Stack Manager and High Availability Configuration Guide, Cisco IOS XE Release 3.6E (Catalyst 3650 Switches)

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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 switch, refer to the switch release notes.

- Cisco Catalyst 3650 Switch documentation, located at:

  http://www.cisco.com/go/cat3650_docs

- Cisco SFP and SFP+ modules documentation, including compatibility matrixes, located at:

  http://www.cisco.com/en/US/products/hw/modules/ps5455/tsd_products_support_series_home.html

- Error Message Decoder, located at:

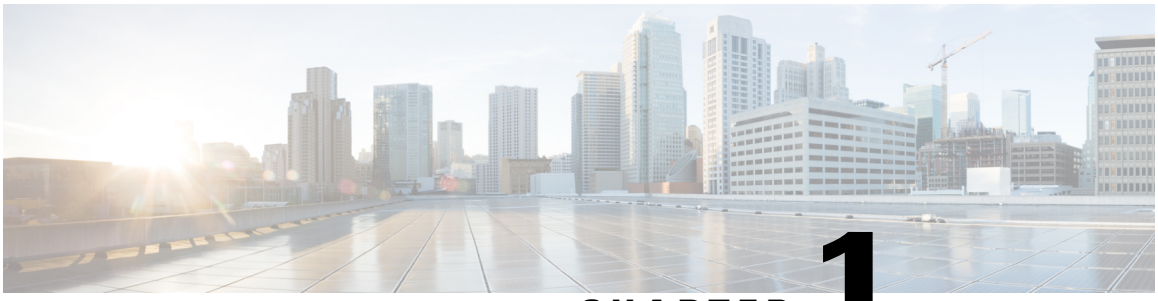
  https://www.cisco.com/cgi-bin/Support/Errordecoder/index.cgi

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

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 switch 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 switch 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.	`Switch>`	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.	`Switch#`	Enter **disable** to exit.	Use this mode to verify commands that you have entered. Use a password to protect access to this mode.
Global configuration	While in privileged EXEC mode, enter the **configure** command.	`Switch(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 switch.
VLAN configuration	While in global configuration mode, enter the **vlan** *vlan-id* command.	`Switch(config-vlan)#`	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 switch startup configuration file.
Interface configuration	While in global configuration mode, enter the **interface** command (with a specific interface).	`Switch(config-if)#`		Use this mode to configure parameters for the Ethernet ports.

Mode	Access Method	Prompt	Exit Method	About This Mode
			To exit to global configuration mode, enter **exit**. To return to privileged EXEC mode, press **Ctrl-Z** or enter **end**.	
Line configuration	While in global configuration mode, specify a line with the **line vty** or **line console** command.	`Switch(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.

Understanding Abbreviated Commands

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

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

```
Switch# 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 switch.

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 switch 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 switch 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.

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:** `Switch# help`	Obtains a brief description of the help system in any command mode.

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

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

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

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

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 switch 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:** `Switch# terminal history size 200`	Changes the number of command lines that the switch 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:** `Switch# 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:** `Switch# 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:** `Switch# terminal editing`	Reenables the enhanced editing mode for the current terminal session in privileged EXEC mode.
Step 2	**terminal no editing** **Example:** `Switch# 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 switch 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:
	`Switch(config)# access-list 101 permit tcp 10.15.22.25 255.255.255.0 10.15.22.35`
	`Switch(config)# $ 101 permit tcp 10.15.22.25 255.255.255.0 10.15.22.35 255.25`
	`Switch(config)# $t tcp 10.15.22.25 255.255.255.0 131.108.1.20 255.255.255.0 eq`
	`Switch(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:** `Switch(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. 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:
	`Switch# 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 on a Switch Stack

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

You manage the switch stack and the stack member interfaces through the active switch. You cannot manage stack members on an individual switch basis. You can connect to the active switch through the console port or the Ethernet management port of one or more stack members. Be careful with using multiple CLI sessions on the active switch. Commands that you enter in one session are not displayed in the other sessions. Therefore, it is possible to lose track of the session from which you entered commands.

Note We recommend using one CLI session when managing the switch stack.

If you want to configure a specific stack member port, you must include the stack member number in the CLI command interface notation.

To debug the standby switch, use the **session standby ios** privileged EXEC command from the active switch to access the IOS console of the standby switch. To debug a specific stack member, use the **session switch** *stack-member-number* privileged EXEC command from the active switch to access the diagnostic shell of the stack member. For more information about these commands, see the switch command reference.

To debug a specific stack member, you can start a CLI session from the stack master by using the **session** *stack-member-number* privileged EXEC command. The stack member number is appended to the system prompt. For example, *Switch-2#* is the prompt for stack member 2 where the system prompt for the stack master is Switch. Only the **show** and **debug** commands are available in a CLI session to a specific stack member. You can also use the **remote command** *stack-member-number LINE* privileged EXEC command on the stack master to enable debugging on a member switch without first starting a session.

Accessing the CLI Through a Console Connection or Through Telnet

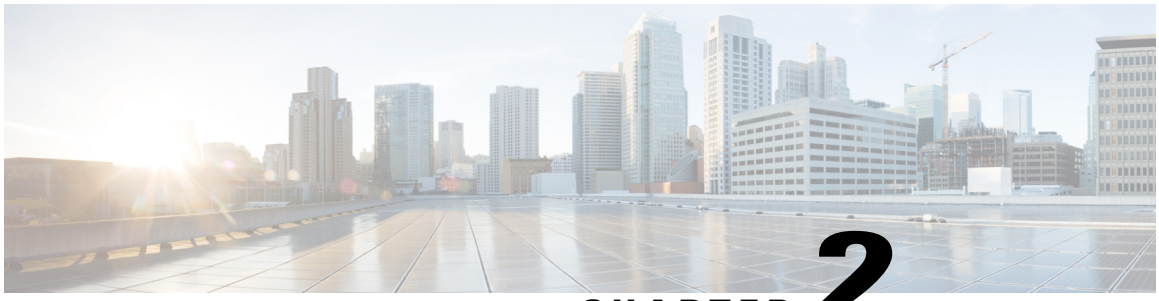
Before you can access the CLI, you must connect a terminal or a PC to the switch console or connect a PC to the Ethernet management port and then power on the switch, as described in the hardware installation guide that shipped with your switch.

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

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

- Connect the switch 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 switch hardware installation guide.
- Use any Telnet TCP/IP or encrypted Secure Shell (SSH) package from a remote management station. The switch must have network connectivity with the Telnet or SSH client, and the switch must have an enable secret password configured.
    - The switch supports up to 16 simultaneous Telnet sessions. Changes made by one Telnet user are reflected in all other Telnet sessions.
    - The switch 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 Vista, Windows XP, Windows 2003, or Windows 2000.
- The switch GUI is compatible with Microsoft Internet Explorer 6.0 and 7.0, and Mozilla Firefox up to version 26.0.

Information About Using The Web GUI

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

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 switch 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 switch, 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 switch 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 switch, WLAN, and radios.
- Enables you to configure and set security policies on your switch.
- Enables you to access the switch operating system software management commands.

The Administration tab enables you to configure system logs.

Connecting the Console Port of the Switch

Before You Begin

Before you can configure the switch 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 switch's RJ-45 console port and the other end to your PC's serial port.

Step 2 Plug the AC power cord into the switch 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 switch 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 switch is configured with the IP address for service port.

Logging On to the Web GUI

Enter the switch 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**.

Enabling Web and Secure Web Modes

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

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

Step 2 To enable web mode, which allows users to access the switch 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 switch 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 Switch Web GUI

The configuration wizard enables you to configure basic settings on the switch. You can run the wizard after you receive the switch from the factory or after the switch 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 switch. The switch 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 Switch <Model Number> <Hostname>** page appears.

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

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

Step 5 On the **Admin Users** page, enter the administrative username to be assigned to this switch in the User Name text box and the administrative password to be assigned to this switch 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 switch. 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 switch, and click **Next**:

- Customer-definable switch 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**.

- Choose **Mobility Controller** or **Mobility Agent** from the Mobility Role drop-down list:

- If Mobility Agent is chosen, enter the mobility controller IP address in the Mobility Controller IP Address text box and mobility controller IP address in the Mobility Controller Public IP Address text box.
- If Mobility Controller is chosen, then the mobility controller IP address and mobility controller public IP address are displayed in the respective text boxes.

- Displays mobility protocol port number in the Mobility Protocol Port text box.
- Displays the mobility switch peer group name in the Mobility Switch Peer 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.
- The amount of time (in seconds) between each ping request sent to an peer switch 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 switch 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 switch in the Mobility Control Message DSCP Value (0-63) text box.

  The valid range is 0 to 63, and the default value is 0.
- Displays the number of mobility switch peer group member configured in the Switch Peer Group Members Configured text box.

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 switch based on the following parameters, and click **Next**.

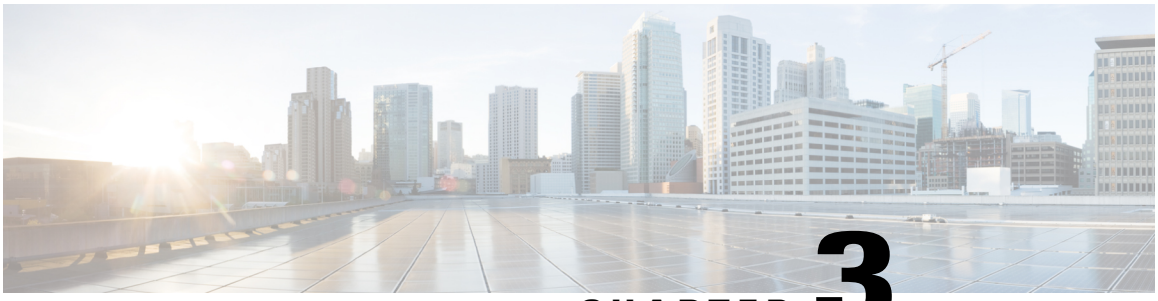
- Displays current timestamp on the switch in the Current Time text box.
- Choose either Manual or NTP from the Mode drop-down list.

  On using the NTP server, all access points connected to the switch, synchronizes its time based on the NTP server settings available.

- Choose date on the switch 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 switch 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 switch using these steps, and if you wish to change any configuration value, click **Previous** and navigate to that page.
You can save the switch 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 switch.



CHAPTER 3

Managing Switch Stacks

Finding Feature Information

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

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

Prerequisites for Switch Stacks

All the switches in the switch stack need to be running the same license level as the active switch. For information about license levels, see the *System Management Configuration Guide (Catalyst 3650 Switches)*.

All switches in the switch stack need to be running compatible software versions.

A StackWise adapter must be installed in the stacking port to enable stacking. For switch stack hardware considerations, see the *Catalyst 3650 Switch Hardware Installation Guide*.

Restrictions for Switch Stacks

The following are restrictions for your switch stack configuration:

- Switch stacks running the LAN Base license level do not support Layer 3 features.
- A switch stack can have up to nine stacking-capable switches connected through their StackWise-160 ports.
- You cannot have a switch stack containing a mix of Catalyst 3850 and Catalyst 3650 switches.

Information About Switch Stacks

Switch Stack Overview

A switch stack can have up to nine stacking-capable switches connected through their StackWise-160 ports. The stack members work together as a unified system. Layer 2 and Layer 3 protocols present the entire switch stack as a single entity to the network.

A switch stack always has one active switch and one standby switch. If the active switch becomes unavailable, the standby switch assumes the role of the active switch, and continues to the keep the stack operational.

The active switch controls the operation of the switch stack, and is the single point of stack-wide management. From the active switch, you configure:

- System-level (global) features that apply to all stack members
- Interface-level features for each stack member

The active switch contains the saved and running configuration files for the switch stack. The configuration files include the system-level settings for the switch stack and the interface-level settings for each stack member. Each stack member has a current copy of these files for back-up purposes.

Supported Features in a Switch Stack

The system-level features supported on the active switch are supported on the entire switch stack.

Encryption Features

If the active switch is running the cryptographic universal software image (supports encryption), the encryption features are available on the switch stack.

StackWise-160

The stack members use the StackWise-160 technology to work together as a unified system. Layer 2 and Layer 3 protocols support the entire switch stack as a single entity in the network.

Note Switch stacks running the LAN Base image do not support Layer 3 features.

StackWise-160 has a stack bandwidth of 160 Gbps, and uses stateful switchover (SSO) to provide resiliency within the stack. The stack behaves as a single switching unit that is managed by an active switch elected by the member switches. The active switch automatically elects a standby switch within the stack. The active switch creates and updates all the switching, routing and wireless information and constantly synchronizes that information with the standby switch. Access points continue to remain connected during an active-to-standby switchover unless the access point is directly connected to the active switch. In this case the access point will lose power and reboot. A working stack can accept new members or delete old ones without service interruption.

Switch Stack Membership

A standalone switch is a switch stack with one stack member that also operates as the active switch. You can connect one standalone switch to another to create a switch stack containing two stack members, with one of them as the active switch. You can connect standalone switches to an existing switch stack to increase the stack membership.

Hello messages are sent and received by all stack members.

- If a stack member does not respond, that member is removed from the stack.
- If the standby switch does not respond, a new standby switch is elected.
- If the active switch does not respond, the standby switch becomes the active switch.

In addition, keepalive messages are sent and received between the active and standby switches.

- If the standby switch does not respond, a new standby switch is elected.
- If the active switch does not respond, the standby switch becomes the active switch.

Changes to Switch Stack Membership

If you replace a stack member with an identical model, the new switch functions with exactly the same configuration as the replaced switch, assuming that the new switch (referred to as the provisioned switch) is using the same member number as the replaced switch.

The operation of the switch stack continues uninterrupted during membership changes unless you remove the active switch or you add powered-on standalone switches or switch stacks.

- Adding powered-on switches (merging) causes all switches to reload and elect a new active switch from among themselves. The newly elected active switch retains its role and configuration. All other switches retain their stack member numbers and use the stack configuration of the newly elected active switch.
- Removing powered-on stack members causes the switch stack to divide (partition) into two or more switch stacks, each with the same configuration. This can cause:
  - An IP address conflict in your network. If you want the switch stacks to remain separate, change the IP address or addresses of the newly created switch stacks.

- A MAC address conflict between two members in the stack. You can use the **stack-mac update force** command to resolve the conflict.

If a newly created switch stack does not have an active switch or standby switch, the switch stack will reload and elect a new active switch.

Note Make sure that you power off the switches that you add to or remove from the switch stack.

After adding or removing stack members, make sure that the switch stack is operating at full bandwidth (160 Gbps). Press the Mode button on a stack member until the Stack mode LED is on. The last two right port LEDs on all switches in the stack should be green. Depending on the switch model, the last two right ports are 10-Gigabit Ethernet ports or small form-factor pluggable (SFP) module ports (10/100/1000 ports). If one or both of these LEDs are not green on any of the switches, the stack is not operating at full bandwidth.

If you remove powered-on members but do not want to partition the stack:

- Power off the switches in the newly created switch stacks.
- Reconnect them to the original switch stack through their stack ports.
- Power on the switches.

For cabling and power considerations that affect switch stacks, see the *Catalyst 3650 Switch Hardware Installation Guide* .

Stack Member Numbers

The stack member number (1 to 9) identifies each member in the Switch stack. The member number also determines the interface-level configuration that a stack member uses. You can display the stack member number by using the **show switch** EXEC command.

A new, out-of-the-box Switch (one that has not joined a Switch stack or has not been manually assigned a stack member number) ships with a default stack member number of 1. When it joins a Switch stack, its default stack member number changes to the lowest available member number in the stack.

Stack members in the same Switch stack cannot have the same stack member number. Every stack member, including a standalone Switch, retains its member number until you manually change the number or unless the number is already being used by another member in the stack.

- If you manually change the stack member number by using the **switch** *current-stack-member-number* **renumber** *new-stack-member-number* command, the new number goes into effect after that stack member resets (or after you use the **reload slot** *stack-member-number* privileged EXEC command) and only if that number is not already assigned to any other members in the stack. Another way to change the stack member number is by changing the Switch_NUMBER environment variable.

  If the number is being used by another member in the stack, the Switch selects the lowest available number in the stack.

  If you manually change the number of a stack member and no interface-level configuration is associated with that new member number, that stack member resets to its default configuration.

You cannot use the **switch** *current-stack-member-number* **renumber** *new-stack-member-number* command on a provisioned Switch. If you do, the command is rejected.

- If you move a stack member to a different Switch stack, the stack member retains its number only if the number is not being used by another member in the stack. If it is being used, the Switch selects the lowest available number in the stack.
- If you merge Switch stacks, the Switch that join the Switch stack of a new active switch select the lowest available numbers in the stack.

As described in the hardware installation guide, you can use the Switch port LEDs in Stack mode to visually determine the stack member number of each stack member.

Stack Member Priority Values

A higher priority value for a stack member increases the probability of it being elected active switch and retaining its stack member number. The priority value can be 1 to 15. The default priority value is 1. You can display the stack member priority value by using the **show switch** EXEC command.

Note We recommend assigning the highest priority value to the switch that you prefer to be the active switch. This ensures that the switch is reelected as the active switch if a reelection occurs.

To change the priority value for a stack member, use the **switch** *stack-member-number* **priority** *new priority-value* command. For more information, see the "Setting the Stack Member Priority Value" section.

The new priority value takes effect immediately but does not affect the current active switch. The new priority value helps determine which stack member is elected as the new active switch when the current active switch or the switch stack resets.

Switch Stack Bridge ID and MAC Address

A switch stack is identified in the network by its *bridge ID* and, if it is operating as a Layer 3 device, its router MAC address. The bridge ID and router MAC address are determined by the MAC address of the active switch.

If the active switch changes, the MAC address of the new active switch determines the new bridge ID and router MAC address.

If the entire switch stack reloads, the switch stack uses the MAC address of the active switch.

Persistent MAC Address on the Switch Stack

You can use the persistent MAC address feature to set a time delay before the stack MAC address changes. During this time period, if the previous active switch rejoins the stack, the stack continues to use its MAC address as the stack MAC address, even if the switch is now a stack member and not an active switch. If the previous active switch does not rejoin the stack during this period, the switch stack takes the MAC address of the new active switch as the stack MAC address. By default, the stack MAC address will be the MAC address of the first active switch, even if a new active switch takes over.

You can use the persistent MAC address feature to set a time delay before the stack MAC address changes to the MAC address of the new stack master. When this feature is enabled, the stack MAC address changes in approximately 4 minutes. During this time, if the previous stack master rejoins the stack, the stack continues to use its MAC address as the stack MAC address, even if the switch is now a stack member and not a stack master. If the previous stack master does not rejoin the stack during this period, the switch stack takes the MAC address of the new stack master as the stack MAC address.

You can also configure stack MAC persistency so that the stack MAC address never changes to the new active switch MAC address.

Active and Standby Switch Election and Reelection

All stack members are eligible to be the active switch or the standby switch. If the active switch becomes unavailable, the standby switch becomes the active switch.

An active switch retains its role unless one of these events occurs:

- The switch stack is reset.
- The active switch is removed from the switch stack.
- The active switch is reset or powered off.
- The active switch fails.
- The switch stack membership is increased by adding powered-on standalone switches or switch stacks.

All stack members are eligible stack masters. If the stack master becomes unavailable, the remaining members elect a new stack master from among themselves.

The active switch is elected or reelected based on one of these factors and in the order listed:

1. The switch that is currently the active switch.
2. The switch with the highest stack member priority value.

Note We recommend assigning the highest priority value to the switch that you prefer to be the active switch. This ensures that the switch is reelected as active switch if a reelection occurs.

3. The switch with the shortest start-up time.
4. The switch that has the configuration file.
5. The switch with the lowest MAC address.

Note The factors for electing or reelecting a new standby switch are same as those for the active switch election or reelection, and are applied to all participating switches except the active switch.

After election, the new active switch becomes available after a few seconds. In the meantime, the switch stack uses the forwarding tables in memory to minimize network disruption. The physical interfaces on the other available stack members are not affected during a new active switch election and reset.

When the previous active switch becomes available, it *does not* resume its role as the active switch.

If you power on or reset an entire switch stack, some stack members *might not* participate in the active switch election. Stack members that are powered on within the same 2-minute timeframe participate in the active switch election and have a chance to become the active switch. Stack members that are powered on after the 120-second timeframe do not participate in this initial election and become stack members. For powering considerations that affect active-switch elections, see the switch hardware installation guide.

As described in the hardware installation guide, you can use the ACTV LED on the switch to see if the switch is the active switch.

A stack master retains its role unless one of these events occurs:

- The switch stack is reset.*
- The stack master is removed from the switch stack.
- The stack master is reset or powered off.
- The stack master fails.
- The switch stack membership is increased by adding powered-on standalone switches or switch stacks.*

In the events marked by an asterisk (*), the current stack master *might* be reelected based on the listed factors.

When you power on or reset an entire switch stack, some stack members *might not* participate in the stack master election. Stack members that are powered on within the same 20-second time frame participate in the stack master election and have a chance to become the stack master. Stack members that are powered on after the 20-second time frame do not participate in this initial election and become stack members. All stack members participate in reelections. For all powering considerations that affect stack-master elections, see the "Switch Installation" chapter in the hardware installation guide.

The new stack master becomes available after a few seconds. In the meantime, the switch stack uses the forwarding tables in memory to minimize network disruption. The physical interfaces on the other available stack members are not affected during a new stack master election and reset.

After a new stack master is elected and the previous stack master becomes available, the previous stack master *does not* resume its role as stack master.

Switch Stack Configuration Files

The active switch has the saved and running configuration file for the switch stack. The standby switch automatically receives the synchronized running configuration file. Stack members receive synchronized copies when the running configuration file is saved into the startup configuration file. If the active switch becomes unavailable, the standby switch takes over with the current running configuration.

The active switch has the saved and running configuration files for the switch stack. All stack members periodically receive synchronized copies of the configuration files from the active switch. If the active switch becomes unavailable, any stack member assuming the role of active switch has the latest configuration files.

The configuration files record these settings:

- System-level (global) configuration settings such as IP, STP, VLAN, and SNMP settings that apply to all stack members
- Stack member interface-specific configuration settings that are specific for each stack member

Note The interface-specific settings of the active switch are saved if the active switch is replaced without saving the running configuration to the startup configuration.

A new, out-of-box switch joining a switch stack uses the system-level settings of that switch stack. If a switch is moved to a different switch stack before it is powered on, that switch loses its saved configuration file and uses the system-level configuration of the new switch stack. If the switch is powered on as a standalone switch before it joins the new switch stack, the stack will reload. When the stack reloads, the new switch may become the active switch, retain its configuration and overwrite the configuration files of the other stack members.

The interface-specific configuration of each stack member is associated with the stack member number. Stack members retain their numbers unless they are manually changed or they are already used by another member in the same switch stack. If the stack member number changes, the new number goes into effect after that stack member resets.

- If an interface-specific configuration does not exist for that member number, the stack member uses its default interface-specific configuration.
- If an interface-specific configuration exists for that member number, the stack member uses the interface-specific configuration associated with that member number.

If you replace a failed member with an identical model, the replacement member automatically uses the same interface-specific configuration as the failed switch. You do not need to reconfigure the interface settings. The replacement switch (referred to as the provisioned switch) must have the same stack member number as the failed switch.

You back up and restore the stack configuration in the same way as you would for a standalone switch configuration.

Offline Configuration to Provision a Stack Member

You can use the offline configuration feature to *provision* (to supply a configuration to) a new switch before it joins the switch stack. You can configure the stack member number, the switch type, and the interfaces associated with a switch that is not currently part of the stack. The configuration that you create on the switch stack is called the *provisioned configuration*. The switch that is added to the switch stack and that receives this configuration is called the *provisioned switch*.

You manually create the provisioned configuration through the **switch** *stack-member-number* **provision** *type* global configuration command. You must change the *stack-member-number* on the provisioned switch before you add it to the stack, and it must match the stack member number that you created for the new switch on the switch stack. The switch type in the provisioned configuration must match the switch type of the newly added switch. The provisioned configuration is automatically created when a switch is added to a switch stack and when no provisioned configuration exists.

When you configure the interfaces associated with a provisioned switch, the switch stack accepts the configuration, and the information appears in the running configuration. However, as the switch is not active, any configuration on the interface is not operational and the interface associated with the provisioned switch does not appear in the display of the specific feature. For example, VLAN configuration information associated with a provisioned switch does not appear in the **show vlan** user EXEC command output on the switch stack.

The switch stack retains the provisioned configuration in the running configuration whether or not the provisioned switch is part of the stack. You can save the provisioned configuration to the startup configuration file by entering the **copy running-config startup-config** privileged EXEC command. The startup configuration

file ensures that the switch stack can reload and can use the saved information whether or not the provisioned switch is part of the switch stack.

Effects of Adding a Provisioned Switch to a Switch Stack

When you add a provisioned Switch to the switch stack, the stack applies either the provisioned configuration or the default configuration. This table lists the events that occur when the switch stack compares the provisioned configuration with the provisioned switch.

Table 4: Results of Comparing the Provisioned Configuration with the Provisioned Switch

Scenario		Result
The stack member numbers and the Switch types match.	**1** If the stack member number of the provisioned switch matches the stack member number in the provisioned configuration on the stack, and **2** If the Switch type of the provisioned switch matches the Switch type in the provisioned configuration on the stack.	The switch stack applies the provisioned configuration to the provisioned switch and adds it to the stack.
The stack member numbers match but the Switch types do not match.	**1** If the stack member number of the provisioned switch matches the stack member number in the provisioned configuration on the stack, but **2** The Switch type of the provisioned switch does not match the Switch type in the provisioned configuration on the stack.	The switch stack applies the default configuration to the provisioned switch and adds it to the stack. The provisioned configuration is changed to reflect the new information.
The stack member number is not found in the provisioned configuration.		The switch stack applies the default configuration to the provisioned switch and adds it to the stack. The provisioned configuration is changed to reflect the new information.
The stack member number of the provisioned switch is not found in the provisioned configuration.		The switch stack applies the default configuration to the provisioned switch and adds it to the stack.

If you add a provisioned switch that is a different type than specified in the provisioned configuration to a powered-down switch stack and then apply power, the switch stack rejects the (now incorrect) **switch** *stack-member-number* **provision** *type* global configuration command in the startup configuration file. However, during stack initialization, the nondefault interface configuration information in the startup configuration file for the provisioned interfaces (potentially of the wrong type) is executed. Depending on the differences between the actual Switch type and the previously provisioned switch type, some commands are rejected, and some commands are accepted.

Note If the switch stack does not contain a provisioned configuration for a new Switch, the Switch joins the stack with the default interface configuration. The switch stack then adds to its running configuration with a **switch** *stack-member-number* **provision** *type* global configuration command that matches the new Switch. For configuration information, see the *Provisioning a New Member for a Switch Stack* section.

Effects of Replacing a Provisioned Switch in a Switch Stack

When a provisioned switch in a switch stack fails, it is removed from the stack, and is replaced with another Switch, the stack applies either the provisioned configuration or the default configuration to it. The events that occur when the switch stack compares the provisioned configuration with the provisioned switch are the same as those when you add a provisioned switch to a stack.

Effects of Removing a Provisioned Switch from a Switch Stack

If you remove a provisioned switch from the switch stack, the configuration associated with the removed stack member remains in the running configuration as provisioned information. To completely remove the configuration, use the **no switch** *stack-member-number* **provision** global configuration command.

Upgrading a Switch Running Incompatible Software

The auto-upgrade and auto-advise features enable a switch with software packages that are incompatible with the switch stack to be upgraded to a compatible software version so that it can join the switch stack.

Auto-Upgrade

The purpose of the auto-upgrade feature is to allow a switch to be upgraded to a compatible software image, so that the switch can join the switch stack.

When a new switch attempts to join a switch stack, each stack member performs compatibility checks with itself and the new switch. Each stack member sends the results of the compatibility checks to the active switch, which uses the results to determine whether the switch can join the switch stack. If the software on the new switch is incompatible with the switch stack, the new switch enters version-mismatch (VM) mode.

If the auto-upgrade feature is enabled on the new switch, the active switch automatically upgrades the new switch with the same software image running on a compatible stack member. Auto-upgrade starts a few minutes after the mismatched software is detected before starting.

Auto-upgrade is disabled by default.

Auto-upgrade includes an auto-copy process and an auto-extract process.

- Auto-copy automatically copies the software image running on any stack member to the new switch to automatically upgrade it. Auto-copy occurs if auto-upgrade is enabled, if there is enough flash memory in the new switch, and if the software image running on the switch stack is suitable for the new switch.

Note A switch in VM mode might not run all released software. For example, new switch hardware is not recognized in earlier versions of software.

- Automatic extraction (auto-extract) occurs when the auto-upgrade process cannot find the appropriate software in the stack to copy to the new switch. In that case, the auto-extract process searches all switches in the stack for the bin file needed to upgrade the switch stack or the new switch. The bin file can be in any flash file system in the switch stack or in the new switch. If a bin file suitable for the new switch is found on a stack member, the process extracts the file and automatically upgrades the new switch.

The auto-upgrade feature is not available in bundle mode. The switch stack must be running in installed mode. If the switch stack is in bundle mode, use the **software expand** privileged EXEC command to change to installed mode.

You can enable auto-upgrade by using the **software auto-upgrade enable** global configuration command on the new switch. You can check the status of auto-upgrade by using the **show running-config** privileged EXEC command and by checking the *Auto upgrade* line in the display.

You can configure auto-upgrade to upgrade the new switch with a specific software bundle by using the **software auto-upgrade source url** global configuration command. If the software bundle is invalid, the new switch is upgraded with the same software image running on a compatible stack member.

When the auto-upgrade process is complete, the new switch reloads and joins the stack as a fully functioning member. If you have both stack cables connected during the reload, network downtime does not occur because the switch stack operates on two rings.

For more information about upgrading a switch running incompatible software see the *Cisco IOS File System, Configuration Files, and Bundle Files Appendix, Cisco IOS XE Release 3SE (Catalyst 3650 Switches)*.

Auto-Advise

The auto-advise feature is triggered when:

- The auto-upgrade feature is disabled.
- The new switch is in bundle mode and the stack is in installed mode. Auto-advise displays syslog messages about using the **software auto-upgrade** privileged EXEC command to change the new switch to installed mode.
- The stack is in bundle mode. Auto-advise displays syslog messages about booting the new switch in bundle mode so that it can join the stack.
- An auto-upgrade attempt fails because the new switch is running incompatible software. After the switch stack performs compatibility checks with the new switch, auto-advise displays syslog messages about whether the new switch can be auto-upgraded.

Auto-advise cannot be disabled. It does *not* give suggestions when the switch stack software and the software of the switch in version-mismatch (VM) mode do not contain the same license level.

Automatic advise (auto-advise) occurs when the auto-upgrade process cannot find appropriate stack member software to copy to the new switch. This process tells you the command (**archive copy-sw** or **archive**

download-sw privileged EXEC command) and the image name (tar filename) needed to manually upgrade the switch stack or the new switch. The recommended image can be the running switch stack image or a tar file in any flash file system in the switch stack (including the new switch). If an appropriate image is not found in the stack flash file systems, the auto-advise process tells you to install new software on the switch stack. Auto-advise cannot be disabled, and there is no command to check its status.

Examples of Auto-Advise Messages

Auto-Upgrade Is Disabled and Incompatible Switch Attempting to Join: Example

This sample auto-advise output shows the system messages displayed when the auto-upgrade feature is disabled and an incompatible switch 1 tries to join the switch stack:

```
*Oct 18 08:36:19.379: %INSTALLER-6-AUTO_ADVISE_SW_INITIATED: 2 installer:  Auto advise
initiated for switch 1
*Oct 18 08:36:19.380: %INSTALLER-6-AUTO_ADVISE_SW: 2 installer:  Searching stack for software
 to upgrade switch 1
*Oct 18 08:36:19.382: %INSTALLER-6-AUTO_ADVISE_SW: 2 installer:  Switch 1 with incompatible
 software has been
*Oct 18 08:36:19.382: %INSTALLER-6-AUTO_ADVISE_SW: 2 installer:  added to the stack. The
software running on
*Oct 18 08:36:19.382: %INSTALLER-6-AUTO_ADVISE_SW: 2 installer:  all stack members was
scanned and it has been
*Oct 18 08:36:19.382: %INSTALLER-6-AUTO_ADVISE_SW: 2 installer:  determined that the 'software
 auto-upgrade'
*Oct 18 08:36:19.382: %INSTALLER-6-AUTO_ADVISE_SW: 2 installer:  command can be used to
install compatible
*Oct 18 08:36:19.382: %INSTALLER-6-AUTO_ADVISE_SW: 2 installer:  software on switch 1.
```

Auto-Upgrade is Disabled and New Switch is in Bundle Mode: Example

This sample auto-advise output shows the system messages displayed when auto-upgrade is disabled and a switch running in bundle mode tries to join the stack that is running in installed mode:

```
*Oct 18 11:09:47.005: %INSTALLER-6-AUTO_ADVISE_SW_INITIATED: 2 installer:  Auto advise
initiated for switch 1
*Oct 18 11:09:47.005: %INSTALLER-6-AUTO_ADVISE_SW: 2 installer:  Switch 1 running bundled
software has been added
*Oct 18 11:09:47.005: %INSTALLER-6-AUTO_ADVISE_SW: 2 installer:  to the stack that is running
 installed software.
*Oct 18 11:09:47.005: %INSTALLER-6-AUTO_ADVISE_SW: 2 installer:  The 'software auto-upgrade'
 command can be used to
*Oct 18 11:09:47.005: %INSTALLER-6-AUTO_ADVISE_SW: 2 installer:  convert switch 1 to the
installed running mode by
*Oct 18 11:09:47.005: %INSTALLER-6-AUTO_ADVISE_SW: 2 installer:  installing its running
software.
```

SDM Template Mismatch in Switch Stacks

All stack members use the Switch Database Management (SDM) template configured on the active switch. When a new switch is added to a stack, the SDM configuration that is stored on the active switch overrides the template configured on an individual switch.

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

Version-mismatch (VM) mode has priority over SDM-mismatch mode. If a VM-mode condition and an SDM-mismatch mode exist, the switch stack first attempts to resolve the VM-mode condition.

Switch Stack Management Connectivity

You manage the switch stack and the stack member interfaces through the active switch. You can use the CLI, SNMP, and supported network management applications such as CiscoWorks. You cannot manage stack members on an individual Switch basis.

Note Use SNMP to manage network features across the stack that are defined by supported MIBs. The switch does not support MIBs to manage stacking-specific features such as stack membership and election.

Connectivity to Specific Stack Members

If you want to configure a specific stack member port, you must include the stack member number in the CLI command interface notation.

To debug a specific stack member, you can access it from the stack master by using the **session** *stack-member-number* privileged EXEC command. The stack member number is appended to the system prompt. For example, Switch-2# is the prompt in privileged EXEC mode for stack member 2, and the system prompt for the stack master is Switch. Only the **show** and **debug** commands are available in a CLI session to a specific stack member.

To debug the standby switch, you can access it from the active switch using the **session standby ios** privileged EXEC command. To debug a specific stack member, use the **session switch** *stack-member-number* privileged EXEC command from the active switch to access the diagnostic shell of the stack member. Only the **show** and **debug** commands are available in a CLI session to a specific stack member.

Connectivity to the Switch Stack Through an IP Address

The switch stack is managed through a single IP address. The IP address is a system-level setting and is not specific to the active switch or to any other stack member. You can still manage the stack through the same IP address even if you remove the active switch or any other stack member from the stack, provided there is IP connectivity.

Note Stack members retain their IP addresses 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 addresses of any Switch that you remove from the switch stack.

For related information about switch stack configurations, see the *Switch Stack Configuration Files section*.

Connectivity to the Switch Stack Through Console Ports or Ethernet Management Ports

You can connect to the active switch by using one of these methods:

- You can connect a terminal or a PC to the active switch through the console port of one or more stack members.

- You can connect a PC to the active switch through the Ethernet management ports of one or more stack members. For more information about connecting to the switch stack through Ethernet management ports, see the *Using the Ethernet Management Port section*.

Be careful when using multiple CLI sessions to the active switch. 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.

We recommend using only one CLI session when managing the switch stack.

How to Configure a Switch Stack

Default Switch Stack Configuration

The following table shows the default switch stack configuration settings:

Table 5: Default Switch Stack Configuration

Feature	Default Setting
Stack MAC address timer	Disabled.
Stack member number	1
Stack member priority value	1
Offline configuration	The switch stack is not provisioned.
Persistent MAC address	Disabled.

Enabling the Persistent MAC Address Feature

Note When you enter the command to configure this feature, a warning message appears with the consequences of your configuration. You should use this feature cautiously. Using the old active switch MAC address elsewhere in the same domain could result in lost traffic.

Follow these steps to enable persistent MAC address:

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **stack-mac persistent timer** [**0** | *time-value*]
4. **end**
5. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Switch> enable`	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Switch# configure terminal`	Enters the global configuration mode.
Step 3	**stack-mac persistent timer** [**0**	*time-value*] **Example:** `Switch(config)# stack-mac persistent timer 7`	Enables a time delay after an active-switch change before the stack MAC address changes to that of the new active switch. If the previous active switch rejoins the stack during this period, the stack uses that MAC address as the stack MAC address. • Enter the command with no value or with a value of **0** to continue using the MAC address of the current active switch indefinitely. • Enter a *time-value* from 1 to 60 minutes to configure the time period before the stack MAC address changes to the new active switch. The stack MAC address of the previous active switch is used until the configured time period expires.
Step 4	**end** **Example:** `Switch(config)# end`	Returns to privileged EXEC mode.
Step 5	**copy running-config startup-config** **Example:** `Switch# copy running-config startup-config`	(Optional) Saves your entries in the configuration file.

What to Do Next

Use the **no stack-mac persistent timer** global configuration command to disable the persistent MAC address feature.

Assigning a Stack Member Number

This optional task is available only from the active switch.

Follow these steps to assign a member number to a stack member:

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **switch** *current-stack-member-number* **renumber** *new-stack-member-number*
4. **end**
5. **reload slot** *stack-member-number*
6. **show switch**
7. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Switch> enable`	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Switch# configure terminal`	Enters the global configuration mode.
Step 3	**switch** *current-stack-member-number* **renumber** *new-stack-member-number* **Example:** `Switch(config)# switch 3 renumber 4`	Specifies the current stack member number and the new stack member number for the stack member. The range is 1 to 9. You can display the current stack member number by using the **show switch** user EXEC command.

	Command or Action	Purpose
Step 4	**end** **Example:** `Switch(config)# end`	Returns to privileged EXEC mode.
Step 5	**reload slot** *stack-member-number* **Example:** `Switch# reload slot 4`	Resets the stack member.
Step 6	**show switch** **Example:** `showSwitch`	Verify the stack member number.
Step 7	**copy running-config startup-config** **Example:** `Switch# copy running-config startup-config`	(Optional) Saves your entries in the configuration file.

Setting the Stack Member Priority Value

This optional task is available only from the active switch.

Follow these steps to assign a priority value to a stack member:

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **switch** *stack-member-number* **priority** *new-priority-number*
4. **end**
5. **show switch** *stack-member-number*
6. **copy running-config startup-config**

DETAILED STEPS

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

	Command or Action	Purpose
	Example: `Switch> enable`	
Step 2	**configure terminal** **Example:** `Switch# configure terminal`	Enters the global configuration mode.
Step 3	**switch** *stack-member-number* **priority** *new-priority-number* **Example:** `Switch(config)# switch 3 priority 2`	Specifies the stack member number and the new priority for the stack member. The stack member number range is 1 to 9. The priority value range is 1 to 15. You can display the current priority value by using the **show switch** user EXEC command. The new priority value takes effect immediately but does not affect the current active switch. The new priority value helps determine which stack member is elected as the new active switch when the current active switch or switch stack resets.
Step 4	**end** **Example:** `Switch(config)# end`	Returns to privileged EXEC mode.
Step 5	**show switch** *stack-member-number* **Example:** `Switch(config)# show switch`	Verify the stack member priority value.
Step 6	**copy running-config startup-config** **Example:** `Switch# copy running-config startup-config`	(Optional) Saves your entries in the configuration file.

Provisioning a New Member for a Switch Stack

This optional task is available only from the active switch.

SUMMARY STEPS

1. **show switch**
2. **configure terminal**
3. **switch** *stack-member-number* **provision** *type*
4. **end**
5. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**show switch** **Example:** `Switch# show switch`	Displays summary information about the switch stack.
Step 2	**configure terminal** **Example:** `Switch# configure terminal`	Enters global configuration mode.
Step 3	**switch** *stack-member-number* **provision** *type* **Example:** `Switch(config)# switch 3 provision WS-xxxx`	Specifies the stack member number for the preconfigured switch. By default, no switches are provisioned. For *stack-member-number*, the range is 1 to 9. Specify a stack member number that is not already used in the switch stack. See Step 1. For *type*, enter the model number of a supported switch that is listed in the command-line help strings.
Step 4	**end** **Example:** `Switch(config)# end`	Returns to privileged EXEC mode.
Step 5	**copy running-config startup-config** **Example:** `Switch# copy running-config startup-config`	(Optional) Saves your entries in the configuration file.

Removing Provisioned Switch Information

Before you begin, you must remove the provisioned switch from the stack. This optional task is available only from the active switch.

SUMMARY STEPS

1. **configure terminal**
2. **no switch** *stack-member-number* **provision**
3. **end**
4. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Switch# configure terminal`	Enters global configuration mode.
Step 2	**no switch** *stack-member-number* **provision** **Example:** `Switch(config)# no switch 3 provision`	Removes the provisioning information for the specified member.
Step 3	**end** **Example:** `Switch(config)# end`	Returns to privileged EXEC mode.
Step 4	**copy running-config startup-config** **Example:** `Switch# copy running-config startup-config`	(Optional) Saves your entries in the configuration file.

If you are removing a provisioned switch in a stack with this configuration:

- The stack has four members
- Stack member 1 is the active switch
- Stack member 3 is a provisioned switch

and want to remove the provisioned information and to avoid receiving an error message, you can remove power from stack member 3, disconnect the StackWise-160stack cables between the stack member 3 and switches to which it is connected, reconnect the cables between the remaining stack members, and enter the **no switch** *stack-member-number* **provision** global configuration command.

Displaying Incompatible Switches in the Switch Stack

SUMMARY STEPS

1. **show switch**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**show switch** **Example:** `Switch# show switch`	Displays any incompatible switches in the switch stack (indicated by a 'Current State' of 'V-Mismatch'). The V-Mismatch state identifies the switches with incompatible software. The output displays Lic-Mismatch for switches that are not running the same license level as the active switch. For information about managing license levels, see the *System Management Configuration Guide (Catalyst 3650 Switches)*.

Upgrading an Incompatible Switch in the Switch Stack

SUMMARY STEPS

1. **software auto-upgrade**
2. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**software auto-upgrade** **Example:** `Switch# software auto-upgrade`	Upgrades incompatible switches in the switch stack, or changes switches in bundle mode to installed mode.
Step 2	**copy running-config startup-config** **Example:** `Switch# copy running-config startup-config`	(Optional) Saves your entries in the configuration file.

Troubleshooting the Switch Stack

Accessing the Diagnostic Console of a Stack Member

Before You Begin

This optional task is available only from the active switch.

SUMMARY STEPS

1. **session switch** *stack-member-number*
2. **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**session switch** *stack-member-number* **Example:** `Switch# session switch 2`	Accesses the diagnostic shell of the stack member from the active switch.
Step 2	**exit** **Example:** `Switch(diag)> exit`	Returns to the CLI session on the active switch.

Temporarily Disabling a Stack Port

If a stack port is flapping and causing instability in the stack ring, to disable the port, enter the **switch** *stack-member-number* **stack port** *port-number* **disable** privileged EXEC command. To reenable the port, enter the **switch** *stack-member-number* **stack port** *port-number* **enable** command.

Note Be careful when using the **switch** *stack-member-number* **stack port** *port-number* **disable** command. When you disable the stack port, the stack operates at half bandwidth.

A stack is in the full-ring state when all members are connected through the stack ports and are in the ready state.

The stack is in the partial-ring state when the following occurs:

- All members are connected through their stack ports but some are not in the ready state.

- Some members are not connected through the stack ports.

SUMMARY STEPS

1. **switch** *stack-member-number* **stack port** *port-number* **disable**
2. **switch** *stack-member-number* **stack port** *port-number* **enable**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**switch** *stack-member-number* **stack port** *port-number* **disable** **Example:** `Switch# switch 2 stack port 1 disable`	Disables the specified stack port.
Step 2	**switch** *stack-member-number* **stack port** *port-number* **enable** **Example:** `Switch# switch 2 stack port 1 enable`	Reenables the stack port.

When you disable a stack port and the stack is in the full-ring state, you can disable only one stack port. This message appears:

```
Enabling/disabling a stack port may cause undesired stack changes. Continue?[confirm]
```

When you disable a stack port and the stack is in the partial-ring state, you cannot disable the port. This message appears:

```
Disabling stack port not allowed with current stack configuration.
```

Reenabling a Stack Port While Another Member Starts

Stack Port 1 on Switch 1 is connected to Port 2 on Switch 4. If Port 1 is flapping, you can disable Port 1 with the **switch 1 stack port 1 disable** privileged EXEC command. While Port 1 on Switch 1 is disabled and Switch 1 is still powered on, follow these steps to reenable a stack port:

Step 1	Disconnect the stack cable between Port 1 on Switch 1 and Port 2 on Switch 4.
Step 2	Remove Switch 4 from the stack.
Step 3	Add a switch to replace Switch 4 and assign it switch-number 4.
Step 4	Reconnect the cable between Port 1 on Switch 1 and Port 2 on Switch 4 (the replacement switch).
Step 5	Reenable the link between the switches. Enter the **switch 1 stack port 1 enable** privileged EXEC command to enable Port 1 on Switch 1.
Step 6	Power on Switch 4.

Caution Powering on Switch 4 before enabling the Port 1 on Switch 1 might cause one of the switches to reload.

If Switch 4 is powered on first, you might need to enter the **switch 1 stack port 1 enable** and the **switch 4 stack port 2 enable** privileged EXEC commands to bring up the link.

Monitoring the Switch Stack

Table 6: Commands for Displaying Stack Information

Command	Description
show switch	Displays summary information about the stack, including the status of provisioned switches and switches in version-mismatch mode.
show switch *stack-member-number*	Displays information about a specific member.
show switch detail	Displays detailed information about the stack.
show switch neighbors	Displays the stack neighbors.
show switch stack-ports [**summary**]	Displays port information for the stack.
show redundancy	Displays the redundant system and the current processor information. The redundant system information includes the system uptime, standby failures, switchover reason, hardware, configured and operating redundancy mode. The current processor information displayed includes the active location, the software state, the uptime in the current state and so on.
show redundancy state	Displays all the redundancy states of the active and standby switches.

Configuration Examples for Switch Stacks

Switch Stack Configuration Scenarios

Most of these switch stack configuration scenarios assume that at least two switch are connected through their StackWise-160stack ports.

Table 7: Configuration Scenarios

Scenario		Result
Active switch election specifically determined by existing active switches	Connect two powered-on switch stacks through the StackWise-160stack ports.	Only one of the two active switches becomes the new active switch.
Active switch election specifically determined by the stack member priority value	**1** Connect two switches through their StackWise-160stack ports. **2** Use the **switch** *stack-member-number* **priority** *new-priority-number* global configuration command to set one stack member with a higher member priority value. **3** Restart both stack members at the same time.	The stack member with the higher priority value is elected active switch.
Active switch election specifically determined by the configuration file	Assuming that both stack members have the same priority value: **1** Make sure that one stack member has a default configuration and that the other stack member has a saved (nondefault) configuration file. **2** Restart both stack members at the same time.	The stack member with the saved configuration file is elected active switch.
Active switch election specifically determined by the MAC address	Assuming that both stack members have the same priority value, configuration file, and feature set, restart both stack members at the same time.	The stack member with the lower MAC address is elected active switch.

Scenario		Result
Stack member number conflict	Assuming that one stack member has a higher priority value than the other stack member: **1** Ensure that both stack members have the same stack member number. If necessary, use the **switch** *current-stack-member-number* **renumber** *new-stack-member-number* global configuration command. **2** Restart both stack members at the same time.	The stack member with the higher priority value retains its stack member number. The other stack member has a new stack member number.
Add a stack member	**1** Power off the new switch. **2** Through their StackWise-160stack ports, connect the new switch to a powered-on switch stack. **3** Power on the new switch.	The active switch is retained. The new switch is added to the switch stack.
Active switch failure	Remove (or power off) the active switch.	One of the remaining stack members becomes the new stack master. All other stack members in the stack remain as stack members and do not reboot.
Add more than nine stack members	**1** Through their StackWise-160stack ports, connect ten switch. **2** Power on all switch.	Two switch become active switches. One active switch has nine stack members. The other active switch remains as a standalone switch. Use the Mode button and port LEDs on the switch to identify which switch are active switches and which switch belong to each active switch.

Enabling the Persistent MAC Address Feature: Example

This example shows how to configure the persistent MAC address feature for a 7-minute time delay and to verify the configuration:

```
Switch(config)# stack-mac persistent timer 7
  WARNING: The stack continues to use the base MAC of the old Master
  WARNING: as the stack MAC after a master switchover until the MAC
  WARNING: persistency timer expires. During this time the Network
  WARNING: Administrators must make sure that the old stack-mac does
  WARNING: not appear elsewhere in this network domain. If it does,
  WARNING: user traffic may be blackholed.
  Switch(config)# end
  Switch# show switch
  Switch/Stack Mac Address : 0016.4727.a900
  Mac persistency wait time: 7 mins
                                                H/W   Current
  Switch#  Role   Mac Address     Priority Version  State
  -----------------------------------------------------------
  *1       Active 0016.4727.a900     1      P2B     Ready
```

Provisioning a New Member for a Switch Stack: Example

This example shows how to provision a switch with a stack member number of 2 for the switch stack. The **show running-config** command output shows the interfaces associated with the provisioned switch:

```
Switch(config)# switch 2 provision switch_PID
  Switch(config)# end
  Switch# show running-config | include switch 2
  !
  interface GigabitEthernet2/0/1
  !
  interface GigabitEthernet2/0/2
  !
  interface GigabitEthernet2/0/3
  <output truncated>
```

show switch stack-ports summary Command Output: Example

Only Port 1 on stack member 2 is disabled.

```
Switch# show switch stack-ports summary
  Switch#/  Stack   Neighbor   Cable    Link   Link   Sync      #         In
   Port#     Port              Length    OK   Active   OK    Changes   Loopback
             Status                                        To LinkOK
  --------  ------  --------  --------  ----  ------  ----  ---------  --------
    1/1     OK         3      50 cm     Yes    Yes    Yes        1        No
    1/2     Down      None    3 m       Yes    No     Yes        1        No
    2/1     Down      None    3 m       Yes    No     Yes        1        No
    2/2     OK         3      50 cm     Yes    Yes    Yes        1        No
    3/1     OK         2      50 cm     Yes    Yes    Yes        1        No
    3/2     OK         1      50 cm     Yes    Yes    Yes        1        No
```

Table 8: show switch stack-ports summary Command Output

Field	Description
Switch#/Port#	Member number and its stack port number.
Stack Port Status	Status of the stack port. • Absent—No cable is detected on the stack port. • Down—A cable is detected, but either no connected neighbor is up, or the stack port is disabled. • OK—A cable is detected, and the connected neighbor is up.
Neighbor	Switch number of the active member at the other end of the stack cable.
Cable Length	Valid lengths are 50 cm, 1 m, or 3 m. If the switch cannot detect the cable length, the value is *no cable*. The cable might not be connected, or the link might be unreliable.
Link OK	Whether the stack cable is connected and functional. There may or may not be a neighbor connected on the other end. The *link partner* is a stack port on a neighbor switch. • No—There is no stack cable connected to this port or the stack cable is not functional. • Yes—There is a functional stack cable connected to this port.
Link Active	Whether a neighbor is connected on the other end of the stack cable. • No—No neighbor is detected on the other end. The port cannot send traffic over this link. • Yes—A neighbor is detected on the other end. The port can send traffic over this link.

Field	Description
Sync OK	Whether the link partner sends valid protocol messages to the stack port. • No—The link partner does not send valid protocol messages to the stack port. • Yes—The link partner sends valid protocol messages to the port.
# Changes to LinkOK	The relative stability of the link. If a large number of changes occur in a short period of time, link flapping can occur.
In Loopback	Whether a stack cable is attached to a stack port on the member. • No—At least one stack port on the member has an attached stack cable. • Yes—None of the stack ports on the member has an attached stack cable.

Software Loopback: Examples

In a stack with three members, stack cables connect all the members:

```
Switch# show switch stack-ports summary
  Switch#
 Sw#/Port#  Port    Neighbor  Cable     Link  Link    Sync   #Changes   In
            Status            Length    OK    Active  OK     To LinkOK  Loopback
  --------  ------  --------  --------  ----  ------  ----  ---------  --------
    1/1     OK         3      50 cm     Yes    Yes    Yes        1        No
    1/2     OK         2      3 m       Yes    Yes    Yes        1        No
    2/1     OK         1      3 m       Yes    Yes    Yes        1        No
    2/2     OK         3      50 cm     Yes    Yes    Yes        1        No
    3/1     OK         2      50 cm     Yes    Yes    Yes        1        No
    3/2     OK         1      50 cm     Yes    Yes    Yes        1        No
```

If you disconnect the stack cable from Port 1 on Switch 1, these messages appear:

```
01:09:55: %STACKMGR-4-STACK_LINK_CHANGE: Stack Port 2 Switch 3 has changed to state DOWN
  01:09:56: %STACKMGR-4-STACK_LINK_CHANGE: Stack Port 1 Switch 1 has changed to state DOWN

  Switch# show switch stack-ports summary
  Switch#
 Sw#/Port#  Port    Neighbor  Cable     Link  Link    Sync  #Changes   In
            Status            Length    OK    Active  OK    To LinkOK  Loopback

  --------  ------  --------  --------  ----  ------  ----  ---------  --------
    1/1     Absent    None    No cable  No     No     No        1        No
    1/2     OK         2      3 m       Yes    Yes    Yes       1        No
    2/1     OK         1      3 m       Yes    Yes    Yes       1        No
    2/2     OK         3      50 cm     Yes    Yes    Yes       1        No
    3/1     OK         2      50 cm     Yes    Yes    Yes       1        No
    3/2     Down      None    50 cm     No     No     No        1        No
```

If you disconnect the stack cable from Port 2 on Switch 1, the stack splits.

Switch 2 and Switch 3 are now in a two-member stack connected through stack cables:

```
Switch# show sw stack-ports summary
  Switch#
 Sw#/Port#  Port    Neighbor  Cable     Link  Link    Sync  #Changes   In
            Status            Length    OK    Active  OK    To LinkOK  Loopback
  --------  ------  --------  --------  ----  ------  ----  ---------  --------
    2/1     Down      None    3 m       No     No     No         1        No
    2/2     OK          3     50 cm     Yes    Yes    Yes        1        No
    3/1     OK          2     50 cm     Yes    Yes    Yes        1        No
    3/2     Down      None    50 cm     No     No     No         1        No
```

Switch 1 is a standalone switch:

```
Switch# show switch stack-ports summary
  Switch#
 Sw#/Port#  Port    Neighbor  Cable     Link  Link    Sync  #Changes   In
            Status            Length    OK    Active  OK    To LinkOK  Loopback
  --------  ------  --------  --------  ----  ------  ----  ---------  --------
    1/1     Absent    None    No cable  No     No     No         1        Yes
    1/2     Absent    None    No cable  No     No     No         1        Yes
```

Software Loopback with Connected Stack Cables: Examples

- On Port 1 on Switch 1, the port status is *Down*, and a cable is connected.

  On Port 2 on Switch 1, the port status is *Absent*, and no cable is connected.

  ```
  Switch# show switch stack-ports summary
    Switch#
   Sw#/Port#  Port    Neighbor  Cable     Link  Link    Sync  #Changes   In
              Status            Length    OK    Active  OK    To LinkOK  Loopback
    --------  ------  --------  --------  ----  ------  ----  ---------  --------
      1/1     Down      None    50 Cm     No     No     No         1        No
      1/2     Absent    None    No cable  No     No     No         1        No
  ```

- In a *physical loopback*, a cable connects both stack ports on a switch. You can use this configuration to test

  - Cables on a switch that is running properly
  - Stack ports with a cable that works properly

  ```
  Switch# show switch stack-ports summary
    Switch#
   Sw#/Port#  Port    Neighbor  Cable     Link  Link    Sync  #Changes   In
              Status            Length    OK    Active  OK    To LinkOK  Loopback
    --------  ------  --------  --------  ----  ------  ----  ---------  --------
      2/1       OK        2     50 cm     Yes    Yes    Yes        1        No
      2/2       OK        2     50 cm     Yes    Yes    Yes        1        No
  ```

  The port status shows that

  - Switch 2 is a standalone switch.
  - The ports can send and receive traffic.

Software Loopback with no Connected Stack Cable: Example

```
Switch# show switch stack-ports summary
  Switch#
 Sw#/Port#  Port    Neighbor  Cable     Link  Link    Sync  #Changes   In
            Status            Length    OK    Active  OK    To LinkOK  Loopback
  --------  ------  --------  --------  ----  ------  ----  ---------  --------
    1/1     Absent    None    No cable   No     No     No       1         Yes
    1/2     Absent    None    No cable   No     No     No       1         Yes
```

Finding a Disconnected Stack Cable: Example

Stack cables connect all stack members. Port 2 on Switch 1 connects to Port 1 on Switch 2.

This is the port status for the members:

```
Switch# show switch stack-ports summary
  Switch#
 Sw#/Port#  Port    Neighbor  Cable     Link  Link    Sync  #Changes   In
            Status            Length    OK    Active  OK    To LinkOK  Loopback
  --------  ------  --------  --------  ----  ------  ----  ---------  --------
    1/1     OK         2      50 cm     Yes    Yes    Yes       0         No
    1/2     OK         2      50 cm     Yes    Yes    Yes       0         No
    2/1     OK         1      50 cm     Yes    Yes    Yes       0         No
    2/2     OK         1      50 cm     Yes    Yes    Yes       0         No
```

If you disconnect the cable from Port 2 on Switch 1, these messages appear:

```
%STACKMGR-4-STACK_LINK_CHANGE: Stack Port 1 Switch 2 has changed to state DOWN

  %STACKMGR-4-STACK_LINK_CHANGE: Stack Port 2 Switch 1 has changed to state DOWN
```

This is now the port status:

```
  Switch# show switch stack-ports summary
  Switch#
 Sw#/Port#  Port    Neighbor  Cable     Link  Link    Sync  #Changes   In
            Status            Length    OK    Active  OK    To LinkOK  Loopback
  --------  ------  --------  --------  ----  ------  ----  ---------  --------
    1/1       OK       2      50 cm     Yes    Yes    Yes       1         No
    1/2     Absent    None    No cable   No     No     No       2         No
    2/1      Down     None    50 cm      No     No     No       2         No
    2/2       OK       1      50 cm     Yes    Yes    Yes       1         No
```

Only one end of the cable connects to a stack port, Port 1 on Switch 2.

- The *Stack Port Status* value for Port 2 on Switch 1 is *Absent*, and the value for Port 1 on Switch 2 is *Down*.
- The *Cable Length* value is *No cable*.

Diagnosing the problem:

- Verify the cable connection for Port 2 on Switch 1.
- Port 2 on Switch 1 has a port or cable problem if
  - The *In Loopback* value is *Yes*.

or

- The *Link OK*, *Link Active*, or *Sync OK* value is *No*.

Fixing a Bad Connection Between Stack Ports: Example

Stack cables connect all members. Port 2 on Switch 1 connects to Port 1 on Switch 2.

This is the port status:

```
Switch# show switch stack-ports summary
  Switch#
 Sw#/Port#  Port     Neighbor  Cable     Link  Link    Sync  #Changes   In
            Status             Length    OK    Active  OK    To LinkOK  Loopback
  --------  ------   --------  --------  ----  ------  ----  ---------  --------
    1/1       OK        2      50 cm     Yes    Yes    Yes       1          No
    1/2      Down      None    50 cm      No     No     No       2          No
    2/1      Down      None    50 cm      No     No     No       2          No
    2/2       OK        1      50 cm     Yes    Yes    Yes       1          No
```

Diagnosing the problem:

- The Stack Port Status value is *Down*.
- Link OK, Link Active, and Sync OK values are *No*.
- The Cable Length value is *50 cm*. The switch detects and correctly identifies the cable.

The connection between Port 2 on Switch 1 and Port 1 on Switch 2 is unreliable on at least one of the connector pins.

Additional References for Switch Stacks

Related Documents

Related Topic	Document Title
Cabling and powering on a switch stack.	*Catalyst 3650 Switch Hardware Installation Guide*

Error Message Decoder

Description	Link
To help you research and resolve system error messages in this release, use the Error Message Decoder tool.	https://www.cisco.com/cgi-bin/Support/Errordecoder/index.cgi

Standards and RFCs

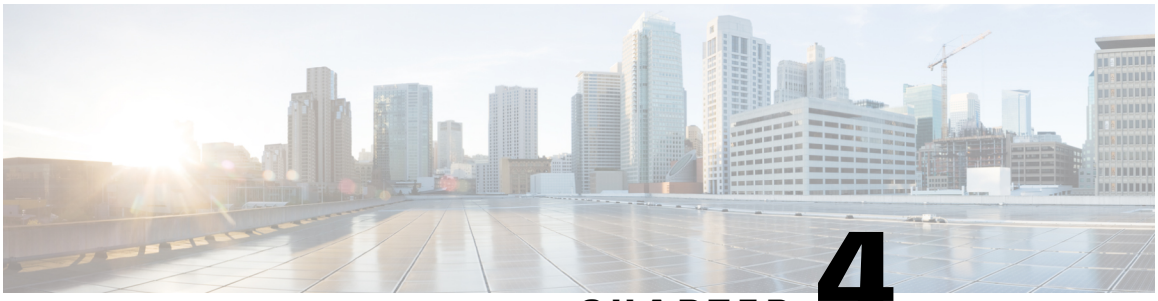
Standard/RFC	Title
None	—

MIBs

MIB	MIBs Link
All supported MIBs for this release.	To locate and download MIBs for selected platforms, Cisco IOS releases, and , 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



CHAPTER 4

Configuring Cisco NSF with SSO

Finding Feature Information

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

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

Prerequisites for NSF with SSO

The following are prerequisites and considerations for configuring NSF with SSO.

- Use of the routing protocols requires the IP Services license level. EIGRP-stub and OSPF for routed access are supported on IP Base license level.
- BGP support in NSF requires that neighbor networking devices be NSF-aware; that is, the devices must have the graceful restart capability and advertise that capability in their OPEN message during session establishment. If an NSF-capable router discovers that a particular BGP neighbor does not have graceful restart capability, it does not establish an NSF-capable session with that neighbor. All other neighbors that have graceful restart capability continue to have NSF-capable sessions with this NSF-capable networking device.
- OSPF support in NSF requires that all neighbor networking devices be NSF-aware. If an NSF-capable router discovers that it has non-NSF -aware neighbors on a particular network segment, it disables NSF

capabilities for that segment. Other network segments composed entirely of NSF-capable or NSF-aware routers continue to provide NSF capabilities.

Restrictions for NSF with SSO

The following are restrictions for configuring NSF with SSO:

- NSF capability is supported for IPv4 routing protocols only. NSF capability is not supported for IPv6 routing protocols.
- NSF does not support IP Multicast Routing, as it is not SSO-aware.
- NSF is not supported if the IOS-XE software is running in the LAN Base mode.
- For NSF operation, you must have SSO configured on the device.
- NSF with SSO supports IP Version 4 traffic and protocols only; NSF with SSO does not support IPv6 traffic.
- All Layer 3 neighboring devices must be NSF Helper or NSF-capable to support graceful restart capability.
- For IETF, all neighboring devices must be running an NSF-aware software image.

Information About NSF with SSO

Overview of NSF with SSO

The switch supports fault resistance by allowing a standby switch to take over if the active switch becomes unavailable. Cisco nonstop forwarding (NSF) works with stateful switchover (SSO) to minimize the amount of time a network is unavailable.

NSF provides these benefits:

- Improved network availability—NSF continues forwarding network traffic and application state information so that user session information is maintained after a switchover.
- Overall network stability—Network stability may be improved with the reduction in the number of route flaps, which were created when routers in the network failed and lost their routing tables.
- Neighboring routers do not detect a link flap—Because the interfaces remain up during a switchover, neighboring routers do not detect a link flap (the link does not go down and come back up).
- Prevents routing flaps—Because SSO continues forwarding network traffic during a switchover, routing flaps are avoided.
- Maintains user sessions established prior to the switchover.

Keepalive messages are sent and received between the active and standby switches.

- If the standby switch does not respond, a new standby switch is elected.
- If the active switch does not respond, the standby switch becomes the active switch.

In addition, hello messages are sent and received by all stack members.

- If a stack member does not respond, that member is removed from the stack.
- If the standby switch does not respond, a new standby switch is elected.
- If the active switch does not respond, the standby switch becomes the active switch.

SSO Operation

When a standby switch runs in SSO mode, the standby switch starts up in a fully-initialized state and synchronizes with the persistent configuration and the running configuration of the active switch. It subsequently maintains the state on the protocols listed below, and all changes in hardware and software states for features that support stateful switchover are kept in synchronization. Consequently, it offers minimum interruption to Layer 2 sessions in a redundant active switch configuration.

If the active switch fails, the standby switch becomes the active switch. This new active switch uses existing Layer 2 switching information to continue forwarding traffic. Layer 3 forwarding will be delayed until the routing tables have been repopulated in the newly active switch.

Note SSO is not supported if the IOS-XE software is running the LAN Base license level.

The state of these features is preserved between both the active and standby switches:

- 802.3
- 802.3u
- 802.3x (Flow Control)
- 802.3ab (GE)
- 802.3z (Gigabit Ethernet including CWDM)
- 802.3ad (LACP)
- 802.1p (Layer 2 QoS)
- 802.1q
- 802.1X (Authentication)
- 802.1D (Spanning Tree Protocol)
- 802.3af (Inline power)
- PAgP
- VTP
- Dynamic ARP Inspection
- DHCP snooping
- IP source guard
- IGMP snooping (versions 1 and 2)
- DTP (802.1q and ISL)

- MST
- PVST+
- Rapid-PVST
- PortFast/UplinkFast/BackboneFast
- BPDU guard and filtering
- Voice VLAN
- Port security
- Unicast MAC filtering
- ACL (VACLS, PACLS, RACLS)
- QOS (DBL)
- Multicast storm control/broadcast storm control

SSO is compatible with the following list of features. However, the protocol database for these features is not synchronized between the standby and active switches:

- 802.1Q tunneling with Layer 2 Protocol Tunneling (L2PT)
- Baby giants
- Jumbo frame support
- CDP
- Flood blocking
- UDLD
- SPAN/RSPAN
- NetFlow

All Layer 3 protocols on a switch are learned on the standby switch if SSO is enabled.

NSF Operation

Cisco IOS Nonstop Forwarding (NSF) always runs with stateful switchover (SSO) and provides redundancy for Layer 3 traffic. NSF is supported by the BGP, OSPF, and EIGRP routing protocols and is supported by Cisco Express Forwarding (CEF) for forwarding. The routing protocols have been enhanced with NSF-capability and awareness, which means that routers running these protocols can detect a switchover and take the necessary actions to continue forwarding network traffic and to recover route information from the peer devices.

Each protocol depends on CEF to continue forwarding packets during switchover while the routing protocols rebuild the Routing Information Base (RIB) tables. After the routing protocols have converged, CEF updates the FIB table and removes stale route entries. CEF then updates the hardware with the new FIB information.

If the active switch is configured for BGP (with the **graceful-restart** command), OSPF, or EIGRP routing protocols, routing updates are automatically sent during the active switch election.

The switch supports NSF-awareness and NSF-capability for the BGP, OSPF, and EIGRP protocols in IP Services license level and NSF-awareness for the EIGRP-stub in IP Base license level.

NSF has two primary components:

- NSF-awareness

  A networking device is NSF-aware if it is running NSF-compatible software. If neighboring router devices detect that an NSF router can still forward packets when an active switch election happens, this capability is referred to as NSF-awareness. Cisco IOS enhancements to the Layer 3 routing protocols (BGP, OSPF, and EIGRP) are designed to prevent route-flapping so that the CEF routing table does not time out or the NSF router does not drop routes. An NSF-aware router helps to send routing protocol information to the neighboring NSF router. NSF-awareness is enabled by default for EIGRP-stub, EIGRP, and OSPF protocols. NSF-awareness is disabled by default for BGP.

- NSF-capability

  A device is NSF-capable if it has been configured to support NSF; it rebuilds routing information from NSF-aware or NSF-capable neighbors. NSF works with SSO to minimize the amount of time that a Layer 3 network is unavailable following an active switch election by continuing to forward IP packets. Reconvergence of Layer 3 routing protocols (BGP, OSPFv2, and EIGRP) is transparent to the user and happens automatically in the background. The routing protocols recover routing information from neighbor devices and rebuild the Cisco Express Forwarding (CEF) table.

Note NSF does not support IPv6 and is IPv4 Unicast only.

Cisco Express Forwarding

A key element of Cisco IOS Nonstop Forwarding (NSF) is packet forwarding. In a Cisco networking device, packet forwarding is provided by Cisco Express Forwarding (CEF). CEF maintains the FIB and uses the FIB information that was current at the time of the switchover to continue forwarding packets during a switchover. This feature reduces traffic interruption during the switchover.

During normal NSF operation, CEF on the active supervisor switch synchronizes its current FIB and adjacency databases with the FIB and adjacency databases on the standby switch. Upon switchover, the standby switch initially has FIB and adjacency databases that are mirror images of those that were current on the active switch. CEF keeps the forwarding engine on the standby switch current with changes that are sent to it by CEF on the active switch. The forwarding engine can continue forwarding after a switchover as soon as the interfaces and a data path are available.

As the routing protocols start to repopulate the RIB on a prefix-by-prefix basis, the updates cause prefix-by-prefix updates to CEF, which it uses to update the FIB and adjacency databases. Existing and new entries receive the new version (“epoch”) number, indicating that they have been refreshed. The forwarding information is updated on the forwarding engine during convergence. The switch signals when the RIB has converged. The software removes all FIB and adjacency entries that have an epoch older than the current switchover epoch. The FIB now represents the newest routing protocol forwarding information.

BGP Operation

When an NSF-capable router begins a BGP session with a BGP peer, it sends an OPEN message to the peer. Included in the message is a statement that the NSF-capable device has “graceful” restart capability. Graceful restart is the mechanism by which BGP routing peers avoid a routing flap following a switchover. If the BGP

peer has received this capability, it is aware that the device sending the message is NSF-capable. Both the NSF-capable router and its BGP peers need to exchange the graceful restart capability in their OPEN messages at the time of session establishment. If both the peers do not exchange the graceful restart capability, the session will not be capable of a graceful restart.

If the BGP session is lost during the active switch switchover, the NSF-aware BGP peer marks all the routes associated with the NSF-capable router as stale; however, it continues to use these routes to make forwarding decisions for a set period of time. This functionality prevents packets from being lost while the newly active switch is waiting for convergence of the routing information with the BGP peers.

After an active switch switchover occurs, the NSF-capable router reestablishes the session with the BGP peer. In establishing the new session, it sends a new graceful restart message that identifies the NSF-capable router as having restarted.

At this point, the routing information is exchanged between the two BGP peers. After this exchange is complete, the NSF-capable device uses the routing information to update the RIB and the FIB with the new forwarding information. The NSF-aware device uses the network information to remove stale routes from its BGP table; the BGP protocol then is fully converged.

If a BGP peer does not support the graceful restart capability, it ignores the graceful restart capability in an OPEN message but establishes a BGP session with the NSF-capable device. This function allows interoperability with non-NSF-aware BGP peers (and without NSF functionality), but the BGP session with non-NSF-aware BGP peers is not capable of a graceful restart.

Note BGP support in NSF requires that neighbor networking devices be NSF-aware; that is, the devices must have the graceful restart capability and advertise that capability in their OPEN message during session establishment. If an NSF-capable router discovers that a particular BGP neighbor does not have graceful restart capability, it does not establish an NSF-capable session with that neighbor. All other neighbors that have graceful restart capability continue to have NSF-capable sessions with this NSF-capable networking device.

OSPF Operation

When an OSPF NSF-capable router performs an active switch switchover, it must perform the following tasks in order to resynchronize its link state database with its OSPF neighbors:

- Relearn the available OSPF neighbors on the network without causing a reset of the neighbor relationship
- Reacquire the contents of the link state database for the network

As quickly as possible after an active switch switchover, the NSF-capable router sends an OSPF NSF signal to neighboring NSF-aware devices. Neighbor networking devices recognize this signal as an indicator that the neighbor relationship with this router should not be reset. As the NSF-capable router receives signals from other routers on the network, it can begin to rebuild its neighbor list.

After neighbor relationships are reestablished, the NSF-capable router begins to resynchronize its database with all of its NSF-aware neighbors. At this point, the routing information is exchanged between the OSPF neighbors. Once this exchange is complete, the NSF-capable device uses the routing information to remove stale routes, update the RIB, and update the FIB with the new forwarding information. The OSPF protocols are then fully converged.

Note OSPF support in NSF requires that all neighbor networking devices be NSF-aware. If an NSF-capable router discovers that it has non-NSF -aware neighbors on a particular network segment, it disables NSF capabilities for that segment. Other network segments composed entirely of NSF-capable or NSF-aware routers continue to provide NSF capabilities.

EIGRP Operation

When an EIGRP NSF-capable router initially re-boots after an NSF restart, it has no neighbor and its topology table is empty. The router is notified by the standby (now active) switch when it needs to bring up the interfaces, reacquire neighbors, and rebuild the topology and routing tables. The restarting router and its peers must accomplish these tasks without interrupting the data traffic directed toward the restarting router. EIGRP peer routers maintain the routes learned from the restarting router and continue forwarding traffic through the NSF restart process.

To prevent an adjacency reset by the neighbors, the restarting router uses a new Restart (RS) bit in the EIGRP packet header to indicate a restart. The RS bit is set in the hello packets and in the initial INIT update packets during the NSF restart period. The RS bit in the hello packets allows the neighbors to be quickly notified of the NSF restart. Without seeing the RS bit, the neighbor can only detect an adjacency reset by receiving an INIT update or by the expiration of the hello hold timer. Without the RS bit, a neighbor does not know if the adjacency reset should be handled using NSF or the normal startup method.

When the neighbor receives the restart indication, either by receiving the hello packet or the INIT packet, it recognizes the restarting peer in its peer list and maintains the adjacency with the restarting router. The neighbor then sends it topology table to the restarting router with the RS bit set in the first update packet indicating that it is NSF-aware and is helping out the restarting router. The neighbor does not set the RS bit in their hello packets, unless it is also a NSF restarting neighbor.

Note A router may be NSF-aware but may not be helping the NSF restarting neighbor because booting from a cold start.

If at least one of the peer routers is NSF-aware, the restarting router would then receive updates and rebuild its database. The restarting router must then find out if it had converged so that it can notify the routing information base (RIB). Each NSF-aware router is required to send an end of table (EOT) marker in the last update packet to indicate the end of the table content. The restarting router knows it has converged when it receives the EOT marker. The restarting router can then begin sending updates.

An NSF-aware peer would know when the restarting router had converged when it receives an EOT indication from the restarting router. The peer then scans its topology table to search for the routes with the restarted neighbor as the source. The peer compares the route timestamp with the restart event timestamp to determine if the route is still available. The peer then goes active to find alternate paths for the routes that are no longer available through the restarted router.

When the restarting router has received all EOT indications from its neighbors or when the NSF converge timer expires, EIGRP notifies the RIB of convergence. EIGRP waits for the RIB convergence signal and then floods its topology table to all awaiting NSF-aware peers.

How to Configure Cisco NSF with SSO

Configuring SSO

You must configure SSO in order to use NSF with any supported protocol.

SUMMARY STEPS

1. **redundancy**
2. **mode sso**
3. **end**
4. **show running-config**
5. **show redundancy states**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**redundancy** **Example:** `Switch(config)# redundancy`	Enters redundancy configuration mode.
Step 2	**mode sso** **Example:** `Switch(config-red)# mode sso`	Configures SSO. When this command is entered, the standby switch is reloaded and begins to work in SSO mode.
Step 3	**end** **Example:** `Switch(config-red)# end`	Returns to EXEC mode.
Step 4	**show running-config** **Example:** `Switch# show running-config`	Verifies that SSO is enabled.
Step 5	**show redundancy states** **Example:** `Switch# show redundancy states`	Displays the operating redundancy mode.

Configuring SSO Example

This example shows how to configure the system for SSO and display the redundancy state:

```
Switch(config)# redundancy
  Switch(config)# mode sso
  Switch(config)# end
  Switch# show redundancy states
  my state = 13 -ACTIVE
  peer state = 8 -STANDBY HOT
  Mode = Duplex
  Unit = Primary
  Unit ID = 5
  Redundancy Mode (Operational) = sso
  Redundancy Mode (Configured) = sso
  Split Mode = Disabled
  Manual Swact = Enabled
  Communications = Up
  client count = 29
  client_notification_TMR = 30000 milliseconds
  keep_alive TMR = 9000 milliseconds
  keep_alive count = 1
  keep_alive threshold = 18
  RF debug mask = 0x0
```

Verifying CEF NSF

To verify CEF NSF, use the **show cef state** privileged EXEX command.

```
Switch# show cef state
CEF Status:
RP instance
common CEF enabled
IPv4 CEF Status:
CEF enabled/running
dCEF enabled/running
CEF switching enabled/running
universal per-destination load sharing algorithm, id DEA83012
IPv6 CEF Status:
CEF disabled/not running
dCEF disabled/not running
universal per-destination load sharing algorithm, id DEA83012
RRP state:
I am standby RRP: no
RF Peer Presence: yes
RF PeerComm reached: yes
RF Progression blocked: never
Redundancy mode: rpr(1)
CEF NSF sync: disabled/not running
CEF ISSU Status:
FIBHWIDB broker
No slots are ISSU capable.
FIBIDB broker
No slots are ISSU capable.
FIBHWIDB Subblock broker
No slots are ISSU capable.
FIBIDB Subblock broker
No slots are ISSU capable.
Adjacency update
No slots are ISSU capable.
IPv4 table broker
No slots are ISSU capable.
CEF push
No slots are ISSU capable.
```

Configuring BGP for NSF

You must configure BGP graceful restart on all peer devices participating in BGP NSF.

SUMMARY STEPS

1. **configure terminal**
2. **router bgp as-number**
3. **bgp graceful-restart**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Switch(config)# configure terminal`	Enters global configuration mode.
Step 2	**router bgp as-number** **Example:** `Switch(config)# router bgp 300`	Enables a BGP routing process, which places the switch in switch configuration mode.
Step 3	**bgp graceful-restart** **Example:** `Switch(config)# bgp graceful-restart`	Enables the BGP graceful restart capability, starting BGP NSF. If you enter this command after the BGP session has been established, you must restart the session for the capability to be exchanged with the BGP neighbor. Use this command on the restarting switch and all of its peers.

Verifying BGP NSF

To verify BGP NSF, you must check that BGP graceful restart is configured on the SSO-enabled networking device and on the neighbor devices. To verify, follow these steps:

Step 1 Verify that "bgp graceful-restart" appears in the BGP configuration of the SSO-enabled switch by entering the **show running-config** command:

Example:

```
Switch# show running-config
.
.
.
router bgp 120
.
.
.
```

```
bgp graceful-restart
neighbor 192.0.2.0 remote-as 300
.
.
.
```

Step 2 Repeat Step 1 on each of the BGP neighbors.

Step 3 On the SSO device and the neighbor device, verify that the graceful restart function is shown as both advertised and received, and confirm the address families that have the graceful restart capability. If no address families are listed, BGP NSF does not occur either:

Example:

```
Switch# show ip bgp neighbors
BGP neighbor is 192.0.2.3, remote AS 1, internal link
BGP version 4, remote router ID 192.0.2.4
BGP state = Established, up for 00:02:38
Last read 00:00:38, last write 00:00:35, hold time is 180, keepalive interval is 60
seconds
Neighbor capabilities:
Route refresh: advertised and received(new)
Address family IPv4 Unicast: advertised and received
Message statistics:
InQ depth is 0
OutQ depth is 0
Sent Rcvd
Opens: 1 1
Notifications: 0 0
Updates: 0 0
Keepalives: 4 4
Route Refresh: 0 0
Total: 5 5
Default minimum time between advertisement runs is 0 seconds
.....................................................
(Remaining output deleted)
```

Configuring OSPF NSF

All peer devices participating in OSPF NSF must be made OSPF NSF-aware, which happens automatically when you install an NSF software image on the device.

SUMMARY STEPS

1. **configure terminal**
2. **router ospf** *processID*
3. **nsf**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Switch(config)# configure terminal`	Enters global configuration mode.
Step 2	**router ospf** *processID* **Example:** `Switch(config)# router ospf processID`	Enables an OSPF routing process, which places the switch in router configuration mode.
Step 3	**nsf** **Example:** `Switch(config)# nsf`	Enables NSF operations for OSPF.

Verifying OSPF NSF

Step 1 Verify that 'nsf' appears in the OSPF configuration of the SSO-enabled device by entering the show running-config command:

Example:
```
Switch(config)#show running-config
route ospf 120
log-adjacency-changes
nsf
network 192.0.2.0 192.0.2.255 area 0
network 192.0.2.1 192.0.2.255 area 1
network 192.0.2.2 192.0.2.255 area 2
.
.
.
```

Step 2 Enter the **show ip ospf** command to verify that NSF is enabled on the device:

Example:
```
Switch show ip ospf
Routing Process "ospf 1" with ID 192.0.2.1
Start time: 00:02:07.532, Time elapsed: 00:39:05.052
Supports only single TOS(TOS0) routes
Supports opaque LSA
Supports Link-local Signaling (LLS)
transit capable is 0
External flood list length 0
IETF Non-Stop Forwarding enabled
restart-interval limit: 120 sec
IETF NSF helper support enabled
Cisco NSF helper support enabled
Reference bandwidth unit is 100 mbps
Area BACKBONE(0)
```

```
Number of interfaces in this area is 3 (1 loopback)
Area has no authentication
SPF algorithm last executed 00:08:53.760 ago
SPF algorithm executed 2 times
Area ranges are
Number of LSA 3. Checksum Sum 0x025BE0
Number of opaque link LSA 0. Checksum Sum 0x000000
Number of DCbitless LSA 0
Number of indication LSA 0
Number of DoNotAge LSA 0
Flood list length 0
```

Configuring EIGRP NSF

SUMMARY STEPS

1. **configure terminal**
2. **router eigrp** *as-number*
3. **nsf**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Switch configure terminal`	Enters global configuration mode.
Step 2	**router eigrp** *as-number* **Example:** `Switch(config)# router eigrp as-number`	Enables an EIGRP routing process, which places the switch in router configuration mode.
Step 3	**nsf** **Example:** `Switch(config-router)# nsf`	Enables EIGRP NSF. Use this command on the “restarting” switch and all of its peers.

Verifying EIGRP NSF

Step 1 Verify that “nsf” appears in the EIGRP configuration of the SSO-enabled device by entering the show **running-config command**:

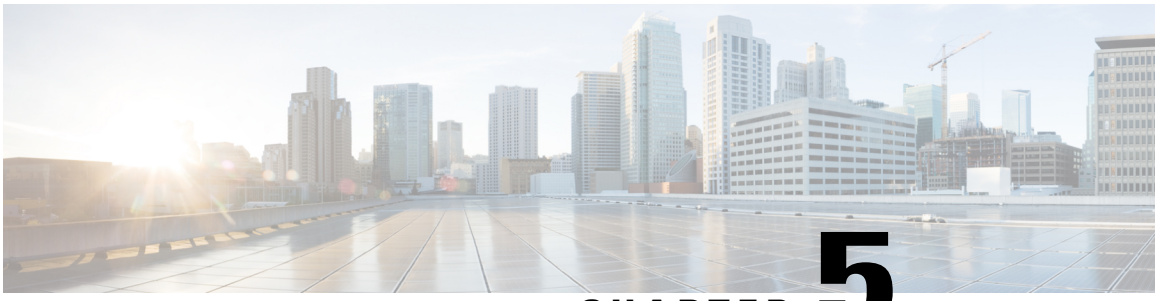
Example:

```
Switch show running-config
..
.
router eigrp 100
auto-summary
nsf
..
.
```

Step 2 Enter the **show ip protocols** command to verify that NSF is enabled on the device:

Example:

```
Switch show ip protocols
*** IP Routing is NSF aware ***
Routing Protocol is "ospf 1"
Outgoing update filter list for all interfaces is not set
Incoming update filter list for all interfaces is not set
Router ID 192.0.2.3
Number of areas in this router is 1. 1 normal 0 stub 0 nssa
Maximum path: 1
Routing for Networks:
Routing on Interfaces Configured Explicitly (Area 0):
Loopback0
GigabitEthernet5/3
TenGigabitEthernet3/1
Routing Information Sources:
Gateway Distance Last Update
192.0.2.1 110 00:01:02
Distance: (default is 110)
Routing Protocol is "bgp 601"
Outgoing update filter list for all interfaces is not set
Incoming update filter list for all interfaces is not set
IGP synchronization is disabled
Automatic route summarization is disabled
Neighbor(s):
Address FiltIn FiltOut DistIn DistOut Weight RouteMap
192.0.2.0
Maximum path: 1
Routing Information Sources:
Gateway Distance Last Update
192.0.2.0 20 00:01:03
Distance: external 20 internal 200 local 200
```



CHAPTER 5

Configuring Wireless High Availability

Finding Feature Information

Your software release may not support all 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 High Availability

The high availability feature is enabled by default when the switches are connected using the stack cable and the Cisco StackWise-160 technology is enabled. You cannot disable it; however, you can initiate a manual graceful-switchover using the command line interface to use the high availability feature enabled in the switch.

In Cisco Wireless LAN Controllers, high availability is achieved with redundancy.

In Cisco Wireless LAN Controllers, redundancy is achieved in two ways— n+1 and AP SSO redundancy.

Keepalive messages are sent and received between the active and standby controllers.

- If the standby controller does not respond, a new standby controller is elected.

- If the active controller does not respond, the standby controller becomes the active controller.

In addition, hello messages are sent and received by all stack members.

- If a stack member does not respond, that member is removed from the stack.
- If the standby controller does not respond, a new standby controller is elected.
- If the active controller does not respond, the standby controller becomes the active controller.

Information About Redundancy

In case of n+1 redundancy, access points are configured with primary, secondary, and tertiary controllers. When the primary controller fails, depending upon the number of access points managed by a controller, the access point fails over to the secondary controller. In case of AP SSO redundancy, once the primary controller is unavailable, the access points re-discovers the controller and reestablishes the CAPWAP tunnel with the secondary controller. However, all clients must disconnect and a re-authentication is performed to rejoin the controller.

You can configure primary, secondary, and tertiary controllers for a selected access point and a selected controller.

In an ideal high availability deployment, you can have access points connected to primary and secondary controllers and one controller can remain with out connection to any access points. This way the controller that does not have any access points can take over when a failure occurs and resume services of active controller.

Configuring Redundancy in Access Points

You must use the commands explained in this section to configure primary, secondary, or tertiary controllers for a selected access point.

Before You Begin

SUMMARY STEPS

1. conf t
2. ap capwap backup primary
3. **ap capwap backup secondary**
4. ap capwap backup tertiary

DETAILED STEPS

	Command or Action	Purpose
Step 1	conf t **Example:** `Controller # conf t`	Configures the terminal

	Command or Action	Purpose
Step 2	ap capwap backup primary **Example:** `Controller # ap capwap backup primary WLAN-Controller-A`	Configures the primary controller for the selected access point.
Step 3	**ap capwap backup secondary** **Example:** `Controller # ap capwap backup secondary WLAN-Controller-B`	Configures the secondary controller for the selected access point.
Step 4	ap capwap backup tertiary **Example:** `Controller # ap capwap backup tertiary WLAN-Controller-C`	Configures the tertiary controller for the selected access point.

What to Do Next

Once you complete configuration of the primary, secondary, and tertiary controllers for a selected access point, you must verify the configuration using the **show ap name** *AP-NAME* command. For more details on, **show ap name** *AP-NAME* command, see the Lightweight Access Point Configuration Guide for Cisco Wireless LAN Controller.

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Configuring Heartbeat Messages

Hearbeat messages enable you to reduce the controller failure detection time. When a failure occurs, a switchover from active to hot standby happens after the controller waits for the heartbeat timer. If the controller does not function within the heartbeat time, then the standby takes over as then active controller. Ideally the access point generates three heartbeat messages within the time out value specified, and when the controller does not respond within the timeout value, the standby controller takes over as active. You can specify the timeout value depending on your network. Ideally the timer value is not a higher value as some chaos will occur while performing a switchover. This section explains on how to configure heartbeat interval between the controller and the access points using a timeout value to reduce the controller failure detection time.

Before You Begin

SUMMARY STEPS

1. conf t
2. ap capwap timers heartbeat-timeout

DETAILED STEPS

	Command or Action	Purpose
Step 1	conf t **Example:** `controller # conf t`	Configures the terminal.
Step 2	ap capwap timers heartbeat-timeout **Example:** `controller #  ap capwap timers heartbeat-timeout`	Configures the heartbeat interval between the controller and access points. The timeout value ranges from 1 to 30.

Information about Access Point Stateful Switch Over

An Access Point Stateful Switch Over (AP SSO) implies that all the access point sessions are switched over state-fully and the user session information is maintained during a switchover, and access points continue to operate in network with no loss of sessions, providing improved network availability. The active switch in the stack is equipped to perform all network functions, including IP functions and routing information exchange. The switch supports 1000 access points and 12000 clients.

However, all the clients are de-authenticated and need to be re-associated with the new active switch except for the locally switched clients in FlexConnect mode when a switchover occurs.

Once a redundancy pair is formed while in a stack, high availability is enabled, which includes that access points continue to remain connected during an active-to-standby switchover.

Note You can not disable AP SSO while in a switch stack once the switches form a redundant pair.

Initiating Graceful Switchover

To perform a manual switchover and to use the high availability feature enabled in the switch, execute the **redundancy force-switchover** command. This command initiates a graceful switchover from the active to the standby switch.

```
Switch# redundancy force-switchover
System configuration has been modified. Save ? [yes/no] : yes
Building configuration ...
Preparing for switchover ...
Compressed configuration from 14977 bytes to 6592 bytes[OK]This will reload the active unit
 and force switchover to standby[confirm] : y
```

Configuring EtherChannels for High Availability

The LAG, or an EtherChannel, bundles all the existing ports in both the standby and active units into a single logical port to provide an aggregate bandwidth of 60 Gbps. The creation of an EtherChannel enables protection against failures. The EtherChannels or LAGs created are used for link redundancy to ensure high availability of access points.

For more details on configuring EtherChannel, and Etherchannel modes, see the Layer 2 (Link Aggregation) Configuration Guide, Cisco IOS XE Release 3SE (Cisco WLC 5700 Series)

Step 1 Connect two switches that are in powered down state using the stack cable.

Step 2 Power up and perform a boot on both switches simultaneously or power and boot one switch.
The switches boot up successfully, and form a high availability pair.

Step 3 Configure EtherChannel or LAG on the units.

Step 4 Use the **show etherchannel summary** command to view the status of the configured EtherChannel.
On successful configuration, all the specified ports will be bundled in a single channel and listed in the command output of **show etherchannel summary**.

Step 5 Execute the **show ap uptime** command to verify the connected access points.

Configuring LACP

SUMMARY STEPS

1. **configure terminal**
2. **interface port-channel** *number*
3. **lacp max-bundle** *number*
4. **lacp port-priority** *number*
5. **switchport backup interface** *po2*
6. **end**
7. **show etherchannel summary**
8. **show interfaces switchport backup**

DETAILED STEPS

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

	Command or Action	Purpose
Step 2	**interface port-channel** *number* **Example:** `Switch(config)# interface Port-channel Po2`	Enters port-channel interface configuration mode.
Step 3	**lacp max-bundle** *number* **Example:** `Switch(config-if)# lacp max-bundle 6`	Defines the maximum number of active bundled LACP ports allowed in a port channel. The value ranges from 1 to 8.
Step 4	**lacp port-priority** *number* **Example:** `Switch(config-if)# lacp port-priority 4`	Specifies port priority to be configured on the port using LACP. The value ranges from 0 to 65535.
Step 5	**switchport backup interface** *po2* **Example:** `Switch(config-if)# switchport backup interface Po2`	Specifies an interface as the backup interface.
Step 6	**end**	Exits the interface and configuration mode.
Step 7	**show etherchannel summary** **Example:** `Switch# show etherchannel summary`	Displays a summary of EtherChannel properties.
Step 8	**show interfaces switchport backup** **Example:** `Switch# show interfaces switchport backup`	Displays summary of backup EtherChannel properties.

Troubleshooting High Availability

Access the Standby Console

You can only access the console of the active switch in a stack. To access the standby switch, use the following commands.

Before You Begin

Use this functionality only under supervision of Cisco Support.

SUMMARY STEPS

1. **configure terminal**
2. **service internal**
3. **redundancy**
4. **main-cpu**
5. **standby console enable**
6. **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Switch# configure terminal`	Enters global configuration mode.
Step 2	**service internal** **Example:** `Switch(config)# service internal`	Enables Cisco IOS debug commands.
Step 3	**redundancy** **Example:** `Switch(config)# redundancy`	Enters redundancy configuration mode.
Step 4	**main-cpu** **Example:** `Switch(config)# main-cpu`	Enters the redundancy main configuration submode.
Step 5	**standby console enable** **Example:** `Switch(config)# standby console enable`	Enables the standby console.
Step 6	**exit** **Example:** `Switch(config)# exit`	Exits the configuration mode.

Before a Switchover

A switchover happens when the active switch fails; however, while performing a manual switchover, you can execute these commands to initiate a successful switchover:

SUMMARY STEPS

1. **show redundancy states**
2. **show switch detail**
3. **show platform ses states**
4. **show ap summary**
5. **show capwap detail**
6. **show dtls database-brief**
7. **show power inline**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**show redundancy states** **Example:** `Switch# show redundancy states`	Displays the high availability role of the active and standby switches.
Step 2	**show switch detail** **Example:** `Switch# show switch detail`	Display physical property of the stack. Verify if the physical states of the stacks are "Ready" or "Port".
Step 3	**show platform ses states** **Example:** `Switch# show platform ses states`	Displays the sequences of the stack manager.
Step 4	**show ap summary** **Example:** `Switch# show ap summary`	Displays all the access points in the active and standby switches.
Step 5	**show capwap detail** **Example:** `Switch# show capwap detail`	Displays the details of the CAPWAP tunnel in the active and standby switches.
Step 6	**show dtls database-brief** **Example:** `Switch# show dtls database-brief`	Displays DTLS details in the active and standby switches.
Step 7	**show power inline** **Example:** `Switch# show power inline`	Displays the power on Ethernet power state. **Note** When a failover occurs, the standby controller must be in a standby-hot state and the redundant port in a terminal state in SSO for successful switchover to occur.

After a Switchover

This section defines the steps that you must perform to ensure that successful switchover from the active to standby switch is performed. On successful switchover of the standby switch as active, all access points connected to the active need to re-join the standby (then active) switch.

SUMMARY STEPS

1. **show ap uptime**
2. **show wireless summary**
3. **show wcdb database all**
4. **show power inline**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**show ap uptime** **Example:** `Switch# show ap uptime`	Verify if the uptime of the access point after the switchover is large enough.
Step 2	**show wireless summary** **Example:** `Switch# show wireless summary`	Display the clients connected in the active switch.
Step 3	**show wcdb database all** **Example:** `Switch# show wcdb database all`	Display if the client has reached the uptime.
Step 4	**show power inline** **Example:** `Switch# show power inline`	Display the power over Ethernet power state.

Viewing Redundancy Switchover History (GUI)

Step 1 Click **Monitor > Controller > Redundancy** > **States.**
The Redundancy States page is displayed. The values for the following parameters are displayed in the page:

Parameter	Description
Index	Displays the index number of the of the redundant unit.

Parameter	Description
Previous Active	Displays the Switches that was active before.
Current Active	Displays the Switches that is currently active.
Switch Over Time	Displays the system time when the switchover occurs.
Switch Over Reason	Displays the cause of the switchover.

Step 2 Click **Apply**.

Viewing Switchover States (GUI)

Step 1 Click **Monitor > Controller > Redundancy** > **States.**
The Redundancy States page is displayed. The values for the following parameters are displayed in the page:

Parameter	Description
My State	Shows the state of the active CPU Switch module. Values are as follows: • Active • Standby HOT • Disable
Peer State	Displays the state of the peer (or standby) CPU Switch module. Values are as follows: • Standby HOT • Disable
Mode	Displays the current state of the redundancy peer. Values are as follows: • Simplex— Single CPU switch module • Duplex— Two CPU switch modules
Unit ID	Displays the unit ID of the CPU switch module.
Redundancy Mode (Operational)	Displays the current operational redundancy mode supported on the unit.
Redundancy Mode (Configured)	Displays the current configured redundancy mode supported on the unit.

Parameter	Description
Redundancy State	Displays the current functioning redundancy state of the unit. Values are as follows: • SSP • Not Redundant
Manual SWACT	Displays whether manual switchovers have been enabled without the force option.
Communications	Displays whether communications are up or down between the two CPU Switch modules.
Client Count	Displays the number of redundancy subsystems that are registered as RF clients.
Client Notification TMR	Displays, in milliseconds, the time that an internal RF timer has for notifying RF client subsystems.
Keep Alive TMR	Displays, in milliseconds, the time interval the RF manager has for sending keep-alive messages to its peer on the standby CPU switch module.
Keep Alive Count	Displays the number of keep-alive messages sent without receiving a response from the standby CPU Switch module.
Keep Alive Threshold	Displays the threshold for declaring that interprocessor communications are down when keep-alive messages have been enabled (which is the default).
RF Debug Mask	Displays an internal mask used by the RF to keep track of which debug modes are on.

Step 2 Click **Apply**.

Monitoring the Switch Stack

Table 9: Commands for Displaying Stack Information

Command	Description
show switch	Displays summary information about the stack, including the status of provisioned switches and switches in version-mismatch mode.
show switch *stack-member-number*	Displays information about a specific member.
show switch detail	Displays detailed information about the stack.
show switch neighbors	Displays the stack neighbors.
show switch stack-ports [**summary**]	Displays port information for the stack.

Command	Description
show redundancy	Displays the redundant system and the current processor information. The redundant system information includes the system uptime, standby failures, switchover reason, hardware, configured and operating redundancy mode. The current processor information displayed includes the active location, the software state, the uptime in the current state and so on.
show redundancy state	Displays all the redundancy states of the active and standby switches.

LACP Configuration: Example

This example shows how to configure LACP and to verify creation of the LACP bundle and the status:

```
Switch(config)# !
interface TenGigabitEthernet1/0/1
 switchport mode trunk
 channel-group 1 mode active
 lacp port-priority 10
 ip dhcp snooping trust
!
interface TenGigabitEthernet1/0/2
 switchport mode trunk
 channel-group 1 mode active
 lacp port-priority 10
 ip dhcp snooping trust
!
interface TenGigabitEthernet1/0/3
 switchport mode trunk
 channel-group 1 mode active
 lacp port-priority 10
 ip dhcp snooping trust
!
interface TenGigabitEthernet1/0/4
 switchport mode trunk
 channel-group 1 mode active
 ip dhcp snooping trust
!
interface TenGigabitEthernet1/0/5
 switchport mode trunk
 channel-group 1 mode active
 ip dhcp snooping trust
!
interface TenGigabitEthernet1/0/6
 switchport mode trunk
 channel-group 1 mode active
 ip dhcp snooping trust
!
interface TenGigabitEthernet2/0/1
 switchport mode trunk
 channel-group 1 mode active
 lacp port-priority 10
 ip dhcp snooping trust
!
interface TenGigabitEthernet2/0/2
 switchport mode trunk
 channel-group 1 mode active
 lacp port-priority 10
```

```
 ip dhcp snooping trust
!
interface TenGigabitEthernet2/0/3
 switchport mode trunk
 channel-group 1 mode active
 lacp port-priority 10
 ip dhcp snooping trust
!
interface TenGigabitEthernet2/0/4
 switchport mode trunk
 channel-group 1 mode active
 ip dhcp snooping trust
!
interface TenGigabitEthernet2/0/5
 switchport mode trunk
 channel-group 1 mode active
 ip dhcp snooping trust
!
interface TenGigabitEthernet2/0/6
 switchport mode trunk
 channel-group 1 mode active
 ip dhcp snooping trust
!
interface Vlan1
 no ip address
 ip igmp version 1
 shutdown
!

Switch#  show etherchannel summary

  Flags:  D - down        P - bundled in port-channel
          I - stand-alone s - suspended
          H - Hot-standby (LACP only)
          R - Layer3      S - Layer2
          U - in use      f - failed to allocate aggregator

          M - not in use, minimum links not met
          u - unsuitable for bundling
          w - waiting to be aggregated
          d - default port


Number of channel-groups in use: 1
Number of aggregators:           1

Group  Port-channel  Protocol    Ports
------+-------------+-----------+-----------------------------------------------
1      Po1(SU)         LACP      Te1/0/1(P)  Te1/0/2(P)  Te1/0/3(P)
                                 Te1/0/4(H)  Te1/0/5(H)  Te1/0/6(H)
                                 Te2/0/1(P)  Te2/0/2(P)  Te2/0/3(P)
                                 Te2/0/4(H)  Te2/0/5(H)  Te2/0/6(H)
```

This example shows the switch backup interface pairs:

```
Switch# show interfaces switchport backup

Switch Backup Interface Pairs:

Active Interface        Backup Interface        State
------------------------------------------------------------------------
Port-channel1             Port-channel2             Active Standby/Backup Up
```

This example shows the summary of the EtherChannel configured in the switch:

```
Switch# show ethernet summary

Flags:  D - down        P - bundled in port-channel
        I - stand-alone s - suspended
        H - Hot-standby (LACP only)
        R - Layer3      S - Layer2
        U - in use      f - failed to allocate aggregator
```

```
        M - not in use, minimum links not met
        u - unsuitable for bundling
        w - waiting to be aggregated
        d - default port


Number of channel-groups in use: 2
Number of aggregators:           2

Group  Port-channel  Protocol    Ports
------+-------------+-----------+-----------------------------------------------
1      Po1(SU)         LACP      Te1/0/1(P)  Te1/0/2(P)  Te1/0/3(P)
                                 Te1/0/4(P)  Te1/0/5(P)  Te1/0/6(P)
2      Po2(SU)         LACP      Te2/0/1(P)  Te2/0/2(P)  Te2/0/3(P)
                                 Te2/0/4(P)  Te2/0/5(P)  Te2/0/6(P)
```

Flex Link Configuration: Example

This example shows how to configure flex link and to verify creation and the status of the created link:

```
Switch(config)# !
interface Port-channel1
 description Ports 1-6 connected to NW-55-SW
 switchport mode trunk
 switchport backup interface Po2
 switchport backup interface Po2 preemption mode forced
 switchport backup interface Po2 preemption delay 1
 ip dhcp snooping trust
!
interface Port-channel2
 description Ports 7-12connected to NW-55-SW
 switchport mode trunk
 ip dhcp snooping trust
!
interface GigabitEthernet0/0
 vrf forwarding Mgmt-vrf
 no ip address
 negotiation auto
!
interface TenGigabitEthernet1/0/1
 switchport mode trunk
 channel-group 1 mode on
 ip dhcp snooping trust
!
interface TenGigabitEthernet1/0/2
 switchport mode trunk
 channel-group 1 mode on
 ip dhcp snooping trust
!
interface TenGigabitEthernet1/0/3
 switchport mode trunk
 channel-group 1 mode on
 ip dhcp snooping trust
!
interface TenGigabitEthernet1/0/4
 switchport mode trunk
 channel-group 1 mode on
 ip dhcp snooping trust
!
interface TenGigabitEthernet1/0/5
 switchport mode trunk
 channel-group 1 mode on
 ip dhcp snooping trust
!
interface TenGigabitEthernet1/0/6
 switchport mode trunk
 channel-group 1 mode on
 ip dhcp snooping trust
!
interface TenGigabitEthernet2/0/1
```

```
 switchport mode trunk
 channel-group 2 mode on
 ip dhcp snooping trust
!
interface TenGigabitEthernet2/0/2
 switchport mode trunk
 channel-group 2 mode on
 ip dhcp snooping trust
!
interface TenGigabitEthernet2/0/3
 switchport mode trunk
 channel-group 2 mode on
 ip dhcp snooping trust
!
interface TenGigabitEthernet2/0/4
 switchport mode trunk
 channel-group 2 mode on
 ip dhcp snooping trust
!
interface TenGigabitEthernet2/0/5
 switchport mode trunk
 channel-group 2 mode on
 ip dhcp snooping trust
!
interface TenGigabitEthernet2/0/6
 switchport mode trunk
 channel-group 2 mode on
 ip dhcp snooping trust
!
interface Vlan1
 no ip address
```

```
Switch#  show etherchannel summary

Flags:  D - down        P - bundled in port-channel
        I - stand-alone s - suspended
        H - Hot-standby (LACP only)
        R - Layer3      S - Layer2
        U - in use      f - failed to allocate aggregator

        M - not in use, minimum links not met
        u - unsuitable for bundling
        w - waiting to be aggregated
        d - default port


Number of channel-groups in use: 2
Number of aggregators:           2

Group  Port-channel  Protocol    Ports
------+-------------+-----------+-----------------------------------------------
1      Po1(SU)          -        Te1/0/1(P)  Te1/0/2(P)  Te1/0/3(P)
                                 Te1/0/4(P)  Te1/0/5(P)  Te1/0/6(P)
2      Po2(SU)          -        Te2/0/1(P)  Te2/0/2(P)  Te2/0/3(D)
                                 Te2/0/4(P)  Te2/0/5(P)  Te2/0/6(P)
```

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