session in privileged EXEC mode.
Step 2	**terminal no editing** **Example:** `Controller# terminal no editing`	Disables the enhanced editing mode for the current terminal session in privileged EXEC mode.

Editing Commands Through Keystrokes

The keystrokes help you to edit the command lines. These keystrokes are optional.

Note The arrow keys function only on ANSI-compatible terminals such as VT100s.

Table 3: Editing Commands

Editing Commands	Description

Ctrl-B or use the **left arrow** key	Moves the cursor back one character.
Ctrl-F or use the **right arrow** key	Moves the cursor forward one character.
Ctrl-A	Moves the cursor to the beginning of the command line.
Ctrl-E	Moves the cursor to the end of the command line.
Esc B	Moves the cursor back one word.
Esc F	Moves the cursor forward one word.
Ctrl-T	Transposes the character to the left of the cursor with the character located at the cursor.
Delete or **Backspace** key	Erases the character to the left of the cursor.
Ctrl-D	Deletes the character at the cursor.
Ctrl-K	Deletes all characters from the cursor to the end of the command line.
Ctrl-U or **Ctrl-X**	Deletes all characters from the cursor to the beginning of the command line.
Ctrl-W	Deletes the word to the left of the cursor.
Esc D	Deletes from the cursor to the end of the word.
Esc C	Capitalizes at the cursor.
Esc L	Changes the word at the cursor to lowercase.
Esc U	Capitalizes letters from the cursor to the end of the word.
Ctrl-V or **Esc Q**	Designates a particular keystroke as an executable command, perhaps as a shortcut.
Return key	Scrolls down a line or screen on displays that are longer than the terminal screen can display. **Note** The More prompt is used for any output that has more lines than can be displayed on the terminal screen, including **show** command output. You can use the **Return** and **Space** bar keystrokes whenever you see the More prompt.
Space bar	Scrolls down one screen.

Ctrl-L or **Ctrl-R**	Redisplays the current command line if the controller suddenly sends a message to your screen.

Editing Command Lines That Wrap

You can use a wraparound feature for commands that extend beyond a single line on the screen. When the cursor reaches the right margin, the command line shifts ten spaces to the left. You cannot see the first ten characters of the line, but you can scroll back and check the syntax at the beginning of the command. The keystroke actions are optional.

To scroll back to the beginning of the command entry, press **Ctrl-B** or the left arrow key repeatedly. You can also press **Ctrl-A** to immediately move to the beginning of the line.

Note The arrow keys function only on ANSI-compatible terminals such as VT100s.

The following example shows how to wrap a command line that extends beyond a single line on the screen.

SUMMARY STEPS

1. **access-list**
2. **Ctrl-A**
3. **Return** key

DETAILED STEPS

	Command or Action	Purpose

Step 1	**access-list**
	
	Example:
	`Controller(config)# access-list 101 permit tcp 10.15.22.25 255.255.255.0 10.15.22.35`
	`Controller(config)# $ 101 permit tcp 10.15.22.25 255.255.255.0 10.15.22.35 255.25`
	`Controller(config)# $t tcp 10.15.22.25 255.255.255.0 131.108.1.20 255.255.255.0 eq`
	`Controller(config)# $15.22.25 255.255.255.0 10.15.22.35 255.255.255.0 eq 45`
		Displays the global configuration command entry that extends beyond one line.
		
		When the cursor first reaches the end of the line, the line is shifted ten spaces to the left and redisplayed. The dollar sign ($) shows that the line has been scrolled to the left. Each time the cursor reaches the end of the line, the line is again shifted ten spaces to the left.

Step 2	**Ctrl-A** **Example:** `Controller(config)# access-list 101 permit tcp 10.15.22.25 255.255.255.0 10.15.2$`	Checks the complete syntax. The dollar sign ($) appears at the end of the line to show that the line has been scrolled to the right.
Step 3	**Return** key	Execute the commands.

	Command or Action	Purpose
		The software assumes that you have a terminal screen that is 80 columns wide. If you have a different width, use the **terminal width** privileged EXEC command to set the width of your terminal. Use line wrapping with the command history feature to recall and modify previous complex command entries.

Searching and Filtering Output of show and more Commands

You can search and filter the output for **show** and **more** commands. This is useful when you need to sort through large amounts of output or if you want to exclude output that you do not need to see. Using these commands is optional.

SUMMARY STEPS

1. {**show** | **more**} *command* | {**begin** | **include** | **exclude**} *regular-expression*

DETAILED STEPS

	Command or Action	Purpose

Step 1	{**show** | **more**} *command* | {**begin** | **include** | **exclude**} *regular-expression*
	
	Example:
	`Controller# show interfaces | include protocol`
	`Vlan1 is up, line protocol is up`
	`Vlan10 is up, line protocol is down`
	`GigabitEthernet1/0/1 is up, line protocol is down`
	`GigabitEthernet1/0/2 is up, line protocol is up`
		Searches and filters the output.
		Expressions are case sensitive. For example, if you enter **| exclude output**, the lines that contain **output** are not displayed, but the lines that contain **output** appear.

Accessing the CLI Through a Console Connection or Through Telnet

Before you can access the CLI, you must connect a terminal or a PC to the controller console or connect a PC to the Ethernet management port and then power on the controller, as described in the hardware installation guide that shipped with your controller.

If your controller is already configured, you can access the CLI through a local console connection or through a remote Telnet session, but your controller must first be configured for this type of access.

You can use one of these methods to establish a connection with the controller:

- Connect the controller console port to a management station or dial-up modem, or connect the Ethernet management port to a PC. For information about connecting to the console or Ethernet management port, see the controller hardware installation guide.
- Use any Telnet TCP/IP or encrypted Secure Shell (SSH) package from a remote management station. The controller must have network connectivity with the Telnet or SSH client, and the controller must have an enable secret password configured.
    - The controller supports up to 16 simultaneous Telnet sessions. Changes made by one Telnet user are reflected in all other Telnet sessions.
    - The controller supports up to five simultaneous secure SSH sessions.

After you connect through the console port, through the Ethernet management port, through a Telnet session or through an SSH session, the user EXEC prompt appears on the management station.

CHAPTER 2

Using the Web Graphical User Interface

Prerequisites for Using the Web GUI

- The GUI must be used on a PC running Windows 7, Windows XP SP1 (or later releases), or Windows 2000 SP4 (or later releases).
- The controller GUI is compatible with Microsoft Internet Explorer version 10.x, Mozilla Firefox 20.x, or Google Chrome 26.x.

Information About Using The Web GUI

A web browser, or graphical user interface (GUI), is built into each controller.

You can use either the service port interface or the management interface to access the GUI. We recommend that you use the service-port interface. Click Help at the top of any page in the GUI to display online help. You might need to disable your browser's pop-up blocker to view the online help.

Web GUI Features

The controller web GUI supports the following:

The Configuration Wizard—After initial configuration of the IP address and the local username/password or auth via the authentication server (privilege 15 needed), the wizard provides a method to complete the initial

wireless configuration. Start the wizard through Configuration -> Wizard and follow the nine-step process to configure the following:

- Admin Users
- SNMP System Summary
- Management Port
- Wireless Management
- RF Mobility and Country code
- Mobility configuration
- WLANs
- 802.11 Configuration
- Set Time

The Monitor tab:

- Displays summary details of controller, clients, and access points.
- Displays all radio and AP join statistics.
- Displays air quality on access points.
- Displays list of all Cisco Discovery Protocol (CDP) neighbors on all interfaces and the CDP traffic information.
- Displays all rogue access points based on their classification-friendly, malicious, ad hoc, classified, and unclassified.

The Configuration tab:

- Enables you to configure the controller for all initial operation using the web Configuration Wizard. The wizard allows you to configure user details, management interface, and so on.
- Enables you to configure the system, internal DHCP server, management, and mobility management parameters.
- Enables you to configure the controller, WLAN, and radios.
- Enables you to configure and set security policies on your controller.
- Enables you to access the controller operating system software management commands.

The Administration tab enables you to configure system logs.

Connecting the Console Port of the Controller

Before You Begin

Before you can configure the controller for basic operations, you need to connect it to a PC that uses a VT-100 terminal emulation program (such as HyperTerminal, ProComm, Minicom, or Tip).

Step 1 Connect one end of a null-modem serial cable to the controller's RJ-45 console port and the other end to your PC's serial port.

Step 2 Plug the AC power cord into the controller and a grounded 100 to 240 VAC, 50/60-Hz electrical outlet. Turn on the power supply. The bootup script displays operating system software initialization (code download and power-on self-test verification) and basic configuration. If the controller passes the power-on self-test, the bootup script runs the configuration wizard, which prompts you for basic configuration input.

Step 3 Enter **yes**. Proceed with basic initial setup configuration parameters in the CLI setup wizard. Specify the IP address for the service port which is the gigabitethernet 0/0 interface.
After entering the configuration parameters in the configuration wizard, you can access the Web GUI. Now, the controller is configured with the IP address for service port.

Logging On to the Web GUI

Step 1 Enter the controller IP address in your browser's address bar. For a secure connection, enter https://**ip-address**. For a less secure connection, enter http://**ip-address**.

Step 2 When prompted, enter a valid username and password and click **OK**.

Note The administrative username and password that you created in the configuration wizard are case sensitive. The default username is admin, and the default password is cisco.

The Accessing page appears.

Enabling Web and Secure Web Modes

Step 1 Choose **Configuration** > **Controller** > **Management** > **Protocol Management** > **HTTP-HTTPS**.

The **HTTP-HTTPS Configuration** page appears.

Step 2 To enable web mode, which allows users to access the controller GUI using "http://ip-address," choose Enabled from the HTTP Access drop-down list. Otherwise, choose Disabled. Web mode (HTTP) is not a secure connection.

Step 3 To enable secure web mode, which allows users to access the controller GUI using "https://ip-address," choose Enabled from the HTTPS Access drop-down list. Otherwise, choose Disabled. Secure web mode (HTTPS) is a secure connection.

Step 4 Choose to track the device in the IP Device Tracking check box.

Step 5 Choose to enable the trust point in the Enable check box.

Step 6 Choose the trustpoints from the Trustpoints drop-down list.

Step 7 Enter the amount of time, in seconds, before the web session times out due to inactivity in the HTTP Timeout-policy (1 to 600 sec) text box.
The valid range is from 1 to 600 seconds.

Step 8 Enter the server life time in the Server Life Time (1 to 86400 sec) text box.
The valid range is from1 to 86400 seconds.

Step 9 Enter the maximum number of connection requests that the server can accept in the Maximum number of Requests (1 to 86400) text box.
The valid range is from 1 to 86400 connections.

Step 10 Click **Apply**.

Step 11 Click **Save Configuration**.

Configuring the Controller Web GUI

The configuration wizard enables you to configure basic settings on the controller. You can run the wizard after you receive the controller from the factory or after the controller has been reset to factory defaults. The configuration wizard is available in both GUI and CLI formats.

Step 1 Connect your PC to the service port and configure an IPv4 address to use the same subnet as the controller. The controller is loaded with IOS XE image and the service port interface is configured as gigabitethernet 0/0.

Step 2 Start Internet Explorer 10 (or later), Firefox 2.0.0.11 (or later), or Google Chrome on your PC and enter the management interface IP address on the browser window. The management interface IP address is same as the gigabitethernet 0/0 (also known as service port interface). When you log in for the first time, you need to enter HTTP username and password. By default, the username is **admin** and the password is **cisco**.
You can use both HTTP and HTTPS when using the service port interface. HTTPS is enabled by default and HTTP can also be enabled.

When you log in for the first time, the **Accessing Cisco Controller <Model Number> <Hostname>** page appears.

Step 3 On the **Accessing Cisco Controller** page, click the **Wireless Web GUI** link to access controller web GUI **Home** page.

Step 4 Choose **Configuration** > **Wizard** to perform all steps that you need to configure the controller initially.
The **Admin Users** page appears.

Step 5 On the **Admin Users** page, enter the administrative username to be assigned to this controller in the User Name text box and the administrative password to be assigned to this controller in the Password and Confirm Password text boxes. Click **Next**.
The default username is **admin** and the default password is **cisco**. You can also create a new administrator user for the controller. You can enter up to 24 ASCII characters for username and password.

The **SNMP System Summary** page appears.

Step 6 On the **SNMP System Summary** page, enter the following SNMP system parameters for the controller, and click **Next**:

- Customer-definable controller location in the Location text box.
- Customer-definable contact details such as phone number with names in the Contact text box.
- Choose **enabled** to send SNMP notifications for various SNMP traps or **disabled** not to send SNMP notifications for various SNMP traps from the SNMP Global Trap drop-down list.
- Choose **enabled** to send system log messages or **disabled** not to send system log messages from the SNMP Logging drop-down list.

Note The SNMP trap server, must be reachable through the distribution ports (and not through the gigabitethernet0/0 service or management interface).

The **Management Port** page appears.

Step 7 In the **Management Port** page, enter the following parameters for the management port interface (gigabitethernet 0/0) and click **Next**.

- Interface IP address that you assigned for the service port in the IP Address text box.
- Network mask address of the management port interface in the Netmask text box.
- The IPv4 Dynamic Host Configuration Protocol (DHCP) address for the selected port in the IPv4 DHCP Server text box.

The **Wireless Management** page appears.

Step 8 In the **Wireless Management** page, enter the following wireless interface management details, and click **Next**.

- Choose the interface—VLAN, or Ten Gigabit Ethernet from the Select Interface drop-down list.
- VLAN tag identifier, or 0 for no VLAN tag in the VLAN id text box.
- IP address of wireless management interface where access points are connected in the IP Address text box.
- Network mask address of the wireless management interface in the Netmask text box.
- DHCP IPv4 IP address in the IPv4 DHCP Server text box.

When selecting VLAN as interface, you can specify the ports as –Trunk or Access ports from the selected list displayed in the Switch Port Configuration text box.

The **RF Mobility and Country Code** page appears.

Step 9 In the **RF Mobility and Country Code** page, enter the RF mobility domain name in the RF Mobility text box, choose current country code from the Country Code drop-down list, and click **Next**. From the GUI, you can select only one country code.

Note Before configuring RF grouping parameters and mobility configuration, ensure that you refer to the relevant conceptual content and then proceed with the configuration.

The **Mobility Configuration** page with mobility global configuration settings appears.

Step 10 In the **Mobility Configuration** page, view and enter the following mobility global configuration settings, and click **Next**.

- Displays Mobility Controller in the Mobility Role text box.

- Displays mobility protocol port number in the Mobility Protocol Port text box.
- Displays the mobility group name in the Mobility Group Name text box.
- Displays whether DTLS is enabled in the DTLS Mode text box.

  DTLS is a standards-track Internet Engineering Task Force (IETF) protocol based on TLS.
- Displays mobility domain identifier for 802.11 radios in the Mobility Domain ID for 802.11 radios text box.
- Displays the number of members configured on the controller in the Mobility Domain Member Count text box.
- To enable the controller as a Mobility Oracle, select the Mobility Oracle Enabled check box.

  Note Only the controller can be configured as Mobility Oracle. You cannot configure the switch as Mobility Oracle.

  The Mobility Oracle is optional, it maintains the client database under one complete mobility domain.
- The amount of time (in seconds) between each ping request sent to an peer controller in the Mobility Keepalive Interval (1-30)sec text box.

  Valid range is from 1 to 30 seconds, and the default value is 10 seconds.
- Number of times a ping request is sent to an peer controller before the peer is considered to be unreachable in the Mobility Keepalive Count (3-20) text box.

  The valid range is from 3 to 20, and the default value is 3.
- The DSCP value that you can set for the mobility controller in the Mobility Control Message DSCP Value (0-63) text box.

  The valid range is 0 to 63, and the default value is 0.

The **WLANs** page appears.

Step 11 In the **WLANs** page, enter the following WLAN configuration parameters, and click **Next**.

- WLAN identifier in the WLAN ID text box.
- SSID of the WLAN that the client is associated with in the SSID text box.
- Name of the WLAN used by the client in the Profile Name text box.

The **802.11 Configuration** page appears.

Step 12 In the **802.11 Configuration** page, check either one or both 802.11a/n/ac and 802.11b/g/n check boxes to enable the 802.11 radios, and click **Next**.
The **Set Time** page appears.

Step 13 In the **Set Time** page, you can configure the time and date on the controller based on the following parameters, and click **Next**.

- Displays current timestamp on the controller in the Current Time text box.
- Choose either Manual or NTP from the Mode drop-down list.

  On using the NTP server, all access points connected to the controller, synchronizes its time based on the NTP server settings available.
- Choose date on the controller from the Year, Month, and Day drop-down list.

- Choose time from the Hours, Minutes, and Seconds drop-down list.
- Enter the time zone in the Zone text box and select the off setting required when compared to the current time configured on the controller from the Offset drop-down list.

The **Save Wizard** page appears.

Step 14 In the **Save Wizard** page, you can review the configuration settings performed on the controller using these steps, and if you wish to change any configuration value, click **Previous** and navigate to that page.
You can save the controller configuration created using the wizard only if a success message is displayed for all the wizards. If the **Save Wizard** page displays errors, you must recreate the wizard for initial configuration of the controller.

CHAPTER 3

Administering the System

Information About Administering the Controller

System Time and Date Management

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

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.

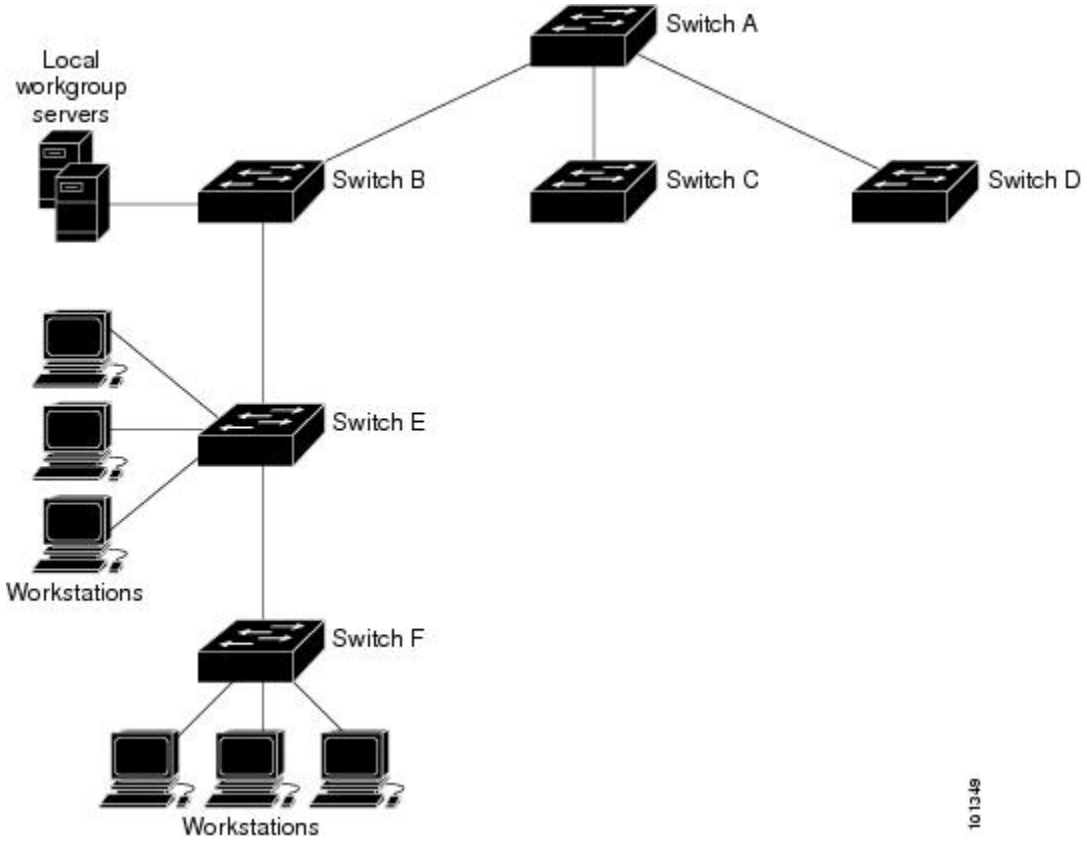
The communications between devices running NTP (known as associations) are usually statically configured; each device is given the IP address of all devices with which it should form associations. Accurate timekeeping is possible by exchanging NTP messages between each pair of devices with an association. 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 shows a typical network example using NTP. Switch A is the NTP master, 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.

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.

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.

NTP Associations

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.

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 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.

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.

NTP Version 4

NTP version 4 is implemented on the controller. NTPv4 is an extension of NTP version 3. NTPv4 supports both IPv4 and IPv6 and is backward-compatible with NTPv3.

NTPv4 provides these capabilities:

- Support for IPv6.
- Improved security compared to NTPv3. The NTPv4 protocol provides a security framework based on public key cryptography and standard X509 certificates.
- Automatic calculation of the time-distribution hierarchy for a network. Using specific multicast groups, NTPv4 automatically configures the hierarchy of the servers to achieve the best time accuracy for the lowest bandwidth cost. This feature leverages site-local IPv6 multicast addresses.

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 controller, 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 4: 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.

The MOTD and login banners are not configured.

Default Banner Configuration

The MOTD and login banners are not configured.

MAC Address Table

The MAC address table contains address information that the controller 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 controller 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 controller 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).

MAC Address Table Creation

With multiple MAC addresses supported on all ports, you can connect any port on the controller to other network devices. The controller 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 controller 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 controller maintains an address table for each VLAN, and STP can accelerate the aging interval on a per-VLAN basis.

The controller sends packets between any combination of ports, based on the destination address of the received packet. Using the MAC address table, the controller 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 controller 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.

Default MAC Address Table Settings

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

Table 5: 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.

How to Administer the Controller

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 controller 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 fails and a different stack member assumes the role of .

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.

SUMMARY STEPS

1. Use one of the following:
   - **clock set** *hh:mm:ss day month year*
   - **clock set** *hh:mm:ss month day year*

DETAILED STEPS

	Command or Action	Purpose
Step 1	Use one of the following: • **clock set** *hh:mm:ss day month year* • **clock set** *hh:mm:ss month day year* **Example:** `Controller# clock set 13:32:00 23 March 2013`	Sets the system clock using one of these formats: • *hh:mm:ss*—Specifies the time in hours (24-hour format), minutes, and seconds. The time specified is relative to the configured time zone. • *day*—Specifies the day by date in the month. • *month*—Specifies the month by name. • *year*—Specifies the year (no abbreviation).

Configuring the Time Zone

SUMMARY STEPS

1. **configure terminal**
2. **clock timezone** *zone hours-offset* [*minutes-offset*]
3. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.
Step 2	**clock timezone** *zone hours-offset* [*minutes-offset*] **Example:** `Controller(config)# clock timezone AST -3 30`	Sets the time zone. 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. • *zone*—Enters the name of the time zone to be displayed when standard time is in effect. The default is UTC. • *hours-offset*—Enters the hours offset from UTC. • (Optional) *minutes-offset*—Enters the minutes offset from UTC. This available where the local time zone is a percentage of an hour different from UTC.

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

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:

SUMMARY STEPS

1. **configure terminal**
2. **clock summer-time** *zone* **date** *date month year hh:mm date month year hh:mm* [*offset*]]
3. **clock summer-time** *zone* **recurring** [*week day month hh:mm week day month hh:mm* [*offset*]]
4. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.
Step 2	**clock summer-time** *zone* **date** *date month year hh:mm date month year hh:mm* [*offset*]] **Example:** `Controller(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 3	**clock summer-time** *zone* **recurring** [*week day month hh:mm week day month hh:mm* [*offset*]] **Example:** `Controller(config)# clock summer-time PDT recurring 10 March 2013 2:00 3`	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. 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.

	Command or Action	Purpose
	`November 2013 2:00`	If the starting month is after the ending month, the system assumes that you are in the southern hemisphere. • *zone*—Specifies the name of the time zone (for example, PDT) to be displayed when summer time is in effect. • (Optional) *week*— Specifies the week of the month (1 to 4, **first**, or **last**). • (Optional) *day*—Specifies the day of the week (Sunday, Monday...). • (Optional) *month*—Specifies the month (January, February...). • (Optional) *hh:mm*—Specifies the time (24-hour format) in hours and minutes. • (Optional) *offset*—Specifies the number of minutes to add during summer time. The default is 60.
Step 4	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode.

Configuring a System Name

SUMMARY STEPS

1. **configure terminal**
2. **hostname** *name*
3. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.

	Command or Action	Purpose
Step 2	**hostname** *name* **Example:** `Controller(config)# hostname remote-users`	Configures a system name. When you set the system name, it is also used as the system prompt. The default setting is Controller. 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.
Step 3	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode.

Setting Up DNS

If you use the controller 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.

SUMMARY STEPS

1. **configure terminal**
2. **ip domain-name** *name*
3. **ip name-server** *server-address1* [*server-address2 ... server-address6*]
4. **ip domain-lookup** [**nsap** | **source-interface** *interface*]
5. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.

	Command or Action	Purpose
Step 2	**ip domain-name** *name* **Example:** `Controller(config)# ip domain-name Cisco.com`	Defines a default domain name that the software uses to complete unqualified hostnames (names without a dotted-decimal domain name). Do not include the initial period that separates an unqualified name from the domain name. At boot time, no domain name is configured; however, if the controller 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).
Step 3	**ip name-server** *server-address1* [*server-address2 ... server-address6*] **Example:** `Controller(config)# ip name-server 192.168.1.100 192.168.1.200 192.168.1.300`	Specifies the address of one or more name servers to use for name and address resolution. You can specify up to six name servers. Separate each server address with a space. The first server specified is the primary server. The controller sends DNS queries to the primary server first. If that query fails, the backup servers are queried.
Step 4	**ip domain-lookup** [**nsap** | **source-interface** *interface*] **Example:** `Controller(config)# ip domain-lookup`	(Optional) Enables DNS-based hostname-to-address translation on your controller. This feature is enabled by default. 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).
Step 5	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode.

What to Do Next

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 controller

SUMMARY STEPS

1. **configure terminal**
2. **banner motd** *c message c*
3. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.

Step 2	**banner motd** *c message c*
	
	Example:
	
	`Controller(config)# banner motd #`
	`This is a secure site. Only`
	`authorized users are allowed.`
	`For access, contact technical`
	`support.`
	`#`
		Specifies the message of the day.
		
		c—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.
		
		message—Enters a banner message up to 255 characters. You cannot use the delimiting character in the message.

Step 3	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode.

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.

SUMMARY STEPS

1. **configure terminal**
2. **banner login** *c message c*
3. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.

	Command or Action	Purpose

Step 2	**banner login** *c message c*
	
	Example:
	
	`Controller(config)# banner login $`
	`Access for authorized users only.`
	`Please enter your username and password.`
	`$`
		Specifies the login message.
		
		c— 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.
		
		message—Enters a login message up to 255 characters. You cannot use the delimiting character in the message.

Step 3	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode.

Managing the MAC Address Table

Changing the Address Aging Time

SUMMARY STEPS

1. **configure terminal**
2. **mac address-table aging-time** [*0* | *10-1000000*] [**routed-mac** | **vlan** *vlan-id*]
3. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.
Step 2	**mac address-table aging-time** [*0* | *10-1000000*] [**routed-mac** | **vlan** *vlan-id*] **Example:** `Controller(config)# mac address-table aging-time 500 vlan 2`	Sets the length of time that a dynamic entry remains in the MAC address table after the entry is used or updated. 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. *vlan-id*—Valid IDs are 1 to 4094.

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

Configuring MAC Address Change Notification Traps

SUMMARY STEPS

1. **configure terminal**
2. **snmp-server host** *host-addr community-string notification-type* { **informs** | **traps** } {**version** {**1** | **2c** | **3**}} {**vrf** *vrf instance name*}
3. **snmp-server enable traps mac-notification change**
4. **mac address-table notification change**
5. **mac address-table notification change** [**interval** *value*] [**history-size** *value*]
6. **interface** *interface-id*
7. **snmp trap mac-notification change** {**added** | **removed**}
8. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.
Step 2	**snmp-server host** *host-addr community-string notification-type* { **informs** | **traps** } {**version** {**1** | **2c** | **3**}} {**vrf** *vrf instance name*} **Example:** `Controller(config)# snmp-server host 172.20.10.10 traps private mac-notification`	Specifies the recipient of the trap message. • *host-addr*—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. • *community-string*—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

	Command or Action	Purpose
		this string by using the **snmp-server community** command before using the **snmp-server host** command. • *notification-type*—Uses the **mac-notification** keyword. • **vrf** *vrf instance name*—Specifies the VPN routing/forwarding instance for this host.
Step 3	**snmp-server enable traps mac-notification change** **Example:** `Controller(config)# snmp-server enable traps mac-notification change`	Enables the controller to send MAC address change notification traps to the NMS.
Step 4	**mac address-table notification change** **Example:** `Controller(config)# mac address-table notification change`	Enables the MAC address change notification feature.

Step 5	**mac address-table notification change** [**interval** *value*] [**history-size** *value*]
	
	Example:
	
	`Controller(config)# mac address-table notification change interval 123`
	`Controller(config)#mac address-table notification change history-size 100`
		Enters the trap interval time and the history table size.
		• (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 MAC notification history table. The range is 0 to 500; the default is 1.

Step 6	**interface** *interface-id* **Example:** `Controller(config)# interface gigabitethernet1/0/2`	Enters interface configuration mode, and specifies the Layer 2 interface on which to enable the SNMP MAC address notification trap.
Step 7	**snmp trap mac-notification change** {**added** | **removed**} **Example:** `Controller(config-if)# snmp trap mac-notification change added`	Enables the MAC address change notification trap on the interface. • Enables the trap when a MAC address is **added** on this interface. • Enables the trap when a MAC address is **removed** from this interface.

	Command or Action	Purpose
Step 8	**end** **Example:** `Controller(config-if)# end`	Returns to privileged EXEC mode.

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.

Beginning in privileged EXEC mode, follow these steps to configure the controller to send MAC address-move notification traps to an NMS host:

SUMMARY STEPS

1. **configure terminal**
2. **snmp-server host** *host-addr* {**traps** | **informs**} {**version** {**1** | **2c** | **3**}} *community-string notification-type*
3. **snmp-server enable traps mac-notification move**
4. **mac address-table notification mac-move**
5. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.
Step 2	**snmp-server host** *host-addr* {**traps** | **informs**} {**version** {**1** | **2c** | **3**}} *community-string notification-type* **Example:** `Controller(config)# snmp-server host 172.20.10.10 traps private mac-notification`	Specifies the recipient of the trap message. • *host-addr*—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. • *community-string*—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

	Command or Action	Purpose
		define this string by using the **snmp-server community** command before using the **snmp-server host** command. • *notification-type*—Uses the **mac-notification** keyword.
Step 3	**snmp-server enable traps mac-notification move** **Example:** `Controller(config)# snmp-server enable traps mac-notification move`	Enables the controller to send MAC address move notification traps to the NMS.
Step 4	**mac address-table notification mac-move** **Example:** `Controller(config)# mac address-table notification mac-move`	Enables the MAC address move notification feature.
Step 5	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode.

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.

SUMMARY STEPS

1. **configure terminal**
2. **snmp-server host** *host-addr* {**traps** | **informs**} {**version** {**1** | **2c** | **3**}} *community-string notification-type*
3. **snmp-server enable traps mac-notification threshold**
4. **mac address-table notification threshold**
5. **mac address-table notification threshold** [**limit** *percentage*] | [**interval** *time*]
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.
Step 2	**snmp-server host** *host-addr* {**traps** | **informs**} {**version** {**1** | **2c** | **3**}} *community-string notification-type* **Example:** `Controller(config)# snmp-server host 172.20.10.10 traps private mac-notification`	Specifies the recipient of the trap message. • *host-addr*—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. • *community-string*—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. • *notification-type*—Uses the **mac-notification** keyword.
Step 3	**snmp-server enable traps mac-notification threshold** **Example:** `Controller(config)# snmp-server enable traps mac-notification threshold`	Enables MAC threshold notification traps to the NMS.
Step 4	**mac address-table notification threshold** **Example:** `Controller(config)# mac address-table notification threshold`	Enables the MAC address threshold notification feature.
Step 5	**mac address-table notification threshold** [**limit** *percentage*] | [**interval** *time*] **Example:** `Controller(config)# mac address-table notification threshold interval 123`	Enters the threshold value for the MAC address threshold usage monitoring. • (Optional) **limit** *percentage*—Specifies the percentage of the MAC address table use; valid values are from 1 to 100 percent. The default is 50 percent. • (Optional) **interval** *time*—Specifies the time between notifications; valid values are greater than or equal to 120 seconds. The default is 120 seconds.

	Command or Action	Purpose
	`Controller(config)# mac address-table notification threshold limit 78`	
Step 6	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode.

What to Do Next

Adding and Removing Static Address Entries

SUMMARY STEPS

1. **configure terminal**
2. **mac address-table static** *mac-addr* **vlan** *vlan-id* **interface** *interface-id*
3. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.
Step 2	**mac address-table static** *mac-addr* **vlan** *vlan-id* **interface** *interface-id* **Example:** `Controller(config)# mac address-table static c2f3.220a.12f4 vlan 4 interface gigabitethernet 1/0/1`	Adds a static address to the MAC address table. • *mac-addr*—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. • *vlan-id*—Specifies the VLAN for which the packet with the specified MAC address is received. Valid VLAN IDs are 1 to 4094. • *interface-id*—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.

	Command or Action	Purpose
Step 3	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.

Configuring Unicast MAC Address Filtering

SUMMARY STEPS

1. **configure terminal**
2. **mac address-table static** *mac-addr* **vlan** *vlan-id* **drop**
3. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.
Step 2	**mac address-table static** *mac-addr* **vlan** *vlan-id* **drop** **Example:** `Controller(config)# mac address-table static c2f3.220a.12f4 vlan 4 drop`	Enables unicast MAC address filtering and configure the controller to drop a packet with the specified source or destination unicast static address. • *mac-addr*—Specifies a source or destination unicast MAC address (48-bit). Packets with this MAC address are dropped. • *vlan-id*—Specifies the VLAN for which the packet with the specified MAC address is received. Valid VLAN IDs are 1 to 4094.
Step 3	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode.

Monitoring and Maintaining Administration of the Controller

Command	Purpose
clear mac address-table dynamic	Removes all dynamic entries.
clear mac address-table dynamic address *mac-address*	Removes a specific MAC address.
clear mac address-table dynamic interface *interface-id*	Removes all addresses on the specified physical port or port channel.
clear mac address-table dynamic vlan *vlan-id*	Removes all addresses on a specified VLAN.
show clock [*detail*]	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 *mac-address*	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.
show mac address-table interface *interface-name*	Displays the MAC address table information for the specified interface.
show mac address-table move update	Displays the MAC address table move update information.
show mac address-table multicast	Displays a list of multicast MAC addresses.
show mac address-table notification {change | mac-move | threshold}	Displays the MAC notification parameters and history table.
show mac address-table secure	Displays the secure MAC addresses.
show mac address-table static	Displays only static MAC address table entries.
show mac address-table vlan *vlan-id*	Displays the MAC address table information for the specified VLAN.

Configuration Examples for Controller Administration

Example: Setting the System Clock

This example shows how to manually set the system clock:

```
Controller# 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:

```
Controller(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:

```
Controller(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:

```
Controller(config)# banner motd #

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

#

Controller(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:

```
Controller(config)# banner login $

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

$

Controller(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:

```
Controller(config)# snmp-server host 172.20.10.10 traps private mac-notification
Controller(config)# snmp-server enable traps mac-notification change
Controller(config)# mac address-table notification change
Controller(config)# mac address-table notification change interval 123
Controller(config)# mac address-table notification change history-size 100
Controller(config)# interface gigabitethernet1/2/1
Controller(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:

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

```
Controller(config)# mac address-table static c2f3.220a.12f4 vlan 4 interface
gigabitethernet1/1/1
```

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:

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

Feature History and Information for Controller Administration

Release	Modification
Cisco IOS XE 3.2SE	This feature was introduced.

CHAPTER 4

Performing Controller Setup Configuration

Information About Performing Controller Setup Configuration

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

Controller Boot Process

To start your controller, you need to follow the procedures in the hardware installation guide for installing and powering on the controller and setting up the initial controller configuration (IP address, subnet mask, default gateway, secret and Telnet passwords, and so forth).

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 controller.

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.

The boot loader also provides trap-door access into the system if the operating system has problems serious enough that it cannot be used. The trap-door mechanism provides enough access to the system so that if it is

necessary, you can reinstall the operating system software image by using the Xmodem Protocol, recover from a lost or forgotten password, and finally restart the operating system.

Before you can assign controller 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 controller 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.
- 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.

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

Software Boot Modes

Your controller supports two modes to boot the software packages:

- Installed mode
- Bundle mode

Related Topics

Examples: Displaying Software Bootup in Install Mode, on page 64
Example: Emergency Installation, on page 65

Installed Boot Mode

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

```
controller: 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.

Related Topics

Examples: Displaying Software Bootup in Install Mode, on page 64

Example: Emergency Installation, on page 65

Bundle Boot Mode

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

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.

Note Auto install and smart install functionality is not supported in bundle boot mode.

Related Topics

Examples: Displaying Software Bootup in Install Mode, on page 64

Example: Emergency Installation, on page 65

Controllers Information Assignment

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

Use the controller 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.

The switch stack is managed through a single IP address. The IP address is a system-level setting and is not specific to the stack master or to any other stack member. You can still manage the stack through the same

IP address even if you remove the stack master or any other stack member from the stack, provided there is IP connectivity.

Note Stack members retain their IP address when you remove them from a switch stack. To avoid a conflict by having two devices with the same IP address in your network, change the IP address of the switch that you removed from the switch stack.

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 controller receives the dynamically assigned IP address and reads the configuration file.

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

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 controller can act as both a DHCP client and a DHCP server.

During DHCP-based autoconfiguration, your controller (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 controller. 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.

The DHCP server for your controller can be on the same LAN or on a different LAN than the controller. If the DHCP server is running on a different LAN, you should configure a DHCP relay device between your controller 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 controller.

DHCP Client Request Process

When you boot up your controller, the DHCP client is invoked and requests configuration information from a DHCP server when the configuration file is not present on the controller. 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 2: DHCP Client and Server Message Exchange

The client, Controller 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 controller 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 controller accepts replies from a BOOTP server and configures itself, the controller broadcasts, instead of unicasts, TFTP requests to obtain the controller configuration file.

The DHCP hostname option allows a group of controllers to obtain hostnames and a standard configuration from the central management DHCP server. A client (controller) includes in its DCHPDISCOVER 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 DCHP 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 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 controller by the controller hardware address.
- If you want the controller 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 controller) (required)

- If you want the controller 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 controller 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 controller is not configured. If the router IP address or the TFTP server name are not found, the controller might send broadcast, instead of unicast, TFTP requests. Unavailability of other lease options does not affect autoconfiguration.
- The controller can act as a DHCP server. By default, the Cisco IOS DHCP server and relay agent features are enabled on your controller but are not configured. (These features are not operational.)

Purpose of the TFTP Server

Based on the DHCP server configuration, the controller attempts to download one or more configuration files from the TFTP server. If you configured the DHCP server to respond to the controller 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 controller 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 controller 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 controller'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 controller 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 controller configuration file).
- The network-confg or the cisconet.cfg file (known as the default configuration files).
- The router-confg or the ciscortr.cfg file (These files contain commands common to all controllers. 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 controller, or if it is to be accessed by the controller 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 controller.

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 controller. If it is on a different LAN, the controller 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 controller obtains its configuration information in these ways:

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

  The controller receives its IP address, subnet mask, TFTP server address, and the configuration filename from the DHCP server. The controller 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 controller, but the TFTP server address is not provided in the DHCP reply (one-file read method).

  The controller receives its IP address, subnet mask, and the configuration filename from the DHCP server. The controller 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 controller and provided in the DHCP reply. The configuration filename is not provided (two-file read method).

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

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

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

  If the controller cannot read the network-confg, cisconet.cfg, or the hostname file, it reads the router-confg file. If the controller cannot read the router-confg file, it reads the ciscortr.cfg file.

Note The controller 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 controller, you enter the boot loader mode only through the console connection configured for 9600 bps. Unplug the controller power cord, and press the **Mode** button while reconnecting the power cord. You can release the **Mode** button after all the amber system LEDs turn on and remain solid. The boot loader controller prompt then appears.

The controller 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.

Scheduled Reload of the Software Image

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

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

If you modify your configuration file, the controller 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 Controller Setup Configuration

Using DHCP to download a new image and a new configuration to a controller requires that you configure at least two controllers. One controller acts as a DHCP and TFTP server and the second controller (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 controller in the network so that it can support the autoconfiguration of a new controller.

SUMMARY STEPS

1. **configure terminal**
2. **ip dhcp pool** *poolname*
3. **boot** *filename*
4. **network** *network-number mask prefix-length*
5. **default-router** *address*
6. **option 150** *address*
7. **exit**
8. **tftp-server flash**:*filename.text*
9. **interface** *interface-id*
10. **no switchport**
11. **ip address** *address mask*
12. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.

	Command or Action	Purpose
Step 2	**ip dhcp pool** *poolname* **Example:** `Controller(config)# ip dhcp pool pool`	Creates a name for the DHCP server address pool, and enters DHCP pool configuration mode.
Step 3	**boot** *filename* **Example:** `Controller(dhcp-config)# boot config-boot.text`	Specifies the name of the configuration file that is used as a boot image.
Step 4	**network** *network-number mask prefix-length* **Example:** `Controller(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** *address* **Example:** `Controller(dhcp-config)# default-router 10.10.10.1`	Specifies the IP address of the default router for a DHCP client.
Step 6	**option 150** *address* **Example:** `Controller(dhcp-config)# option 150 10.10.10.1`	Specifies the IP address of the TFTP server.
Step 7	**exit** **Example:** `Controller(dhcp-config)# exit`	Returns to global configuration mode.
Step 8	**tftp-server flash**:*filename.text* **Example:** `Controller(config)# tftp-server flash:config-boot.text`	Specifies the configuration file on the TFTP server.

	Command or Action	Purpose
Step 9	**interface** *interface-id* **Example:** `Controller(config)# interface gigabitethernet1/0/4`	Specifies the address of the client that will receive the configuration file.
Step 10	**no switchport** **Example:** `Controller(config-if)# no switchport`	Puts the interface into Layer 3 mode.
Step 11	**ip address** *address mask* **Example:** `Controller(config-if)# ip address 10.10.10.1 255.255.255.0`	Specifies the IP address and mask for the interface.
Step 12	**end** **Example:** `Controller(config-if)# end`	Returns to privileged EXEC mode.

Manually Assigning IP Information to Multiple SVIs

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

SUMMARY STEPS

1. **configure terminal**
2. **interface vlan** *vlan-id*
3. **ip address** *ip-address subnet-mask*
4. **exit**
5. **ip default-gateway** *ip-address*
6. **end**
7. **show interfaces vlan** *vlan-id*
8. **show ip redirects**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.
Step 2	**interface vlan** *vlan-id* **Example:** `Controller(config)# interface vlan 99`	Enters interface configuration mode, and enters the VLAN to which the IP information is assigned. The range is 1 to 4094.
Step 3	**ip address** *ip-address subnet-mask* **Example:** `Controller(config-vlan)# ip address 10.10.10.2 255.255.255.0`	Enters the IP address and subnet mask.
Step 4	**exit** **Example:** `Controller(config-vlan)# exit`	Returns to global configuration mode.
Step 5	**ip default-gateway** *ip-address* **Example:** `Controller(config)# ip default-gateway 10.10.10.1`	Enters the IP address of the next-hop router interface that is directly connected to the controller where a default gateway is being configured. The default gateway receives IP packets with unresolved destination IP addresses from the controller. Once the default gateway is configured, the controller has connectivity to the remote networks with which a host needs to communicate. **Note** When your controller is configured to route with IP, it does not need to have a default gateway set. **Note** The controller capwap relays on default-gateway configuration to support routed access point join the controller.
Step 6	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode.

	Command or Action	Purpose
Step 7	**show interfaces vlan** *vlan-id* **Example:** `Controller# show interfaces vlan 99`	Verifies the configured IP address.
Step 8	**show ip redirects** **Example:** `Controller# show ip redirects`	Verifies the configured default gateway.

Modifying the Controller 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 controller for this task.

SUMMARY STEPS

1. **configure terminal**
2. **boot flash**:*/file-url*
3. **end**
4. **show boot**
5. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.

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

Booting the Controller in Installed Mode

SUMMARY STEPS

1. **cp** *source_file_path destination_file_path*
2. **software expand file** *source_file_path*
3. **reload**
4. **boot flash:packages.conf**
5. **show version**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**cp** *source_file_path destination_file_path* **Example:** `Controller#`	(Optional) Copies the bin file (`image.bin`) from the FTP or TFTP server to flash or USB flash.

	Command or Action	Purpose
Step 2	**software expand file** *source_file_path* **Example:**	Expands the bin file stored in flash, FTP, TFTP, HTTP, or HTTPS server on the booted controller. **Note** Ensure that the `packages.conf` file is available in the expanded list.
Step 3	**reload** **Example:** `Controller: reload`	Reloads the controller. **Note** You can boot the controller manually or automatically using the `packages.conf` file. If you are booting manually, you can proceed to Step 4. Otherwise, the controller boots up automatically.
Step 4	**boot flash:packages.conf** **Example:** `switch: boot flash:packages.conf`	Boots the controller with the `packages.conf` file.
Step 5	**show version** **Example:**	Verifies that the controller is in the **INSTALL** mode.

Booting the Controller in Bundle Mode

There are several methods by which you can boot the controller—either by copying the bin file from the TFTP server and then boot the controller, or by booting the controller 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 controller from th TFTP server in the bundle mode.

SUMMARY STEPS

1. **cp** *source_file_path destination_file_path*
2.
3. **boot**
4. **show version**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**cp** *source_file_path destination_file_path* **Example:** `Controller#`	(Optional) Copies the bin file (`image.bin`) from the FTP or TFTP server to flash or USB flash.

	Command or Action	Purpose
Step 2	**Example:** `Controller:`	Sets the boot parameters.
Step 3	**boot** **Example:** `switch: boot`	Boots the controller.
Step 4	**show version** **Example:**	Verifies that the controller is in the **BUNDLE** mode.

Configuring a Scheduled Software Image Reload

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

SUMMARY STEPS

1. **configure terminal**
2. **copy running-config startup-config**
3. **reload in** [*hh*:]*mm* [*text*]
4. **reload at** *hh*: *mm* [*month day* | *day month*] [*text*]
5. **reload cancel**
6. **show reload**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.
Step 2	**copy running-config startup-config** **Example:** `copy running-config startup-config`	Saves your controller configuration information to the startup configuration before you use the **reload** command.
Step 3	**reload in** [*hh*:]*mm* [*text*] **Example:** `Controller(config)# reload in 12`	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.

	Command or Action	Purpose
	`System configuration has been modified. Save? [yes/no]: y`	
Step 4	**reload at** *hh*: *mm* [*month day* | *day month*] [*text*] **Example:** `Controller(config)# reload at 14:00`	Specifies the time in hours and minutes for the reload to occur. **Note** Use the **at** keyword only if the controller 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 controller. To schedule reloads across several controllers to occur simultaneously, the time on each controller must be synchronized with NTP.
Step 5	**reload cancel** **Example:** `Controller(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 controller.

Monitoring Controller Setup Configuration

Example: Verifying the Controller Running Configuration

```
Controller# 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.$DMUvAUnZOAmvmgqBEzIxE0
!
.
<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

Getting rest of image
Reading full image into memory....done
Reading full base package into memory...: done = 74596432
Nova Bundle Image
--------------------------------------
Kernel Address : 0x6042f354
Kernel Size : 0x318412/3245074
Initramfs Address : 0x60747768
Initramfs Size : 0xdc08e8/14420200
Compression Format: .mzip

Bootable image at @ ram:0x6042f354
Bootable image segment 0 address range [0x81100000, 0x81b80000] is in range [0x80180000,
0x90000000].
@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@boot_system:
 377
Loading Linux kernel with entry point 0x811060f0 ...
Bootloader: Done loading app on core_mask: 0xf

### Launching Linux Kernel (flags = 0x5)

All packages are Digitally Signed
Starting System Services
Nov 7 09:57:05 %IOSXE-1-PLATFORM: process stack-mgr: %STACKMGR-1-DISC_START: Switch 2 is
starting stack discovery
##################################################################################################
Nov 7 09:59:07 %IOSXE-1-PLATFORM: process stack-mgr: %STACKMGR-1-DISC_DONE: Switch 2 has
finished stack discovery
Nov 7 09:59:07 %IOSXE-1-PLATFORM: process stack-mgr: %STACKMGR-1-SWITCH_ADDED: Switch 2 has
 been added to the stack
Nov 7 09:59:14 %IOSXE-1-PLATFORM: process stack-mgr: %STACKMGR-1-ACTIVE_ELECTED: Switch 2
has been elected ACTIVE

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Cisco IOS Software, IOS-XE Software, Catalyst L3 Switch Software (CAT3K_CAA-UNIVERSALK9-M),

Version 03.09.12.EMD EARLY DEPLOYMENT ENGINEERING NOVA_WEEKLY BUILD, synced to
```

```
DSGS_PI2_POSTPC_FLO_DSBU7_NG3K_1105
Copyright (c) 1986-2012 by Cisco Systems, Inc.
Compiled Sun 04-Nov-12 22:53 by gereddy
License level to iosd is ipservices
```

Related Topics

Software Boot Modes, on page 48
Installed Boot Mode, on page 49
Bundle Boot Mode, on page 49

Example: Emergency Installation

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

Related Topics

Software Boot Modes, on page 48
Installed Boot Mode, on page 49
Bundle Boot Mode, on page 49

Configuration Examples for Performing Controller Setup

Example: Configuring a Controller 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:

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

```
Controller#
```

Examples: Scheduling Software Image Reload

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

```
Controller# 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 controller at a future time:

```
Controller# 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]
```

Feature History and Information For Performing Controller Setup Configuration

Command History

Release	Modification
Cisco IOS XE 3.2SE	This feature was introduced.

CHAPTER 5

Configuring Right-To-Use Licenses

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.

Restrictions for Right-To-Use AP-Count Licenses

The following are the restrictions you must keep in mind when using license for the Cisco 5700 Series Wireless Controller:

- The license you have purchased is applicable only for the Cisco 5700 Series Wireless Controller. You cannot use the same license for the earlier version of the Cisco 5700 Series Wireless Controllers.
- The CLI commands that you run for the Cisco 5700 Series Wireless Controller are applicable only for these controllers. You cannot run these commands for the earlier version of the controllers.

Information About Configuring RTU Licenses

Right-To-Use AP-Count Licensing

Right-to-use licensing (RTU) allows you to order and activate a specific license type, and then to manage license usage on your controller.

You can order your controller with support for a specific number of adder access point count licenses, but the total number of licenses ordered should not exceed 1000. You can also order your adder access point count licenses after receiving the controller.

For example, if you have ordered 700 new adder licenses, you can add only those ordered adder licenses to the controller. The licenses can be added in increments of 1, but the total number of licenses added for the controller should not exceed 1000.

You can configure controller to manage the access point count licenses from the CLI and view the number of access points currently in use from both the CLI and GUI.

The following are two different types of access point licenses:

1. Permanent licenses for the access points
   - Adder access point count license—You can purchase the adder license to increase the controller capacity at a later time. You can transfer the adder access point count license from one controller to another.
2. Evaluation licenses for the access points
   - You can activate these licenses to evaluate more access points before purchasing the licenses.
   - The maximum number of access points that can be evaluated is 1000.
   - The evaluation period for using the access point licenses is 90 days.
   - You can activate and deactivate the evaluation licenses from the CLI.

Right-to-Use AP-Count Evaluation Licenses

If you are considering upgrading to a license with a higher access point count, you can try an evaluation license before upgrading to a permanent version of the license. For example, if you are using a permanent license with a 50-access-point count and want to try an evaluation license with a 100-access-point count, you can try out the evaluation license for 90 days.

When an evaluation license is activated, the permanent AP-count licenses are ignored. The maximum supported licenses of 1000 access points are available for 90 days .

To prevent disruptions in operation, the controller does not change licenses when an evaluation license expires. A warning expiry message is displayed daily starting five days prior to the expiry date. After 90 days, the evaluation license expires with a warning message. You must disable the evaluation license and then purchase the permanent license.

When the controller reboots after the evaluation license expiry, the license defaults to a permanent license.

Right-To-Use Adder AP-Count Rehosting Licenses

Revoking a license from one device and installing it on another is called rehosting. You might want to rehost a license to change the purpose of a device. For example, if you want to move your Office Extend or indoor access points to a different controller, you could transfer the adder ap-count license from one controller to another.

To rehost a license, you must deactivate the adder ap-count license from one device and activate the same license on another device.

Evaluation licenses cannot be rehosted.

How to Configure RTU Licenses

Activating an AP-Count Evaluation License (CLI)

When an evaluation license is activated, the maximum supported ap-count licenses are made available. A maximum of 1000 access points can be evaluated for 90 days by enabling the evaluation ap-count licenses.

SUMMARY STEPS

1. **license right-to-use activate ap-count evaluation**
2. **show license right-to-use summary**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**license right-to-use activate ap-count evaluation** **Example:** `Controller# license right-to-use activate ap-count evaluation`	Enables the ap-count evaluation licenses on the controller. By default during activation, the EULA gets displayed. If the **acceptEULA** is passed, the EULA content is not displayed, and you can activate the evaluation license. This option is useful for automation and scripting.
Step 2	**show license right-to-use summary** **Example:** `Controller# show license right-to-use summary`	Verifies that the evaluation license is activated on the controller.

Activating an AP-Count Permanent License

You can deactivate an evaluation ap-count license and activate the permanent ap-count license on the controller.

After activating ap-count permanent or adder license, if the **show license right-to-use summary** command still shows evaluation ap-count licenses, then you must deactivate the previously used evaluation license that was not deactivated earlier. Deactivate the evaluation license to enable permanent or adder ap-count licenses.

SUMMARY STEPS

1. **license right-to-use deactivate ap-count evaluation**
2. **show license right-to-use summary**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**license right-to-use deactivate ap-count evaluation** **Example:** `Controller# license right-to-use deactivate ap-count evaluation`	Deactivates particular evaluation license level and activates the permanent ap-count licenses on the controller.
Step 2	**show license right-to-use summary** **Example:** `Controller# show license right-to-use summary`	Verifies the number of permanent ap-count licenses activated on the controller.

Obtaining an Upgrade or Capacity Adder License

You can use the capacity adder licenses to increase the number of access points supported by the controller.

SUMMARY STEPS

1. **license right-to-use activate ap-count** *ap-number* **slot** *1*
2. **show license right-to-use summary**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**license right-to-use activate ap-count** *ap-number* **slot** *1* **Example:** `Controller# license right-to-use activate ap-count 500 slot 1`	Obtains an upgrade or increases the license capacity by adding new adder licenses.
Step 2	**show license right-to-use summary** **Example:** `Controller# show license right-to-use summary`	Verifies the number of permanent ap-count licenses activated on the controller.

Transferring Licenses to a Replacement Controller after an RMA

The replacement controller comes with same permanent ap-count licences.

SUMMARY STEPS

1. **license right-to-use deactivate ap-count** *count* **slot** *1* **acceptEULA**
2. **license right-to-use activate ap-count** *count* **slot** *1* **acceptEULA**
3. **show license right-to-use summary**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**license right-to-use deactivate ap-count** *count* **slot** *1* **acceptEULA** **Example:** `Controller# license right-to-use deactivate ap-count 55 slot 1 acceptEULA`	Deactivates the permanent ap-count licenses on earlier controller to be replaced.
Step 2	**license right-to-use activate ap-count** *count* **slot** *1* **acceptEULA** **Example:** `Controller# license right-to-use activate ap-count 55 slot 1 acceptEULA`	Activates the same permanent ap-count licenses on the replacement controller.
Step 3	**show license right-to-use summary** **Example:** `Controller# show license right-to-use summary`	Verifies the number of ap-count licenses points activated on the replacement controller.

Configuring Right-To-Use Licenses (GUI)

Step 1 Choose **Administration** > **Software Activation** > **Licenses** to open the Licenses page.

Step 2 In the License Activation area, choose **Activate** or **Deactivate** from the **License** drop box and enter the number of adder licenses you want to activate or deactive in the License Adder of AP-Count (1 to 1000) text box.

Step 3 Click **Apply** and **Save Configuration**.

Monitoring and Maintaining RTU Licenses

Viewing Right-To-Use AP-Count Licenses (GUI)

You can view the details of access point licenses installed on the controller using the **Licenses** and **License Usage** pages from the controller GUI.

Step 1 Choose **Administration** > **Software Activation** > **Licenses**.

Example:
The **Licenses** page appears.

This page lists all of the access point licenses installed on the controller. You can view the following details for the license:

- License name
- License type (adder, permanent, or evaluation)
- Count (the maximum number of access points allowed for this license)
- Period left for the license

In addition, you can view the following details of the AP-Count licenses:

- Whether the ap-count license is enabled or not
- The maximum number of access points allowed for this license
- The number of access points currently using this license
- The remaining ap-count licenses

Step 2 Choose **Administration** > **Software Activation** > **License Usage**.

Example:
The **License Usage** page appears.

In the **License Usage** page, you can view the consolidated list of all of the licenses based on their usage duration, use of the license, and the end-user license agreement (EULA) acceptance state.

Step 3 Choose **Administration** > **Software Activation** > **Eula** > **Adder**, **Evaluation**, or **Permanent**.

Example:
The **Eula** page for the selected license appears.

You can read the terms and the conditions for the **Adder**, **Evaluation**, or **Permanent** license.

Viewing Right-To-Use AP-Count Licenses (CLI)

You can view the detailed information of ap-count licenses installed on the controller using the **show license right-to-use** commands from the controller CLI.

SUMMARY STEPS

1. **show license right-to-use detail**
2. **show license right-to-use detail** | *output modifiers*
3. **show license right-to-use eula**
4. **show license right-to-use**
5. **show license right-to-use usage**
6. **show license right-to-use** | *output modifiers*
7. **show license right-to-use summary**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**show license right-to-use detail** **Example:** `Controller# show license right-to-use detail`	Displays details of all of the licenses installed on the stack 1.

Step 2	**show license right-to-use detail** | *output modifiers*
	
	Example:
	`Controller# show license right-to-use detail | append <url>`
	
	Example:
	`Controller# show license right-to-use detail | begin apcount`
	
	Example:
	`Controller# show license right-to-use detail | count ap`
	
	Example:
	`Controller# show license right-to-use detail | exclude ap`
	
	Example:
	`Controller# show license right-to-use detail | format <spec file location>`
	
	Example:
	`Controller# show license right-to-use detail | include apcount`
		Displays the details of licenses based on the filtered search using output modifiers such as append, begin, count, exclude, format, include, redirect, section, and tee.
		
		Appends the redirected license information output to URL. The URLs supporting append operation are crash information, flash, FTP, HTTP, HTTPS, NVRAM, RCP, SCP, TFTP, UNIX, and USB flash0.
		
		Displays the license information that begins with the lines which match the regular expression.
		
		Displays the number of lines that match the regular expression.
		
		Displays the details of license information that excludes lines which match the regular expression.
		
		Displays the details of license information based on the format specified in the spec file.
		
		Displays the lines that match the regular expression.
		
		Redirects the license information output to URL. The URLs that support the redirect operation are crash information, flash, FTP, HTTP, HTTPS, NVRAM, RCP, SCP, TFTP, UNIX, and USB flash0.
		
		Filters the section of the license information output based on the include, exclude, or other regular expression options specified.

	Command or Action	Purpose

	Example:
	`Controller# show license right-to-use detail | redirect <url>`
	
	Example:
	`Controller# show license right-to-use detail | section include apcount`
	`Controller# show license right-to-use detail | section exclude apcount`
	`Controller# show license right-to-use detail | section license`
	
	Example:
	`Controller# show license right-to-use detail | tee <url>`
		Copies the license information output to URL. The URLs that support the copy operation are crash information, flash, FTP, HTTP, HTTPS, NVRAM, RCP, SCP, TFTP, UNIX, and USB flash0.

Step 3	**show license right-to-use eula**
	
	Example:
	`Controller# show license right-to-use eula adder`
	`Controller# show license right-to-use eula evaluation`
	`Controller# show license right-to-use eula permanent`
		Displays the EULA content for the adder, evaluation, and permanent AP-count licenses.

Step 4	**show license right-to-use** **Example:** `Controller# show license right-to-use`	Displays the licenses that got activated with EULA.
Step 5	**show license right-to-use usage** **Example:** `Controller# show license right-to-use usage`	Displays the usage details of all licenses.
Step 6	**show license right-to-use |** *output modifiers* **Example:** `Controller# show license right-to-use | append`	Displays the details of licenses based on the filtered search using output modifiers such as append, begin, count, exclude, format, include, redirect, section, and tee.
Step 7	**show license right-to-use summary** **Example:** `Controller# show license right-to-use summary`	Displays the summary of licenses that are currently in use.

Examples: RTU Licenses Configuration

This example shows how to activate an ap-count evaluation license:

```
Controller# license right-to-use activate ap-count evaluation
Controller# show license right-to-use summary
```

This example shows how to activate an ap-count permanent license:

```
Controller# license right-to-use deactivate ap-count evaluation
Controller# show license right-to-use summary
```

This example shows how to obtain an upgrade or adder license:

```
Controller# license right-to-use activate ap-count 700 slot 1
Controller# show license right-to-use summary
```

This example shows how to transfer licenses to a replacement controller after an RMA. Deactivate the licenses from the controller to be replaced and activate or add the same number of licenses in the replacement controller:

```
Controller# license right-to-use deactivate ap-count 250 slot 1
```

```
Controller# license right-to-use activate ap-count 250 slot 1
Controller# show license right-to-use summary
```

Additional References for RTU Licensing

Related Documents

Related Topic	Document Title
RTU commands	*System Management Command Reference (Cisco WLC 5700 Series)*
RTU AP image preload feature	*System Management Configuration Guide (Cisco WLC 5700 Series)*

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

Feature History and Information for RTU Licensing

Release	Feature Information
Cisco IOS XE 3.2SE	This feature was introduced.

CHAPTER 6

Configuring Administrator Usernames and Passwords

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 Configuring Administrator Usernames and Passwords

You can configure administrator usernames and passwords to prevent unauthorized users from reconfiguring the controller and viewing configuration information. This section provides instructions for initial configuration and for password recovery.

You can also set administrator usernames and passwords to manage and configure one or more access points that are associated with the controller.

Strong Passwords

You can set strong administrator passwords such as encrypted passwords with ASCII keys for the administrator user for managing access points.

Use the following guidelines while creating strong passwords:

- There should be at least three of the following categories—lowercase letters, uppercase letters, digits, and special characters.
- The new password should not be the same as that of the associated username and the username should not be reversed.
- The characters in the password should not be repeated more than three times consecutively.
- The password should not be **cisco**, **ocsic**, **admin**, **nimda**, or any variant obtained by changing the capitalization of letters therein, or by substituting "1" "|" or "!" for i, and/or substituting "0" for "o", and/or substituting "$" for "s".
- The maximum number of characters accepted for the username and password is 32.

Encrypted Passwords

You can set three types of keys for the password:

- Randomly generated key—This key is generated randomly and it is the most secure option. To export the configuration file from one system to another, the key should also be exported.
- Static key—The simplest option is to use a fixed (static) encryption key. By using a fixed key, no key management is required, but if the key is somehow discovered, the data can be decrypted by anyone with the knowledge of that key. This is not a secure option and it is called obfuscation in the CLI.
- User defined key—You can define the key by yourself. To export the configuration file from one system to another, both systems should have the same key configured.

Configuring Administrator Usernames and Passwords

SUMMARY STEPS

1. **configure terminal**
2. **wireless security strong-password**
3. **username** *admin-username* **password {0** *unencrypted_password* **| 7** *hidden_password* **|** *unencrypted_text***}**
4. **username** *admin-username* **secret {0** *unencrypted_secret_text* **| 4** *SHA256 encrypted_secret_text* **| 5** *MD5 encrypted_secret_text* **| LINE}**
5. **ap mgmtuser username** *username* **password {0** *unencrypted password* **| 8** *AES encrypted password* **}secret {0** *unencrypted password* **| 8** *AES encrypted password* **}**
6. **ap dot1x username** *username* **password {0** *unencrypted password* **| 8** *AES encrypted password* **}**
7. **end**
8. **ap name apname mgmtuser username** *username***password** *password* **secret** *secret _text*
9. **ap name apname dot1x-user** *username* **password** *password*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.
Step 2	**wireless security strong-password** **Example:** `Controller(config)# wireless security strong-password`	Enables strong password policy for the administrator user.
Step 3	**username** *admin-username* **password {0** *unencrypted_password* **| 7** *hidden_password* **|** *unencrypted_text***}** **Example:** `Controller(config)# username adminuser1 password 0 QZsek239@`	Specifies a username and password for an administrator. The administrator can configure the controller and view the configured information.
Step 4	**username** *admin-username* **secret {0** *unencrypted_secret_text* **| 4** *SHA256 encrypted_secret_text* **| 5** *MD5 encrypted_secret_text* **| LINE}** **Example:** `Controller(config)# username adminuser1 secret 0 QZsek239@`	Specifies the secret for the administrator.
Step 5	**ap mgmtuser username** *username* **password {0** *unencrypted password* **| 8** *AES encrypted password* **}secret {0** *unencrypted password* **| 8** *AES encrypted password* **}** **Example:** `Controller(config)# ap mgmtuser username cisco password 0 Qwci12@ secret 0 Qwci14@!`	Specifies administrator username and password for managing all of the access points configured to the controller. You can also include the secret text to perform privileged access point management. **Note** If your password is not strong enough to fulfill the strong password policy, then the password is rejected with a valid error message. For example, the following password is rejected because it is not a strong password. `Controller# ap mgmtuser username cisco password 0 abcd secret 0 1234`
Step 6	**ap dot1x username** *username* **password {0** *unencrypted password* **| 8** *AES encrypted password* **}** **Example:** `Controller(config)# ap dot1x username cisco password 0 Qwci12@`	Specifies the 802.1X username and password for managing all of the access points configured to the controller.

	Command or Action	Purpose
Step 7	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.
Step 8	**ap name apname mgmtuser username** *username***password** *password* **secret** *secret _text* **Example:** `Controller# ap name APf0f7.55c7.7b23 mgmtuser username cisco password Qne35! secret Nzep592$`	Configures the administrator username, password, and secret text for managing a specific access point that is configured to the controller.
Step 9	**ap name apname dot1x-user** *username* **password** *password* **Example:** `Controller# ap name APf0f7.55c7.7b23 dot1x-user username cisco password Qne35!`	Configures the 802.1X username and password for a specific access point.

Examples: Administrator Usernames and Passwords Configuration

This example shows how to configure administrator usernames and passwords with the strong password policy in configuration mode:

```
Controller# configure terminal
Controller(config)# wireless security strong-password
Controller(config)# username adminuser1 password 0 QZsek239@
Controller(config)# ap mgmtuser username cisco password 0 Qwci12@ secret 0 Qwci14@!
Controller(config)# ap dot1x username cisco password 0 Qwci12@
Controller# end
```

This example shows how to configure administrator usernames and passwords for an access point in global EXEC mode:

```
Controller# wireless security strong-password
Controller# ap name APf0f7.55c7.7b23 mgmtuser username cisco password Qwci12@ secret Qwci14@
Controller# ap name APf0f7.55c7.7b23 dot1x-user username cisco password Qwci12@
Controller# end
```

Additional References for Administrator Usernames and Passwords

Related Documents

Related Topic	Document Title
System management commands	*System Management Command Reference Guide (Cisco IOS XE Release 3SE (Cisco WLC 5700 Series)*

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

Feature History and Information For Performing Administrator Usernames and Passwords Configuration

Release	Feature Information
Cisco IOS XE 3.2SE	This feature was introduced.

CHAPTER 7

Configuring 802.11 parameters and Band Selection

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.

Restrictions on Band Selection, 802.11 Bands, and Parameters

- Band-selection enabled WLANs do not support time-sensitive applications like voice and video because of roaming delays.
- Band selection can be used only with Cisco Aironet 1040, 1140, 1250, 1260, 2600, 3500, 3600, series access points.

- Band selection operates only on access points that are connected to a controller. A FlexConnect access point without a controller connection does not perform band selection after a reboot.
- The band-selection algorithm directs dual-band clients only from the 2.4-GHz radio to the 5-GHz radio of the same access point, and it only runs on an access point when both the 2.4-GHz and 5-GHz radios are up and running.
- You can enable both band selection and aggressive load balancing on the controller. They run independently and do not impact one another.
- It is not possible to enable or disable band selection and client load balancing globally through the controller GUI or CLI. You can, however, enable or disable band selection and client load balancing for a particular WLAN. Band selection and client load balancing are enabled globally by default.

Information About Configuring Band Selection, 802.11 Bands, and Parameters

Band Selection

Band selection enables client radios that are capable of dual-band (2.4- and 5-GHz) operation to move to a less congested 5-GHz access point. The 2.4-GHz band is often congested. Clients on this band typically experience interference from Bluetooth devices, microwave ovens, and cordless phones as well as co-channel interference from other access points because of the 802.11b/g limit of three nonoverlapping channels. To prevent these sources of interference and improve overall network performance, you can configure band selection on the controller.

Band selection is enabled globally by default.

Band selection works by regulating probe responses to clients. It makes 5-GHz channels more attractive to clients by delaying probe responses to clients on 2.4-GHz channels.

802.11 Bands

You can configure the 802.11b/g/n (2.4-GHz) and 802.11a/n (5-GHz) bands for the controller to comply with the regulatory requirements in your country. By default, both 802.11b/g/n and 802.11a/n are enabled.

When a controller is configured to allow only 802.11g traffic, 802.11b client devices are able to successfully connect to an access point but cannot pass traffic. When you configure the controller for 802.11g traffic only, you must mark 11g rates as mandatory.

802.11n Parameter

This section provides instructions for managing 802.11n devices such as the Cisco Aironet 1140 and 3600 Series Access Points on your network. The 802.11n devices support the 2.4- and 5-GHz bands and offer high-throughput data rates.

The 802.11n high-throughput rates are available on all 802.11n access points for WLANs using WMM with no Layer 2 encryption or with WPA2/AES encryption enabled.

Note Some Cisco 802.11n APs may intermittently emit incorrect beacon frames, which can trigger false wIPS alarms. We recommend that you ignore these alarms. The issue is observed in the following Cisco 802.11n APs: 1140, 1250, 2600, 3500, and 3600.

802.11h Parameter

802.11h informs client devices about channel changes and can limit the transmit power of those client devices.

How to Configure 802.11 Bands and Parameters

Configuring Band Selection (CLI)

SUMMARY STEPS

1. **configure terminal**
2. **wireless client band-select cycle-count** *cycle_count*
3. **wireless client band-select cycle-threshold** *milliseconds*
4. **wireless client band-select expire suppression** *seconds*
5. **wireless client band-select expire dual-band** *seconds*
6. **wireless client band-select client-rssi** *client_rssi*
7. **end**
8. **wlan** *wlan_profile_name wlan_ID SSID_network_name* **band-select**
9. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.
Step 2	**wireless client band-select cycle-count** *cycle_count* **Example:** `Controller(config)# wireless client band-select cycle-count 3`	Sets the probe cycle count for band select. You can enter a value between 1 and 10 for the *cycle_count* parameter.
Step 3	**wireless client band-select cycle-threshold** *milliseconds*	Sets the time threshold for a new scanning cycle period. You can enter a value for threshold between 1 and 1000 for the *milliseconds* parameter.

	Command or Action	Purpose
	Example: `Controller(config)# wireless client band-select cycle-threshold 5000`	
Step 4	**wireless client band-select expire suppression** *seconds* **Example:** `Controller(config)# wireless client band-select expire suppression 100`	Sets the suppression expire to the band select. You can enter a value for suppression between 10 to 200 for the *seconds* parameter.
Step 5	**wireless client band-select expire dual-band** *seconds* **Example:** `Controller(config)# wireless client band-select expire dual-band 100`	Sets the dual band expire. You can enter a value for dual band between 10 and 300 for the *seconds* parameter.
Step 6	**wireless client band-select client-rssi** *client_rssi* **Example:** `Controller(config)# wireless client band-select client-rssi 40`	Sets the client RSSI threshold. You can enter a value for minimum dBm of a client RSSI to respond to a probe between 20 and 90 for the *client_rssi* parameter.
Step 7	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.

Step 8	**wlan** *wlan_profile_name wlan_ID SSID_network_name* **band-select**
	
	Example:
	`Controller(config)# wlan wlan1 25 ssid12`
	`Controller(config-wlan)# band-select`
		Configures band selection on specific WLANs.
		You can enter a value between 1 and 512 for the *wlan_ID* parameter.
		You can enter the up to 32 alphanumeric characters for *SSID_network_name* parameter.

Step 9	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.

Configuring the 802.11 Bands (CLI)

You can configure 802.11 bands and parameters.

SUMMARY STEPS

1. **configure terminal**
2. **ap dot11 5ghz shutdown**
3. **ap dot11 24ghz shutdown**
4. **ap dot11 {5ghz | 24ghz} beaconperiod** *time_unit*
5. **ap dot11 {5ghz | 24ghz} fragmentation** *threshold*
6. **ap dot11 {5ghz | 24ghz} dtpc**
7. **wireless client association limit** *number* **interval** *milliseconds*
8. **ap dot11 {5ghz | 24ghz} rate** *rate {disable | mandatory | supported}*
9. **no ap dot11 5ghz shutdown**
10. **no ap dot11 24ghz shutdown**
11. **ap dot11 24ghz dot11g**
12. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.
Step 2	**ap dot11 5ghz shutdown** **Example:** `Controller(config)# ap dot11 5ghz shutdown`	Disables the 802.11a band. **Note** You must disable the 802.11a band before configuring the 802.11a network parameters.
Step 3	**ap dot11 24ghz shutdown** **Example:** `Controller(config)# ap dot11 24ghz shutdown`	Disables the 802.11b band. **Note** You must disable the 802.11b band before configuring the 802.11b network parameters.
Step 4	**ap dot11 {5ghz | 24ghz} beaconperiod** *time_unit* **Example:** `Controller(config)# ap dot11 5ghz beaconperiod 500`	Specifies the rate at which the SSID is broadcast by the access point. The beacon interval is measured in time units (TUs). One TU is 1024 microseconds. You can configure the access point to send a beacon every 20 to 1000 milliseconds.
Step 5	**ap dot11 {5ghz | 24ghz} fragmentation** *threshold* **Example:** `Controller(config)# ap dot11 5ghz fragmentation 300`	Specifies the size at which packets are fragmented. The threshold is a value between 256 and 2346 bytes (inclusive). Specify a low number for areas where communication is poor or where there is a great deal of radio interference.

	Command or Action	Purpose

Step 6	**ap dot11 {5ghz | 24ghz} dtpc**
	
	Example:
	`Controller(config)# ap dot11 5ghz dtpc`
	
	`Controller(config)# no ap dot11 24ghz dtpc`
		Enables access points to advertise their channels and transmit the power levels in beacons, and probe responses.
		
		The default value is enabled. Client devices using dynamic transmit power control (DTPC) receive the channel and power level information from the access points and adjust their settings automatically. For example, a client device used primarily in Japan could rely on DTPC to adjust its channel and power settings automatically when it travels to Italy and joins a network there.
		Note On access points that run Cisco IOS software, this feature is called world mode.
		
		The **no** form of the command disables the 802.11a or 802.11b DTPC setting.

Step 7	**wireless client association limit** *number* **interval** *milliseconds* **Example:** `Controller(config)# wireless client association limit 50 interval 1000`	Specifies the maximum allowed clients that can be configured. You can configure a maximum number of association request on a single access point slot at a given interval. The range of association limit that you can configure is from one through 100. The association request limit interval is measured between 100 to 10000 milliseconds.
Step 8	**ap dot11 {5ghz | 24ghz} rate** *rate {disable | mandatory | supported}* **Example:** `Controller(config)# ap dot11 5ghz rate 36 mandatory`	Specifies the rate at which data can be transmitted between the controller and the client. • *disabled*—Defines that the clients specify the data rates used for communication. • *mandatory*—Defines that the clients support this data rate in order to associate to an access point on the controller. • *supported*—Any associated clients that support this data rate may communicate with the access point using that rate. However, the clients are not required to be able to use this rate in order to associate. • *rate*—Specifies the rate at which data is transmitted. For the 802.11a and 802.11b bands, the data is transmitted at the rate of 1, 2, 5.5, 6, 9, 11, 12, 18, 24, 36, 48, or 54 Mbps.
Step 9	**no ap dot11 5ghz shutdown** **Example:** `Controller(config)# no ap dot11 5ghz shutdown`	Enables the 802.11a band. **Note** The default value is enabled.
Step 10	**no ap dot11 24ghz shutdown** **Example:** `Controller(config)# no ap dot11 24ghz shutdown`	Enables the 802.11b band. **Note** The default value is enabled.
Step 11	**ap dot11 24ghz dot11g**	Enables or disables 802.11g network support.

	Command or Action	Purpose
	Example: `Controller(config)# ap dot11 24ghz dot11g`	The default value is enabled. You can use this command only if the 802.11b band is enabled. If you disable this feature, the 802.11b band is enabled without 802.11g support.
Step 12	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode.

Configuring the 802.11 Bands (GUI)

Step 1 Choose **Configuration** > **Wireless** > **802.11a/n/ac** > **Network** or **Configuration** > **Wireless** > **802.11b/g/n** > **Network** to open the Global Parameters page.

Step 2 Select the **802.11a/n/ac** (or **802.11b/g**) **Network Status** check box to enable the 802.11a or 802.11b/g band. To disable the band, unselect the check box. The default value is enabled. You can enable both the 802.11a and 802.11b/g bands.

Step 3 If you enabled the 802.11b/g band in *Step 2*, select the **802.11g Support** check box if you want to enable 802.11g network support. The default value is enabled. If you disable this feature, the 802.11b band is enabled without 802.11g support.

Step 4 Specify the period at which the SSID is broadcast by the access point by entering a value between 20 and 1000 milliseconds (inclusive) in the Beacon Period text box. The default value is 100 milliseconds.

Note The beacon period in controllers is listed in terms of milliseconds. The beacon period can also be measured in time units, where one time unit equals 1024 microseconds or 102.4 milliseconds. If a beacon interval is listed as 100 milliseconds in a controller, it is only a rounded off value for 102.4 milliseconds. Due to hardware limitation in certain radios, even though the beacon interval is, say 100 time units, it is adjusted to 102 time units, which roughly equals 104.448 milliseconds. When the beacon period is to be represented in terms of time units, the value is adjusted to the nearest multiple of 17.

Step 5 Specify the size at which packets are fragmented by entering a value between 256 and 2346 bytes (inclusive) in the Fragmentation Threshold text box. Enter a low number for areas where communication is poor or where there is a great deal of radio interference.

Step 6 Make access points advertise their channel and transmit power level in beacons and probe responses for CCX clients. Select the **DTPC Support** check box. Otherwise, unselect this check box. The default value is enabled.
Client devices using dynamic transmit power control (DTPC) receive the channel and power level information from the access points and adjust their settings automatically. For example, a client device used primarily in Japan could rely on DTPC to adjust its channel and power settings automatically when it travels to Italy and joins a network there.

Note On access points that run Cisco IOS software, this feature is called *world mode*.

Note DTPC and 801.11h power constraint cannot be enabled simultaneously.

Step 7 Specify the maximum allowed clients by entering a value between 1 to 200 in the Maximum Allowed Client text box. The default value is 200.

Step 8 Use the Data Rates options to specify the rates at which data can be transmitted between the access point and the client. These data rates are available:

- 802.11a—6, 9, 12, 18, 24, 36, 48, and 54 Mbps
- 802.11b/g—1, 2, 5.5, 6, 9, 11, 12, 18, 24, 36, 48, or 54 Mbps

For each data rate, choose one of these options:

- **Mandatory—**Clients must support this data rate in order to associate to an access point on the controller.
- **Supported—**Any associated clients that support this data rate may communicate with the access point using that rate. However, the clients are not required to be able to use this rate in order to associate.
- **Disabled—**The clients specify the data rates used for communication.

Step 9 Click **Apply**.

Step 10 Click **Save Configuration**.

Configuring 802.11n Parameters (CLI)

SUMMARY STEPS

1. **configure terminal**
2. **ap dot11 {5ghz | 24ghz} dot11n**
3. **ap dot11 {5ghz | 24ghz} dot11n mcs tx** *rtu*
4. **wlan***wlan_profile_name wlan_ID SSID_network_name* **wmm require**
5. **ap dot11 {5ghz | 24ghz} shutdown**
6. **{ap | no ap} dot11 {5ghz | 24 ghz} dot11n a-mpdu tx priority {all | 0-7}**
7. **no ap dot11 {5ghz | 24ghz} shutdown**
8. **ap dot11 {5ghz | 24ghz} dot11n guard-interval {any | long}**
9. **ap dot11 {5ghz | 24ghz} dot11n rifs rx**
10. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.
Step 2	**ap dot11 {5ghz | 24ghz} dot11n** **Example:** `Controller(config)# ap dot11 5ghz dot11n`	Enables 802.11n support on the network. The **no** form of the command disables the 802.11n support on the network.

	Command or Action	Purpose
Step 3	**ap dot11 {5ghz | 24ghz} dot11n mcs tx** *rtu* **Example:** `Controller(config)# ap dot11 5ghz dot11n mcs tx 20`	Specifies the modulation and coding scheme (MCS) rates at which data can be transmitted between the access point and the client. You can set a value from 0 through 23 for the **mcs tx** parameter. The **no** form of the command disables the MCS rates that is configured.

Step 4	**wlan***wlan_profile_name wlan_ID SSID_network_name* **wmm require**
	
	Example:
	`Controller(config)# wlan wlan1 25 ssid12`
	`Controller(config-wlan)# wmm require`
		Enables WMM on the WLAN and uses the 802.11n data rates that you configured.
		
		The **require** parameter requires client devices to use WMM. Devices that do not support WMM cannot join the WLAN.

Step 5	**ap dot11 {5ghz | 24ghz} shutdown** **Example:** `Controller(config)# ap dot11 5ghz shutdown`	Disables the network.
Step 6	**{ap | no ap} dot11 {5ghz | 24 ghz} dot11n a-mpdu tx priority {all | 0-7}** **Example:** `Controller(config)# ap dot11 5ghz dot11n a-mpdu tx priority all`	Specifies the aggregation method used for 802.11n packets. Aggregation is the process of grouping packet data frames together rather than transmitting them separately. Two aggregation methods are available: Aggregated MAC Protocol Data Unit (A-MPDU) and Aggregated MAC Service Data Unit (A-MSDU). Both A-MPDU and A-MSDU are performed in the software. You can specify the aggregation method for various types of traffic from the access point to the clients. The following table defines the priority levels (0-7) assigned per traffic type. ***Table 6: Traffic Type Priority Levels*** **User Priority** — **Traffic Type** 0 — Best effort 1 — Background 2 — Spare 3 — Excellent effort 4 — Controlled load 5 — Video, less than 100-ms latency and jitter

	Command or Action	Purpose
		<table><tr><td>6</td><td>Voice, less than 100-ms latency and jitter</td></tr><tr><td>7</td><td>Network control</td></tr></table> You can configure each priority level independently, or you can use the all parameter to configure all of the priority levels at once. You can configure priority levels so that the traffic uses either A-MPDU transmission or A-MSDU transmission. • When you use the **ap** command along with the other options, the traffic associated with that priority level uses A-MPDU transmission. • When you use the **no ap** command along with the other options, the traffic associated with that priority level uses A-MSDU transmission. Configure the priority levels to match the aggregation method used by the clients. By default, A-MPDU is enabled for priority level 0, 4 and 5 and the rest are disabled. By default, A-MPDU is enabled for all priorities except 6 and 7.
Step 7	**no ap dot11 {5ghz | 24ghz} shutdown** **Example:** `Controller(config)# no ap dot11 5ghz shutdown`	Reenables the network.
Step 8	**ap dot11 {5ghz | 24ghz} dot11n guard-interval {any | long}** **Example:** `Controller(config)# ap dot11 5ghz dot11n guard-interval long`	Configures the guard interval for the network.
Step 9	**ap dot11 {5ghz | 24ghz} dot11n rifs rx** **Example:** `Controller(config)# ap dot11 5ghz dot11n rifs rx`	Configures the Reduced Interframe Space (RIFS) for the network.
Step 10	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.

Configuring the 802.11n Parameters (GUI)

Step 1 Choose **Configuration** > **Wireless** > **802.11a/n/ac or 802.11b/g/n** > **High Throughput (802.11n)** to open the 802.11n/ac (5 GHz or 2.4 GHz) Throughput page.

Step 2 Select the **Enable 11n** check box to enable 802.11n support on the network. The default value is enabled.

Step 3 Select the check boxes of the desired rates to specify the modulation and coding scheme (MCS) rates at which data can be transmitted between the access point and the client. These data rates, which are calculated for a 20-MHz channel width using a short guard interval, are available:

- 0 (7 Mbps)
- 1 (14 Mbps)
- 2 (21 Mbps)
- 3 (29 Mbps)
- 4 (43 Mbps)
- 5 (58 Mbps)
- 6 (65 Mbps)
- 7 (72 Mbps)
- 8 (14 Mbps)
- 9 (29 Mbps)
- 10 (43 Mbps)
- 11 (58 Mbps)
- 12 (87 Mbps)
- 13 (116 Mbps)
- 14 (130 Mbps)
- 15 (144 Mbps)
- 16 (22 Mbps)
- 17 (43 Mbps)
- 18 (65 Mbps)
- 19 (87 Mbps)
- 20 (130 Mbps)
- 21 (173 Mbps)
- 22 (195 Mbps)
- 23 (217 Mbps)

- Any associated clients that support the selected rates may communicate with the access point using those rates. However, the clients are not required to be able to use this rate in order to associate. The MCS settings determine the number of spatial streams, the modulation, the coding rate, and the data rate values that are used.

Step 4 Click **Apply**.

Step 5 Use the 802.11n data rates that you configured by enabling WMM on the WLAN as follows:

a) Choose **WLANs** to open the WLANs page.

b) Click the ID number of the WLAN for which you want to configure WMM mode.

c) When the WLANs > Edit page appears, choose the **QoS** tab to open the WLANs > Edit (Qos) page.

d) From the WMM Policy drop-down list, choose **Required** or **Allowed** to require or allow client devices to use WMM. Devices that do not support WMM cannot join the WLAN.
If you choose **Allowed**, devices that cannot support WMM can join the WLAN but will not benefit from the 802.11n rates.

e) Click **Apply**.

Step 6 Click **Save Configuration**.

Note To determine if an access point supports 802.11n, look at the 11n Supported text box on either the 802.11a/n (or 802.11b/g/n) Cisco APs > Configure page or the 802.11a/n (or 802.11b/g/n) AP Interfaces > Details page.

Configuring 802.11h Parameters (CLI)

SUMMARY STEPS

1. **configure terminal**
2. **ap dot11 5ghz shutdown**
3. **{ap | no ap} dot11 5ghz channelswitch mode** *switch_mode*
4. **ap dot11 5ghz power-constraint** *value*
5. **no ap dot11 5ghz shutdown**
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.
Step 2	**ap dot11 5ghz shutdown** **Example:** `Controller(config)# ap dot11 5ghz shutdown`	Disables the 802.11a network.

	Command or Action	Purpose
Step 3	**{ap | no ap} dot11 5ghz channelswitch mode** *switch_mode* **Example:** `Controller(config)# ap dot11 5ghz channelswitch mode 0`	Enables or disables the access point to announce when it is switching to a new channel. You can enter a 0 or 1 for the **channelswitch** parameter to specify whether transmissions are restricted until the actual channel switch (0) or are not restricted (1). The default value is disabled.
Step 4	**ap dot11 5ghz power-constraint** *value* **Example:** `Controller(config)# ap dot11 5ghz power-constraint 200`	Configures the 802.11h power constraint value in a range from zero through 255. The default value for the value parameter is 3 dB.
Step 5	**no ap dot11 5ghz shutdown** **Example:** `Controller(config)# no ap dot11 5ghz shutdown`	Reenables the 802.11a network.
Step 6	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.

Configuring the 802.11h Parameters (GUI)

Step 1 Disable the 802.11 band as follows:

a) Choose **Configuration** > **Wireless > 802.11a/n/ac > Network** to open the 802.11a/n/ac Global Parameters page.
b) Unselect the **802.11a Network Status** check box.
c) Click **Apply**.

Step 2 Choose **Configuration** > **Wireless > 802.11a/n/ac > DFS (802.11h)** to open the 802.11h Global Parameters page.

Step 3 In the Power Constraint area, enter the local power constraint. The valid range is between 0 dBm and 30 dBm.

Step 4 In the Channel Switch Announcement area, enter the channel switch announcement mode. You can enter a value of either 1 or 0.

Step 5 Click **Apply**.

Step 6 Reenable the 802.11a band as follows:

a) Choose **Wireless > 802.11a/n/ac > Network** to open the 802.11a/n/ac Global Parameters page.
b) Select the **802.11a Network Status** check box.
c) Click **Apply**.

Step 7 Click **Save Configuration**.

Monitoring Configuration Settings for Band Selection, 802.11 Bands, and Parameters

Monitoring Configuration Settings Using Band Selection and 802.11 Bands Commands

This section describes the new commands for band selection and 802.11 bands.

The following commands can be used to monitor band selection, and 802.11 bands and parameters the controller.

Table 7: Monitoring Configuration Settings Using Band Selection and 802.11 Bands Commands

Command	Purpose
show ap dot11 5ghz network	Displays 802.11a bands network parameters, 802.11a operational rates, 802.11n MCS settings, and 802.11n status information.
show ap dot11 24ghz network	Displays 802.11b bands network parameters, 802.11b/g operational rates, 802.11n MCS settings, and 802.11n status information.
show wireless dot11h	Displays 802.11h configuration parameters.
show wireless band-select	Displays band select configuration settings.

Example: Viewing the Configuration Settings for 5-GHz Band

```
Controller# show ap dot11 5ghz network
802.11a Network : Enabled
11nSupport : Enabled
  802.11a Low Band : Enabled
  802.11a Mid Band : Enabled
  802.11a High Band : Enabled

802.11a Operational Rates
  802.11a 6M : Mandatory
  802.11a 9M : Supported
  802.11a 12M : Mandatory
  802.11a 18M : Supported
  802.11a 24M : Mandatory
  802.11a 36M : Supported
  802.11a 48M : Supported
  802.11a 54M : Supported
802.11n MCS Settings:
  MCS 0 : Supported
  MCS 1 : Supported
  MCS 2 : Supported
```

```
  MCS 3 : Supported
  MCS 4 : Supported
  MCS 5 : Supported
  MCS 6 : Supported
  MCS 7 : Supported
  MCS 8 : Supported
  MCS 9 : Supported
  MCS 10 : Supported
  MCS 11 : Supported
  MCS 12 : Supported
  MCS 13 : Supported
  MCS 14 : Supported
  MCS 15 : Supported
  MCS 16 : Supported
  MCS 17 : Supported
  MCS 18 : Supported
  MCS 19 : Supported
  MCS 20 : Supported
  MCS 21 : Supported
  MCS 22 : Supported
  MCS 23 : Supported
802.11n Status:
  A-MPDU Tx:
    Priority 0 : Enabled
    Priority 1 : Disabled
    Priority 2 : Disabled
    Priority 3 : Disabled
    Priority 4 : Enabled
    Priority 5 : Enabled
    Priority 6 : Disabled
    Priority 7 : Disabled
  A-MSDU Tx:
    Priority 0 : Enabled
    Priority 1 : Enabled
    Priority 2 : Enabled
    Priority 3 : Enabled
    Priority 4 : Enabled
    Priority 5 : Enabled
    Priority 6 : Disabled
    Priority 7 : Disabled
Guard Interval : Any
  Rifs Rx : Enabled
Beacon Interval : 100
CF Pollable mandatory : Disabled
CF Poll Request Mandatory : Disabled
CFP Period : 4
CFP Maximum Duration : 60
Default Channel : 36
Default Tx Power Level : 1
DTPC Status : Enabled
Fragmentation Threshold : 2346
Pico-Cell Status : Disabled
Pico-Cell-V2 Status : Disabled
TI Threshold : 0
Legacy Tx Beamforming setting : Disabled
Traffic Stream Metrics Status : Disabled
Expedited BW Request Status : Disabled
EDCA profile type check : default-wmm
Call Admision Control (CAC) configuration
Voice AC
  Voice AC - Admission control (ACM) : Disabled
  Voice Stream-Size : 84000
  Voice Max-Streams : 2
  Voice Max RF Bandwidth : 75
  Voice Reserved Roaming Bandwidth : 6
  Voice Load-Based CAC mode : Enabled
  Voice tspec inactivity timeout : Enabled
CAC SIP-Voice configuration
  SIP based CAC : Disabled
  SIP Codec Type : CODEC_TYPE_G711
  SIP call bandwidth : 64
  SIP call bandwith sample-size : 20
Video AC
```

```
  Video AC - Admission control (ACM) : Disabled
  Video max RF bandwidth : Infinite
  Video reserved roaming bandwidth : 0
```

Example: Viewing the Configuration Settings for 24-GHz Band

```
Controller# show ap dot11 24ghz network
802.11b Network : Enabled
11gSupport : Enabled
11nSupport : Enabled

  802.11b/g Operational Rates
  802.11b 1M : Mandatory
  802.11b 2M : Mandatory
  802.11b 5.5M : Mandatory
  802.11g 6M : Supported
  802.11g 9M : Supported
  802.11b 11M : Mandatory
  802.11g 12M : Supported
  802.11g 18M : Supported
  802.11g 24M : Supported
  802.11g 36M : Supported
  802.11g 48M : Supported
  802.11g 54M : Supported
802.11n MCS Settings:
  MCS 0 : Supported
  MCS 1 : Supported
  MCS 2 : Supported
  MCS 3 : Supported
  MCS 4 : Supported
  MCS 5 : Supported
  MCS 6 : Supported
  MCS 7 : Supported
  MCS 8 : Supported
  MCS 9 : Supported
  MCS 10 : Supported
  MCS 11 : Supported
  MCS 12 : Supported
  MCS 13 : Supported
  MCS 14 : Supported
  MCS 15 : Supported
  MCS 16 : Supported
  MCS 17 : Supported
  MCS 18 : Supported
  MCS 19 : Supported
  MCS 20 : Supported
  MCS 21 : Supported
  MCS 22 : Supported
  MCS 23 : Supported
802.11n Status:
  A-MPDU Tx:
    Priority 0 : Enabled
    Priority 1 : Disabled
    Priority 2 : Disabled
    Priority 3 : Disabled
    Priority 4 : Enabled
    Priority 5 : Enabled
    Priority 6 : Disabled
    Priority 7 : Disabled
  A-MSDU Tx:
    Priority 0 : Enabled
    Priority 1 : Enabled
    Priority 2 : Enabled
    Priority 3 : Enabled
    Priority 4 : Enabled
    Priority 5 : Enabled
  Priority 6 : Disabled
    Priority 7 : Disabled
  Guard Interval : Any
```

```
  Rifs Rx : Enabled
Beacon Interval : 100
CF Pollable Mandatory : Disabled
CF Poll Request Mandatory : Disabled
CFP Period : 4
CFP Maximum Duration : 60
Default Channel : 11
Default Tx Power Level : 1
DTPC Status : true
Call Admission Limit : 105
G711 CU Quantum : 15
ED Threshold : -50
Fragmentation Threshold : 2346
PBCC Mandatory : Disabled
Pico-Cell Status : Disabled
Pico-Cell-V2 Status : Disabled
RTS Threshold : 2347
Short Preamble Mandatory : Enabled
Short Retry Limit : 7
Legacy Tx Beamforming setting : Disabled
Traffic Stream Metrics Status : Disabled
Expedited BW Request Status : Disabled
EDCA profile type : default-wmm
Call Admision Control (CAC) configuration
Voice AC
  Voice AC - Admission control (ACM) : Disabled
  Voice Stream-Size : 84000
  Voice Max-Streams : 2
  Voice Max RF Bandwidth : 75
  Voice Reserved Roaming Bandwidth : 6
  Voice Load-Based CAC mode : Enabled
  Voice tspec inactivity timeout : Enabled
CAC SIP-Voice configuration
  SIP based CAC : Disabled
  SIP Codec Type : CODEC_TYPE_G711
  SIP call bandwidth : 64
  SIP call bandwith sample-size : 20
Video AC
  Video AC - Admission control (ACM) : Disabled
  Video max RF bandwidth : Infinite
  Video reserved roaming bandwidth : 0
```

Example: Viewing the status of 802.11h Parameters

```
Controller# show wireless dot11h
Power Constraint: 0
Channel Switch: 0
Channel Switch Mode: 0
```

Example: Verifying the Band Selection Settings

```
Controller# show wireless band-select
Band Select Probe Response    : per WLAN enabling
Cycle Count                   : 2
Cycle Threshold (millisec)    : 200
Age Out Suppression (sec)     : 20
Age Out Dual Band (sec)       : 60
Client RSSI (dBm)             : 80
```

Configuration Examples for Band Selection, 802.11 Bands, and Parameters

Examples: Band Selection Configuration

This example shows how to set the probe cycle count and time threshold for a new scanning cycle period for band select:

```
Controller# configure terminal
Controller(config)# wireless client band-select cycle-count 3
Controller(config)# wireless client band-select cycle-threshold 5000
Controller(config)# end
```

This example shows how to set the suppression expire to the band select:

```
Controller# configure terminal
Controller(config)# wireless client band-select expire suppression 100
Controller(config)# end
```

This example shows how to set the dual band expire for the band select:

```
Controller# configure terminal
Controller(config)# wireless client band-select expire dual-band 100
Controller(config)# end
```

This example shows how to set the client RSSI threshold for the band select:

```
Controller# configure terminal
Controller(config)# wireless client band-select client-rssi 40
Controller(config)# end
```

This example shows how to configure band selection on specific WLANs:

```
Controller# configure terminal
Controller(config)# wlan wlan1 25 ssid12
Controller(config-wlan)# band-select
Controller(config)# end
```

Examples: 802.11 Bands Configuration

This example shows how to configure 802.11 bands using beacon interval, fragmentation, and dynamic transmit power control:

```
Controller# configure terminal
Controller(config)# ap dot11 5ghz shutdown
Controller(config)# ap dot11 24ghz shutdown
Controller(config)# ap dot11 5ghz beaconperiod 500
Controller(config)# ap dot11 5ghz fragmentation 300
Controller(config)# ap dot11 5ghz dtpc
Controller(config)# wireless client association limit 50 interval 1000
Controller(config)# ap dot11 5ghz rate 36 mandatory
Controller(config)# no ap dot11 5ghz shutdown
Controller(config)# no ap dot11 24ghz shutdown
Controller(config)# ap dot11 24ghz dot11g
Controller(config)#end
```

Examples: 802.11n Configuration

This example shows how to configure 802.11n parameters for 5-GHz band using aggregation method:

```
Controller# configure terminal
Controller(config)# ap dot11 5ghz dot11n
Controller(config)# ap dot11 5ghz dot11n mcs tx 20
Controller(config)# wlan wlan1 25 ssid12
Controller(config-wlan)# wmm require\
Controller(config-wlan)# exit
Controller(config)# ap dot11 5ghz shutdown
Controller(config)# ap dot11 5ghz dot11n a-mpdu tx priority all
Controller(config)# no ap dot11 5ghz shutdown
Controller(config)#exit
```

This example shows how to configure the guard interval for 5-GHz band:

```
Controller# configure terminal
Controller(config)# ap dot11 5ghz dot11n
Controller(config)# ap dot11 5ghz dot11n mcs tx 20
Controller(config)# wlan wlan1 25 ssid12
Controller(config-wlan)# wmm require\
Controller(config-wlan)# exit
Controller(config)# no ap dot11 5ghz shutdown
Controller(config)# ap dot11 5ghz dot11n guard-interval long
Controller(config)#end
```

This example shows how to configure the RIFS for 5-GHz band:

```
Controller# configure terminal
Controller(config)# ap dot11 5ghz dot11n
Controller(config)# ap dot11 5ghz dot11n mcs tx 20
Controller(config)# wlan wlan1 25 ssid12
Controller(config-wlan)# wmm require\
Controller(config-wlan)# exit
Controller(config)# ap dot11 5ghz shutdown
Controller(config)# ap dot11 5ghz dot11n rifs rx
Controller(config)#end
```

Examples: 802.11h Configuration

This example shows how to configure the access point to announce when it is switching to a new channel using restriction transmission:

```
Controller# configure terminal
Controller(config)# ap dot11 5ghz shutdown
Controller(config)# ap dot11 5ghz channelswitch mode 0
Controller(config)# no ap dot11 5ghz shutdown
Controller(config)#end
```

This example shows how to configure the 802.11h power constraint for 5-GHz band:

```
Controller# configure terminal
Controller(config)# ap dot11 5ghz shutdown
Controller(config)# ap dot11 5ghz power-constraint 200
Controller(config)# no ap dot11 5ghz shutdown
Controller(config)#end
```

Additional References for 802.11 Parameters and Band Selection

Related Documents

Related Topic	Document Title
System management commands	*System Management Command Reference, Cisco IOS XE Release 3SE (Cisco WLC 5700 Series)*

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

Feature History and Information For Performing 802.11 parameters and Band Selection Configuration

Release	Feature Information
Cisco IOS XE 3.2SE	This feature was introduced.

CHAPTER 8

Configuring Aggressive Load Balancing

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.

Restrictions for Aggressive Load Balancing

- You can configure aggressive load balancing only from the command-line interface.
- Aggressive load balancing is disabled by default, you must enable it manually.
- You can enable load balancing either separately or together with the band select configurations.
- When the band select is enabled on the dual-band clients, the load balancing parameter selects only the lowest load radio from 5-GHz radios. For the 2.4-GHz clients, there is no probe information of the client on 5 GHz and therefore the load balancing algorithm can only be selected between radio on 2.4 GHz.
- You can operate load balancing of clients between access points on the same controller but not for the clients between access points on the different controller.

- The load balancing uses an existing association denial mechanism based on the number of client on the radio and the band select is implemented by the distributed probe response suppression on the access point only.

Information for Configuring Aggressive Load Balancing Parameters

Aggressive Load Balancing

Enabling aggressive load balancing on the controller allows lightweight access points to load balance wireless clients across access points. You can enable aggressive load balancing using the controller.

When a wireless client attempts to associate to a lightweight access point, association response packets are sent to the client with an 802.11 response packet including status code 17. The code 17 indicates that the AP is busy. The AP responds with an association response bearing 'success' if the AP threshold is not met, and with code 17 (AP busy) if the AP utilization threshold is reached or exceeded and another less busy AP heard the client request.

For example, if the number of clients on AP1 is more than the number of clients on AP2 plus the load-balancing window, then AP1 is considered to be busier than AP2. When a client attempts to associate to AP1, it receives an 802.11 response packet with status code 17, indicating that the access point is busy, and the client attempts to associate to a different access point.

You can configure the controller to deny client associations up to 10 times (if a client attempted to associate 11 times, it would be allowed to associate on the 11th try). You can also enable or disable load balancing on a particular WLAN, which is useful if you want to disable load balancing for a select group of clients (such as time-sensitive voice clients).

The maximum number of client associations that the access points can support is dependent upon the following factors:

- The maximum number of client associations differs for lightweight and autonomous Cisco IOS access points.
- There may be a limit per radio and an overall limit per AP.
- AP hardware (the 16-MB APs have a lower limit than the 32-MB and higher APs)

The Client Association Limits for Lightweight Access Points are as follows:

- For 16-MB APs, the limit is 128 clients per AP. This limit is applicable to 1100 and 1200 series APs.
- For 32-MB and higher APs, there is no per-AP limit.

The maximum Client Association Limits per-radio for all of the Cisco IOS APs is 200 associations.

Note With 32-MB and higher lightweight Cisco IOS APs, with two radios, up to 200 + 200 = 400 associations are supported.

The maximum Client Association Limits per Autonomous Cisco IOS access point is around 80 to 127 clients per AP. This number varies depending on the following factors:

- AP model (whether it is 16 MB or 32 MB or higher)
- Cisco IOS software release
- Hardware configuration (two radios use more memory than one)
- Enabled features (WDS functionality in particular)

The per-radio limit is about 200 associations. One association will likely hit the per-AP limit first. Unlike Cisco Unified Wireless Network, autonomous Cisco IOS supports per-SSID/per-AP association limits. This limit is configured using the max-associations CLI, under dot11 SSID. The maximum number is 255 associations (which is also the default number).

How to Configure Aggressive Load Balancing

Configuring Aggressive Load Balancing

SUMMARY STEPS

1. **configure terminal**
2. **wireless load-balancing window** *client-count*
3. **wireless load-balancing denial** *denial-count*
4. **end**
5. **wlan** *wlan_profile_name wlan_ID SSID_network_name* **load-balance**
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.
Step 2	**wireless load-balancing window** *client-count* **Example:** `Controller(config)# wireless load-balancing window 1`	Sets the client window for aggressive load balancing. You can enter a value between 0 and 20 for the *client_count* parameter.
Step 3	**wireless load-balancing denial** *denial-count* **Example:** `Controller(config)# wireless load-balancing denial-count 1`	Sets the denial count for load balancing. You can enter a value between 0 and 10 for the *denial_count* parameter.

	Command or Action	Purpose
Step 4	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.

Step 5	**wlan** *wlan_profile_name wlan_ID SSID_network_name* **load-balance**
	
	Example:
	`Controller(config)# wlan wlan1 25 ssid12`
	`Controller(config-wlan)# load-balance`
		Enables or disables aggressive load balancing on specific WLANs.
		
		You can enter a value between 1 and 512 for the *wlan_ID* parameter.
		
		You can enter the up to 32 alphanumeric characters for *SSID_network_name* parameter.

Step 6	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.

Monitoring Aggressive Load Balancing

This section describes the new command for aggressive load balancing.

The following command can be used to monitor aggressive load balancing on the controller.

Table 8: Monitoring Aggressive Load Balancing Command

Command	Purpose
show wireless load-balancing	Displays the status of the load-balancing feature.

Examples: Aggressive Load Balancing Configuration

This example shows how to configure the load balancing denial count:

```
Controller# configure terminal
Controller(config)# wireless load-balancing denial-count 1
Controller(config)# end
Controller# show wireless load-balancing
```

This example shows how to configure the client window for aggressive load balancing:

```
Controller# configure terminal
Controller(config)# wireless load-balancing window 1
Controller(config)# end
Controller# show wireless load-balancing
```

This example shows how to configure load balancing on specific WLAN:

```
Controller# configure terminal
Controller(config)# wlan wlan1 25 ssid12
Controller(config-wlan)# load-balance
Controller(config)# end
Controller# show wireless load-balancing
```

Additional References for Aggressive Load Balancing

Related Documents

Related Topic	Document Title
System management commands	*System Management Command Reference Guide, Cisco IOS XE Release 3SE (Cisco WLC 5700 Series)*

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

Feature History and Information For Performing Aggressive Load Balancing Configuration

Release	Feature Information
Cisco IOS XE 3.2SE	This feature was introduced.

CHAPTER 9

Configuring Client Roaming

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.

Prerequisites for Configuring Client Roaming

- There should be one active mobility controller to manage client roaming.
- The WLAN SSID on the mobility agents across which roaming is desired should be the same.

Restrictions for Configuring Client Roaming

The following are the restrictions that you should be aware while configuring client roaming:

- Cisco Compatible Extensions (CCX) support is enabled automatically for every WLAN on the controller and cannot be disabled. The controller stores the CCX version of the client in its client database and uses it to generate and respond to CCX frames appropriately. Clients must support CCXv4 or v5 (or CCXv2 for access point assisted roaming) to utilize these roaming enhancements.
- Client roaming between 600 Series Access points is not supported.

Information About Client Roaming

The controllers deliver high-end wireless services to the clients roaming across wireless network. Now, the wireless services are integrated with the switches, thus delivering a value-added Cisco unified new mobility architecture. This unified architecture enables client-roaming services to both wireless and wired clients with seamless, fast- roaming services.

The new mobility architecture supports fast client roaming services using logical categorization of network into Mobility Domains (MDs), Mobility Groups (MGs), Mobility Subdomains (MSDs), and Switch Peer Groups (SPGs) using systems such as Mobility Oracle (MO), Mobility Controller (MC), and Mobility Agent (MA).

- A **Mobility Domain** is the entire domain across which client roaming is supported. It is a collection of mobility groups. For example, a campus network can be considered as a mobility domain.
- A **Mobility Group** is a collection of mobility subdomains across which fast roaming is supported. The mobility group can be one or more buildings within a campus across which frequent roaming is supported.
- A **Mobility Subdomain** is an autonomous portion of the mobility domain network. Each mobility subdomain contains one mobility controller (MC) and a collection of SPGs. A subdomain is equivalent to an 802.11r key domain.
- A **Switch Peer Group** is a collection of mobility agents.
- The **Mobility Oracle** acts as the point of contact for mobility events that occur across mobility subdomains. The mobility oracle also maintains a local database of each client in the entire mobility domain, their home and current subdomain. There is only one MO for an entire mobility domain. The Cisco WLC 5700 Series Controllers or Cisco Unified Wireless Networking Solution controller can act as MO.
- The **Mobility Controller** provides mobility management services for inter-SPG roaming events. The MC sends the configuration like SPG name and SPG peer member list to all of the mobility agents under its subdomain. The Cisco WLC 5700 Series Controllers, Cisco Catalyst 3850 Switch, or Cisco Unified Wireless Networking Solution controller can act as MC. The MC has MC functionality and MA functionality that is running internally into it.
- The **Mobility Agent** is the component that maintains client mobility state machine for a mobile client. All APs are connected to the mobility agent.

The New mobility architecture supports seamless roaming in the following scenarios:

- Intra-switch roaming—The client roaming between APs managed by same mobility agent.
- Intra-SPG roaming—The client roaming between mobility agents in the same SPG.
- Inter-SPG, Intra-subdomain roaming—The client roaming between mobility agents in different SPGs within the same subdomain.

- Inter-subdomain roaming—The client roaming between mobility agents across a subdomain.

Fast Roaming

New mobility architecture supports fast roaming when clients roam within a mobility group by eliminating the need for full authentication. Security polices should be same across the switches for fast roaming.

Local, anchor, foreign MAs and MCs

When a client joins an MA initially and its point of attachment has not changed, that MA is referred as local or associated MA. The MC to which this MA is associated is referred as local or associated MC.

When a client roams between two MAs, the MA to which the client was previously associated is the anchor MA (point of attachment) and the MA to which the client is currently associated is the foreign or associated MA (point of presence). The MCs to which these MAs are associated are referred as anchor, foreign, or associated MCs, respectively.

Inter-Subnet Roaming

Multiple-controller deployments support client roaming across access points managed by controllers in the same mobility group on different subnets. This roaming is transparent to the client because the session is sustained and a tunnel between the controllers allows the client to continue using the same DHCP-assigned or client-assigned IP address as long as the session remains active. The tunnel is torn down, and the client must reauthenticate when the client sends a DHCP Discover with a 0.0.0.0 client IP address or a 169.254.*.* client auto-IP address or when the operator-set user timeout is exceeded.

Voice-over-IP Telephone Roaming

802.11 voice-over-IP (VoIP) telephones actively seek out associations with the strongest RF signal to ensure the best quality of service (QoS) and the maximum throughput. The minimum VoIP telephone requirement of 20-millisecond or shorter latency time for the roaming handover is easily met by the Cisco Unified Wireless Network (Cisco UWN) solution, which has an average handover latency of 5 or fewer milliseconds when open authentication is used. This short latency period is controlled by controllers rather than allowing independent access points to negotiate roaming handovers.

The Cisco UWN solution supports 802.11 VoIP telephone roaming across lightweight access points managed by controllers on different subnets, as long as the controllers are in the same mobility group. This roaming is transparent to the VoIP telephone because the session is sustained and a tunnel between controllers allows the VoIP telephone to continue using the same DHCP-assigned IP address as long as the session remains active. The tunnel is torn down, and the VoIP client must reauthenticate when the VoIP telephone sends a DHCP Discover with a 0.0.0.0 VoIP telephone IP address or a 169.254.*.* VoIP telephone auto-IP address or when the operator-set user timeout is exceeded.

CCX Layer 2 Client Roaming

The controller supports five CCX Layer 2 client roaming enhancements:

- Access point assisted roaming—This feature helps clients save scanning time. When a CCXv2 client associates to an access point, it sends an information packet to the new access point listing the characteristics of its previous access point. Roaming time decreases when the client recognizes and uses an access point list built by compiling all previous access points to which each client was associated and

sent (unicast) to the client immediately after association. The access point list contains the channels, BSSIDs of neighbor access points that support the client's current SSID(s), and time elapsed since disassociation.

- Enhanced neighbor list—This feature focuses on improving a CCXv4 client's roam experience and network edge performance, especially when servicing voice applications. The access point provides its associated client information about its neighbors using a neighbor-list update unicast message.
- Enhanced neighbor list request (E2E)—The End-2-End specification is a Cisco and Intel joint program that defines new protocols and interfaces to improve the overall voice and roaming experience. It applies only to Intel clients in a CCX environment. Specifically, it enables Intel clients to request a neighbor list at will. When this occurs, the access point forwards the request to the controller. The controller receives the request and replies with the current CCX roaming sublist of neighbors for the access point to which the client is associated.

Note To see whether a particular client supports E2E, choose **Wireless** > **Clients** on the controller GUI, click the **Detail** link for the desired client, and look at the E2E Version text box in the Client Properties area.

- Roam reason report—This feature enables CCXv4 clients to report the reason why they roamed to a new access point. It also allows network administrators to build and monitor a roam history.
- Directed roam request—This feature enables the controller to send directed roam requests to the client in situations when the controller can better service the client on an access point different from the one to which it is associated. In this case, the controller sends the client a list of the best access points that it can join. The client can either honor or ignore the directed roam request. Non-CCX clients and clients running CCXv3 or below must not take any action. No configuration is required for this feature.

How to Configure Layer 2 or Layer 3 Roaming

Configuring Layer 2 or Layer 3 Roaming

Before You Begin

To configure the mobility agent for Layer 2 or Layer 3 roaming, the following requisites should be considered:

- SSID and security polices should be same across MAs for Layer 2 and Layer 3 roaming.
- Client VLAN ID should be same for Layer 2 roaming and different for Layer 3 roaming.
- Bridge domain ID and client VLAN IDs should be same for Layer 2 roaming. Either one or both of the bridge domain ID and client VLAN ID should be different for Layer 3 roaming.

SUMMARY STEPS

1. **configure terminal**
2. **wlan** *wlan_profile_name wlan_ID SSID_network_name*
3. **no mobility anchor sticky**
4. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.
Step 2	**wlan** *wlan_profile_name wlan_ID SSID_network_name* **Example:** `Controller(config)#wlan wlan1`	Enters WLAN configuration mode.
Step 3	**no mobility anchor sticky** **Example:** `Controller(config-wlan)#no mobility anchor sticky`	(Optional) Disables Layer 2 anchoring.
Step 4	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.

Configuring CCX Client Roaming Parameters (CLI)

SUMMARY STEPS

1. **configure terminal**
2. **ap dot11 {5ghz | 24ghz} l2roam rf-params** {**default | custom** *min-rssi roam-hyst scan-thresh trans-time*}
3. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.
Step 2	**ap dot11 {5ghz | 24ghz} l2roam rf-params** {**default** | **custom** *min-rssi roam-hyst scan-thresh trans-time*} **Example:** `Controller#ap dot11 5ghz l2roam rf-params custom -80`	Configures CCX Layer 2 client roaming parameters. To choose the default RF parameters, enter the **default** option. To fine-tune the RF parameters that affect client roaming, enter the **custom** option and then enter any one of the following options: • Minimum RSSI—Indicates minimum Received Signal Strength Indicator (RSSI) required for the client to associate to an access point. If the client's average received signal power dips below this threshold, reliable communication is usually impossible. Therefore, clients must already have found and roamed to another access point with a stronger signal before the minimum RSSI value is reached. You can configure the minimum RSSI range from –80 through –90 dBm and the default is –85 dBm. • Hysteresis—Indicates how much greater the signal strength of a neighboring access point must be for the client to roam to it. This parameter is intended to reduce the amount of roaming between access points if the client is physically located on or near the border between two access points. You can configure the hysteresis range from 3 through 20 dB and the default is 3 dB. • Scan Threshold—Indicates a minimum RSSI that is allowed before the client should roam to a better access point. When the RSSI drops below the specified value, the client must be able to roam to a better access point within the specified transition time. This parameter also provides a power-save method to minimize the time that the client spends in active or passive scanning. For example, the client can scan slowly when the RSSI is above the threshold and scan more rapidly when the RSSI is below the threshold. You can configure the RSSI range from –70 through –77 dBm and the default value is –72 dBm. • Transition Time—Indicates the maximum time allowed for the client to detect a suitable neighboring access point to roam to and to complete the roam, whenever the RSSI from the client's associated access point is below the scan threshold. The Scan Threshold and Transition Time parameters guarantee a minimum level of client roaming performance. Together with the highest expected client speed and roaming hysteresis, these parameters make it possible to design a wireless LAN network that supports roaming simply by ensuring a certain minimum overlap distance between access points.

	Command or Action	Purpose
		You can configure the time period in the range from 1 through 10 seconds and the default time is 5 seconds.
Step 3	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.

Configuring Mobility Oracle

SUMMARY STEPS

1. **configure terminal**
2. **wireless mobility oracle**
3. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.
Step 2	**wireless mobility oracle** **Example:** `Controller(config)# wireless mobility oracle`	Enables mobility oracle on the controller.
Step 3	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.

Configuring Mobility Controller

SUMMARY STEPS

1. **configure terminal**
2. **wireless mobility controller**
3. **wireless mobility controller peer-group** *switch-peer-group-name*
4. **wireless mobility controller peer-group** *switch-peer-group-name* **member ip** *ip-address* {**public-ip** *public-ip-address*}
5. **wireless mobility controller peer-group** *switch-peer-group-name* **multicast**
6. **wireless mobility controller peer-group** *switch-peer-group-name* **multicast ip** *peer-group-multicast-ip-addr*
7. **wireless mobility controller peer-group***switch-peer-group-name* **bridge-domain-id** *id*
8. **wireless mobility group member ip** *ip-address* [**public-ip** *public-ip-address*] [**group** *group-name*]
9. **wireless mobility dscp** *value*
10. **wireless mobility group keepalive** {*count* | *interval*}
11. **wireless mobility group name** *name*
12. **wireless mobility oracle ip***mo-ip-address*
13. **wireless management interface** *interface-name*
14. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.
Step 2	**wireless mobility controller** **Example:** `Controller(config)# wireless mobility controller`	Enables wireless mobility controller.
Step 3	**wireless mobility controller peer-group** *switch-peer-group-name* **Example:** `Controller(config)# wireless mobility controller peer-group SPG1`	Configures a switch peer group name. You can enter up to 31 case-sensitive ASCII printable characters for the group name. Spaces are not allowed in mobility group. **Note** The **No** form of the command deletes the switch peer group.
Step 4	**wireless mobility controller peer-group** *switch-peer-group-name* **member ip** *ip-address* {**public-ip** *public-ip-address*}	Adds a mobility group member to a switch peer group. **Note** The **No** form of the command deletes the member from the switch peer group.

	Command or Action	Purpose
	Example: `Controller(config)# wireless mobility controller peer-group SPG1 member ip 10.0.0.1`	
Step 5	**wireless mobility controller peer-group** *switch-peer-group-name* **multicast** **Example:** `Controller(config)# wireless mobility controller peer-group SPG1 multicast`	Configures the multicast mode within a switch peer group.
Step 6	**wireless mobility controller peer-group** *switch-peer-group-name* **multicast ip** *peer-group-multicast-ip-addr* **Example:** `Controller(config)# wireless mobility controller peer-group SPG1 multicast ip 10.0.0.4`	Configures the multicast IP address for a switch peer group. **Note** The **No** form of the command deletes the multicast IP for the switch peer group.
Step 7	**wireless mobility controller peer-group***switch-peer-group-name* **bridge-domain-id** *id* **Example:** `Controller(config)# wireless mobility controller peer-group SPG bridge-domain-id 10.0.0.5`	Configures the bridge domain ID for a switch peer group. The default is zero. **Note** The **No** form of command sets the bridge domain ID to the default value.
Step 8	**wireless mobility group member ip** *ip-address* [**public-ip** *public-ip-address*] [**group** *group-name*] **Example:** `Controller(config)# wireless mobility group member ip 10.0.0.1`	Adds a mobility group member. **Note** The **No** form of the command removes the member from the group. The default group name is the group name of MC.
Step 9	**wireless mobility dscp** *value* **Example:** `Controller(config)# wireless mobility dscp 46`	Sets the DSCP value for mobility control packet. You can configure the DSCP value in a range from 0 through 63. The default value is 46.
Step 10	**wireless mobility group keepalive** {*count* | *interval*} **Example:** `Controller(config)# wireless mobility group keepalive count`	Configures the wireless mobility group keepalive count which is the number of keepalive retries before a member status is termed DOWN and keepalive interval which is interval between two keepalives.
Step 11	**wireless mobility group name** *name* **Example:** `Controller(config)# wireless mobility group name group1`	Specifies the case sensitive wireless mobility group name which can be ASCII printable string up to 31 characters.
Step 12	**wireless mobility oracle ip***mo-ip-address*	Configures the mobility oracle IP address.

	Command or Action	Purpose
	Example: `Controller(config)# wireless mobility oracle ip 10.0.0.5`	
Step 13	**wireless management interface** *interface-name* **Example:** `Controller(config)# wireless management interface Vlan21`	Configures the wireless management interface.
Step 14	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.

Configuring Mobility Agent

SUMMARY STEPS

1. **configure terminal**
2. **wireless mobility controller ip** *ip-address*
3. **wireless mobility load-balance**
4. **wireless mobility load-balance threshold** *threshold -value*
5. **wireless management interface** *interface-name*
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.
Step 2	**wireless mobility controller ip** *ip-address* **Example:** `Controller(config)# wireless mobility controller ip 10.10.10.20`	Sets the IP address of the mobility controller.
Step 3	**wireless mobility load-balance** **Example:** `Controller(config)# wireless mobility load-balance`	Configures wireless mobility load balancing.

	Command or Action	Purpose
Step 4	**wireless mobility load-balance threshold** *threshold -value* **Example:** `Controller(config)# wireless mobility load-balance threshold 100`	Configures the number of clients that can be local or anchored on the MA. You can configure the threshold value in a range from 100 to 2000. The default value is 1000.
Step 5	**wireless management interface** *interface-name* **Example:** `Controller(config)# wireless management interface Vlan21`	Configures wireless management interface for the mobility agent.
Step 6	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.

Monitoring Client Roaming Parameters

This section describes the new commands for the client parameters.

The following commands can be used to monitor the client roaming parameters on the controller.

Table 9: Monitoring Client Roaming Parameters Commands

Command	Purpose
show ap dot11 {5ghz | 24ghz} l2roam rf-param	Displays the current RF parameters configured for client roaming for the 802.11a or 802.11b/g network.
show ap dot11 {5ghz | 24ghz} l2roam statistics	Displays the CCX Layer 2 client roaming statistics for the 802.11a or 802.11b/g network.
show ap dot11 {5ghz | 24ghz} l2roam mac-address *mac-address* **statistics**	Displays the CCX Layer 2 client roaming statistics for a particular access point.

Monitoring Mobility Configurations

This section describes the new commands for monitoring mobility configurations.

The following command can be used to monitor mobility configurations on the Mobility Oracle, Mobility Controller, and Mobility Agent.

Table 10: Monitoring Mobility Configuration Commands on the Mobility Controller and Mobility Agent

Command	Purpose
show wireless mobility summary	Displays the summary information for the Mobility Controller and Mobility Agent.
show wireless mobility statistics	Displays mobility statistics.
show wireless mobility dtls connections	Displays established DTLS connections.

Table 11: Monitoring Mobility Configuration Commands on the Mobility Oracle

Command	Purpose
show wireless mobility oracle summary	Displays the status of the Mobility Controllers known to the Mobility Oracle.
show wireless mobility oracle client summary	Displays the information of a list of clients in the Mobility Oracle database.
show wireless mobility oracle client detail *client -mac-address*	Displays the detailed information of a particular client in the Mobility Oracle database.
show wireless mobility oracle *mc-ip*	Displays the information of a list of clients in the Mobility Oracle database that are anchored or associated to a specified Mobility Controller.

Table 12: Monitoring Mobility Configuration Commands on the Mobility Controller

Command	Purpose
show wireless mobility controller client summary	Displays a list of clients in the subdomain.
show wireless mobility controller client *mac-address* **detail**	Displays detailed information for a client in a subdomain.
show wireless mobility agent *ma-ip* **client summary**	Displays a list of clients anchored or associated to a specified Mobility Agent.
show wireless mobility ap-list	Displays the list of Cisco APs known to the mobility group.

Table 13: Monitoring Mobility Configuration Commands on the Mobility Agent

Command	Purpose
show wireless mobility load-balance summary	Displays the summary of mobility load-balance properties.

Additional References for Configuring Client Roaming

Related Documents

Related Topic	Document Title
Mobility configuration	*Mobility Configuration Guide, Cisco IOS XE Release 3SE (Cisco WLC 5700 Series)*
Mobility-related commands	*Mobility Command Reference Guide, Cisco IOS XE Release 3SE (Cisco WLC 5700 Series)*

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

Feature History and Information For Performing Client Roaming Configuration

Release	Feature Information
Cisco IOS XE 3.2SE	This feature was introduced.

CHAPTER 10

Configuring Application Visibility and Control

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

Application Visibility and Control (AVC) classifies applications using deep packet inspection techniques with the Network-Based Application Recognition (NBAR2) engine, and provides application-level visibility and control (QoS) in wireless networks. After the applications are recognized, the AVC feature enables you to either drop, mark, or police the data traffic.

AVC is configured by defining a class map in a QoS client policy to match a protocol.

Using AVC, we can detect more than 1000 applications. AVC enables you to perform real-time analysis and create policies to reduce network congestion, costly network link usage, and infrastructure upgrades.

Note You can view list of 30 applications in Top Applications in Monitor Summary section of the UI.

Traffic flows are analyzed and recognized using the NBAR2 engine at the access point. Refer to 8.0 protocol pack for the NBAR2-supported protocols or applications. The specific flow is marked with the recognized protocol or application, such as WebEx. This per-flow information can be used for application visibility using Flexible NetFlow (FNF). For more information on FNF, see the *Flexible NetFlow Configuration Guide, Cisco IOS XE Release 3E (Cisco WLC 5700 Series)*. The same application name can also be used for control of traffic using QoS. For more information on QoS, see the *QoS Configuration Guide, Cisco IOS XE Release 3E (Cisco WLC 5700 Series)*.

AVC QoS actions are applied with AVC filters in both upstream and downstream directions. The QoS actions supported for upstream flow are drop, mark, and police, and for downstream flow are mark and police. AVC QoS is applicable only when the application is classified correctly and matched with the class map filter in the policy map. For example, if the policy has a filter based on an application name, and the traffic has also been classified to the same application name, then the action specified for this match in the policy will be applied. For all QoS actions, refer Supported AVC Class Map and Policy Map Formats, on page 126.

Supported AVC Class Map and Policy Map Formats

Supported AVC Class Map Format

Class Map Format	Class Map Example	Direction
match protocol *protocol name*	`class-map match-any webex-class` `match protocol webex-media`	Both upstream and downstream
match protocol attribute category *category-name*	`class-map match-any IM` `match protocol attribute category instant-messaging`	Both upstream and downstream
match protocol attribute sub-category *sub-category-name*	`class-map match-any realtimeconferencing` `match protocol attribute sub-category voice-video-chat-collaboration`	Both upstream and downstream
match protocol attribute application-group *application-group-name*	`class-map match-any skype` `match protocol attribute application-group skype-group`	Both upstream and downstream

Combination filters	`class-map match-any webex-class`
	`match protocol webex`
	`match dscp 45`
	`match wlan user-priority 6`
		Upstream only

Supported AVC Policy Format

Policy Format	QoS Action
Upstream client policy based on match protocol filter	Mark, police, and drop
Downstream client 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	`policy-map webex-policy`
	` class webex-class`
	` set dscp ef //or set up,cos`
		Upstream and downstream

Basic police	`policy-map webex-policy`
	` class webex-class`
	` police 5000000`
		Upstream and downstream

Basic set and police	`policy-map webex-policy`
	` class webex-class`
	` set dscp ef //or set up,cos`
	` police 5000000`
		Upstream and downstream

Multiple set and police including default	`policy-map webex-policy`
	` class webex-class`
	` set dscp af31 //or set up,cos`
	` police 4000000`
	` class class-webex-category`
	` set dscp ef //or set up,cos`
	` police 6000000`
	` class class-default`
	` set dscp <>`
		Upstream and downstream

Hierarchical police	`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 //or set up,cos`
	` police 6000000`
	` police 200000`
		Upstream and downstream

Hierarchical set and police	`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`	

Drop action		Upstream only

AVC Policy Format	AVC Policy Example	Direction

	Any of the above examples apply to this format with this additional example:
	`policy-map webex-policy`
	` class webex-class`
	` drop`
	` class netflix`
	` set dscp ef //or set up,cos`
	` police 6000000`
	` class class-default`
	` set dscp <>`	

Prerequisites for Application Visibility and Control

- The access points should be AVC capable.
- For the control part of AVC (QoS) to work, the application visibility feature with FNF has to be configured.

Guidelines for Inter-Controller Roaming with Application Visibility and Control

Follow these guidelines to prevent clients from getting excluded due to malformed QoS policies:

- When a new QoS policy is added to the controller, a QoS policy with the same name should be added to other controller within the same roam or mobility domain.
- When a controller is loaded with a software image of a later release, the new policy formats are supported. If you have upgraded the software image from an earlier release to a later release, you should save the configuration separately. When an earlier release image is loaded, some QoS policies might show as not supported, and you should restore those QoS policies to supported policy formats.

Restrictions for Application Visibility and Control

- AVC is supported only on the following access points:
  - Cisco Aironet 1260 Series Access Points
  - Cisco Aironet 1600 Series Access Points
  - Cisco Aironet 2600 Series Access Point
  - Cisco Aironet 2600 Series Wireless Access Points
  - Cisco Aironet 2700 Series Access Point
  - Cisco Aironet 3500 Series Access Points

  - Cisco Aironet 3600 Series Access Points

- AVC is not supported on Cisco Aironet 702W, 702I (128 M memory), and 1530 Series Access Points.
- Dropping or marking of the data traffic (control part) is not supported for software Release 3.3.
- Dropping or marking of the data traffic (control part) is supported in software Release 3E.
- Only the applications that are recognized with application visibility can be used for applying QoS control.
- Multicast traffic classification is not supported.
- Only the applications that are recognized with App visibility can be used for applying QoS control.
- IPv6 including ICMPv6 traffic classifications are not supported.
- Datalink is not supported for NetFlow fields for AVC.
- The following commands are not supported for AVC flow records:
  - **collect flow username**
  - **collect interface** { **input** | **output**}
  - **collect wireless client ipv4 address**
  - **match interface** { **input** | **output**}
  - **match transport igmp type**
- The template timeout cannot be modified on exporters configured with AVC. Even if the template timeout value is configured to a different value, only the default value of 600 seconds is used.
- For the username information in the AVC-based record templates, ensure that you configure the options **records** to get the user MAC address to username mapping. For more information, refer Creating a Flow Exporter (Optional), on page 133.
- When there is a mix of AVC-enabled APs such as 3600, and non-AVC-enabled APs such as 1140, and the chosen policy for the client is AVC-enabled, the policy will not be sent to the APs that cannot support AVC.
- Only ingress AVC statistics are supported. The frequency of statistics updates depends on the number of clients loaded at the AP at that time. Statistics are not supported for very large policy format sizes.
- The total number of flows for which downstream AVC QoS supported per client is 1000.
- The maximum number of flows supported for Cisco WLC 5700 Series is 360 K and Catalyst 3850 Series Switch is 48 K.
- These are some class map and policy map-related restrictions. For supported policy formats, see Supported AVC Class Map and Policy Map Formats, on page 126.
  - AVC and non-AVC classes cannot be defined together in a policy in a downstream direction. For example, when you have a class map with match protocol, you cannot use any other type of match filter in the policy map in the downstream direction.
  - Drop action is not applicable for the downstream AVC QoS policy.
  - Match protocol is not supported in ingress or egress for SSID policy.

How to Configure Application Visibility and Control

Configuring Application Visibility and Control (CLI)

To configure Application Visibility, follow these general steps:

1. Create a flow record by specifying keys and non-key fields to the flow.
2. Create an optional flow exporter by specifying the flow record as an option.
3. Create a flow monitor based on the flow record and flow exporter.
4. Configure WLAN to apply flow monitor in IPv4 input or output direction.

To configure Application Control, follow these general steps:

1. Create an AVC QoS policy.
2. Attach AVC QoS policy to the client in one of three ways: configuring WLAN, using ACS or ISE, or adding local policies.

Creating a Flow Record

By default, **wireless avc basic** (flow record) is available. When you click **Apply** from the GUI, then the record is mapped to the flow monitor.

Default flow record cannot be edited or deleted. If you require a new flow record, you need to create one and map it to the flow monitor from CLI.

SUMMARY STEPS

1. **configure terminal**
2. **flow record** *flow_record_name*
3. **description** *string*
4. **match ipv4 protocol**
5. **match ipv4 source address**
6. **match ipv4 destination address**
7. **match transport source-port**
8. **match transport destination-port**
9. **match flow direction**
10. **match application name**
11. **match wireless ssid**
12. **collect counter bytes long**
13. **collect counter packets long**
14. **collect wireless ap mac address**
15. **collect wireless client mac address**
16. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.

Step 2	**flow record** *flow_record_name*
	
	Example:
	`Controller(config)# flow record record1`
	`Controller (config-flow-record)#`
		Enters flow record configuration mode.

Step 3	**description** *string* **Example:** `Controller(config-flow-record)# description IPv4flow`	(Optional) Describes the flow record as a maximum 63-character string.
Step 4	**match ipv4 protocol** **Example:** `Controller (config-flow-record)# match ipv4 protocol`	Specifies a match to the IPv4 protocol.
Step 5	**match ipv4 source address** **Example:** `Controller (config-flow-record)# match ipv4 source address`	Specifies a match to the IPv4 source address-based field.
Step 6	**match ipv4 destination address** **Example:** `Controller (config-flow-record)# match ipv4 destination address`	Specifies a match to the IPv4 destination address-based field.
Step 7	**match transport source-port** **Example:** `Controller (config-flow-record)# match transport source-port`	Specifies a match to the transport layer source-port field.
Step 8	**match transport destination-port** **Example:** `Controller (config-flow-record)# match transport destination-port`	Specifies a match to the transport layer destination-port field.
Step 9	**match flow direction** **Example:** `Controller (config-flow-record)# match flow direction`	Specifies a match to the direction the flow was monitored in.
Step 10	**match application name**	Specifies a match to the application name.

	Command or Action	Purpose
	Example: `Controller (config-flow-record)# match application name`	**Note** This action is mandatory for AVC support, as this allows the flow to be matched against the application.
Step 11	**match wireless ssid** **Example:** `Controller (config-flow-record)# match wireless ssid`	Specifies a match to the SSID name identifying the wireless network.
Step 12	**collect counter bytes long** **Example:** `Controller (config-flow-record)# collect counter bytes long`	Specifies to collect counter fields total bytes.
Step 13	**collect counter packets long** **Example:** `Controller (config-flow-record)# collect counter bytes long`	Specifies to collect counter fields total packets.
Step 14	**collect wireless ap mac address** **Example:** `Controller (config-flow-record)# collect wireless ap mac address`	Specifies to collect the BSSID with MAC addresses of the access points that the wireless client is associated with.
Step 15	**collect wireless client mac address** **Example:** `Controller (config-flow-record)# collect wireless client mac address`	Specifies to collect MAC address of the client on the wireless network.
Step 16	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.

Creating a Flow Exporter (Optional)

You can create a flow export to define the export parameters for a flow. This is an optional procedure for configuring flow parameters.

SUMMARY STEPS

1. **configure terminal**
2. **flow exporter** *flow_exporter_name*
3. **description** *string*
4. **destination** *{hostname | ip-address}*
5. **transport udp** *port-value*
6. **option application-table timeout** *seconds* **(optional)**
7. **option usermac-table timeout** *seconds* **(optional)**
8. **end**
9. **show flow exporter**
10. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.

Step 2	**flow exporter** *flow_exporter_name*
	
	Example:
	`Controller(config)# flow exporter record1`
	`Controller (config-flow-exporter)#`
		Enters flow exporter configuration mode.

Step 3	**description** *string* **Example:** `Controller(config-flow-exporter)# description IPv4flow`	Describes the flow record as a maximum 63-character string.
Step 4	**destination** *{hostname | ip-address}* **Example:** `Controller (config-flow-exporter) # destination 10.99.1.4`	Specifies the hostname or IPv4 address of the system to which the exporter sends data.
Step 5	**transport udp** *port-value* **Example:** `Controller (config-flow-exporter) # transport udp 2`	Configures a port value for the UDP protocol.
Step 6	**option application-table timeout** *seconds* **(optional)** **Example:** `Controller (config-flow-exporter)# option application-table timeout 500`	(Optional) Specifies application table timeout option. The valid range is from 1 to 86400 seconds.

	Command or Action	Purpose
Step 7	**option usermac-table timeout** *seconds* **(optional)** **Example:** `Controller (config-flow-exporter)# option usermac-table timeout 1000`	(Optional) Specifies wireless usermac-to-username table option. The valid range is from 1 to 86400 seconds.
Step 8	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.
Step 9	**show flow exporter** **Example:** `Controller # show flow exporter`	Verifies your configuration.
Step 10	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.

Creating a Flow Monitor

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

SUMMARY STEPS

1. **configure terminal**
2. **flow monitor** *monitor-name*
3. **description** *description*
4. **record** *record-name*
5. **exporter** *exporter-name*
6. **cache timeout** {**active** | **inactive**} **(Optional)**
7. **end**
8. **show flow monitor**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.

	Command or Action	Purpose
Step 2	**flow monitor** *monitor-name* **Example:** `Controller (config)# flow monitor flow-monitor-1`	Creates a flow monitor and enters flow monitor configuration mode.
Step 3	**description** *description* **Example:** `Controller (config-flow-monitor)# description flow-monitor-1`	Creates a description for the flow monitor.
Step 4	**record** *record-name* **Example:** `Controller (config-flow-monitor)# record flow-record-1`	Specifies the name of a recorder that was created previously.
Step 5	**exporter** *exporter-name* **Example:** `Controller (config-flow-monitor)# exporter flow-exporter-1`	Specifies the name of an exporter that was created previously.

Step 6	**cache timeout** {**active** | **inactive**} **(Optional)**
	
	Example:
	`Controller (config-flow-monitor)# cache timeout active 1800`
	
	`Controller (config-flow-monitor)# cache timeout inactive 200`
		Specifies to configure flow cache parameters. You can configure for a time period of 1 to 604800 seconds (optional).
		Note To achieve optimal result for the AVC flow monitor, we recommend you to configure the inactive cache timeout value to be greater than 90 seconds.

Step 7	**end** **Example:** `Controller(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:** `Controller # show flow monitor`	Verifies your configuration.

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 a policy map to the client in one of the following ways:
   a. Apply a policy map over WLAN either from the CLI or GUI.

b Apply a policy map through the AAA server (ACS server or ISE) from the CLI.

For more information, refer to the *Cisco Identity Services Engine User Guide* and *Cisco Secure Access Control System User Guide*.

c Apply local policies either from the CLI or GUI.

Creating a Class Map

You need to create a class map before configuring any match protocol filter. The QoS actions such as marking, policing, and dropping can be applied to the traffic. The AVC match protocol filters are applied only for the wireless clients. Refer 8.0 protocol pack for the protocols supported.

SUMMARY STEPS

1. **configure terminal**
2. **class-map** *class-map-name*
3. **match protocol** {*application-name* | **attribute category** *category-name* | **attribute sub-category** *sub-category-name* | **attribute application-group** *application-group-name*}
4. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.
Step 2	**class-map** *class-map-name* **Example:** `Controller(config)# class-map webex-class`	Creates a class map.

Step 3	**match protocol** {*application-name* | **attribute category** *category-name* | **attribute sub-category** *sub-category-name* | **attribute application-group** *application-group-name*}
	
	Example:
	`Controller(config)# class-map webex-class`
	`Controller(config-cmap)# match protocol webex-media`
	
	`Controller(config)# class-map class-webex-category`
	`Controller(config-cmap)# match protocol attribute category webex-media`
	
	`Controller# class-map class-webex-sub-category`
	`Controller(config-cmap)# match protocol attribute sub-category webex-media`
	
	`Controller# class-map class-webex-application-group`
		Specifies match to the application name, category name, subcategory name, or application group.

	Command or Action	Purpose
	`Controller(config-cmap)# match protocol attribute application-group webex-media`	
Step 4	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.

Creating a Policy Map

SUMMARY STEPS

1. **configure terminal**
2. **policy-map** *policy-map-name*
3. **class** [*class-map-name* | **class-default**]
4. **police** *rate-bps burst-byte* [**exceed-action** {**drop** | **policed-dscp-transmit**}]
5. **set** {**dscp** *new-dscp* | **cos** *cos-value*}
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.

Step 2	**policy-map** *policy-map-name*
	
	Example:
	
	`Controller(config)# policy-map webex-policy`
	`Controller(config-pmap)#`
		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.
		
		Note To delete an existing policy map, use the **no policy-map** *policy-map-name* global configuration command.

Step 3	**class** [*class-map-name*	**class-default**]
		
		Example:
		
		`Controller(config-pmap)# class-map webex-class`
		`Controller(config-pmap-c)#`
			Defines a traffic classification, and enters policy-map class configuration mode.
			
			By default, no policy map and class maps are defined.
			
			If a traffic class has already been defined by using the **class-map** global configuration command, specify its name for *class-map-name* in this command.
			
			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

	Command or Action	Purpose
		in the **class-default** class, all packets that have not already matched the other traffic classes will match **class-default**. **Note** To delete an existing class map, use the **no class** *class-map-name* policy-map configuration command.
Step 4	**police** *rate-bps burst-byte* [**exceed-action** {**drop** | **policed-dscp-transmit**}] **Example:** `Controller(config-pmap-c)# police 100000 80000 drop`	Defines a policer for the classified traffic. By default, no policer is defined. • For *rate-bps,* specify an average traffic rate in bits per second (b/s). The range is 8000 to 10000000000. • For *burst-byte,* specify the normal burst size in bytes. The range is 8000 to 1000000. • (Optional) Specifies the action to take when the rates are exceeded. Use the **exceed-action drop** keywords to drop the packet. Use the **exceed-action policed-dscp-transmit** keywords to mark down the DSCP value (by using the policed-DSCP map) and to send the packet.
Step 5	**set** {**dscp** *new-dscp* | **cos** *cos-value*} **Example:** `Controller(config-pmap-c)# set dscp 45`	Classifies IP traffic by setting a new value in the packet. • For **dscp** *new-dscp*, enter a new DSCP value to be assigned to the classified traffic. The range is 0 to 63.
Step 6	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.

What to Do Next

After creating your policy maps, attach the traffic policy or polices to an interface using the **service-policy** command.

Configuring Local Policies (CLI)

To configure local policies, complete these procedures:

1. Create a service template.
2. Create a parameter map.
3. Create a policy map.
4. Apply a local policy on a WLAN.

Creating a Service Template (CLI)

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.

Step 2	**service-template** *service-template-name*
	
	Example:
	`Controller(config)# service-template cisco-phone-template`
	`Controller(config-service-template)#`
		Enters service template configuration mode.

Step 3	**access-group** *acl_list* **Example:** `Controller(config-service-template)# access-group foo-acl`	Specifies the access list to be applied.
Step 4	**vlan** *vlan_id* **Example:** `Controller(config-service-template)# vlan 100`	Specifies VLAN ID. You can specify a value from 1 to 4094.
Step 5	**absolute-timer** *seconds* **Example:** `Controller(config-service-template)# absolute-timer 20`	Specifies session timeout value for service template. You can specify a value from 1 to 65535.
Step 6	**service-policy qos** {**input** | **output**} **Example:** `Controller(config-service-template)# service-policy qos input foo-qos`	Configures QoS policies for the client.
Step 7	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.

Creating a Parameter Map (CLI)

Parameter map is preferred to use than class map.

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.
Step 2	**parameter-map type subscriber attribute-to-service** *parameter-map-name* **Example:** `Controller(config)# parameter-map type subscriber attribute-to-service Aironet-Policy-para`	Specifies the parameter map type and name.
Step 3	*map-index* **map** { **device-type** | **mac-address** | **oui** | **user-role** | **username**} {**eq** | **not-eq** | **regex** *filter-name* } **Example:** `Controller(config-parameter-map-filter)# 10 map device-type eq "WindowsXP-Workstation"`	Specifies parameter map attribute filter criteria.

Step 4	**service-template** *service-template-name*
	
	Example:
	`Controller(config-parameter-map-filter-submode)# service-template cisco-phone-template`
	`Controller(config-parameter-map-filter-submode)#`
		Enters service template configuration mode.

Step 5	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.

Creating a Policy Map (CLI)

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.

	Command or Action	Purpose
Step 2	**policy-map type control subscriber** *policy-map-name* **Example:** `Controller(config)# policy-map type control subscriber Aironet-Policy`	Specifies the policy map type.
Step 3	**event identity-update** {**match-all** | **match-first**} **Example:** `Controller(config-policy-map)# event identity-update match-all`	Specifies match criteria to the policy map.
Step 4	*class_number* **class** {*class_map_name* | **always** } {**do-all** | **do-until-failure** | **do-until-success**} **Example:** `Controller(config-class-control-policymap)# 1 class local_policy1_class do-until-success`	Configures the local profiling policy class map number and specifies how to perform the action. The class map configuration mode includes the following command options: • **always—**Executes without doing any matching but return success. • **do-all—**Executes all the actions. • **do-until-failure—**Execute all the actions until any match failure is encountered. This is the default value. • **do-until-success—**Execute all the actions until any match success happens.
Step 5	*action-index* **map attribute-to-service table** *parameter-map-name* **Example:** `Controller(config-policy-map)# 10 map attribute-to-service table Aironet-Policy-para`	Specifies parameter map table to be used.
Step 6	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.

Applying a Local Policy for a Device on a WLAN (CLI)

Before You Begin

If the service policy contains any device type-based rules in the parameter map, ensure that the device classifier is already enabled.

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.
Step 2	**wlan** *wlan-name* **Example:** `Controller(config)# wlan wlan1`	Enters WLAN configuration mode.
Step 3	**service-policy type control subscriber** *policymapname* **Example:** `Controller(config-wlan)# service-policy type control subscriber Aironet-Policy`	Applies local policy to WLAN.
Step 4	**profiling local http (optional)** **Example:** `Controller(config-wlan)# profiling local http`	Enables only profiling of devices based on HTTP protocol (optional).
Step 5	**profiling radius http (optional)** **Example:** `Controller(config-wlan)# profiling radius http`	Enables profiling of devices on ISE (optional).
Step 6	**no shutdown** **Example:** `Controller(config-wlan)# no shutdown`	Specifies not to shut down the WLAN.
Step 7	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.

Configuring Local Policies (GUI)

To configure local policies, complete these procedures:

1. Create a service template.
2. Create a policy map.
3. Apply a local policy that you have created to a WLAN.

Creating a Service Template (GUI)

Step 1 Choose **Configuration** > **Security** > **Local Policies** > **Service Template** to open the **Service Template** page.

Step 2 Create a new template as follows:

a) Click **New** to open the **Service Template > New** page.
b) In the Service Template name text box, enter the new service template name.
c) In the VLAN ID text box, enter the VLAN identifier that has to be associated with the policy. The value ranges from 1 to 4094.
d) In the Session timeout text box, enter the maximum amount of time, in seconds, after which a client is forced to reauthenticate. The value ranges from 1 to 65535 seconds.
e) From the Access control list drop-down list, choose the access control list to be mapped to the policy.
f) From the Ingress QoS drop-down list, choose the ingress QoS policy to be applied.
g) From the Egress QoS drop-down list, choose the egress QoS policy to be applied.
h) Click **Apply** to save the configuration.

Step 3 Edit a service template as follows:

a) From the **Service Template** page, click the service template to open the **Service Template > Edit** page.
b) In the VLAN ID text box, enter the VLAN identifier that has to be associated with the policy. The value ranges from 1 to 4094.
c) In the Session timeout text box, enter the maximum amount of time, in seconds, after which a client is forced to reauthenticate. The value ranges from 1 to 65535 seconds.
d) From the Access control list drop-down list, choose the access control list to be mapped to the policy.
e) From the Ingress QoS drop-down list, choose the ingress QoS policy to be applied.
f) From the Egress QoS drop-down list, choose the egress QoS policy to be applied.
g) Click **Apply** to save the configuration.

Step 4 Remove a service template as follows:

a) From the **Service Template** page, select the service template.
b) Click **Remove**.
c) Click **Apply** to save the configuration.

Creating a Policy Map (GUI)

Step 1 Choose **Configuration** > **Security** > **Local Policies** > **Policy Map** to open the **Policy Map** page.

Step 2 Create a new policy map as follows:

a) Click **New** to open the **Policy Map > New** page.
b) In the Policy Map name text box, enter the new policy map name.
c) Click **Add** to open the Match Criteria area.
d) From the Device Type drop-down list, choose the device type. The match criteria for the device type can be eq, not-eq, or regex with respect to the device type you are choosing.
e) From the User Role drop-down list, select the match criteria as eq, not-eq, or regex and enter the user type or user group of the user, for example, student, teacher, and so on.
f) From the Service Template drop-down list, choose the service template to be mapped to the policy.

g) Click **Add**. The match criteria is added to the Match Criteria Lists.
h) In the Match Criteria Lists area, click **Add** to add the match criteria to the policy.
i) Click **Apply** to save the configuration.

Step 3 Edit a policy map as follows:

a) In the **Policy Map** page, select the policy map that you want to edit, and click **Edit** to open the **Policy Map > Edit** page.
b) In the Match Criteria area, choose the device type from the Device Type drop-down list. The match criteria for the device type can be eq, not-eq, or regex with respect to the device type you are choosing.
c) In the Match Criteria area, choose the user role from the User Role drop-down list. Select the match criteria as eq, not-eq, or regex and enter the user type or user group of the user
d) From the Service Template drop-down list, choose the service template to be mapped to the policy.
e) Click **Ok** to save the configuration or **Cancel** to discard the configuration.
f) Click **Add** to add more match criteria based on device type, user role, and service template to the policy.
g) In the Match Criteria Lists area, select the match criteria and click **Move to** to move the match criteria with respect to a value entered in the row text box.
h) Select the match criteria and click **Move up** to move the match criteria up in the list.
i) Select the match criteria and click **Move down** to move the match criteria down in the list.
j) Select the match criteria and click **Remove** to remove the match criteria from the policy map list.
k) Click **Apply** to save the configuration.

Step 4 Remove a policy map as follows:

a) From the **Policy Map** page, select the policy map.
b) Click **Remove**.
c) Click **Apply** to save the configuration.

Applying Local Policies to WLAN (GUI)

Step 1 Choose **Configuration** > **Wireless** > **WLAN** to open the **WLANs** page.
Step 2 Click the corresponding WLAN profile. The **WLANs > Edit** page is displayed.
Step 3 Click the **Policy-Mapping** tab.
Step 4 Check the **Device Classification** check box to enable classification based on device type.
Step 5 From the Local Subscriber Policy drop-down list, choose the policy that has to be applied for the WLAN.
Step 6 Select **Local HTTP Profiling** to enable profiling on devices based on HTTP (optional).
Step 7 Select **Radius HTTP Profiling** to enable profiling on devices based on RADIUS (optional).
Step 8 Click **Apply** to save the configuration.

Configuring WLAN to Apply Flow Monitor in IPV4 Input/Output Direction

SUMMARY STEPS

1. **configure terminal**
2. **wlan** *wlan-id*
3. **ip flow monitor** *monitor-name* **{input | output}**
4. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.
Step 2	**wlan** *wlan-id* **Example:** `Controller (config) # wlan 1`	Enters WLAN configuration submode. For *wlan-id*, enter the WLAN ID. The range is 1 to 64.
Step 3	**ip flow monitor** *monitor-name* **{input | output}** **Example:** `Controller (config-wlan) # ip flow monitor flow-monitor-1 input`	Associates a flow monitor to the WLAN for input or output packets.
Step 4	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.

Configuring Application Visibility and Control (GUI)

Configuring Application Visibility (GUI)

You can apply the default flow record (**wireless avc basic**) to the default flow monitor (**wireless-avc-basic**).

If you are using the flow record and flow monitor you have created, then the record name and monitor name should be same. This is specific only for configuring AVC from GUI and not for the CLI configuration.

You can use the flow monitor you have created either for upstream or downstream, or both, but ensure that you use the same record name while mapping with the flow monitor.

Step 1 Choose **Configuration** > **Wireless** > **WLAN**.
The **WLAN** page appears.

Step 2 Click on the corresponding WLAN ID to open the **WLAN > Edit** page and click **AVC**.
The **Application Visibility** page appears.

a) Select the **Application Visibility Enabled** check box to enable AVC on a WLAN.
b) In the **Upstream Profile** text box, enter the name of the AVC profile.
c) In the **Downstream Profile** text box, enter the name of the AVC profile.

To enable AVC, you need to enter the profile names for the upstream and downstream profiles. The profile names are the flow monitor names. By default, the flow monitor names (**wireless-avc-basic**) appear in the **Upstream Profile** and **Downstream Profile** text boxes. For the default flow monitor, the default flow record (**wireless avc basic**) will be taken. The default flow record is generated by the system and is available.

You can change the profile names for the upstream and downstream profiles but ensure that the same flow records are available for the flow monitors.

The upstream and downstream profiles can have different profile names but there should be flow records available for the flow monitors.

Step 3 Click **Apply** to apply AVC on the WLAN.

Step 4 To disable AVC on a specific WLAN, perform the following steps:

- Choose **Configuration** > **Wireless** > **WLAN** to open the **WLAN** page.
- Click on the corresponding WLAN ID to open the **WLAN > Edit** page.
- Click **AVC** to open the **Application Visibility** page.
- Uncheck the **Application Visibility Enabled** check box.
- Click **Apply** to disable AVC on the specific WLAN.

Configuring Application Visibility and Control (GUI)

Step 1 Choose **Configuration** > **Wireless**.

Step 2 Expand the **QoS** node by clicking the left pane and choosing **QOS-Policy**.
The **QOS-Policy** page is displayed.

Step 3 Click **Add New** to create a new QoS Policy.
The **Create QoS Policy** page is displayed.

Step 4 Select **Client** from the Policy Type drop-down list.

Step 5 Select the direction into which the policy needs to be applied from the Policy Direction drop-down list.

The available options are:

- **Ingress**
- **Egress**

Step 6 In the **Policy Name** text box, specify a policy name.

Step 7 In the **Description** text box, provide a description to the policy.

Step 8 Check the **Enable Application Recognition** check box to configure the AVC class map for a client policy.

Note For an egress client policy, when you enable Application Recognition, the Voice, Video, and User Defined check boxes are disabled.

The following options are available:

- **Trust—**Specify a classification type for this policy.
  - **Protocol—**Allows you to choose the protocols and configure the marking and policing of the packets.
  - **Category—**Allows you to choose the category of the application, for example, browsing.
  - **Subcategory—**Allows you to choose the subcategory of the application, for example, file-sharing.
  - **Application-Group—**Allows you to choose the application group, for example, ftp-group.
- **Protocol Choice—**Choose the protocols, category, subcategory, or application group from the **Available Protocols** list into the **Assigned Protocols** to apply the marking and policing of the packets.
- **Mark—**Specify the marking label for each packet. The following options are available:
  - **DSCP—**Assigns a label to indicate the given quality of service. The range is from 0 to 63.
  - **CoS—**Matches IEEE 802.1Q class of service. The range is from 0 to 7.
  - **None—**Does not mark the packets.
- **Police (kbps)—**Specify the policing rate in kbps. This option is available when the **Policy Direction** is egress.
- **Drop—**Specify to drop the ingress packets that correspond to the chosen protocols.

Note You can add a maximum of five AVC classes for each client policy.

Step 9 Click **Add** to create an AVC class map. The new class map is listed in a tabular format.

Step 10 Click **Apply** to create an AVC QoS policy.

Step 11 Click the QoS policy link in the **QOS-Policy** page to edit the QoS policy. The **QOS-Policy** > **Edit** page is displayed. Make changes and click **Apply** to commit your changes.

Step 12 Remove an AVC class map from the QoS policy by navigating to the corresponding AVC class map row in the AVC class map table and clicking **Remove**. Click **Apply** to commit your changes.

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 controller and access points.

Table 14: Monitoring Application Visibility Commands on the controller

Command	Purpose
show avc client *client-mac* **top** *n* **application** [**aggregate** | **upstream** | **downstream**]	Displays information about top "N" applications for the given client MAC.
show avc wlan *ssid* **top** *n* **application** [**aggregate** | **upstream** | **downstream**]	Displays information about top "N" applications for the given SSID.
show wlan id *wlan-id*	Displays information whether AVC is enabled or disabled on a particular WLAN.
show flow monitor *flow_monitor_name* **cache**	Displays information about flow monitors.
show wireless client mac-address *mac-address* **service-policy** { **input** | **output** }	Displays information about policy mapped to the wireless clients.
show policy-map target **show policy-map** **show policy-map** *policy-name*	Displays information about policy map.

Table 15: Clearing Application Visibility Statistics Commands

Command	Purpose
clear avc client *mac* **stats**	Clears the statistics per client.
clear avc wlan *wlan-name* **stats**	Clears the statistics per WLAN.

Monitoring Application Visibility and Control (GUI)

You can view AVC information on a WLAN in a single shot using a **AVC on WLAN** pie chart on the **Home** page of the controller. The pie chart displays the AVC data (Aggregate - Application Cumulative usage %) of the first WLAN. In addition, the top 5 WLANs based on clients are displayed first. Click on any one of the

WLANs to view the corresponding pie chart information. If AVC is not enabled on the first WLAN, then the **Home** page does not display the AVC pie chart.

Step 1 Choose **Monitor** > **Controller** > **AVC** > **WLANs**.
The **WLANs** page appears.

Step 2 Click the corresponding WLAN profile.
The **Application Statistics** page appears.

From the **Top Applications** drop-down list, choose the number of top applications you want to view and click **Apply**. The valid range is between 5 to 30, in multiples of 5.

a) On the Aggregate, Upstream, and Downstream tabs, you can view the application cumulative and last 90 seconds statistics and usage percent with the following fields:

- Application name
- Packet count
- Byte count
- Average packet size
- usage (%)

Step 3 Choose **Monitor** > **Clients** > **Client Details** > **Clients**.
The **Clients** page appears.

Step 4 Click **Client MAC Address** and then click **AVC Statistics** tab.
The **Application Visibility** page appears.

a) On the Aggregate, Upstream, and Downstream tabs, you can view the application cumulative and last 90 seconds statistics and usage percent with the following fields:

- Application name
- Packet count
- Byte count
- Average packet size
- usage (%)

Monitoring SSID and Client Policies Statistics (GUI)

Statistics are supported only for ingress policies with a maximum of five classes on wireless targets. For very large policies, statistics for ingress policies are not visible at the controller. The frequency of the statistics depends on the number of clients associated with the access point. Maximum time for the client statistics to appear at the controller is around 5 minutes.

Type of Statistics	Method	Details
SSID Policies	Choose **Monitor > Controller > Statistics > QoS**.	The QoS page is displayed with a list of SSID policies, Radio Type, and AP. Choose an SSID policy, radio, and access point from the drop-down lists and click **Apply** to view the statistics of the chosen SSID policy. You can view details such as match criteria, confirmed bytes, conformed rate, and exceeded rate.
Client Policies	Choose **Monitor > Clients > Client Details** .	The Clients page is displayed with a list of client MAC addresses, AP, and other details. Click the MAC address of a client and click the **QoS Statistics** tab. You can view details such as match criteria, confirmed bytes, conformed rate, and exceeded rate.

Examples: Application Visibility and Control

Examples: Application Visibility Configuration

This example shows how to create a flow record, create a flow monitor, apply the flow record to the flow monitor, and apply the flow monitor on a WLAN:

```
Controller# configure terminal
Controller(config)# flow record fr_v4
Controller(config-flow-record)# match ipv4 protocol
Controller(config-flow-record)# match ipv4 source address
Controller(config-flow-record)# match ipv4 destination address
Controller(config-flow-record)# match transport destination-port
Controller(config-flow-record)# match flow direction
Controller(config-flow-record)# match application name
Controller(config-flow-record)# match wireless ssid
Controller(config-flow-record)# collect counter bytes long
Controller(config-flow-record)# collect counter packets long
Controller(config-flow-record)# collect wireless ap mac address
Controller(config-flow-record)# collect wireless client mac address
Controller(config)#end


Controller# configure terminal
Controller# flow monitor fm_v4
Controller(config-flow-monitor)# record fr_v4
Controller(config-flow-monitor)# cache timeout active 1800
```

```
Controller(config)#end


Controller(config)#wlan wlan1
Controller(config-wlan)#ip flow monitor fm_v4 input
Controller(config-wlan)#ip flow mon fm-v4 output
Controller(config)#end
```

Examples: Application Visibility and Control QoS Configuration

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

```
Controller# configure terminal
Controller(config)# class-map cat-browsing
Controller(config-cmap)# match protocol attribute category browsing
Controller(config-cmap)#end

Controller# configure terminal
Controller(config)# class-map cat-fileshare
Controller(config-cmap)# match protocol attribute category file-sharing
Controller(config-cmap)#end

Controller# configure terminal
Controller(config)# class-map match-any subcat-terminal
Controller(config-cmap)# match protocol attribute sub-category terminal
Controller(config-cmap)#end

Controller# configure terminal
Controller(config)# class-map match-any webex-meeting
Controller(config-cmap)# match protocol webex-meeting
Controller(config-cmap)#end
```

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

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


Controller# configure terminal
Controller(config)# policy-map test-avc-up
Controller(config-pmap)# class cat-fileshare
Controller(config-pmap-c)# police 1000000
Controller(config-pmap-c)# set dscp 20
Controller(config-pmap-c)#end


Controller# configure terminal
Controller(config)# policy-map test-avc-up
Controller(config-pmap)# class subcat-terminal
Controller(config-pmap-c)# police 120000
Controller(config-pmap-c)# set dscp 15
Controller(config-pmap-c)#end

Controller# configure terminal
Controller(config)# policy-map test-avc-up
Controller(config-pmap)# class webex-meeting
Controller(config-pmap-c)# police 50000000
Controller(config-pmap-c)# set dscp 21
Controller(config-pmap-c)#end
```

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

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


Controller# configure terminal
Controller(config)# policy-map test-avc-up
Controller(config-pmap)# class cat-fileshare
Controller(config-pmap-c)# police 300000
Controller(config-pmap-c)# set wlan user-priority 2
Controller(config-pmap-c)# set dscp 20
Controller(config-pmap-c)#end


Controller# configure terminal
Controller(config)# policy-map test-avc-up
Controller(config-pmap)# class subcat-terminal
Controller(config-pmap-c)# police 100000
Controller(config-pmap-c)# set dscp 25
Controller(config-pmap-c)#end

Controller# configure terminal
Controller(config)# policy-map test-avc-up
Controller(config-pmap)# class webex-meeting
Controller(config-pmap-c)# police 60000000
Controller(config-pmap-c)# set dscp 41
Controller(config-pmap-c)#end
```

This example shows how to apply defined QoS policy on a WLAN:

```
Controller# configure terminal
Controller(config)#wlan  alpha
Controller(config-wlan)#shut
Controller(config-wlan)#end
Controller(config-wlan)#service-policy client input test-avc-up
Controller(config-wlan)#service-policy client output test-avc-down
Controller(config-wlan)#no shut
Controller(config-wlan)#end
```

Example: Configuring QoS Attribute for Local Profiling Policy

The following example shows how to configure QoS attribute for a local profiling policy:

```
Controller(config)# class-map type control subscriber match-all local_policy1_class
Controller(config-filter-control-classmap)# match device-type android
Controller(config)# service-template local_policy1_template
Controller(config-service-template)# vlan 40
Controller(config-service-template)# service-policy qos output local_policy1
Controller(config)# policy-map type control subscriber local_policy1
Controller(config-event-control-policymap)# event identity-update match-all
Controller(config-class-control-policymap)# 1 class local_policy1_class do-until-success
Controller(config-action-control-policymap)# 1 activate service-template
local_policy1_template
Controller(config)# wlan open_auth 9
Controller(config-wlan)# client vlan VLAN40
Controller(config-wlan)# service-policy type control subscriber local_policy1
```

Additional References for Application Visibility and Control

Related Documents

Related Topic	Document Title
System management commands	*System Management Command Reference Guide, Cisco IOS XE Release 3SE (Cisco WLC 5700 Series)*
Flexible NetFlow configuration	*Flexible NetFlow Configuration Guide, Cisco IOS XE Release 3SE (Cisco WLC 5700 Series)*
Flexible NetFlow commands	*Flexible NetFlow Command Reference, Cisco IOS XE Release 3SE (Cisco WLC 5700 Series)*
QoS configuration	*QoS Configuration Guide, Cisco IOS XE Release 3E (Cisco WLC 5700 Series)*
QoS commands	*QoS Command Reference, Cisco IOS XE Release 3E (Cisco WLC 5700 Series)*

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

Feature History and Information For Application Visibility and Control

Release	Feature Information
Cisco IOS XE 3.3SE	This feature was introduced.
Cisco IOS XE 3E	AVC control with QoS was introduced.

CHAPTER 11

Configuring Voice and Video Parameters

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.

Prerequisites for Voice and Video Parameters

You can confirm the following points before configuring voice and video parameters:

- Ensure that the controller has access points connected to it.
- Configure SSID.

Restrictions for Voice and Video Parameters

The following are the restrictions that you should keep in mind while configuring voice and video parameters:

- SIP CAC can be used for the 9971 Cisco phones that support TSPEC-based admission control. You can also use the phones that support Status code 17.
- SIP snooping is supported for providing voice priority to the non-TSPEC SIP phones.
- TSPEC for video CAC is not supported.
- The following features are not supported for the 802.11ac module on the Cisco 3600 Access Point:
  - Voice support
  - CAC support
  - TSM support
- When the 802.11ac module is enabled, the 11n LBCAC parameters can be inaccurate resulting in degradation in voice quality of 11ac enabled calls.
- Cisco 792x IP phones that are admitted as non-WMM devices with 11K enabled will experience audio problems with the phones.

Note Disable 11K for voice WLAN for all 792x Cisco IP phones that are admitted as non-WMM devices with 11K enabled. Upgrade the firmware on Cisco Unified Call Manager to 1.4.5 to resolve this issue. Refer to the Cisco Unified Call Manager configuration guide for more information.

Information About Configuring Voice and Video Parameters

Three parameters on the controller affect voice and/or video quality:

- Call Admission Control
- Expedited bandwidth requests
- Unscheduled automatic power save delivery

Call Admission Control (CAC) and UAPSD are supported on Cisco Compatible Extensions (CCX) v4 and v5; however, these parameters are also supported even without CCX but on any device implementing WMM (that supports 802.1e). Expedited bandwidth requests are supported only on CCXv5.

Traffic stream metrics (TSM) can be used to monitor and report issues with voice quality.

Call Admission Control

Call Admission Control (CAC) enables an access point to maintain controlled quality of service (QoS) when the wireless LAN is experiencing congestion. The WMM protocol deployed in CCXv4 maintains QoS under differing network loads.

Two types of Over The Air (OTA) CAC are available: static-based CAC and load-based CAC.

The controller supports the following QoS policies:

- User-defined policies: You can define your own QoS policies. You can have more control over these policies than the existing metal policies.
- System-defined precious metal policies: To support backward compatibility.
  - Platinum: Used for VoIP clients.
  - Gold: Used for video clients.
  - Silver: Used for best effort traffic.
  - Bronze: Used for NRT traffic.

Static-Based CAC

Voice over WLAN applications supporting WMM and TSPEC can specify how much bandwidth or shared medium time is required to initiate a call. Bandwidth-based, or static, CAC enables the access point to determine whether it is capable of accommodating a particular call. The access point rejects the call if necessary in order to maintain the maximum allowed number of calls with acceptable quality.

The QoS setting for a WLAN determines the level of bandwidth-based CAC support. To use bandwidth-based CAC with voice applications, the WLAN must be configured for Platinum QoS. With bandwidth-based CAC, the access point bandwidth availability is determined based on the amount of bandwidth currently used by the access point clients, to which the bandwidth requested by the Voice over WLAN applications is added. If this total exceeds a configured bandwidth threshold, the new call is rejected.

Note You must enable admission control (ACM) for CCXv4 clients that have WMM enabled. Otherwise, bandwidth-based CAC does not operate properly for these CCXv4 clients.

Load-Based CAC

Load-based CAC incorporates a measurement scheme that takes into account the bandwidth consumed by all traffic types (including that from clients), cochannel access point loads, and coallocated channel interference, for voice and video applications. Load-based CAC also covers the additional bandwidth consumption resulting from PHY and channel impairment.

In load-based CAC, the access point continuously measures and updates the utilization of the RF channel (that is, the mean time of bandwidth that has been exhausted), channel interference, and the additional calls that the access point can admit. The access point admits a new call only if the channel has enough unused bandwidth to support that call. By doing so, load-based CAC prevents oversubscription of the channel and maintains QoS under all conditions of WLAN loading and interference.

Note If you disable load-based CAC, the access points start using bandwidth-based CAC.

IOSd Call Admission Control

IOSd Call Admission Control (CAC) controls bandwidth availability from controller to access point.

You can configure class-based, unconditional packet marking features on your switch for CAC.

CAC is a concept that applies to voice and video traffic only—not data traffic. If an influx of data traffic oversubscribes a particular link in the network, queueing, buffering, and packet drop decisions resolve the congestion. The extra traffic is simply delayed until the interface becomes available to send the traffic, or, if traffic is dropped, the protocol or the end user initiates a timeout and requests a retransmission of the information.

Network congestion cannot be resolved in this manner when real-time traffic, sensitive to both latency and packet loss, is present, without jeopardizing the quality of service (QoS) expected by the users of that traffic. For real-time delay-sensitive traffic such as voice, it is better to deny network access under congestion conditions than to allow traffic onto the network to be dropped and delayed, causing intermittent impaired QoS and resulting in customer dissatisfaction.

CAC is therefore a deterministic and informed decision that is made before a voice call is established and is based on whether the required network resources are available to provide suitable QoS for the new call.

Based on the admit CAC CLI configuration in addition to the existing CAC algorithm, controller allows either voice or video with TSPEC or SIP snooping. The **admit cac** CLI is mandatory for the voice call to pass through.

If the BSSID policer is configured for the voice or video traffic, then additional checks are performed on the packets.

Expedited Bandwidth Requests

The expedited bandwidth request feature enables CCXv5 clients to indicate the urgency of a WMM traffic specifications (TSPEC) request (for example, an e911 call) to the WLAN. When the controller receives this request, it attempts to facilitate the urgency of the call in any way possible without potentially altering the quality of other TSPEC calls that are in progress.

You can apply expedited bandwidth requests to both bandwidth-based and load-based CAC. Expedited bandwidth requests are disabled by default. When this feature is disabled, the controller ignores all expedited requests and processes TSPEC requests as normal TSPEC requests.

The following table lists examples of TSPEC request handling for normal TSPEC requests and expedited bandwidth requests.

Table 16: TSPEC Request Handling Examples

CAC Mode	Reserved bandwidth for voice calls[1]	Usage[2]	Normal TSPEC Request	TSPEC with Expedited Bandwidth Request
Bandwidth-based CAC	75% (default setting)	Less than 75%	Admitted	Admitted
		Between 75% and 90% (reserved bandwidth for voice calls exhausted)	Rejected	Admitted
		More than 90%	Rejected	Rejected
Load-based CAC		Less than 75%	Admitted	Admitted
		Between 75% and 85% (reserved bandwidth for voice calls exhausted)	Rejected	Admitted
		More than 85%	Rejected	Rejected

1 For bandwidth-based CAC, the voice call bandwidth usage is per access point radio and does not take into account cochannel access points. For load-based CAC, the voice call bandwidth usage is measured for the entire channel.
2 Bandwidth-based CAC (consumed voice and video bandwidth) or load-based CAC (channel utilization [Pb]).

Note Admission control for TSPEC G711-20ms and G711-40 ms codec types are supported.

U-APSD

Unscheduled automatic power save delivery (U-APSD) is a QoS facility defined in IEEE 802.11e that extends the battery life of mobile clients. In addition to extending battery life, this feature reduces the latency of traffic flow delivered over the wireless media. Because U-APSD does not require the client to poll each individual packet buffered at the access point, it allows delivery of multiple downlink packets by sending a single uplink trigger packet. U-APSD is enabled automatically when WMM is enabled.

Traffic Stream Metrics

In a voice-over-wireless LAN (VoWLAN) deployment, traffic stream metrics (TSM) can be used to monitor voice-related metrics on the client-access point air interface. It reports both packet latency and packet loss. You can isolate poor voice quality issues by studying these reports.

The metrics consist of a collection of uplink (client side) and downlink (access point side) statistics between an access point and a client device that supports CCX v4 or later releases. If the client is not CCX v4 or CCXv5 compliant, only downlink statistics are captured. The client and access point measure these metrics. The access

point also collects the measurements every 5 seconds, prepares 90-second reports, and then sends the reports to the controller. The controller organizes the uplink measurements on a client basis and the downlink measurements on an access point basis and maintains an hour's worth of historical data. To store this data, the controller requires 32 MB of additional memory for uplink metrics and 4.8 MB for downlink metrics.

TSM can be configured through either the GUI or the CLI on a per radio-band basis (for example, all 802.11a radios). The controller saves the configuration in flash memory so that it persists across reboots. After an access point receives the configuration from the controller, it enables TSM on the specified radio band.

This table shows the upper limit for TSM entries in different controller series.

TSM Entries	5700
MAX AP TSM entries	100
MAX Client TSM entries	250
MAX TSM entries	100*250=25000

Note Once the upper limit is reached, additional TSM entries cannot be stored and sent to WCS or NCS. If client TSM entries are full and AP TSM entries are available, then only the AP entries are stored, and viceversa. This leads to partial output. TSM cleanup occurs every one hour. Entries are removed only for those APs and clients that are not in the system.

Information About Configuring Voice Prioritization Using Preferred Call Numbers

You can configure a controller to provide support for SIP calls from VoWLAN clients that do not support TSPEC-based calls. This feature is known as SIP CAC support. If bandwidth is available in the configured voice pool, the SIP call uses the normal flow and the controller allocates the bandwidth to those calls.

You can also prioritize up to six preferred call numbers. When a call comes to one of the configured preferred numbers, the controller does not check the configured maximum voice bandwidth. The controller allocates the bandwidth needed for the call, even if it exceeds the maximum bandwidth for voice configured for voice CAC. The preferred call will be rejected if bandwidth allocation exceeds 85% of the radio bandwidth. The bandwidth allocation is 85 percent of the entire bandwidth pool, not just from the maximum configured voice pool. The bandwidth allocation is the same even for roaming calls.

You must configure the following parameters before configuring voice prioritization:

- Set WLAN QoS to allow voice calls to pass through.
- Enable ACM for the radio.
- Enable SIP call snooping on the WLAN.

Information About EDCA Parameters

Enhanced distributed channel access (EDCA) parameters are designed to provide preferential wireless channel access for voice, video, and other quality-of-service (QoS) traffic.

How to Configure Voice and Video Parameters

Configuring Voice Parameters (CLI)

Before You Begin

Ensure that you have configured SIP-based CAC.

You should have created a class map for CAC before beginning this procedure.

SUMMARY STEPS

1. **show wlan summary**
2. **show wlan** *wlan_id*
3. **configure terminal**
4. **policy-map** *policy-map name*
5. **class** {*class-name* | **class-default**}
6. **admit cac wmm-tspec**
7. **service-policy** *policy-map name*
8. **end**
9. **wlan** *wlan_profile_name wlan_ID SSID_network_name* **wlan shutdown**
10. **wlan** *wlan_profile_name wlan_ID SSID_network_name*
11. **wlan** *wlan_name* **call-snoop**
12. **wlan** *wlan_name* **service-policy input** *input_policy_name*
13. **wlan** *wlan_name* **service-policy output** *ouput_policy_name*
14. **wlan** *wlan_name* **service-policy input** *ingress_policy_name*
15. **wlan** *wlan_name* **service-policy output** *egress_policy_name*
16. **ap dot11 {5ghz | 24ghz} shutdown**
17. **ap dot11 {5ghz | 24ghz} cac voice sip**
18. **ap dot11 {5ghz | 24ghz} cac voice acm**
19. **ap dot11 {5ghz | 24ghz} cac voice max-bandwidth** *bandwidth*
20. **ap dot11 {5ghz | 24ghz} cac voice roam-bandwidth** *bandwidth*
21. **no wlan shutdown**
22. **no ap dot11 {5ghz | 24ghz} shutdown**
23. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**show wlan summary** **Example:** `Controller# show wlan summary`	Specifies all of the WLANs configured on the controller.
Step 2	**show wlan** *wlan_id* **Example:** `Controller# show wlan 25`	Specifies the WLAN that you plan to modify. For voice over WLAN, ensure that the WLAN is configured for WMM and the QoS level is set to Platinum.
Step 3	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.

Step 4	**policy-map** *policy-map name*
	
	Example:
	`Controller(config)# policy-map test_2000`
	`Controller(config-pmap)#`
		Enters policy map configuration mode.
		Creates or modifies a policy map that can be attached to one or more interfaces to specify a service policy.
		In WLAN, you need to configure service-policy for these commands to take effect.

Step 5	**class** {*class-name* | **class-default**}
	
	Example:
	`Controller(config-pmap)# class test_1000`
	`Controller(config-pmap-c)#`
		Enters policy class map configuration mode. Specifies the name of the class whose policy you want to create or change.
		Specifies the name of the class whose policy you want to create or change.
		You can also create a system default class for unclassified packets.

Step 6	**admit cac wmm-tspec**
	
	Example:
	`Controller(config-pmap-c)# admit cac wmm-tspec`
	`Controller(config-pmap-c)#`
		(Optional) Admits the request for Call Admission Control (CAC) for policy map.

Step 7	**service-policy** *policy-map name*
	
	Example:
	`Controller(config-pmap-c)# service-policy test_2000`
	`Controller(config-pmap-c)#`
		Configures the QoS service policy.

Step 8	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.
Step 9	**wlan** *wlan_profile_name wlan_ID SSID_network_name* **wlan shutdown**	Disables all WLANs with WMM enabled prior to changing the video parameters.

	Command or Action	Purpose

	Example:
	`Controller(config)# wlan wlan1`
	`Controller(config-wlan)# wlan shutdown`	

Step 10	**wlan** *wlan_profile_name wlan_ID SSID_network_name*
	
	Example:
	`Controller(config)# wlan wlan1`
	`Controller(config-wlan)# wlan shutdown`
		Disables all WLANs with WMM enabled prior to changing the voice parameters.

Step 11	**wlan** *wlan_name* **call-snoop** **Example:** `Controller(config)# wlan wlan1 call-snoop`	Enables the call-snooping on a particular WLAN.

Step 12	**wlan** *wlan_name* **service-policy input** *input_policy_name*
	
	Example:
	`Controller(config)# wlan wlan1`
	`Controller(config-wlan)# service-policy input platinum-up`
		Configures input SSID policy on a particular WLAN to voice.

Step 13	**wlan** *wlan_name* **service-policy output** *ouput_policy_name*
	
	Example:
	`Controller(config)# wlan wlan1`
	`Controller(config-wlan)# service-policy output platinum`
		Configures output SSID policy on a particular WLAN to voice.

Step 14	**wlan** *wlan_name* **service-policy input** *ingress_policy_name*
	
	Example:
	`Controller(config)# wlan wlan1`
	`Controller(config-wlan)# service-policy input policy1`
		Configures ingress SSID policy on a particular WLAN as user-defined policy.

Step 15	**wlan** *wlan_name* **service-policy output** *egress_policy_name*
	
	Example:
	`Controller(config)# wlan wlan1`
	`Controller(config-wlan)# service-policy output policy2`
		Configures egress SSID policy on a particular WLAN as user-defined policy.

Step 16	**ap dot11 {5ghz | 24ghz} shutdown** **Example:**	Disables the radio network. `Controller(config)# ap dot11 5ghz shutdown`

	Command or Action	Purpose
Step 17	**ap dot11 {5ghz | 24ghz} cac voice sip** **Example:** `Controller(config)# ap dot11 5ghz cac voice sip`	Enables or disables SIP IOSd CAC for the 802.11a or 802.11b/g network.
Step 18	**ap dot11 {5ghz | 24ghz} cac voice acm** **Example:** `Controller(config)# ap dot11 5ghz cac voice acm`	Enables or disables bandwidth-based voice CAC for the 802.11a or 802.11b/g network.
Step 19	**ap dot11 {5ghz | 24ghz} cac voice max-bandwidth** *bandwidth* **Example:** `Controller(config)# ap dot11 5ghz cac voice max-bandwidth 85`	Sets the percentage of maximum bandwidth allocated to clients for voice applications on the 802.11a or 802.11b/g network. The bandwidth range is 5 to 85%, and the default value is 75%. Once the client reaches the value specified, the access point rejects new videos on this network.
Step 20	**ap dot11 {5ghz | 24ghz} cac voice roam-bandwidth** *bandwidth* **Example:** `Controller(config)# ap dot11 5ghz cac voice roam-bandwidth 10`	Sets the percentage of maximum allocated bandwidth reserved for roaming voice clients. The bandwidth range is 0 to 25%, and the default value is 6%. The controller reserves this much bandwidth from the maximum allocated bandwidth for roaming voice clients.
Step 21	**no wlan shutdown** **Example:** `Controller(config-wlan)# no wlan shutdown`	Reenables all WLANs with WMM enabled.
Step 22	**no ap dot11 {5ghz | 24ghz} shutdown** **Example:** `Controller(config)# no ap dot11 5ghz shutdown`	Reenables the radio network.
Step 23	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.

Configuring Video Parameters (CLI)

SUMMARY STEPS

1. **show wlan summary**
2. **show wlan** *wlan_id*
3. **configure terminal**
4. **policy-map** *policy-map name*
5. **class** {*class-name* | **class-default**}
6. **admit cac wmm-tspec**
7. **service-policy** *policy-map name*
8. **end**
9. **wlan***wlan_profile_name*
10. **ap dot11 {5ghz | 24ghz} shutdown**
11. **ap dot11 {5ghz | 24ghz} cac video acm**
12. **ap dot11 {5ghz | 24ghz} cac video load-based**
13. **ap dot11 {5ghz | 24ghz} cac video max-bandwidth** *bandwidth*
14. **ap dot11 {5ghz | 24ghz} cac video roam-bandwidth** *bandwidth*
15. **no wlan shutdown** *wlan_id*
16. **no ap dot11 {5ghz | 24ghz} shutdown**
17. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**show wlan summary** **Example:** `Controller# show wlan summary`	Specifies all of the WLANs configured on the controller.
Step 2	**show wlan** *wlan_id* **Example:** `Controller# show wlan 25`	Specifies the WLAN that you plan to modify.
Step 3	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.

Step 4	**policy-map** *policy-map name*
	
	Example:
	`Controller(config)# policy-map test_2000`
	`Controller(config-pmap)#`
		Enters policy map configuration mode.
		Creates or modifies a policy map that can be attached to one or more interfaces to specify a service policy.
		In WLAN, you need to configure service-policy for these commands to take effect.

	Command or Action	Purpose

Step 5	**class** {*class-name* | **class-default**}
	
	Example:
	`Controller(config-pmap)# class test_1000`
	`Controller(config-pmap-c)#`
		Enters policy class map configuration mode. Specifies the name of the class whose policy you want to create or change.
		
		Specifies the name of the class whose policy you want to create or change.
		
		You can also create a system default class for unclassified packets.

Step 6	**admit cac wmm-tspec**
	
	Example:
	`Controller(config-pmap-c)# admit cac wmm-tspec`
	`Controller(config-pmap-c)#`
		(Optional) Admits the request for Call Admission Control (CAC) for policy map.

Step 7	**service-policy** *policy-map name*
	
	Example:
	`Controller(config-pmap-c)# service-policy test_2000`
	`Controller(config-pmap-c)#`
		Configures the QoS service policy.

Step 8	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.

Step 9	**wlan***wlan_profile_name*
	
	Example:
	`Controller(config)# wlan wlan1`
	`Controller(config-wlan)# wlan shutdown`
		Disables all WLANs with WMM enabled prior to changing the video parameters.

Step 10	**ap dot11 {5ghz | 24ghz} shutdown** **Example:** `Controller(config)# ap dot11 5ghz shutdown`	Disables the radio network.
Step 11	**ap dot11 {5ghz | 24ghz} cac video acm** **Example:** `Controller(config)# ap dot11 5ghz cac video acm`	Enables or disables bandwidth-based video CAC for the 802.11a or 802.11b/g network.
Step 12	**ap dot11 {5ghz | 24ghz} cac video load-based** **Example:** `Controller(config)# ap dot11 5ghz cac video load-based`	Configures the load-based CAC method. If you do not enter this command, then the default static CAC is applied.
Step 13	**ap dot11 {5ghz | 24ghz} cac video max-bandwidth** *bandwidth* **Example:** `Controller(config)# ap dot11 5ghz cac video max-bandwidth 20`	Sets the percentage of maximum bandwidth allocated to clients for video applications on the 802.11a or 802.11b/g network. The bandwidth range is 5 to 85%, and the default value is 75%. The default value is 0, which means no bandwidth request control. The sum of the voice bandwidth and video bandwidth

	Command or Action	Purpose
		should not exceed 85% or configured maximum media bandwidth.
Step 14	**ap dot11 {5ghz | 24ghz} cac video roam-bandwidth** *bandwidth* **Example:** `Controller(config)# ap dot11 5ghz cac video roam-bandwidth 9`	Sets the percentage of maximum allocated bandwidth reserved for roaming clients for video. The bandwidth range is 0 to 25%, and the default value is 0%.
Step 15	**no wlan shutdown** *wlan_id* **Example:** `Controller(config-wlan)# no wlan shutdown 25`	Reenables all WLANs with WMM enabled.
Step 16	**no ap dot11 {5ghz | 24ghz} shutdown** **Example:** `Controller(config)# no ap dot11 5ghz shutdown`	Reenables the radio network.
Step 17	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.

Configuring SIP-Based CAC (CLI)

SIP CAC controls the total number of SIP calls that can be made.

SUMMARY STEPS

1. **configure terminal**
2. **wlan** *wlan-name*
3. **call-snoop**
4. **service-policy** [**client**] **input** *policy-map name*
5. **service-policy** [**client**] **output** *policy-map name*
6. **end**
7. **show wlan** {*wlan-id* | *wlan-name*}
8. **configure terminal**
9. **ap dot11 {5ghz | 24ghz} cac {voice | video} acm**
10. **ap dot11 {5ghz | 24ghz} cac voice sip**
11. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.

Step 2	**wlan** *wlan-name*
	
	Example:
	`Controller(config)# wlan qos-wlan`
	`Controller(config-wlan)#`
		Enters WLAN configuration submode.

Step 3	**call-snoop** **Example:** `Controller(config-wlan)# call-snoop`	Enables the call-snooping feature for a particular WLAN.
Step 4	**service-policy** [**client**] **input** *policy-map name* **Example:** `Controller(config-wlan)# service-policy input platinum-up`	Assigns a policy map to WLAN input traffic. Ensure that you provide QoS policy to voice for input traffic.
Step 5	**service-policy** [**client**] **output** *policy-map name* **Example:** `Controller(config-wlan)# service-policy output platinum`	Assigns policy map to WLAN output traffic. Ensure that you provide QoS policy to voice for output traffic.
Step 6	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.
Step 7	**show wlan** {*wlan-id* | *wlan-name*} **Example:** `Controller# show wlan qos-wlan`	Verifies the configured QoS policy on the WLAN.
Step 8	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.
Step 9	**ap dot11 {5ghz | 24ghz} cac {voice | video} acm** **Example:** `Controller(config)# ap dot11 5ghz cac voice acm`	Enables the ACM static on the radio. When enabling SIP snooping, use the static CAC, not the load-based CAC.
Step 10	**ap dot11 {5ghz | 24ghz} cac voice sip** **Example:** `Controller(config)# ap dot11 5ghz cac voice sip`	Configures SIP-based CAC.

	Command or Action	Purpose
Step 11	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.

Configuring a Preferred Call Number (CLI)

Before You Begin

You must set the following parameters before configuring a preferred call number.

- Set WLAN QoS to voice.
- Enable ACM for the radio.
- Enable SIP call snooping on the WLAN.
- Enable SIP-based CAC.

SUMMARY STEPS

1. **configure terminal**
2. **wlan** *wlan-name* **qos platinum**
3. **ap dot11 {5ghz | 24ghz} cac {voice | video} acm**
4. **wlan** *wlan-name*
5. **wireless sip preferred-call-no** *call_index call_number*
6. **no wireless sip preferred-call-no** *call_index*
7. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.

Step 2	**wlan** *wlan-name* **qos platinum**
	
	Example:
	`Controller(config)# wlan wlan1`
	`Controller(config-wlan)# qos platinum`
		Sets QoS to voice on a particular WLAN.

Step 3	**ap dot11 {5ghz | 24ghz} cac {voice | video} acm**	Enables the static ACM on the radio.

	Command or Action	Purpose
	Example: `Controller(config)# ap dot11 5ghz cac voice acm`	When enabling SIP snooping, use the static CAC, not the load-based CAC.

Step 4	**wlan** *wlan-name*
	
	Example:
	`Controller(config)# wlan wlan1`
	`Controller(config-wlan)# call-snoop`
		Enables the call-snooping feature for a particular WLAN.

Step 5	**wireless sip preferred-call-no** *call_index call_number* **Example:** `Controller(config)# wireless sip preferred-call-no 1 555333`	Adds a new preferred call.
Step 6	**no wireless sip preferred-call-no** *call_index* **Example:** `Controller(config)# no wireless sip preferred-call-no 1`	Removes a preferred call.
Step 7	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.

Configuring EDCA Parameters (CLI)

SUMMARY STEPS

1. **configure terminal**
2. **ap dot11 {5ghz | 24ghz } shutdown**
3. **ap dot11 {5ghz | 24ghz} edca-parameters {custom-voice | optimized-video-voice | optimized-voice | svp-voice | wmm-default}**
4. **show ap dot11 {5ghz | 24ghz} network**
5. **no ap dot11 {5ghz | 24ghz} shutdown**
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.
Step 2	**ap dot11 {5ghz | 24ghz } shutdown** **Example:** `Controller(config)# ap dot11 5ghz shutdown`	Disables the radio network.
Step 3	**ap dot11 {5ghz | 24ghz} edca-parameters {custom-voice | optimized-video-voice | optimized-voice | svp-voice | wmm-default}** **Example:** `Controller(config)# ap dot11 5ghz edca-parameters optimized-voice`	Enables a specific EDCA parameters for the 802.11a or 802.11b/g network. • custom-voice—Enables custom voice parameters for the 802.11a or 802.11b/g network. • optimized-video-voice—Enables EDCA voice- and video-optimized parameters for the 802.11a or 802.11b/g network. Choose this option when both voice and video services are deployed on your network. • optimized-voice—Enables non-SpectraLink voice-optimized profile parameters for the 802.11a or 802.11b/g network. Choose this option when voice services other than SpectraLink are deployed on your network. • svp-voice—Enables SpectraLink voice priority parameters for the 802.11a or 802.11b/g network. Choose this option if SpectraLink phones are deployed on your network to improve the quality of calls. • wmm-default—Enables the Wi-Fi Multimedia (WMM) default parameters for the 802.11a or 802.11b/g network. This is the default value. Choose this option when voice or video services are not deployed on your network.
Step 4	**show ap dot11 {5ghz | 24ghz} network** **Example:** `Controller(config)# show ap dot11 5ghz network`	Displays the current status of MAC optimization for voice.
Step 5	**no ap dot11 {5ghz | 24ghz} shutdown** **Example:** `Controller(config)# no ap dot11 5ghz shutdown`	Reenables the radio network.

	Command or Action	Purpose
Step 6	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.

Configuring EDCA Parameters (GUI)

Step 1 Choose **Configuration** > **Wireless** > **802.11a/n/ac** > **EDCA Parameters** or **Configuration** > **Wireless** > **802.11b/g/n** > **EDCA Parameters** to open EDCA Parameters page.

Step 2 Choose one of the following options from the **EDCA Profile** drop-down list:

- **wmm-default—**Enables the Wi-Fi Multimedia (WMM) default parameters. This is the default value. Choose this option when voice or video services are not deployed on your network.
- **svp-voice—**Enables SpectraLink voice priority parameters. Choose this option if SpectraLink phones are deployed on your network to improve the quality of calls.
- **optimized-voice—**Enables EDCA voice-optimized profile parameters. Choose this option when voice services other than SpectraLink are deployed on your network.
- **optimized-video-voice—**Enables EDCA voice- and video-optimized profile parameters. Choose this option when both voice and video services are deployed on your network.
- **custom-voice—**Enables custom voice EDCA parameters for 802.11a. The EDCA parameters under this option also match the 6.0 WMM EDCA parameters when this profile is applied.

  Note If you deploy video services, admission control (ACM) must be disabled.

Step 3 If you want to enable MAC optimization for voice, select the **Enable Low Latency MAC** check box. Otherwise, leave this check box unselected, which is the default value. This feature enhances voice performance by controlling packet retransmits and appropriately aging out voice packets on lightweight access points, which improves the number of voice calls serviced per access point.

Note We do not recommend you to enable low latency MAC. You should enable low latency MAC only if the WLAN allows WMM clients. If WMM is enabled, then low latency MAC can be used with any of the EDCA profiles.

Step 4 Click **Apply** to commit your changes.

Step 5 To reenable the radio network, choose **Network** under 802.11a/n or 802.11b/g/n, select the **802.11a/n/ac** (or **802.11b/g/n**) **Network Status** check box, and click **Apply**.

Step 6 Click **Save Configuration**.

Monitoring Voice and Video Parameters

This section describes the new commands for the voice and video parameters.

The following commands can be used to monitor voice and video parameters.

Table 17: Monitoring Voice Parameters Commands

Command	Purpose
show ap dot11 {5ghz | 24ghz} network	Displays the radio-based statistics for voice.
show ap name *ap_name* **dot11 24ghz tsm all**	Displays the TSM voice metrics and current status of MAC optimization for voice.
show ap name *apname* **cac voice**	Displays the information about CAC for a particular access point.
show client detail *client_mac*	Displays the U-APSD status for a particular client.
show policy-map interface wireless client	Displays the video client policy details.
show access-list	Displays the video client dynamic access-list from the controller.
show wireless client voice diag status	Displays information about whether voice diagnostics are enabled or disabled. If enabled, this also displays information about the clients in the watch list and the time remaining for the diagnostics of the voice call. **Note** To work on voice diagnostics CLIs, you need to enter the following command: **debug voice-diagnostic mac-addr** *client_mac_01 client_mac_02*
show wireless client voice diag tspec	Displays the TSPEC information sent from the clients that are enabled for voice diagnostics.
show wireless client voice diag qos-map	Displays information about the QoS/DSCP mapping and packet statistics in each of the four queues: VO, VI, BE, BK. The different DSCP values are also displayed.
show wireless client voice diag rssi	Display the client's RSSI values in the last 5 seconds when voice diagnostics is enabled.
show client voice-diag roam-history	Displays information about the last three roaming calls. The output contains the timestamp, access point associated with roaming, roaming reason, and if there is a roaming failure, reason for roaming-failure.

show policy-map interface wireless mac *mac-address*	Displays information about the voice and video data packet statistics.
show wireless media-stream client summary	Displays a summary of the media stream and video client information.
show controllers d0 | b queue	Displays which queue the packets are going through on an access point.
show platform qos queue stats *interface*	Displays which queue packets are going through from the controller.

You can monitor the video parameters using the following commands.

Table 18: Monitoring Video Parameters Commands

Command	Purpose
show ap join stats summary *ap_mac*	Displays the last join error detail for a specific access point.
show ip igmp snooping wireless mgid	Displays the TSM voice metrics and current status of MAC optimization for voice.
show wireless media-stream multicast-direct state	Displays the media stream multicast-direct parameters.
show wireless media-stream group summary	Displays the summary of the media stream and client information.
show wireless media-stream group detail *group_name*	Displays the details of a specific media-stream group.
show wireless media-stream client summary	Displays the details for a set of media-stream clients.
show wireless media-stream client detail *group_name*	Displays the details for a set of media-stream clients.
show ap dot11 {5ghz | 24ghz) media-stream rrc	Display the details of media stream.
show wireless media-stream message details	Displays information about the message configuration.
show ap name *ap-name* **auto-rf dot11 5ghz | i Util**	Displays the details of channel utilization.
show controllers d0 | b queue	Displays which queue the packets are going through on an access point based on 2.4- and 5-GHz bands.
show controllers d1 | b queue	Displays which queue the packets are going through on an access point based on 2.4- and 5-GHz bands.

show cont d1 | b Media	Displays the video metric details on the band A or B.
show capwap mcast mgid all	Displays information about all of the multicast groups and their corresponding multicast group identifications (MGIDs) associated to the access point.
show capwap mcast mgid id *id*	Displays information about all of the video clients joined to the multicast group in a specific MGID.

Configuration Examples for Voice and Video Parameters

Example: Configuring Voice and Video

Configuring Egress SSID Policy for Voice and Video

The following example shows how to create and configure an egress SSID policy for voice and video:

```
table-map egress_ssid_tb
 map from 24 to 24
 map from 34 to 34
 map from 46 to 46
 default copy

class-map match-any voice
  match  dscp ef
class-map match-any video
  match  dscp af41

policy-map ssid-cac
class class-default
    shape average 25000000
   set dscp dscp table egress_ssid_tb
   queue-buffers ratio 0
   service-policy ssid-child-cac

policy-map ssid-child-cac
 class voice
    priority level 1
    police 5000000
     conform-action transmit
     exceed-action drop
    admit cac wmm-tspec
      rate 1000
      wlan-up  6 7
 class video
    priority level 2
    police 10000000
      conform-action transmit
      exceed-action drop
    admit cac wmm-tspec
      rate 3000
      wlan-up  4 5
```

Configuring Ingress SSID Policy for Voice and Video

The following example shows how to create and configure an ingress SSID policy for voice and video:

```
table-map up_to_dscp
 map from 0 to 0
```

```
 map from 1 to 8
 map from 2 to 8
 map from 3 to 0
 map from 4 to 34
 map from 5 to 34
 map from 6 to 46
 map from 7 to 48
 default copy

policy-map ingress_ssid
 class class-default
   set dscp wlan user-priority table up_to_dscp
```

Configuring Egress Port Policy Voice and Video

The following example shows how to create and configure an egress port policy for voice and video:

```
policy-map port_child_policy
 class non-client-nrt-class
 bandwidth remaining ratio 10

 class voice
 priority level 1
 police rate 3000000

 class video
 priority level 2
 police rate 4000000
```

Applying Ingress and Egress SSID policies for Voice and Video on a WLAN

The following example shows how to apply ingress and egress SSID policies for voice and video on a WLAN:

```
wlan voice_video 1 voice_video
 service-policy input ingress_ssid
 service-policy output ssid-cac
```

Additional References for Voice and Video Parameters

Related Documents

Related Topic	Document Title
Multicast configuration	*Multicast Configuration Guide, Cisco IOS XE Release 3SE (Cisco WLC 5700 Series)*
VideoStream configuration	*VideoStream Configuration Guide, Cisco IOS XE Release 3SE (Cisco WLC 5700 Series)*

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

Feature History and Information For Performing Voice and Video Parameters Configuration

Release	Feature Information
Cisco IOS XE 3.2SE	This feature was introduced.

CHAPTER 12

Configuring RFID Tag Tracking

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 Configuring RFID Tag Tracking

The Controller enables you to configure radio-frequency identification (RFID) tag tracking. RFID tags are small wireless devices that are affixed to assets for real-time location tracking. They operate by advertising their location using special 802.11 packets, which are processed by access points, the controller, and the location appliance.

How to Configure RFID Tag Tracking

Configuring RFID Tag Tracking (CLI)

SUMMARY STEPS

1. **location rfid status**
2. (Optional) **no location rfid status**
3. **location rfid timeout** *seconds*
4. **location rfid mobility vendor-name** *name*
5. (Optional) **no location rfid mobility** *name*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**location rfid status** **Example:** `Controller(config)# location rfid status`	Enables RFID tag tracking. By default, RFID tag tracking is enabled.
Step 2	(Optional) **no location rfid status** **Example:** `Controller(config)# no location rfid status`	Disables RFID tag tracking.
Step 3	**location rfid timeout** *seconds* **Example:** `Controller(config)# location rfid timeout 1500`	Specifies a static timeout value (between 60 and 7200 seconds). The static timeout value is the amount of time that the controller maintains tags before expiring them. For example, if a tag is configured to beacon every 30 seconds, we recommend that you set the timeout value to 90 seconds (approximately three times the beacon value). The default value is 1200 seconds.
Step 4	**location rfid mobility vendor-name** *name* **Example:** `Controller(config)# location rfid mobility vendor-name Aerosct`	Enables RFID tag mobility for specific tags. When you enter the **location rfid mobility vendor-name** command, tags are unable to obtain a DHCP address for client mode when attempting to select and/or download a configuration. **Note** These commands can be used only for Pango tags. Therefore, the only valid entry for **vendor_name** is “pango” in all lowercase letters.
Step 5	(Optional) **no location rfid mobility** *name* **Example:** `Controller(config)# no location rfid mobility test`	Disables RFID tag mobility for specific tags. When you enter the **no location rfid mobility** command , tags can obtain a DHCP address. If a tag roams from one subnet to another, it obtains a new address rather than retaining the anchor state.

Monitoring RFID Tag Tracking Information

This section describes the new commands for the RFID tag tracking Information.

The following commands can be used to monitor the RFID tag tracking Information on the controller.

Table 19: Monitoring RFID Tag Tracking Information Commands

Command	Purpose
show location rfid config	Displays the current configuration for RFID tag tracking.
show location rfid detail *mac_address*	Displays the detailed information for a specific RFID tag.
show location rfid summary	Displays a list of all RFID tags currently connected to the controller.
show location rfid client	Displays a list of RFID tags that are associated to the controller as clients.

Additional References RFID Tag Tracking

Related Documents

Related Topic	Document Title
System management commands	*System Management Command Reference, Cisco IOS XE Release 3SE (Cisco WLC 5700 Series)*

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

Feature History and Information For Performing RFID Tag Tracking Configuration

Release	Feature Information
Cisco IOS XE 3.2SE	This feature was introduced.

CHAPTER 13

Configuring Location Settings

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 Configuring Location Settings

The controller determines the location of client devices by gathering Received Signal Strength Indication (RSSI) measurements from access points all around the client of interest. The controller can obtain location reports from up to 16 access points for clients, RFID tags, and rogue access points.

You can configure the path loss measurement (S60) request for normal clients or calibrating clients to improve location accuracy.

How to Configure Location Settings

Configuring Location Settings (CLI)

SUMMARY STEPS

1. **configure terminal**
2. **location plm** {**calibrating** [**multiband** | **uniband**] | **client** *burst_interval*
3. **location rssi-half-life** {**calibrating-client** | **client** | **rogue-aps** | **tags** } *seconds*
4. **location expiry** {**calibrating-client** | **client** | **rogue-aps** | **tags** } *timeout*
5. **location algorithm** {**rssi-average** | **simple**}
6. **location admin-tag** *string*
7. **location civic-location identifier** {*identifier* | **host**}
8. **location custom-location identifier** {*identifier* | **host**}
9. **location geo-location identifier** {*identifier* | **host**}
10. **location prefer** {**cdp** | **lldp-med** | **static**} **weight** *priority_value*
11. **location rfid** {**status** | **timeout** | **vendor-name**}
12. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.
Step 2	**location plm** {**calibrating** [**multiband** | **uniband**] | **client** *burst_interval* **Example:** `Controller(config)# location plm client 100`	Configures the path loss measurement (S60) request for calibrating clients or non-calibrating. The path loss measurement request improves the location accuracy. You can configure the **burst_interval** parameter for the normal, noncalibrating client from zero through 3600 seconds, and the default value is 60 seconds. You can configure the path loss measurement request for calibrating clients on the associated 802.11a or 802.11b/g radio or on the associated 802.11a/b/g radio. If a client does not send probes often or sends them only on a few channels, its location cannot be updated or cannot be updated accurately. The **location plm** command forces clients to send more packets on all channels. When a CCXv4 (or higher) client associates, the Controller sends it a path loss measurement request, which instructs the client to transmit on the bands and channels that the access points are on (typically, channels 1, 6, and 11 for 2.4-GHz-only access points) at a configurable interval (such as 60 seconds) indefinitely.

	Command or Action	Purpose
Step 3	**location rssi-half-life** {**calibrating-client** | **client** | **rogue-aps** | **tags** } *seconds* **Example:** `Controller(config)# location rssi-half-life calibrating-client 60`	Configures the RSSI half life for the clients, calibrating clients, RFID tags, and rogue access points. You can enter the **location rssi-half-life** parameter value for the clients, calibrating clients, RFID tags, and rogue access points as 0, 1, 2, 5, 10, 20, 30, 60, 90, 120, 180, or 300 seconds, and the default value is 0 seconds. Some client devices transmit at reduced power immediately after changing channels, and RF is variable, so RSSI values might vary considerably from packet to packet. The **location rssi-half-life** command increases accuracy by averaging nonuniformly arriving data using a configurable forget period (or half life). **Note** We recommend that you do not use or modify the **location rssi-half-life** command.
Step 4	**location expiry** {**calibrating-client** | **client** | **rogue-aps** | **tags** } *timeout* **Example:** `Controller(config)# location expiry calibrating-client 50`	Configures the RSSI timeout value for the clients, calibrating clients, RFID tags, and rogue access points. You can enter the RSSI timeout value for the clients, RFID tags, and rogue access points from 5 through 3600 seconds, and the default value is 5 seconds. For the calibrating clients, you can enter the RSSI timeout value from 0 through 3600 seconds, and the default value is 5 seconds. Ensuring that recent, strong RSSIs are retained by the CPU is critical to location accuracy. The **location expiry** command enables you to specify the length of time after which old RSSI averages expire. **Note** We recommend that you do not use or modify the **location expiry** command.
Step 5	**location algorithm** {**rssi-average** | **simple**} **Example:** `Controller(config)# location algorithm rssi-average`	Configures the algorithm used to average RSSI and signal-to-noise ratio (SNR) values. You can enter the **location algorithm rssi-average** command to specify a more accurate algorithm but requires more CPU overhead or the **location algorithm simple** command to specify a faster algorithm that requires low CPU overhead but provides less accuracy. **Note** We recommend that you do not use or modify the **location algorithm** command.
Step 6	**location admin-tag** *string* **Example:** `Controller(config)# location admin-tag`	Sets administrative tag or site information for the location of client devices.
Step 7	**location civic-location identifier** {*identifier* | **host**} **Example:** `Controller(config)# location civic-location identifier host`	Specifies civic location information. You can set the civic location identifier either as a string or host.

	Command or Action	Purpose
Step 8	**location custom-location identifier** {*identifier* | **host**} **Example:** `Controller(config)# location custom-location identifier host`	Specifies custom location information. You can set the custom location identifier either as a string or host.
Step 9	**location geo-location identifier** {*identifier* | **host**} **Example:** `Controller(config)# location geo-location identifier host`	Specifies geographical location information of the client devices. You can set the location identifier either as a string or host.
Step 10	**location prefer** {**cdp** | **lldp-med** | **static**} **weight** *priority_value* **Example:** `Controller(config)# location prefer weight cdp 50`	Sets location information source priority. You can enter the priority weight from zero through 255.
Step 11	**location rfid** {**status** | **timeout** | **vendor-name**} **Example:** `Controller(config)# location rfid timeout 100`	Configures RFID tag tracking options such as RFID tag status, RFID timeout value, and RFID tag vendor name. You can enter the RFID timeout value in a range from 60 and 7200 seconds.
Step 12	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.

Modifying the NMSP Notification Interval for Clients, RFID Tags, and Rogues (CLI)

The Network Mobility Services Protocol (NMSP) manages communication between the mobility services engine and the controller for incoming and outgoing traffic. If your application requires more frequent location updates, you can modify the NMSP notification interval (to a value between 1 and 180 seconds) for clients, active RFID tags, and rogue access points and clients.

Note The TCP port (16113) that the controller and mobility services engine communicate over must be open (not blocked) on any firewall that exists between the controller and the mobility services engine for NMSP to function.

SUMMARY STEPS

1. **configure terminal**
2. **nmsp notification interval** {**attachment** *seconds* | **location** *seconds* | **rssi** [**clients** *interval* | **rfid** *interval* | **rogues** [**ap** | **client**] *interval*]}
3. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.
Step 2	**nmsp notification interval** {**attachment** *seconds* | **location** *seconds* | **rssi** [**clients** *interval* | **rfid** *interval* | **rogues** [**ap** | **client**] *interval*]} **Example:** `Controller(config)# nmsp notification interval rssi rfid 50`	Sets the NMSP notification interval value for clients, RFID tags, and rogue clients and access points. You can enter the NMSP notification interval value for RSSI measurement from 1 through 180 seconds.
Step 3	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.

Modifying the NMSP Notification threshold for Clients, RFID Tags, and Rogues (CLI)

SUMMARY STEPS

1. **configure terminal**
2. **location notify-threshold** {**clients** | **rogues ap** | **tags** } *threshold*
3. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.
Step 2	**location notify-threshold** {**clients** | **rogues ap** | **tags** } *threshold* **Example:** `Controller(config)# location notify-threshold clients 5`	Configures the NMSP notification threshold for clients, RFID tags, and rogue clients and access points. You can enter the RSSI threshold value from zero through 10 db.
Step 3	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.

Monitoring Location Settings and NMSP Settings

Monitoring Location Settings (CLI)

This section describes the new commands for location settings.

The following commands can be used to monitor location settings on the controller.

Table 20: Monitoring Location Settings Commands

Command	Purpose
show location summary	Displays the current location configuration values.
show location statistics rfid	Displays the location-based RFID statistics.
show location detail *client_mac_addr*	Displays the RSSI table for a particular client.

Monitoring NMSP Settings (CLI)

This section describes the new commands for NMSP settings.

The following commands can be used to monitor NMSP settings on the controller.

Table 21: Monitoring NMSP Settings Commands

Command	Purpose
show nmsp attachment suppress interfaces	Displays the attachment suppress interfaces.
show nmsp capability	Displays the NMSP capabilities.
show nmsp notification interval	Displays the NMSP notification intervals.
show nmsp statistics connection	Displays the connection-specific NMSP counters.
show nmsp statistics summary	Displays the common NMSP counters.
show nmsp status	Displays the status of active NMSP connections.
show nmsp subscription detail	Displays all of the mobility services to which the controller is subscribed.
show nmsp subscription detail *ip_addr*	Displays details only for the mobility services subscribed to by a specific IP address.
show nmsp subscription summary	Displays details for all of the mobility services to which the controller is subscribed.

Examples: Location Settings Configuration

This example shows how to configure the path loss measurement (S60) request for calibrating client on the associated 802.11a or 802.11b/g radio:

```
Controller# configure terminal
Controller(config)# location plm calibrating uniband
Controller(config)# end
Controller# show location summary
```

This example shows how to configure the RSSI half life for a rouge access point:

```
Controller# configure terminal
Controller(config)# location rssi-half-life rogue-aps 20
Controller(config)# end
Controller# show location summary
```

Examples: NMSP Settings Configuration

This example shows how to configure the NMSP notification interval for RFID tags:

```
Controller# configure terminal
Controller(config)# nmsp notification interval rssi rfid 50
```

```
Controller(config)# end
Controller# show nmsp notification interval
```

This example shows how to configure the NMSP notification threshold for clients:

```
Controller# configure terminal
Controller(config)# nmsp notify-threshold 5
Controller(config)# end
Controller# show nmsp statistics summary
```

Additional References for Location Settings

Related Documents

Related Topic	Document Title
System management commands	*System Management Command Reference, Cisco IOS XE Release 3SE (Cisco WLC 5700 Series)*

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

Feature History and Information For Performing Location Settings Configuration

Release	Feature Information
Cisco IOS XE 3.2SE	This feature was introduced.

CHAPTER 14

Monitoring Flow Control

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 Flow Control

Flow control is enabled by default on the controller.

Flow control provides shim layers between WCM and Cisco IOS for a reliable IPC. Every component in WCM has a dedicated channel. Few of the components in WCM have leveraged flow control in that. There is no configuration of flow control from CLI. You can monitor the flow control for any channel.

Monitoring Flow Control

This section describes the new commands for flow control.

The following commands can be used to monitor flow control on the controller.

Table 22: Monitoring Flow Control

Command	Purpose
show wireless flow-control *channel -id*	Displays information about flow control on a particular channel.
show wireless flow-control *channel-id* **statistics**	Displays statistical information about flow control on a particular channel.

Examples: Monitoring Flow Control

This example shows how to view information pertaining to any channel:

```
Controller# show wireless flow-control 3
Controller#

Channel Name        : CAPWAP
FC State            : Disabled
Remote Server State : Enabled
Pass-thru Mode      : Disabled
EnQ Disabled        : Disabled
Queue Depth         : 2048
Max Retries         : 5
Min Retry Gap (mSec): 3
```

This example shows how to view flow control for a particular channel:

```
Controller# show wireless flow-control 3
Controller#

Channel Name                                : CAPWAP
# of times channel went into FC             : 0
# of times channel came out of FC           : 0
Total msg count received by the FC Infra    : 1
Pass-thru msgs send count                   : 0
Pass-thru msgs fail count                   : 0
# of msgs successfully queued               : 0
# of msgs for which queuing failed          : 0
# of msgs sent thru after queuing           : 0
# of msgs sent w/o queuing                  : 1
# of msgs for which send failed             : 0
# of invalid EAGAINS received               : 0
Highest watermark reached                   : 0
# of times Q hit max capacity               : 0
Avg time channel stays in FC (mSec)         : 0
```

Additional References for Monitoring Flow Control

Related Documents

Related Topic	Document Title
System management commands	*System Management Command Reference Guide, Cisco IOS XE Release 3SE (Cisco WLC 5700 Series)*

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

Feature History and Information For Monitoring Flow Control

Release	Feature Information
Cisco IOS XE 3.3SE	This feature was introduced.

CHAPTER 15

Configuring System Message Logs

Information About Configuring System Message Logs

System Messsage 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 , and redirects the output to the logging process on the . Though the 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 . If a standalone switch or the stack master 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 23: System Log Message Elements

Element	Description
seq no:	Stamps log messages with a sequence number only if the **service sequence-numbers** global configuration command is configured.
timestamp formats: *mm/dd h h:mm:ss* or *hh:mm:ss* (short uptime) or *d h* (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.
facility	The facility to which the message refers (for example, SNMP, SYS, and so forth).
severity	Single-digit code from 0 to 7 that is the severity of the message.

Element	Description
MNEMONIC	Text string that uniquely describes the message.
description	Text string containing detailed information about the event being reported.
hostname-n	Hostname of a stack member and its switch number in the stack. Though the is a stack member, it does *not* append its hostname to system messages.

Default System Message Logging Settings

Table 24: 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.

SUMMARY STEPS

1. **configure terminal**
2. **logging buffered** [*size*]
3. **logging** *host*
4. **logging file flash:** *filename* [*max-file-size* [*min-file-size*]] [*severity-level-number* | *type*]
5. **end**
6. **terminal monitor**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.
Step 2	**logging buffered** [*size*] **Example:** `Controller(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 . The range is 4096 to 2147483647 bytes. The default buffer size is 4096 bytes. If a standalone switch or the fails, the log file is lost unless you previously saved it to flash memory. See Step 4. **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 *not* be set to this amount.

	Command or Action	Purpose
Step 3	**logging** *host* **Example:** `Controller(config)# logging 125.1.1.100`	Logs messages to a UNIX syslog server host. *host* specifies the name or IP address of the host to be used as the syslog server. To build a list of syslog servers that receive logging messages, enter this command more than once.
Step 4	**logging file flash:** *filename* [*max-file-size* [*min-file-size*]] [*severity-level-number* | *type*] **Example:** `Controller(config)# logging file flash:log_msg.txt 40960 4096 3`	Stores log messages in a file in flash memory on a standalone switch or, in the case of a switch stack, on the . • *filename*—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) *min-file-size*—Specifies the minimum logging file size. The range is 1024 to 2147483647. The default is 2048 bytes. • (Optional) *severity-level-number* | *type*—Specifies either the logging severity level or the logging type. The severity range is 0 to 7.
Step 5	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode.
Step 6	**terminal monitor** **Example:** `Controller# terminal monitor`	Logs messages to a nonconsole terminal during the current session. Terminal parameter-setting commands are set locally and do not remain in effect after the 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.

SUMMARY STEPS

1. **configure terminal**
2. **line** [**console** | **vty**] *line-number* [*ending-line-number*]
3. **logging synchronous** [**level** [*severity-level* | **all**] | **limit** *number-of-buffers*]
4. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.
Step 2	**line** [**console** | **vty**] *line-number* [*ending-line-number*] **Example:** `Controller(config)# line console`	Specifies the line to be configured for synchronous logging of messages. • **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: line vty 2 When you enter this command, the mode changes to line configuration.
Step 3	**logging synchronous** [**level** [*severity-level* | **all**] | **limit** *number-of-buffers*] **Example:** `Controller(config)# logging synchronous level 3 limit 1000`	Enables synchronous logging of messages. • (Optional) **level** *severity-level*—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** *number-of-buffers*—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.

	Command or Action	Purpose
Step 4	**end** **Example:** `Controller(config)# end`	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.

SUMMARY STEPS

1. **configure terminal**
2. **no logging console**
3. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.
Step 2	**no logging console** **Example:** `Controller(config)# no logging console`	Disables message logging.

	Command or Action	Purpose
Step 3	**end** **Example:** `Controller(config)# end`	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.

SUMMARY STEPS

1. **configure terminal**
2. Use one of these commands:
   - **service timestamps log uptime**
   - **service timestamps log datetime**[**msec** | **localtime** | **show-timezone**]
3. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.
Step 2	Use one of these commands: • **service timestamps log uptime** • **service timestamps log datetime**[**msec** | **localtime** | **show-timezone**] **Example:** `Controller(config)# service timestamps log uptime`	Enables log time stamps. • **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
	or `Controller(config)# service timestamps log datetime`	
Step 3	**end** **Example:** `Controller(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.

SUMMARY STEPS

1. **configure terminal**
2. **service sequence-numbers**
3. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.
Step 2	**service sequence-numbers** **Example:** `Controller(config)# service sequence-numbers`	Enables sequence numbers.
Step 3	**end** **Example:** `Controller(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.

SUMMARY STEPS

1. **configure terminal**
2. **logging console** *level*
3. **logging monitor** *level*
4. **logging trap** *level*
5. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.
Step 2	**logging console** *level* **Example:** `Controller(config)# logging console 3`	Limits messages logged to the console. By default, the console receives debugging messages and numerically lower levels.
Step 3	**logging monitor** *level* **Example:** `Controller(config)# logging monitor 3`	Limits messages logged to the terminal lines. By default, the terminal receives debugging messages and numerically lower levels.
Step 4	**logging trap** *level* **Example:** `Controller(config)# logging trap 3`	Limits messages logged to the syslog servers. By default, syslog servers receive informational messages and numerically lower levels.

	Command or Action	Purpose
Step 5	**end** **Example:** `Controller(config)# end`	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.

SUMMARY STEPS

1. **configure terminal**
2. **logging history** *level*
3. **logging history size** *number*
4. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.
Step 2	**logging history** *level* **Example:** `Controller(config)# logging history 3`	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.
Step 3	**logging history size** *number* **Example:** `Controller(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.

	Command or Action	Purpose
Step 4	**end** **Example:** `Controller(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.

SUMMARY STEPS

1. Add a line to the file /etc/syslog.conf.
2. Enter these commands at the UNIX shell prompt.
3. Make sure the syslog daemon reads the new changes.

DETAILED STEPS

	Command or Action	Purpose
Step 1	Add a line to the file /etc/syslog.conf. **Example:** `local7.debug /usr/adm/logs/`*cisco.log*	• **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:** `$ touch /var/log/`*cisco.log*	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
	`$ chmod 666 /var/log/`*cisco.log*	
Step 3	Make sure the syslog daemon reads the new changes. **Example:** `$ kill -HUP `cat /etc/syslog.pid``	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
show archive log config {**all** | **number** [*end-number*] | **user** *username* [**session** *number*] *number* [*end-number*] | **statistics**} [**provisioning**]	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 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 3.2SE	This feature was introduced.

CHAPTER 16

Configuring Online Diagnostics

Information About Configuring Online Diagnostics

Online Diagnostics

With online diagnostics, you can test and verify the hardware functionality of the switch while the switch 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 switch 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 switch 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 switch, 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:

SUMMARY STEPS

1. **diagnostic start switch** *number* **test** {*name* | *test-id* | *test-id-range* | **all** | **basic** | **complete** | **minimal** | **non-disruptive** | **per-port**}

DETAILED STEPS

	Command or Action	Purpose
Step 1	**diagnostic start switch** *number* **test** {*name* | *test-id* | *test-id-range* | **all** | **basic** | **complete** | **minimal** | **non-disruptive** | **per-port**} **Example:** `Controller# diagnostic start switch 2 test basic`	Starts the diagnostic tests. The **switch** *number* keyword is supported only on stacking switches. The range is from 1 to 4. You can specify the tests by using one of these options: • *name*—Enters the name of the test. • *test-id*—Enters the ID number of the test. • *test-id-range*—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 switch. Use the **no** form of this command to remove the scheduling.

SUMMARY STEPS

1. **configure terminal**
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*}

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# 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:** `Controller(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 4. When specifying the tests to be scheduled, use these options: • *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. You can schedule the tests as follows: • Daily—Use the **daily** *hh:mm* parameter. • Specific day and time—Use the **on** *mm dd yyyy hh:mm* parameter.

	Command or Action	Purpose
		• Weekly—Use the **weekly** *day-of-week hh:mm* parameter.

Configuring Health-Monitoring Diagnostics

You can configure health-monitoring diagnostic testing on a switch while it is connected to a live network. You can configure the execution interval for each health-monitoring test, enable the switch 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 switch generates a syslog message when a test fails.

SUMMARY STEPS

1. **configure terminal**
2. **diagnostic monitor interval switch** *number* **test** {*name* | *test-id* | *test-id-range* | **all**} *hh:mm:ss milliseconds day*
3. **diagnostic monitor syslog**
4. **diagnostic monitor threshold switch** *number* **test** {*name* | *test-id* | *test-id-range* | **all**} **failure count** *count*
5. **diagnostic monitor switch** *number* **test** {*name* | *test-id* | *test-id-range* | **all**}
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Controller# configure terminal`	Enters global configuration mode.
Step 2	**diagnostic monitor interval switch** *number* **test** {*name* | *test-id* | *test-id-range* | **all**} *hh:mm:ss milliseconds day* **Example:** `Controller(config)# diagnostic monitor interval switch 2 test 1 12:30:00 750 5`	Configures the health-monitoring interval of the specified tests. The **switch** *number* keyword is supported only on stacking switches. When specifying the tests, use one of these parameters: • *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 of the diagnostic tests.

	Command or Action	Purpose
		When specifying the interval, set these parameters: • *hh:mm:ss*—Monitoring interval in hours, minutes, and seconds. The range for *hh* is 0 to 24, and the range for *mm* and *ss* is 0 to 60. • *milliseconds*—Monitoring interval in milliseconds (ms). The range is from 0 to 999. • *day*—Monitoring interval in the number of days. The range is from 0 to 20.
Step 3	**diagnostic monitor syslog** **Example:** `Controller(config)# diagnostic monitor syslog`	(Optional) Configures the switch to generate a syslog message when a health-monitoring test fails.
Step 4	**diagnostic monitor threshold switch** *number* **test** {*name* | *test-id* | *test-id-range* | **all**} **failure count** *count* **Example:** `Controller(config)# diagnostic monitor threshold switch 2 test 1 failure count 20`	(Optional) Sets the failure threshold for the health-monitoring tests. When specifying the tests, use one of these parameters: • *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 of the diagnostic tests. The range for the failure threshold *count* is 0 to 99.
Step 5	**diagnostic monitor switch** *number* **test** {*name* | *test-id* | *test-id-range* | **all**} **Example:** `Controller(config)# diagnostic monitor switch 2 test 1`	Enables the specified health-monitoring tests. The **switch** *number* keyword is supported only on stacking switches. The range is from 1 to 9. When specifying the tests, use one of these parameters: • *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 of the diagnostic tests.

	Command or Action	Purpose
Step 6	**end** **Example:** `Controller(config)# end`	Returns to privileged EXEC mode.

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 switch ro switch stack and check the test results by using the privileged EXEC **show** commands in this table:

Table 25: Commands for Diagnostic Test Configuration and Results

Command	Purpose
show diagnostic content switch [*number* | **all**]	Displays the online diagnostics configured for a switch. The **switch** [*number* | **all**] parameter is supported only on stacking switches.
show diagnostic status	Displays the currently running diagnostic tests.
show diagnostic result switch [*number* | **all**] [**detail** | **test** {*name* | *test-id* | *test-id-range* | **all**} [**detail**]]	Displays the online diagnostics test results. The **switch** [*number* | **all**] parameter is supported only on stacking switches.
show diagnostic switch [*number* | **all**] [**detail**]	Displays the online diagnostics test results. The **switch** [*number* | **all**] parameter is supported only on stacking switches.
show diagnostic schedule switch [*number* | **all**]	Displays the online diagnostics test schedule. The **switch** [*number* | **all**] parameter is supported only on stacking switches.

Command	Purpose
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:

```
Controller# diagnostic start switch 2 test TestInlinePwrCtlr
```

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

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

Example: Configure a Health Monitoring Test

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

```
Controller(config)# diagnostic monitor threshold switch 1 test 1 failure count 50
Controller(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:

```
Controller(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:

```
Controller(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:

```
Controller# show diagnostic ondemand settings

Test iterations = 1
```

```
Action on test failure = continue
```

This example shows how to display diagnostic events for errors:

```
Controller# 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:

```
Controller# 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.

Controller#
```

This example shows how to display the boot up level:

```
Controller# show diagnostic bootup level

Current bootup diagnostic level: minimal

Controller#
```

Additional References for Online Diagnostics

Related Documents

Related Topic	Document Title
System management commands	*System Management Command Reference (Cisco WLC 5700 Series)*
Platform-independent command reference	*Configuration Fundamentals Command Reference, Cisco IOS XE Release 3S (Catalyst 3850 Switches)*
Platform-independent configuration information	*Configuration Fundamentals Configuration Guide, Cisco IOS XE Release 3S (Catalyst 3850 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
The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.	http://www.cisco.com/support

Feature History and Information for Configuring Online Diagnostics

Release	Modification
Cisco IOS XE 3.2SE	This feature was introduced.

CHAPTER 17

Predownloading an Image to Access Points

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.

Predownloading an Image to an Access Point

To minimize network outages, you can now download an upgrade image to the access point from the controller without resetting the access point or losing network connectivity. Previously, you would download an upgrade image to the controller and reset it, which causes the access point to go into discovery mode. After the access point discovers the controller with the new image, the access point downloads the new image, resets, goes into discovery mode, and rejoins the controller.

You can now download the upgrade image to the controller and then download the image to the access point while the network is still up. When both devices are up, the access point discovers and rejoins the controller.

Restrictions for Predownloading an Image to an Access Point

The following are the restrictions for predownloading an image to an access point:

- The maximum number of concurrent predownloads is limited to half the number of concurrent normal image downloads. This limitation allows new access points to join the controller during image downloading.

  If you reach the predownload limit, then the access points that cannot get an image sleep for a time between 180 to 600 seconds and then reattempt the predownload.
- Access points with 16-MB total available memory may not have enough free memory to download an upgrade image and may automatically delete crash info files, radio files, and any backup images to free up space. However, this limitation does not affect the predownload process because the predownload image replaces any backup image on the access point.
- All of the primary, secondary, and tertiary controllers should run the same images or the feature will not be effective.
- At the time of reset, you must make sure that all of the access points have downloaded the image.
- The access point can store only two software images.

How to Predownload an Image to an Access Point

Predownloading an Image to Access Points (CLI)

Before You Begin

There are some prerequisites that you must keep in mind while predownloading an image to an access point:

- Predownloading can be done only when the controller is booted in the install mode.
- You can copy the new image either from the TFTP server, flash image, or USB.
- Before predownloading the new image, you must install the new software using the **software install** command and select **no** to the **reload** option.

SUMMARY STEPS

1. **ap image predownload** or **ap** *ap-name* **predownload**
2. **show ap image**
3. **ap image swap**
4. **ap image reset**
5. **reload**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**ap image predownload** or **ap** *ap-name* **predownload**
	
	Example:
	`Controller# ap image predownload`
	`Controller# ap ap1 predownload`
		Downloads the new image to all access points or a specific access point connected to the controller.

Step 2	**show ap image** **Example:** `Controller# show ap image`	Verifies the access points predownload process.
Step 3	**ap image swap** **Example:** `Controller# ap image swap`	Specifies to swap the backup image to the primary image.
Step 4	**ap image reset** **Example:** `Controller# ap image reset`	Resets the access points.
Step 5	**reload** **Example:** `Controller# reload`	Resets the system.

Monitoring Access Point Predownload Process

This section describes the command for monitoring the access point predownload process.

The following command can be used to monitor the access point predownload process.

Table 26: Monitoring Access Point Predownload Process Commands

Command	Purpose
show ap image	Verifies the access points predownload process.

Displaying Access Point Predownload Status

While downloading the access point predownload image, you can simultaneously enter the **show ap image** command to verify the predownload progress on the access points:

```
Controller# show ap image
Total number of APs  : 1

Number of APs
```

```
       Initiated                  : 1
       Predownloading             : 1
       Completed predownloading   : 0
       Not Supported              : 0
       Failed to Predownload      : 0

AP Name                           Primary Image   Backup Image    Predownload Status
Predownload Ver...  Next Retry Time    Retry Count
-----------------------------------------------------------------------------------------
AP1                               10.0.1.66       10.0.1.66       Predownloading
10.0.1.67           NA                            0


Controller# show ap image

Total number of APs  : 1

Number of APs
       Initiated                  : 1
       Predownloading             : 0
       Completed predownloading   : 1
       Not Supported              : 0
       Failed to Predownload      : 0

AP Name                           Primary Image   Backup Image    Predownload Status
Predownload Ver...  Next Retry Time    Retry Count
-----------------------------------------------------------------------------------------
AP1                               10.0.1.66       10.0.1.67       Complete
10.0.1.67           NA                            0
```

Examples: Access Point Predownload Process

This example shows how to predownload an image to an access point AP1:

```
Controller# ap image predownload
Controller# show ap image
Controller# ap image swap
Controller# show ap image
Controller# ap image reset
Controller# reload
```

Additional References for Predownloading an Image to an Access Point

Related Documents

Related Topic	Document Title
Lightweight access points configuration	
Lightweight Access Point commands	

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

Feature History and Information For Performing Predownloading an Image to an Access Point

Release	Feature Information
Cisco IOS XE 3.2SE	This feature was introduced.

CHAPTER 18

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.

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.

Related Topics

Recovering from a Software Failure, on page 237

Lost or Forgotten Password on a Controller

The default configuration for the controller allows an end user with physical access to the controller 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 controller.

Note On these controllers, 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.

Related Topics

Recovering from a Lost or Forgotten Password, on page 238

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 Configuration Guide (Cisco WLC 5700 Series)*.

Related Topics

Scenarios to Troubleshoot Power over Ethernet (PoE), on page 250

Disabled Port Caused by Power Loss

If a powered device (such as a Cisco IP Phone 7910) that is connected to a PoE switch 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 switch to recover from the error-disabled state.

On a switch, 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 switch 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.

Related Topics

Executing Ping, on page 244

Example: Pinging an IP Host, on page 253

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 switches in the path. When the switch detects a device in the path that does not support Layer 2 traceroute, the switch continues to send Layer 2 trace queries and lets them time out.

The switch 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 switch is reachable from another switch when you can test connectivity by using the **ping** privileged EXEC command. All switches 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 switch that is not in the physical path from the source device to the destination device. All switches 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 switch 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 switch uses the associated MAC address and identifies the physical path.
    - If an ARP entry does not exist, the switch 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.

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 switches 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 switch is the destination of the traceroute, it is displayed as the final destination in the traceroute output. Intermediate switches 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 switch is a multilayer switch that is routing a particular packet, this switch shows up as a hop in the traceroute output.

The **traceroute** privileged EXEC command uses the Time To Live (TTL) field in the IP header to cause routers and servers to generate specific return messages. Traceroute 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. Traceroute 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, traceroute 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, traceroute 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.

Related Topics

Executing IP Traceroute, on page 246

Example: Performing a Traceroute to an IP Host, on page 253

Time Domain Reflector Guidelines

You can use the Time Domain Reflector (TDR) feature to diagnose and resolve cabling problems. When running TDR, a local device sends a signal through a cable and compares the reflected signal to the initial signal.

TDR is supported only on 10/100/1000 copper Ethernet ports. It is not supported on 10-Gigabit Ethernet ports and on SFP module ports.

TDR can detect these cabling problems:

- Open, broken, or cut twisted-pair wires—The wires are not connected to the wires from the remote device.
- Shorted twisted-pair wires—The wires are touching each other or the wires from the remote device. For example, a shorted twisted pair can occur if one wire of the twisted pair is soldered to the other wire.

If one of the twisted-pair wires is open, TDR can find the length at which the wire is open.

Use TDR to diagnose and resolve cabling problems in these situations:

- Replacing a switch
- Setting up a wiring closet
- Troubleshooting a connection between two devices when a link cannot be established or when it is not operating properly

When you run TDR, the switch reports accurate information in these situations:

- The cable for the gigabit link is a solid-core cable.

- The open-ended cable is not terminated.

When you run TDR, the switch does not report accurate information in these situations:

- The cable for the gigabit link is a twisted-pair cable or is in series with a solid-core cable.
- The link is a 10-megabit or a 100-megabit link.
- The cable is a stranded cable.
- The link partner is a Cisco IP Phone.
- The link partner is not IEEE 802.3 compliant.

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.

Related Topics

Redirecting Debug and Error Message Output, on page 246
Example: Enabling All System Diagnostics, on page 254

Crashinfo Files

The crashinfo files save information that helps Cisco technical support representatives to debug problems that caused the Cisco IOS image to fail (crash). The switch generates two files at the time of the failure: full core and crashinfo.

The information in the crashinfo file includes the Cisco IOS image name and version that failed, a list of the processor registers, and a stack trace. You can provide this information to the Cisco technical support representative by using the **show tech-support** privileged EXEC command.

The file names have the following format:

```
[fullcore | crashinfo]_[process that crashed]_[date]-[timestamp]-UTC
```

From IOS, you can view the crashinfo files on each switch by using the following command:

```
Controller#  dir crashinfo?
crashinfo-1: crashinfo-2: crashinfo-3: crashinfo:
Controller#
```

For example, to access the crashinfo directory for switch 1, enter

```
Controller dir crashinfo-1
```

From the ROMMON prompt, you can view the crashinfo files by using the **dir** command:

```
Controller: dir sda1
```

The following is sample output of a crashinfo file

```
Controller# dir crashinfo:

Directory of crashinfo:/

   12  -rwx        2768  Dec 31 1969 16:00:15 -08:00  koops.dat
   15  -rwx           0  Jan 12 2000 22:53:40 -08:00  deleted_crash_files
   16  -rwx     4246576  Jan 12 2000 22:53:40 -08:00  crashinfo_stack-mgr_20000113-065250-UTC

   17  -rwx          50   Oct 2 2012 03:18:42 -08:00  last_crashinfo
   26  -rwx          39  Jan 22 2013 14:14:14 -08:00  last_systemreport
   18  -rwx     2866565  Jan 12 2000 22:53:41 -08:00  fullcore_stack-mgr_20000113-065250-UTC

   20  -rwx     4391796   Feb 1 2000 17:50:44 -08:00  crashinfo_stack-mgr_20000202-014954-UTC

   21  -rwx     2920325   Feb 1 2000 17:50:45 -08:00  fullcore_stack-mgr_20000202-014954-UTC
34817  -rw-     1050209  Jan 10 2013 20:26:23 -08:00  system-report_1_20130111-042535-UTC.gz
18434  -rw-     1016913  Jan 11 2013 10:35:28 -08:00  system-report_1_20130111-183440-UTC.gz
18435  -rw-     1136167  Jan 22 2013 14:14:11 -08:00  system-report_1_20130122-221322-UTC.gz
34821  -rw-     1094631   Jan 2 2013 17:59:23 -08:00  system-report_1_20130103-015835-UTC.gz

 6147  -rw-      967429   Jan 3 2013 10:32:44 -08:00  system-report_1_20130103-183156-UTC.gz
34824  -rwx          50  Jan 22 2013 14:14:14 -08:00  deleted_sysreport_files
6155  -rwx         373  Jan 22 2013 14:14:13 -08:00  last_systemreport_log

145898496 bytes total (18569216 bytes free)
stack3#

The file name of the most recent crashinfo file is stored in last_crashinfo.
The file name of the most recent system report is stored in last_systemreport.


Controller#
```

System Reports

When a controller crashes, a system report is automatically generated for each switch in the switch stack. The system report file captures all the trace buffers, and other system-wide logs found on the switch. System reports are located in the crashinfo directory in the following format:
`system-report_[switch number]_[date]-[timestamp]-UTC.gz`

After a switch crash, you should check if a system report file was generated. 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 when troubleshooting your issue.

Onboard Failure Logging on the Switch

You can use the onboard failure logging (OBFL) feature to collect information about the switch. The information includes uptime, temperature, and voltage information and helps Cisco technical support representatives to troubleshoot switch 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 switch and small form-factor pluggable (SFP) modules. The switch stores this information in the flash memory:

- CLI commands—Record of the OBFL CLI commands that are entered on a standalone switch or a switch stack member.

- Environment data—Unique device identifier (UDI) information for a standalone switch or a 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 switch or a stack member.
- Power over Ethernet (PoE)—Record of the power consumption of PoE ports on a standalone switch or a stack member.
- Temperature—Temperature of a standalone switch or a stack member.
- Uptime data—Time when a standalone switch or a stack member starts, the reason the switch restarts, and the length of time the switch has been running since it last restarted.
- Voltage—System voltages of a standalone switch or a stack member.

You should manually set the system clock or configure it by using Network Time Protocol (NTP).

When the switch is running, you can retrieve the OBFL data by using the **show logging onboard** privileged EXEC commands. If the switch fails, contact your Cisco technical support representative to find out how to retrieve the data.

When an OBFL-enabled switch is restarted, there is a 10-minute delay before logging of new data begins.

Related Topics

Configuring OBFL, on page 247

Displaying OBFL Information, on page 248

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 switch does not shut down, and this error message appears:

```
Multiple fan(FRU/PS) failure detected. System may get overheated. Change fan quickly.
```

The switch 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 switch fails, the switch automatically shuts down, and this error message appears:

```
Faulty (FRU/PS) fans detected, shutting down system!
```

After the first fan shuts down, if the switch detects a second fan failure, the switch waits for 20 seconds before it shuts down.

To restart the switch, 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.

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:

Related Topics

Software Failure on a Switch, on page 229

Recovering from a Lost or Forgotten Password

The default configuration for the switch allows an end user with physical access to the switch 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 switch.

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.

SUMMARY STEPS

1. Connect a terminal or PC to the switch.
2. Set the line speed on the emulation software to 9600 baud.
3. Power off the standalone switch or the entire switch stack.
4. Reconnect the power cord to the or the . Within 15 seconds, press the **Mode** button while the System LED is still flashing green. Continue pressing the **Mode** button until all the system LEDs turn on and remain solid; then release the **Mode** button.
5. After recovering the password, reload the switch or the .
6. Power on the remaining switches in the stack.

DETAILED STEPS

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 or
- 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 or the . Within 15 seconds, press the **Mode** button while the System LED is still flashing green. Continue pressing the **Mode** button until all the system LEDs turn on and remain solid; then release the **Mode** button.

-

```
Switch:
Xmodem file system is available.
Base ethernet MAC Address: 20:37:06:4d:e9:80
Verifying bootloader digital signature.


The system has been interrupted prior to loading the operating
system software, console will be reset to 9600 baud rate.
```

proceed to the *Procedure with Password Recovery Enabled* section, and follow the steps.

Step 5 After recovering the password, reload the switch or the .
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.

Related Topics

Lost or Forgotten Password on a Controller, on page 230

Procedure with Password Recovery Enabled

If the password-recovery operation is enabled, this message appears:

Step 1 Ignore the startup configuration with the following command:

```
Controller: SWITCH_IGNORE_STARTUP_CFG=1
```

Step 2 Boot the switch with the *packages.conf* file from flash.

```
Controller: 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.

```
Controller> enable
Switch#
```

Step 5 Copy the startup configuration to running configuration.

```
Controller# 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.

```
Controller# configure terminal
Controller(config)#
```

Step 7 Write the running configuration to the startup configuration file.

```
Controller# copy running-config startup-config
```

Step 8 Confirm that manual boot mode is enabled.

```
Controller# show boot

 BOOT variable = flash:packages.conf;
 Manual Boot = yes
 Enable Break = yes
```

Step 9 Reload the controller.

```
Controller# reload
```

Step 10 Return the Bootloader parameters (previously changed in Steps 2 and 3) to their original values.

```
Controller: switch: SWITCH_IGNORE_STARTUP_CFG=0
```

Step 11 Boot the controller with the *packages.conf* file from flash.

```
Controller: boot flash:packages.conf
```

Step 12 After the controller boots up, disable manual boot on the controller.

```
Controller(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 switch 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 switch 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.

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:

```
Controller: dir flash:
```

The switch file system appears.

Step 3 Boot up the system:

```
Controller: 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 switch prompt, enter privileged EXEC mode:

```
Controller> enable
```

Step 5 Enter global configuration mode:

```
Controller# configure terminal
```

Step 6 Change the password:

```
Controller(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:

```
Controller(config)# exit
Controller#
```

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:

```
Controller# copy running-config startup-config
```

The new password is now in the startup configuration.

Step 9 You must now reconfigure the switch. If the system administrator has the backup switch 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 switches 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 switch should be green. Depending on the switch 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 . 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 switches in the stack can make it easier to remotely troubleshoot the switch stack. However, you need to remember that the switches have manually assigned numbers if you add, remove, or rearrange switches 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 switch functions with the exact same configuration as the replaced switch. This is also assuming the new switch is using the same member number as the replaced switch.

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 switches.

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 switch, the switch 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 switch 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 switch, 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 switch brings the interface out of the error-disabled state and retries the operation.

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.

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 switches.

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 switch:

Command	Purpose
ping ip *host* | *address* `Controller# ping 172.20.52.3`	Pings a remote host through IP or by supplying the hostname or network address.

Related Topics

Ping, on page 231
Example: Pinging an IP Host, on page 253

Monitoring Temperature

The switch 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 switch (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.

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 27: Monitoring the Physical Path

Command	Purpose
tracetroute mac [**interface** *interface-id*] {*source-mac-address*} [**interface** *interface-id*] {*destination-mac-address*} [**vlan** *vlan-id*] [**detail**]	Displays the Layer 2 path taken by the packets from the specified source MAC address to the specified destination MAC address.
tracetroute mac ip {*source-ip-address* | *source-hostname*}{*destination-ip-address* | *destination-hostname*} [**detail**]	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* `Controller# traceroute ip 192.51.100.1`	Traces the path that packets take through the network.

Related Topics

IP Traceroute , on page 232
Example: Performing a Traceroute to an IP Host, on page 253

Running TDR and Displaying the Results

To run TDR, enter the **test cable-diagnostics tdr interface** *interface-id* privileged EXEC command.

To display the results, enter the **show cable-diagnostics tdr interface** *interface-id* privileged EXEC command.

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.

Related Topics

Debug Commands, on page 234

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 switch application-specific integrated circuits (ASICs). However, packet forwarding information can also be helpful in troubleshooting.

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 level** *level*] global configuration command. On switches, the range for *switch-number* is from 1 to 9. Use the **message level** *level* parameter to specify the severity of the hardware-related messages that the switch generates and stores in the flash memory.
- To copy the OBFL data to the local network or a specific file system, use the **copy onboard switch** *switch-number* **url** *url-destination* privileged EXEC command.
- To disable OBFL, use the **no hw-switch switch** [*switch-number*] **logging onboard** [**message level**] global configuration command.
- To clear all the OBFL data in the flash memory except for the uptime and CLI command information, use the **clear onboard switch** *switch-number* privileged EXEC command.
- In a switch stack, you can enable OBFL on a standalone switch or on all stack members by using the **hw-switch switch** [*switch-number*] **logging onboard** [**message level** *level*] global configuration command.
- You can enable or disable OBFL on a member switch from the .

Related Topics

Onboard Failure Logging on the Switch, on page 235
Displaying OBFL Information, on page 248

Verifying Troubleshooting of the Software Configuration

Displaying OBFL Information

Table 28: Commands for Displaying OBFL Information

Command	Purpose
show onboard switch *switch-number* **clilog** `Controller# 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** `Controller# 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.
show onboard switch *switch-number* **message** `Controller# show onboard switch 1 message`	Displays the hardware-related messages generated by a standalone switch or the specified stack members.
show onboard switch *switch-number* **counter** `Controller# show onboard switch 1 counter`	Displays the counter information on a standalone switch or the specified stack members.
show onboard switch *switch-number* **temperature** `Controller# show onboard switch 1 temperature`	Displays the temperature of a standalone switch or the specified switch stack members.
show onboard switch *switch-number* **uptime** `Controller# 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 *switch-number* **voltage** `Controller# show onboard switch 1 voltage`	Displays the system voltages of a standalone switch or the specified stack members.
show onboard switch *switch-number* **status** `Controller# show onboard switch 1 status`	Displays the status of a standalone switch or the specified stack members.

Related Topics

Onboard Failure Logging on the Switch, on page 235
Configuring OBFL, on page 247

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.

```
Controller# 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 29: 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 30: Power over Ethernet Troubleshooting Scenarios

Symptom or Problem	Possible Cause and Solution
Only one port does not have PoE. Trouble is on only one switch port. PoE and non-PoE devices do not work on this port, but do on other ports.	Verify that the powered device works on another PoE port. Use the **show run**, or **show interface status** user EXEC commands to verify that the port is not shut down or error-disabled. **Note** Most switches turn off port power when the port is shut down, even though the IEEE specifications make this optional. 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. Verify that the total cable length from the switch front panel to the powered device is not more than 100 meters. 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. 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 inline power** command to verify the amount of available power.

Symptom or Problem	Possible Cause and Solution
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.	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. 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. Use the **show log** privileged EXEC command to review alarms or system messages that previously reported PoE conditions or status changes. 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. Use the **show env power** and **show power inline** privileged EXEC commands to review the PoE status and power budget (available PoE). Review the running configuration to verify that **power inline never** is not configured on the ports. 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. 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. 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. 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. 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.

Symptom or Problem	Possible Cause and Solution
Cisco IP Phone disconnects or resets. After working normally, a Cisco phone or wireless access point intermittently reloads or disconnects from PoE.	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. Verify that the cable length is not more than 100 meters from the switch port to the powered device. Notice what changes in the electrical environment at the switch location or what happens at the powered device when the disconnect occurs. Notice whether any error messages appear at the same time a disconnect occurs. Use the **show log** privileged EXEC command to review error messages. 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.) 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.
Non-Cisco powered device does not work on Cisco PoE switch. 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.	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. Use the **show interface status** command to verify that the switch detects the connected powered device. 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 *inrush*) current that exceeds a current-limit threshold for the port.

Related Topics

Power over Ethernet Ports, on page 230

Configuration Examples for Troubleshooting Software

Example: Pinging an IP Host

This example shows how to ping an IP host:

```
Controller# 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
Controller#
```

Table 31: 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.

Related Topics

Ping, on page 231
Executing Ping, on page 244

Example: Performing a Traceroute to an IP Host

This example shows how to perform a **traceroute** to an IP host:

```
Controller# 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 32: 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.
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.

Related Topics

IP Traceroute , on page 232
Executing IP Traceroute, on page 246

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:

```
Controller# 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.

Related Topics

Debug Commands, on page 234

Feature History and Information for Troubleshooting Software Configuration

Release	Modification
Cisco IOS XE 3.2SE	This feature was introduced.

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