High Availability Configuration Guide, Cisco IOS XE 17 (Cisco NCS 4200 Series)

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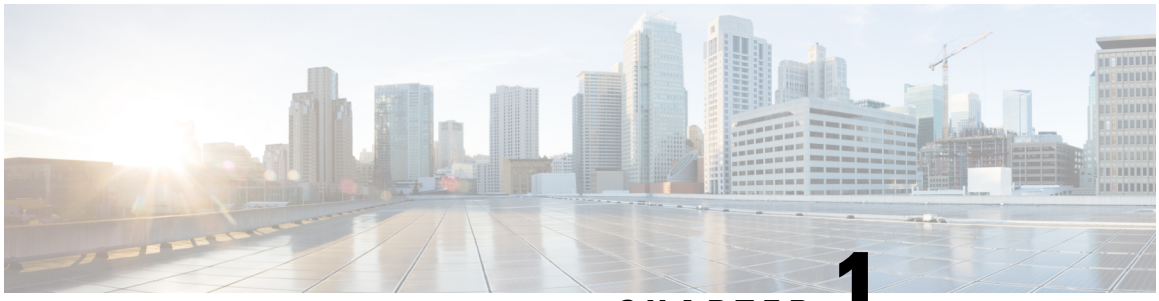
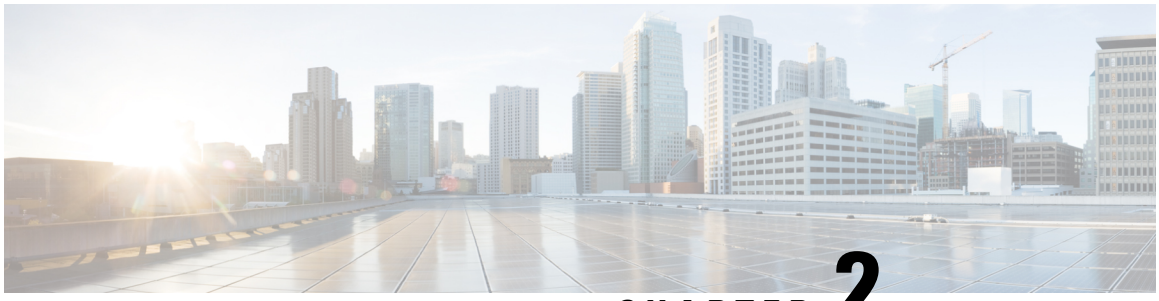


CHAPTER 1

Feature History

The following table lists the new and modified features supported in the High Availability Configuration Guide in Cisco IOS XE 17 releases, on Cisco NCS 4206 and Cisco NCS 4216 routers.

Feature	Description
Cisco IOS XE Bengaluru 17.4.1	
Secondary ROMMON Partition Auto Upgrade	This feature supports secondary ROMMON partition auto upgrade after a successful primary ROMMON partition is complete.



CHAPTER 2

High Availability Overview

Cisco High Availability (HA) enables network-wide protection by providing fast recovery from faults that may occur in any part of the network. With Cisco High Availability, network hardware and software work together and enable rapid recovery from disruptions to ensure fault transparency to users and network applications.

The unique hardware and software architecture of the router is designed to maximize router uptime during any network event, and thereby provide maximum uptime and resilience within any network scenario.

This chapter covers the aspects of High Availability that are unique to the router. It is not intended as a comprehensive guide to High Availability, nor is it intended to provide information on High Availability features that are available on other Cisco routers that are configured and implemented identically on the router. The Cisco IOS feature documents and guides should be used in conjunction with this chapter to gather information about High Availability-related features that are available on multiple Cisco platforms and work identically on the router.

- Hardware Redundancy Overview, on page 3
- Stateful Switchover, on page 4
- Bidirectional Forwarding Detection, on page 5

Hardware Redundancy Overview

The router supports redundant Route Switch Processors (RSPs) and power supplies. Redundancy is not supported on interface modules.

Note Some interface modules require a reload during a software upgrade, briefly interrupting traffic.

Note Route Processor Redundancy (RPR) is *not* supported on the router. Stateful Switchover (SSO) is supported. See Stateful Switchover, on page 4.

Hardware redundancy provides the following benefits:

- A failover option—If a processor fails, the standby processor immediately becomes the active processor with little or no delay. The failover happens completely within the same router, so a second standby router is not needed.

- No downtime upgrades—Using features like ISSU, a software upgrade can be handled on the standby processor while the active processor continues normal operation.

Table 1: Hardware Redundancy Overview

Hardware	Support for Dual Hardware Configuration	Failover Behavior
Route Switch Processor	Yes	If an active RSP experiences an event that makes it unable to forward tra as a hardware failure, a software failure, an OIR, or a manual switch) and RSP is configured, the standby RSP immediately becomes the active RS **Note** The dual RSP reaches the STANDBY HOT state even if the images are different on Active and Standby modules, as long are ISSU compatible. This is not applicable on the RSP3 mo
Interface module	No	No standby configurations are available for interface modules. If an interfac fails, it cannot forward traffic. In the event of an interface module shutdown, all other interface module fully operational.

Stateful Switchover

The Stateful Switchover (SSO) feature takes advantage of processor redundancy by establishing one of the processors as the active processor while the other RSP is designated as the standby processor, and then synchronizing critical state information between them. Following an initial synchronization between the two processors, SSO dynamically maintains RSP state information between the dual processors.

Stateful Switchover is particularly useful in conjunction with Nonstop Forwarding. SSO allows the dual processors to maintain state at all times, and Nonstop Forwarding lets a switchover happen seamlessly when a switchover occurs.

It is important to note that in most cases, SSO requires less downtime for switchover and upgrades than RPR. RPR should only be used when there is a compelling reason to not use SSO.

For additional information on NSF/SSO, see the Cisco Nonstop Forwarding document.

SSO-Aware Protocol and Applications

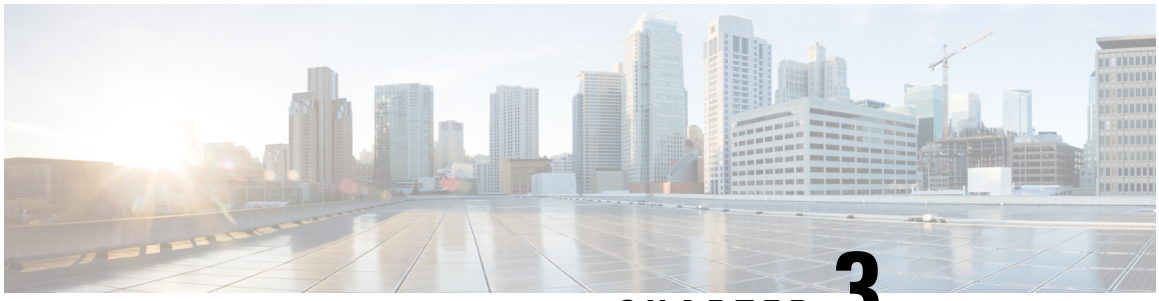
SSO-supported line protocols and applications must be SSO-aware. A feature or protocol is SSO-aware if it maintains, either partially or completely, undisturbed operation through an RSP switchover. State information for SSO-aware protocols and applications is synchronized from active to standby to achieve stateful switchover for those protocols and applications.

The dynamically created state of SSO-unaware protocols and applications is lost on switchover and must be reinitialized and restarted on switchover.

To see which protocols are SSO-aware on your router, use the following commands **show redundancy client** or **show redundancy history**.

Bidirectional Forwarding Detection

Bidirectional Forwarding Detection (BFD) is a detection protocol designed to provide fast forwarding path failure detection times for all media types, encapsulations, topologies, and routing protocols. In addition to fast forwarding path failure detection, BFD provides a consistent failure detection method for network administrators. Because the network administrator can use BFD to detect forwarding path failures at a uniform rate rather than the variable rates for different routing protocol hello mechanisms, network profiling and planning is easier, and reconvergence time is consistent and predictable.



CHAPTER 3

Installing and Upgrading Software

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- Provisioning Files, on page 9
- File Systems on the Router, on page 9
- System Requirements, on page 10
- ISSU Support Matrix, on page 11
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Software Packaging on the Router

Software Package Modes

The router can be booted using any of the following:

- Consolidated—A single software image containing a full collection of software packages. This mode provides a simplified installation and can be stored in the bootflash, a TFTP server, or a network server.
- Sub-package—One or more sub-images that are extracted from the consolidated image. This mode provides optimized memory usage and requires that you store files in the bootflash directory.

Upgrade IOS Image in Sub-packages Mode

To upgrade IOS image in sub-packages mode for the Cisco NCS 4202 routers:

```
request platform software package expand file source-URL [to destination-URL] [force]
[verbose] [wipe]
```

```
configure terminal
config-register 0x2
boot system flash [flash-fs:] [partition-number:] [filename]
exit
copy running-configuration startup-configuration
reload
```

Description of Commands

Command	Description
config-register 0x2	Use the command to boot the router using a specified image in NVRAM.
request platform software package expand file *source-URL* [**to** *destination-URL*] [**force**] [**verbose**] [**wipe**]	Use the command to expand the consolidated image file on the router.
boot system flash [*flash-fs:*] [*partition-number:*] [*filename*]	Use the command to set the router to boot using the packages.conf file.

Configuration Example for Upgrading IOS Image in Sub-packages Mode

The following example shows the upgrade of IOS image in sub-packages mode:

```
Router#request platform software package expand file
bootflash:ncs4202-universalk9_npe.17.03.01.SPA.bin
Verifying parameters
Expanding superpackage bootflash:ncs4202-universalk9_npe.17.03.01.SPA.bin
Validating package type
*Jul 16 14:41:05.881 IST: %INSTALL-5-OPERATION_START_INFO: R0/0: packtool:Started expand
package bootflash:ncs4202-universalk9_npe.17.03.01.SPA.bin

Copying package files
WARNING: packages.conf will replace the identical file that already exists in bootflash:
SUCCESS: Finished expanding all-in-one software package.
Router#
*Jul 16 14:45:30.606 IST: %INSTALL-5-OPERATION_COMPLETED_INFO: R0/0: packtool:Completed
expand package bootflash:ncs4202-universalk9_npe.17.03.01.SPA.bin

Router#config t
Router(config)#config-reg 0x2
Router(config)#no boot sys
Router(config)#boot system bootflash:packages.conf
Router(config)#exit
Router#copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]

Router#reload
```

Understanding Software Packages

Table 2: Individual Sub-Packages

Sub-Package	Purpose
RPBase	Route Switch Processor (RSP) operating system
RPControl	Control plane processes between IOS process and the rest of the platform.
RPAccess	Handles security features including Secure Socket Layer (SSL) and Secure Shell (SSH)
RPIOS	Cisco IOS kernel, which is where IOS features are stored and run. **Note** Each consolidated image has a unique RPIOS package.
SIPSPA Base	Controls interface module daemons.

Provisioning Files

Provisioning files manage the boot process when the router is configured to boot in sub-packages. The provisioning file manages the bootup of each individual sub-package. Provisioning files are extracted automatically when individual sub-package files are extracted from a consolidated package. Provisioning files are not necessary for running the router using the complete consolidated package.

File Systems on the Router

Table 3: File Systems

File System	Description
bootflash:	The boot flash memory file system on the active RSP.
cns:	The Cisco Networking Services file directory.
nvram:	Router NVRAM. You can copy the startup configuration to NVRAM or from NVRAM.
stby-bootflash:	The boot flash memory file system on the standby RSP.
stby-harddisk:	The hard disk file system on the standby RSP.
stby-usb0:	The Universal Serial Bus (USB) flash drive file systems on the standby RSP. **Note** stby-usb1: is an internal port.
system:	The system memory file system, which includes the running configuration.
tar:	The archive file system.
tmpsys:	The temporary system files file system.

File System	Description
usb0:	The Universal Serial Bus (USB) flash drive file systems on the active RSP. **Note** usb1: is an internal port.

If you see a file system not listed in the above table, enter the **?** help option or see the **copy** command reference for additional information on that file system.

System Requirements

RP Memory Recommendations

Table 4: Memory Recommendations for the NCS 4200 RSP3 Module - Consolidated Package Image

Platform	Image Name	Software Image	Individual Sub-package Contents	DRAM Memory
NCS 4200 RSP3 Module	Cisco NCS 4200 Series RSP3 UNIVERSAL W/O CRYPTO	ncs4200rsp3-universal.*version* .bin	ncs4200rsp3-rpbase.*version* .pkg	8 GB (RSP3-400)
			ncs4200rsp3-rpcontrol.*version* .pkg	
			ncs4200rsp3-rpaccess.*version* .pkg	
			ncs4200rsp3-rpios-universal.*version*. pkg	
			ncs4200rsp3-espbase.*version.pkg*	
			ncs4200rsp3-sipbase.*version* .pkg	
			ncs4200rsp3-sipspa.*version* .pkg	
			ncs4200rsp3-packages-universal. version.conf	
			packages.conf	

Platform	Image Name	Software Image	Individual Sub-package Contents	DRAM Memory
NCS 4200 RSP3 Module	Cisco NCS 4200 Series RSP3 UNIVERSAL NPE	ncs4200rsp3-universalk9_npe.*version* .bin	ncs4200-hw-programmables.*version* . pkg	8 GB (RSP3-400)
			ncs4200rsp3-espbase.*version* .pkg	
			ncs4200rsp3-packages-universalk9.*version* .pkg	
			ncs4200rsp3-rpacess.*version* .pkg	
			ncs4200rsp3-rpbase.*version* .pkg	
			ncs4200rsp3-rpcontrol.*version* .pkg	
			ncs4200rsp3-rpios-universalk9_npe.*version* .pkg	
			ncs4200rsp3-sipbase.*version*.pkg	
			ncs4200rsp3-sipspa.*version*.pkg	
			packages.conf	

Determining the Software Version

You can use the **show version installed** command to list the installed sub-packages on the router.

ISSU Support Matrix

Legend:

NA: Not Applicable

NS: Not Supported

Table 5: ISSU Support Matrix

	Supported ISSU Upgrade Or Downgrade Version													
Base IOS Version	16.6.1	16.6.X (X = 2 to 6)	16.6.X (X = 7 and later)	16.9.X (X=1,2)	16.9.X (X= 3 and later)	16.11.X (X = 1 and later)	16.12.X (X= 1 and later)	17.3.1[5]	17.5.1	17.6.1	17.7.1	17.8.1	17.9.X (X=2 to 6)	17.12.X (X=2 to 5)
16.6.1	NA	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
16.6.X (X=2 to 6)	NS	Yes	Yes	Yes[1]	Yes	Yes[11]	Yes	Yes	Yes 3 1	Yes 3 1	Yes 3 1	Yes 3 1	Yes 3 1	Yes 3 1

	Supported ISSU Upgrade Or Downgrade Version													
16.6.X (X=7 and later)	NS	Yes	Yes	Yes[1]	Yes	Yes[3]	Yes	Yes[3]	Yes	Yes	Yes	Yes	Yes	Yes
16.9.X (X = 1-2)	NS	Yes	Yes	Yes	Yes	Yes	Yes	Yes[3]	Yes 3	Yes 3	Yes 3	Yes 3	Yes 3	Yes 3
16.9.X (X = 3 and later)	NS	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
16.11.X (X = 1 and later)	NS	Yes	Yes	Yes	Yes	NA	Yes	Yes[3][2]	Yes 3 4	Yes 3 4	Yes 3 4	Yes 3 4	Yes 3 4	Yes 3 4
16.12.1	NS	Yes	Yes	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes	Yes	Yes	Yes
17.3.X (X = 2 to 8)[3]	NS	NS	NS	NS	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes	Yes	Yes
17.5.1	NS	NS	NS	NS	Yes	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes	Yes
17.6.X (X = 2 to 8)[4]	NS	NS	NS	NS	Yes	Yes	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes
17.7.1	NS	NS	NS	NS	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	Yes	Yes
17.8.1	NS	NS	NS	NS	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	Yes
17.9.X (X=2 to 6)	NS	NS	NS	NS	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes
17.12X (X=2 to 5)	NS	NS	NS	NS	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA

1 Step ISSU (upgrade) to 17.1.1 with any of these images as intermediate image (16.9.3 and higher)
2 Step ISSU (upgrade) to 17.x.x with any of these images as intermediate image (16.12.3)
3 The 17.3.1 image auto ROMMON upgrade enables the RSP for an additional reset during software upgrade if the RSP does not have the latest ROMMON version.
4 The 17.6.1 image auto ROMMON upgrade enables the RSP for an additional reset during software upgrade if the RSP does not have the latest ROMMON version.

Note

- All phase 1 interface modules undergo FPGA upgrade during the ISSU to Cisco IOS XE 17.4.1 from any earlier releases. This impacts the traffic for that IM until the FPGA is upgraded and the IM comes up after reload.
- All phase 1 and phase 2 interface modules undergo FPGA upgrade during ISSU to Cisco IOS XE 17.8.1 from any earlier releases in RSP2 and RSP3. This impacts the traffic for that interface module until the FPGA is upgraded and the interface module comes up after reload.
- For the phase 1 interface module nodes which are ISSU upgraded from Cisco IOS XE 17.4.1 or later release to Cisco IOS XE 17.8.1, the traffic is not impacted.

  Refer the following table for supported IMs:

Table 6: NCS 4200 Supported Ethernet Interface Module

Phase 1 IM	Phase 2 IM	Phase 3 IM
NCS4200-1T8LR	NCS4200-1T8LR-PS	NCS4200-8T-PS
		NCS4200-2Q-P
		NCS4200-2H-PQ

Restrictions

- The ISSU upgrade operation requires that the ROMmon version be 15.6(33r)S or higher for all releases starting from release Cisco IOS XE 16.11.x. For Cisco IOS XE Releases 16.6.x to 16.9.x, the minimum ROMmon version must be 15.6(20r)S.
- You must enable the **port-channel max-memlink-per-pc 8** command when downgrading from Cisco IOS XE Release 16.11.x else, ISSU will fail.
- For Cisco IOS XE Releases from 17.12.x, for ISSU upgrade, there's an increase in the ISSU upgrade duration when CEM scale on the IM is enabled for 5000 or more services.

Setting the Interface Module Delay for ISSU

Interface module delay refers to the duration that the system waits before enabling the new software on the upgraded interface modules. This delay is to ensure that all the interface modules have successfully synchronized with the new software before they are functioning.

The delay duration can vary depending on several factors, including the specific network device, the number of interface modules, and the complexity of the software upgrade being performed.

To set an optimum delay duration for the ISSU process, refer to the following table:

Interface Module	CEM FPD upgrade		FPD Upgrade (Seconds)	CEM & FPD Upgrade	
	CEM Scale	Upgrade Time (Seconds)		CEM Scale	Upgrade Time (Seconds)
NCS4200-48T1E1-CE	256	120	NA	256	240
	512	180		512	300
NCS4200-48T3E3-CE	672	180	NA	672	300
	1344	360		1344	480
NCS4200-3GMS	672	300	NA	672	420
	1344	360		1344	480
NCS4200-1T8S-20CS	100	480	NA	100	660
	500	540		500	720
	1344	660		1344	840
	2500	840		2500	1020
	5000	1200		5000	1380
NCS4200-1T8S-10CS	100	420	NA	100	660
	500	420		500	720
	1344	540		1344	780
	2500	660		2500	900
	5000	900		5000	1140

For example, consider a router with four interface modules:

- NCS4200-48T1E1-CE with 512 CEM FPD upgrade
- NCS4200-48T3E3-CE with 672 CEM FPD upgrade
- NCS4200-3GMS with 1344 CEM FPD upgrade
- NCS4200-1T8S-20CS with 5000 CEM FPD upgrade

Compare the delay durations of the four interface modules and select the one with the longest duration. For example, the NCS4200-1T8S-20CS delay duration is 1200 seconds, which is the longest compared to the delay durations of the other three interface modules.

Based on this information, set the delay duration to 1200 seconds for the ISSU upgrade for this router.

Note For more information on FPGA versions, refer to the respective version release notes.

Autogenerated Files and Directories

Caution Any autogenerated file in the bootflash: directory should not be deleted, renamed, moved, or altered in any way unless directed by customer support; altering these files can have unpredictable consequences for system performance.

Table 7: Autogenerated Files

File or Directory	Description
crashinfo files	A crashinfo file may appear in the bootflash: file system. Crashinfo files are useful for tuning and troubleshooting, but are not related to router operations: you can erase them without impacting the router's performance.
core files	The bootflash/core directory is the storage area for .core files. **Warning** Do not erase or move the core directory.
lost+found directory	This directory is created on bootup if a system check is performed. Its appearance is completely normal and does not indicate any issues with the router.
tracelogs files	The storage area for trace files is bootflash/tracelogs. Trace files are useful for troubleshooting; you can access trace files using diagnostic mode to gather information related to the IOS failure. **Warning** Do not erase or move the tracelog directory.

General Prerequisites for Software Upgrade

- The system must be booted in sub-package mode (with packages.conf).
- The packages.conf (base image packages) and the upgrade image should exist in the same location in the bootflash.

Bootflash Space Requirements

The software upgrade process requires a minimum of 2X image size available space in bootflash memory.

General Restrictions for Software Upgrade

- Cisco IOS XE software compatibility is supported only between identical image types. Cross-image-type upgrades or installations (such as from an Universal image to an *Universalk9_npeimage)* are *not* supported in the upgrade process.

- Running two different image types simultaneously is *not* supported.
- Software upgrades from one package mode to another are *not* supported.
- For software upgrade from IOS XE Release 16.x.x to IOS XE Release 16.z.z images, use the interface module delay as 1500, if the node has TDM IMs.

Upgrading the ROMMON on the RSP Module

Table 8: Feature History

Feature Name	Release Information	Description
Secondary ROMMON Partition Auto Upgrade	Cisco IOS XE Bengaluru 17.4.1	This feature supports secondary ROMMON partition auto upgrade after a successful primary ROMMON partition is complete for NCS 4216 routers.
Secondary ROMMON Version Auto Upgrade	Cisco IOS XE Bengaluru 17.5.1	After primary ROMMON version is auto upgraded, secondary ROMMON version auto upgrade process takes place. The secondary ROMMON upgrade is only completed during the next planned manual reload of the router. This is applicable to NCS 4201/4202 routers.

Starting with Cisco IOS XE Bengaluru release, 17.6.1, the 15.6(49r)S ROMMON version filters the restricted ROMMON variables during the bootup.

Starting with Cisco IOS XE Bengaluru release, 17.5.1, secondary ROMMON partition is also auto upgraded after a successful primary ROMMON partition upgrade is complete. You can reload the router at the next planned reload to complete the secondary ROMMON upgrade.

Note If the secondary ROMMON version is lesser than that of the primary ROMMON version, the secondary ROMMON gets auto upgraded.

For Cisco IOS XE Amsterdam Release 17.3.x, Cisco IOS XE Bengaluru Release 17.4.x, and earlier, the secondary ROMMON partition is not auto upgraded. You must manually upgrade it using the **upgrade rom-mon filename** command.

Starting with ROMMON release version 15.6(43r)S, ROMMON version is secure. Once the ROMMON version is upgraded, it cannot be downgraded to a non-secure ROMMON version.

Secure ROMMON is supported from Cisco IOS XE Amsterdam Release 17.3.1 onwards. However, it is compatible with all the releases.

Any future secure ROMMON upgrade or downgrade is only possible from Cisco IOS XE Amsterdam Release 17.3.1 onwards.

Any non-secure FPGA bundled releases moving to Cisco IOS XE Bengaluru Release 17.3.x or future releases can result in an FPGA upgrade and a ROMMON upgrade. If FPGA upgrade happens parallely with the ROMMON upgrade, you can only expect a single reload. If FPGA upgrade gets delayed and happens post ROMMON upgrade, two reloads are expected to complete both the upgrade processes. This is followed by a successful bootup of the target release image.

The router has two ROMMON regions (ROM0 and ROM1). We recommend that the upgrade is performed on both the regions.

Note For Cisco IOS XE Gibraltar Release 16.9.5, Cisco IOS XE Gibraltar Release 16.12.3, Cisco IOS XE Amsterdam 17.1.x, and Cisco IOS XE Amsterdam 17.3.1, a minimum diskspace of 2 MB is required in the boot flash memory file system for a successful ROMMON auto upgrade process. For a diskspace lesser than 2 MB, ROMMON auto upgrade fails and the router reboots.

Note Routers running a ROMMON version that is lower than version 15.6(33r)S is auto upgraded to version 15.6(33r)S during a router restart. However, if a Cisco IOS XE release with ROMMON image is bundled with a version lower than the running ROMMON version, then the ROMMON is not auto downgraded.

Note Before installing the Cisco IOS XE Amsterdam 17.3.1, you *must* upgrade the ROMMON to version 15_6_43r_s or higher to avoid bootup failure. This is applicable to NCS 4202 routers.

Note Starting with Cisco IOS XE Amsterdam 17.3.1, While performing an auto upgrade of ROMMON, only primary partition is upgraded. Use the **upgrade rom-mon filename** command to upgrade the secondary partition of the ROMMON. However, the router can be reloaded during the next planned reload to complete the secondary ROMMON upgrade.

Caution To avoid actions that might make your system unable to boot, read this entire section before starting the upgrade.

Procedure

Step 1 Check the RSP bootup ROMMON region (ROM0 or ROM1). The example, shows the RSP boots up from ROM0 region.

Example:

```
System Bootstrap, Version 15.6(4r)S, RELEASE SOFTWARE (fc1)
```

```
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 2015 by cisco Systems, Inc.
Compiled Thu 29-Oct-15 23:24 by ccai
Current image running: Boot ROM0
```

Step 2 Copy the ROMMON image to the bootflash on the active and standby RSP.

Example:

```
copy bootflash:ncs4200-rommon.15.6(4r)S.pkg
```

Step 3 Use the **upgrade rom-monitor filename** *bootflash:ncs4200-rommon.15.6(4r)S.pkg* **R0** command to upgrade the version.

Note R0 represents RSP in slot0 of the chassis. Step 3 upgrades the ROMMON region of the RSP that is not used (ROM1 region) as ROM 0 region is used (in this procedure) in Step 1 to boot up the RSP.

Step 4 Upgrade the ROMMON on the Standby RSP (for High Availability) using **upgrade rom-monitor filename** *bootflash:ncs4200rommon.15.6(4r)S.pkg* **R1** command.

Note R1 represents the RSP in slot1 of the chassis. Step 4 upgrades the ROMMON region of the RSP that is not used (ROM 0 region).

Step 5 Reload the router.

Example:

```
System Bootstrap, Version 15.6(4r)S, RELEASE SOFTWARE (fc1)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 2015 by cisco Systems, Inc.
Compiled Thu 29-Oct-15 23:24 by ccai
Current image running: Boot ROM0
Last reset cause: RSP-Board
UEA platform with 2097152 Kbytes of main memory
Rommon upgrade requested
Flash upgrade reset 1 in progress
.......
System Bootstrap, Version 12.2(20120514:121217) [npenumar-pegasus_rommon_02 183], DEVELOPMENT
 SOFTWARE
Copyright (c) 1994-2008 by cisco Systems, Inc.
Compiled Fri 15-Jun-12 11:45 by ccai
Current image running: *Upgrade in progress* Boot ROM1
Last reset cause: BootRomUpgrade
UEA platform with 2097152 Kbytes of main memory
```

Step 6 Reload the router again to confirm bootup from upgraded ROMMON region ROM1.

Example:

```
System Bootstrap, Version 15.6(4r)S, RELEASE SOFTWARE (fc1)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 2015 by cisco Systems, Inc.
Compiled Thu 29-Oct-15 23:24 by ccai
Current image running: Boot ROM1
```

Step 7 Repeat Step 3 to Step 6 to update the other region on the RSP (ROM0) region in this procedure.

Note We recommend that both region ROM0 andROM1 are upgraded.

Upgrading the ROMMON on Cisco NCS 4201 and NCS 4202 Routers

Table 9: Feature History

Feature Name	Release Information	Description
Secondary ROMMON Version Auto Upgrade	Cisco IOS XE Bengaluru 17.5.1	After primary ROMMON version is auto upgraded, secondary ROMMON version auto upgrade process takes place. The secondary ROMMON upgrade is only completed during the next planned manual reload of the router.

Starting with Cisco IOS XE Bengaluru release 17.5.1, after primary ROMMON version is auto upgraded, secondary ROMMON version auto upgrade process takes place. The secondary ROMMON upgrade is only completed during the next planned manual reload of the router.

Note If the secondary ROMMON version is lesser than that of the primary ROMMON version, the secondary ROMMON gets auto upgraded.

The router has two ROMMON regions (ROM0 and ROM1). We recommend that the upgrade is performed on both the regions.

Caution To avoid actions that might make your system unable to boot, read this entire section before starting the upgrade.

1. Check the booted ROMMON region (ROM0 or ROM1). The example, shows the device booting up from ROM0 region.

   Example:

   ```
   System Bootstrap, Version 15.6(32r)S, RELEASE SOFTWARE (fc1)
   Technical Support: http://www.cisco.com/techsupport
   Copyright (c) 2018 by cisco Systems, Inc.
   Compiled Thu 30-Aug-18 06:23 by pallavik
   *Upgrade in progress* Boot ROM1
   Last reset cause: BootRomUpgrade
   link status 0
   link status 0
   UEA platform with 3670016 Kbytes of main memory
   ```

2. Copy the ROMMON pkg file **asr920_15_6_43r_s_rommon.pkg** to the bootflash.
3. Use the **upgrade rom-monitor filename asr920_15_6_43r_s_rommon.pkg all** command to upgrade the version.
4. Reload the router and ensure device is booted from upgrade region ROM0.

Example:

```
System Bootstrap, Version 15.6(32r)S, RELEASE SOFTWARE (fc1)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 2018 by cisco Systems, Inc.
Compiled Thu 30-Aug-18 06:23 by pallavik
Boot ROM1
Last reset cause: RSP-Board
Rommon upgrade requested
Flash upgrade reset 1 in progress
.......
System Bootstrap, Version 15.6(43r)S, RELEASE SOFTWARE (fc1)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 2020 by cisco Systems, Inc.
Compiled Tue 19-May-20 22:55 by pallavik
*Upgrade in progress* Boot ROM0
Last reset cause: BootRomUpgrade
link status 0
link status 0
UEA platform with 3670016 Kbytes of main memory

We're coming up from a flash upgrade reset cookie
rommon 1 >
```

5. Repeat steps 3 and 4 to update the other region router (ROM1) region in this procedure.

Note We recommend you to upgrade that both ROM0 and ROM1 regions.

Starting with Cisco IOS XE Amsterdam 17.3.1 and higher, secondary partition upgrade is performed only after loading version 17.3.1 or higher.

Verifying ROMMON Upgrade on the Cisco NCS 4202

Use the **show platform** command to verify the ROMMON upgrade.

```
Router#show platform
Chassis type: NCS4202-SA

Slot      Type                State                 Insert time (ago)
--------- ------------------- --------------------- -----------------
 0/0      12xGE-4x10GE-FIXED  ok                    00:40:35
 0/1      NCS4200-3GMS        ok                    00:40:35
R0        NCS4202-SA          ok, active            00:47:43
F0                            ok, active            00:47:43
P0        ASR920-PSU0         ok                    00:45:37
P1        ASR920-PSU1         N/A                   never
P2        ASR920-FAN          ok                    00:45:36

Slot      CPLD Version        Firmware Version
--------- ------------------- ----------------------------------------
R0        2008241E            15.6(54r)S
F0        2008241E            15.6(54r)S

Router#
```

Auto Upgrade

Table 10: Feature History

Feature Name	Release Information	Description
Secondary ROMMON Version Auto Upgrade	Cisco IOS XE Bengaluru 17.5.1	After primary ROMMON version is auto upgraded, secondary ROMMON version auto upgrade process takes place. The secondary ROMMON upgrade is only completed during the next planned manual reload of the router.

- The ROMMON image upgrade from Cisco IOS XE Release 3.x to Cisco IOS XE Everest Release 16.5.1 is *not* mandatory. We recommend a ROMMON upgrade for effective utilization of the new features delivered in Cisco IOS XE Everest 16.5.1 and later releases.
- We recommend you to reload the router two times for successful ROMMON and software image upgrade.
- You cannot expand the Cisco IOS XE Release 16.x image into the Cisco IOS XE Release 3.x images. The bin. file may be used to reload the image.
- Before installing the Cisco IOS XE Amsterdam Release 17.3.1, you *must* upgrade the ROMMON to version 15_6_43r_s or higher to avoid bootup failure. Booting in sub package mode takes care of auto upgrade to ROMMON version 15_6_43r_s on bootup. This workaround is not applicable to devices installed with ROMMON version 15.6(9r)S.
- For Cisco IOS XE Amsterdam Release 17.3.x, a minimum diskspace of 2 MB is required in the boot flash memory file system for a successful ROMMON auto upgrade process. For a diskspace lesser than 2 MB, ROMMON auto upgrade fails and the router reboots.
- For Cisco IOS XE Amsterdam Release 17.3.x, Cisco IOS XE Bengaluru Release 17.4.x, and earlier, the secondary ROMMON partition is *not* auto upgraded. You must manually upgrade it using the **upgrade rom-mon filename** command.
- Secure ROMMON is supported from Cisco IOS XE Amsterdam Release 17.3.1 onwards. However, it is compatible with all the releases.
- Any future secure ROMMON upgrade or downgrade is only possible from Cisco IOS XE Amsterdam Release 17.3.1 onwards.
- Starting with Cisco IOS XE Bengaluru Release 17.4.1, Cisco NCS 4201 and Cisco NCS 4202 routers are auto upgraded to ROMMON version 15_6_44r_s.
- Starting with ROMMON release version 15.6(43r)S, ROMMON version is secure. Once the ROMMON version is upgraded, it cannot be downgraded to a non-secure ROMMON version.
- Starting with Cisco IOS XE Bengaluru Release 17.5.1, secondary ROMMON partition is also auto upgraded after a successful primary ROMMON partition upgrade is complete. You can reload the router at the next planned reload to complete the secondary ROMMON upgrade.

Note If the secondary ROMMON version is lesser than that of the primary ROMMON version, the secondary ROMMON gets auto upgraded.

- Any non-secure FPGA bundled releases moving to Cisco IOS XE Bengaluru Release 17.3.x or future releases can result in an FPGA upgrade and a ROMMON upgrade. If FPGA upgrade happens parallely with the ROMMON upgrade, you can only expect a single reload. If FPGA upgrade gets delayed and happens post ROMMON upgrade, two reloads are expected to complete both the upgrade processes. This is followed by a successful bootup of the target release image.

  However, starting with Cisco IOS XE Bengaluru Release 17.5.1, for Cisco NCS 4201 and Cisco NCS 4202 routers, ROMMON and FPGA upgrade are synchronized to happen in a single reload.

Upgrading Firmware of the Power Supply Monitoring Device

Table 11: Feature History

Feature Name	Release Information	Feature Description
Upgrading Power Supply Monitoring Firmware	Cisco IOS XE Bengaluru 17.6.1	This feature allows you to manually upgrade the firmware of the power supply monitoring device in a router. The firmware upgrade reduces unplanned hardware-related downtime caused by input voltage transients during a power outage.

Starting with Cisco IOS XE Bengaluru 17.6.1, you can manually upgrade the firmware of the power supply monitoring device in a router. The firmware upgrade reduces unplanned hardware-related downtime caused by input voltage transients during a power outage.

Supported Platforms

Table 12: Feature History

Feature Name	Release Information	Description
Support for Firmware Upgrade	Cisco IOS XE Cupertino 17.9.1	This release introduces the firmware upgrade support for ASR 920-10SZ-PD and Cisco ASR-920-24SZ-IM, Cisco ASR-920-24SZ-M, and Cisco ASR-920-24TZ-M routers.

Starting with Cisco IOS XE Cupertino Release 17.9.1, firmware upgrade is supported on the following routers:

- ASR 920-10SZ-PD

- ASR-920-24SZ-IM
- ASR-920-24SZ-M
- ASR-920-24TZ-M

The firmware upgrade reduces unplanned hardware-related downtime caused by input voltage transients during a power outage.

- NCS4202-SA using A920-PWR400-D power supply

Restrictions for Upgrading the Firmware

- Automatic firmware upgrade is not supported, you must upgrade it manually.
- For the upgrade to take effect, the router reboots automatically, which results in a service interruption for a few minutes.

Caution Ensure that there's a stable power supply during the firmware upgrade. This mitigates any unplanned hardware-related downtime in a router.

Upgrading the Firmware Manually

To upgrade the firmware, you should perform the following steps:

Procedure

Step 1 Execute the **show upgrade hw-programmable** command to display the current firmware version.

Example:

```
Router#show upgrade hw-programmable adm 0 firmware-version
Hw-programmable ADM Firmware Versions

version[0]               version[1]               version[2]
------------------------------------------------------------------------------
0                        1                        0
```

Step 2 Execute the **upgrade hw-programmable** command to upgrade the firmware.

Example:

```
Router#upgrade hw-programmable adm 0
*Jan 27 06:47:45.760: %IOSXE-3-PLATFORM: F0: cmand: ADM1066 f/w upgrade,
*Jan 27 06:47:45.764: %IOSXE-3-PLATFORM: F0: cmand: ADM1066 CONF EEPROM erase,
*Jan 27 06:47:46.312: %IOSXE-3-PLATFORM: F0: cmand: ADM1066 CONF EEPROM program,
*Jan 27 06:47:47.089: %IOSXE-3-PLATFORM: F0: cmand: ADM1066 CONF EEPROM verify,
*Jan 27 06:47:47.546: %IOSXE-3-PLATFORM: F0: cmand: ADM1066 CONF EEPROM verify done,
*Jan 27 06:47:47.547: %IOSXE-3-PLATFORM: F0: cmand: ADM1066 SE EEPROM erase,
*Jan 27 06:47:48.222: %IOSXE-3-PLATFORM: F0: cmand: ADM1066 SE EEPROM program,
*Jan 27 06:47:49.213: %IOSXE-3-PLATFORM: F0: cmand: ADM1066 SE EEPROM verify,
*Jan 27 06:47:49.714: %IOSXE-3-PLATFORM: F0: cmand: ADM1066 SE EEPROM verify done,
*Jan 27 06:47:49.714: %IOSXE-3-PLATFORM: F0: cmand: ADM Upgrade Completed System Going for
 Power Cycle
```

```
Router#
System Bootstrap, Version 15.6(43r)S, RELEASE SOFTWARE (fc1)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 2020 by cisco Systems, Inc.
Compiled Mon 18-May-20 03:16 by pallavik
Starting Initialization of FMAN0
Loading ucode for FMAN0, size: 31424, ver: 106.04.14
Silicon Rev Major:Minor [1:1]
Initializing the pci..
IOFPGA version[2008241e]
Boot ROM1
Last reset cause: PowerOn
UEA platform with 1048576 Kbytes of main memory
```

Step 3 Execute the **show upgrade hw-programmable** command to verify the upgrade.

Example:

```
Router#show upgrade hw-programmable adm 0 firmware-version
Hw-programmable ADM Firmware Versions

version[0]                version[1]                version[2]
-------------------------------------------------------------------------
0                         1                         1
```

Note
- For Cisco NCS4202-SA, the current firmware version is 0.1.0 and the upgraded version is 0.1.1.

Loading the New Image and Preparing for Upgrade

The following sections describe the steps required to load a new image and prepare for an upgrade.

Creating a Service Upgrade Directory

Before creating a new Service Upgrade directory, verify if that directory already exists in the bootflash of the active and standby RSPs.

```
Router# dir bootflash:
Directory of bootflash:/

   11  drwx            16384  Jan 12 2016 02:05:30 +00:00  lost+found
310689  drwx             4096  May 10 2016 17:14:20 +00:00  .prst_sync
   12  -rwx           145860  Jul 30 2016 00:12:46 +00:00  smartdebug.tcl
523265  drwx            77824  Jul 31 2016 15:52:38 +00:00  tracelogs
   13  -rwx             7074  Jan 12 2016 02:06:34 +00:00  tracelogs.508
179873  drwx             4096  Jul 21 2016 21:59:18 +00:00  core
98113  drwx             4096  Jan 12 2016 02:19:45 +00:00  .rollback_timer
605025  drwx             4096  Jan 12 2016 02:20:40 +00:00  .installer
752193  drwx             4096  Jul 29 2016 23:48:14 +00:00  su
```

If the SU directory exists, skip to Deleting an Existing packages.conf File.

If the directory does not exist in the bootflash, create the directory by running the following command:

```
Router# mkdir su
Create directory filename [su]?
Created dir bootflash:/su
```

Deleting an Existing packages.conf File

Before loading the new image to bootflash:su/, you must delete the existing packages.conf file. This step is required only if the bootflash:su/ directory already existed in the bootflash and contains an expanded image with a packages.conf file.

Note Remove all other unused images (.bin, or expanded image with .conf and .pkg as file extensions) from the existing SU directory.

To delete packages.conf on the active RSP:

```
Router# delete bootflash:su/packages.conf

Delete filename [su/packages.conf]?
Delete bootflash:su/packages.conf? [confirm]
```

Repeat this procedure on the standby RSP by running the command **delete stby-bootflash:su/packages.conf**.

If you created the SU directory in the previous step, skip to Copying the Image to bootflash:su/.

Copying the Image to Bootflash

Caution Ensure that upgrade image that you have chosen is supported by your current software version.

From the privileged EXEC mode:

```
Router# copy usb0:ncs4200rsp3-universalk9_npe.03.18.08v.S.156-2.S8v-std.bin bootflash:su/

Destination filename [su/ncs4200rsp3-universalk9_npe.03.18.08v.S.156-2.S8v-std.bin]?
```

For more information on copying the image from a remote server, seehttp://www.cisco.com/c/en/us/td/docs/routers/ncs4200/configuration/guide/sysmgmt/sysimgmgmt-ncs4200-book.html.

Preparing System for Upgrade

The system is ready for upgrade only if this meets the following conditions:

- The value of the configuration register is set to either 0x2 or 0x2102. These values ensure that the system boots using a specified image in the NVRAM.

  ```
  Router# show bootvar
  BOOT variable = bootflash:su/packages.conf,12;
  CONFIG_FILE variable =
  BOOTLDR variable does not exist
  Configuration register is 0x2
  ```

  If the value of the configuration register is not 0x2 or 0x2102, set the correct value by running the following command:

  ```
  Router# configure terminal
  Router(config)# config-register 0x2
  ```

- The system boot statement points to the packages.conf. This ensures that the systems boots using the packages.conf file.

```
Router#show running-config | section boot
boot-start-marker
boot system bootflash:su/packages.conf
boot-end-marker
```

If the system boot statement points to a different file, delete that file and point the boot statement to the correct file by running the following commands:

```
Router# configure terminal
Router(config)# no boot system
Router(config)# boot system bootflash:su/packages.conf
Router(config)# do copy running-config startup-config
Router(config)# exit
Router# reload
```

Note A system reload affects all services on the system.

Upgrading the Cisco NCS4200 Series Chassis

The following sections describe:

- Upgrading a single-RSP chassis with boot in sub-package mode
- Upgrading a redundant-RSP chassis with boot in sub-package mode

Upgrading a Single-RSP Chassis With Boot in Sub-package Mode

This section describes the standard procedure for all upgrades in an NCS4200 chassis with a single RSP.

Note Ensure that you have followed all instructions in the previous sections to ensure an efficient upgrade.

Expanding the Consolidated Image and Reloading to the New Image

```
Router# request platform software package expand file
bootflash:su/ncs4200rsp3-universalk9_npe.03.18.07v.S.156-2.S7v-std.bin
Router# reload
```

Caution A system reload affects all services on the system.

Note Connectivity to the system is lost while the RSP reboots. Wait for 15 minutes and then reconnect to the system.

Verifying the New Image

After reloading the new image on the chassis, you must verify that the correct image was reloaded.

```
Router# show version

Cisco IOS XE Software, Version 03.18.08v.S - Standard Support Release
```

Upgrading the Firmware on the CEM Cards

First, verify the firmware version on the CEM cards.

```
Router# show hw-module all fpd

==== ===================== ====== ==========================================
                            H/W  Field Programmable
                                                    Current      Min. Required
Slot Card Type             Ver.  Device: "ID-Name"  Version      Version
== ===================== ====== ================== =========== ==============
 0/0 NCS4200-1T8LR-PS        1.0   32-UEA 8x1G 1x10G   69.22        69.22
---- --------------------- ------ ------------------ ----------- --------------
 0/2 NCS4200-1T8LR-PS        1.0   32-UEA 8x1G 1x10G   69.22        69.22
---- --------------------- ------ ------------------ ----------- --------------
 0/3 NCS4200-48T3E3-CE       0.1   44-UEA LOTR DSX FP  1.22         1.22
---- --------------------- ------ ------------------ ----------- --------------
 0/4 NCS4200-48T1E1-CE       0.1   44-UEA LOTR DSX FP  1.22         1.22
---- --------------------- ------ ------------------ ----------- --------------
 0/5 NCS4200-1T8S-10CS       0.2   43-UEA EOWYN OCX F  1.12         1.12
```

To upgrade the firmware version, run the following command to reset and reload the new version.

```
Router# upgrade hw-module subslot 0/4 fpd bundled reload
% Are you sure that you want to perform this operation? [no]: yes
```

Caution A module reload affects all services on that module.

Upgrading the Redundant-RSP Chassis With Boot in Sub-package Mode

This section describes the standard procedure for all upgrades in an NCS4200 chassis with a redundant RSP.

Note Ensure that you have followed all instructions in the previous sections to ensure an efficient upgrade.

Confirming Stateful Switch-Over Configuration

If IGP and MPLS are configured on the chassis, it is recommended that NSR or NSF configuration are enabled for IGP and MPLS. These configuration reduce the loss of traffic during RSP switchover during the upgrade process.

Before upgrading a redundant-RSP chassis, verify if the *redundancy* and *mode sso* are set.

```
Router# show running-config | section redundancy
redundancy
mode sso
```

If the above values are missing, run the following commands to configure the chassis for SSO redundancy:

```
Router(config)# redundancy
Router(config-red)# mode sso
Router# exit

Router# show redundancy states | include peer
peer state = 8 -STANDBY HOT
Router#
```

Note The standby RSP should be in 'STANDBY HOT' state.

Upgrading Using a Single Command

The single-command upgrade initiates the installation procedure using the consolidated image.

You can adjust the delay between the Online Insertion and Removal (OIR) of each Interface Module (IM) using the **interface-module-delay** keyword.

Warning It is recommended to set the value of the **interface-module-delay** to 1200 seconds or more to ensure sufficient time for IM software upgrades.

```
Router# request platform software package install node file bootflash:issu/
ncs4200rsp3-universalk9_npe.03.18.06v.S.156-2.S6v-std.bin interface-module-delay 1200
```

Caution In case of firmware upgrade on an IM, the IM is reset and services on the IM are affected.

Note Connectivity to the system is lost while the active RSP switches over to the standby RSP. Wait for a minute and then reconnect to the system.

Verifying the New Image

After reloading the new image on the chassis, you must verify that the correct image was reloaded.

```
Router# show version

Cisco IOS XE Software, Version 03.18.08v.S - Standard Support Release
```

Upgrading the Firmware on the CEM Cards

First, verify the firmware version on the CEM cards.

```
Router# show hw-module all fpd

==== ====================== ====== ===============================================
                             H/W  Field Programmable
                                                    Current      Min. Required
Slot Card Type             Ver.  Device: "ID-Name"  Version      Version
== ====================== ====== ================== =========== ==============
```

```
 0/0 NCS4200-1T8LR-PS        1.0   32-UEA 8x1G 1x10G   69.22       69.22
---- ---------------------- ------ ------------------ ----------- --------------
 0/2 NCS4200-1T8LR-PS        1.0   32-UEA 8x1G 1x10G   69.22       69.22
---- ---------------------- ------ ------------------ ----------- --------------
 0/3 NCS4200-48T3E3-CE       0.1   44-UEA LOTR DSX FP  1.22        1.22
---- ---------------------- ------ ------------------ ----------- --------------
 0/4 NCS4200-48T1E1-CE       0.1   44-UEA LOTR DSX FP  1.22        1.22
---- ---------------------- ------ ------------------ ----------- --------------
 0/5 NCS4200-1T8S-10CS       0.2   43-UEA EOWYN OCX F  1.12        1.12
```

To upgrade the firmware version, run the following command to reset and reload the new version.

```
Router# upgrade hw-module subslot 0/4 fpd bundled reload
% Are you sure that you want to perform this operation? [no]: yes
```

Caution A module reload affects all services on that module.

Verifying the Upgrade

Example: Single Command Software Upgrade

```
Router# request platform software package install node file bootflash:XE371_k9_0810.bin
interface-module-delay 150


NOTE: Currently node has booted from a provisioning file
NOTE: Going to start a dual rp sub-packages node ISSU install
--- Starting initial file path checking ---
Copying bootflash:XE371_k9_0810.bin to stby-bootflash:XE371_k9_0810.bin
Finished initial file path checking
--- Starting config-register verification ---
Finished config-register verfication
--- Starting image file expansion ---
Expanding image file: bootflash:XE371_k9_0810.bin
Image file expanded and copied
Expanding image file: stby-bootflash:XE371_k9_0810.bin
Image file expanded and copied
Finished image file expansion
STAGE 1: Installing software on standby RP
==========================================
--- Starting local lock acquisition on R0 ---
Finished local lock acquisition on R0
--- Starting installation state synchronization ---
Finished installation state synchronization
--- Starting local lock acquisition on R1 ---
Finished local lock acquisition on R1
--- Starting file path checking ---
Finished file path checking
--- Starting image file verification ---
Checking image file names
Locating image files and validating name syntax
  Found asr903rsp1-espbase.BLD_V152_4_S_XE37_THROTTLE_LATEST_20120810_070021.pkg
  Found asr903rsp1-rpaccess.BLD_V152_4_S_XE37_THROTTLE_LATEST_20120810_070021.pkg
  Found asr903rsp1-rpbase.BLD_V152_4_S_XE37_THROTTLE_LATEST_20120810_070021.pkg
  Found asr903rsp1-rpcontrol.BLD_V152_4_S_XE37_THROTTLE_LATEST_20120810_070021.pkg
 Found asr903rsp1-rpios-universalk9_npe.BLD_V152_4_S_XE37_THROTTLE_LATEST_20120810_070021.pkg

  Found asr903rsp1-sipbase.BLD_V152_4_S_XE37_THROTTLE_LATEST_20120810_070021.pkg
```

```
  Found asr903rsp1-sipspa.BLD_V152_4_S_XE37_THROTTLE_LATEST_20120810_070021.pkg
Verifying image file locations
Inspecting image file types
    WARNING: In-service installation of IOSD package
    WARNING: requires software redundancy on target RP
    WARNING: or on-reboot parameter
    WARNING: Automatically setting the on-reboot flag
    WARNING: In-service installation of RP Base package
    WARNING: requires software reboot of target RP
Processing image file constraints
Creating candidate provisioning file
Finished image file verification
--- Starting candidate package set construction ---
Verifying existing software set
Processing candidate provisioning file
Constructing working set for candidate package set
Constructing working set for running package set
Checking command output
Constructing merge of running and candidate packages
Checking if resulting candidate package set would be complete
Finished candidate package set construction
--- Starting compatibility testing ---
Determining whether candidate package set is compatible
Determining whether installation is valid
Determining whether installation is valid ... skipped
Verifying image type compatibility
Checking IPC compatibility for candidate software
Checking candidate package set infrastructure compatibility
Checking infrastructure compatibility with running software
Checking infrastructure compatibility with running software ... skipped
Checking package specific compatibility
Finished compatibility testing
--- Starting list of software package changes ---
Old files list:
  Removed asr903rsp1-espbase.2012-08-12_15.26_amprajap.pkg
  Removed asr903rsp1-rpaccess.2012-08-12_15.26_amprajap.pkg
  Removed asr903rsp1-rpbase.2012-08-12_15.26_amprajap.pkg
  Removed asr903rsp1-rpcontrol.2012-08-12_15.26_amprajap.pkg
  Removed asr903rsp1-rpios-universalk9_npe.2012-08-12_15.26_amprajap.pkg
  Removed asr903rsp1-sipbase.2012-08-12_15.26_amprajap.pkg
  Removed asr903rsp1-sipspa.2012-08-12_15.26_amprajap.pkg
New files list:
  Added asr903rsp1-espbase.BLD_V152_4_S_XE37_THROTTLE_LATEST_20120810_070021.pkg
  Added asr903rsp1-rpaccess.BLD_V152_4_S_XE37_THROTTLE_LATEST_20120810_070021.pkg
  Added asr903rsp1-rpbase.BLD_V152_4_S_XE37_THROTTLE_LATEST_20120810_070021.pkg
  Added asr903rsp1-rpcontrol.BLD_V152_4_S_XE37_THROTTLE_LATEST_20120810_070021.pkg
 Added asr903rsp1-rpios-universalk9_npe.BLD_V152_4_S_XE37_THROTTLE_LATEST_20120810_070021.pkg

  Added asr903rsp1-sipbase.BLD_V152_4_S_XE37_THROTTLE_LATEST_20120810_070021.pkg
  Added asr903rsp1-sipspa.BLD_V152_4_S_XE37_THROTTLE_LATEST_20120810_070021.pkg
Finished list of software package changes
--- Starting commit of software changes ---
Updating provisioning rollback files
Creating pending provisioning file
Committing provisioning file
Finished commit of software changes
SUCCESS: Software provisioned.  New software will load on reboot.
STAGE 2: Restarting standby RP
==============================
--- Starting standby reload ---
Finished standby reload
--- Starting wait for Standby RP to reach terminal redundancy state ---
Finished wait for Standby RP to reach terminal redundancy state
STAGE 3: Installing sipspa package on local RP
```

```
==============================================
--- Starting local lock acquisition on R0 ---
Finished local lock acquisition on R0
--- Starting installation state synchronization ---
Finished installation state synchronization
--- Starting file path checking ---
Finished file path checking
--- Starting image file verification ---
Checking image file names
Locating image files and validating name syntax
  Found asr903rsp1-sipspa.BLD_V152_4_S_XE37_THROTTLE_LATEST_20120810_070021.pkg
Verifying image file locations
Inspecting image file types
Processing image file constraints
Creating candidate provisioning file
Finished image file verification
--- Starting candidate package set construction ---
Verifying existing software set
Processing candidate provisioning file
Constructing working set for candidate package set
Constructing working set for running package set
Checking command output
Constructing merge of running and candidate packages
Checking if resulting candidate package set would be complete
Finished candidate package set construction
--- Starting compatibility testing ---
Determining whether candidate package set is compatible
WARNING:
WARNING: Candidate software combination not found in compatibility database
WARNING:
Determining whether installation is valid
WARNING:
WARNING: Candidate software combination not found in compatibility database
WARNING:
WARNING:
WARNING: Candidate software combination not found in compatibility database
WARNING:
Software sets are identified as compatible
Verifying image type compatibility
Checking IPC compatibility with running software
Checking candidate package set infrastructure compatibility
Checking infrastructure compatibility with running software
Checking package specific compatibility
Finished compatibility testing
--- Starting impact testing ---
Checking operational impact of change
Finished impact testing
--- Starting list of software package changes ---
Old files list:
  Removed asr903rsp1-sipspa.2012-08-12_15.26_amprajap.pkg
New files list:
  Added asr903rsp1-sipspa.BLD_V152_4_S_XE37_THROTTLE_LATEST_20120810_070021.pkg
Finished list of software package changes
--- Starting commit of software changes ---
Updating provisioning rollback files
Creating pending provisioning file
Committing provisioning file
Finished commit of software changes
--- Starting analysis of software changes ---
Finished analysis of software changes
--- Starting update running software ---
Blocking peer synchronization of operating information
Creating the command set placeholder directory
  Finding latest command set
```

```
  Finding latest command shortlist lookup file
  Finding latest command shortlist file
  Assembling CLI output libraries
  Assembling CLI input libraries
  Assembling Dynamic configuration files
  Applying interim IPC and database definitions
  Replacing running software
  Replacing CLI software
  Restarting software
  Restarting IM: 0/0
Skipping IM reload for Ethernet IM
  Restarting IM: 0/1
Skipping IM reload for Ethernet IM
  Restarting IM: 0/2
Skipping IM reload for Ethernet IM
  Restarting IM: 0/3
Skipping IM reload for Ethernet IM
  Restarting IM: 0/4
Skipping IM reload for Ethernet IM
  Applying final IPC and database definitions
  Generating software version information
  Notifying running software of updates
  Unblocking peer synchronization of operating information
Unmounting old packages
Cleaning temporary installation files
  Finished update running software

SUCCESS: Finished installing software.
STAGE 4: Installing software on active RP
=========================================
--- Starting local lock acquisition on R0 ---
Finished local lock acquisition on R0
--- Starting installation state synchronization ---
Finished installation state synchronization
--- Starting file path checking ---
Finished file path checking
--- Starting image file verification ---
Checking image file names
Locating image files and validating name syntax
  Found asr903rsp1-espbase.BLD_V152_4_S_XE37_THROTTLE_LATEST_20120810_070021.pkg
  Found asr903rsp1-rpaccess.BLD_V152_4_S_XE37_THROTTLE_LATEST_20120810_070021.pkg
  Found asr903rsp1-rpbase.BLD_V152_4_S_XE37_THROTTLE_LATEST_20120810_070021.pkg
  Found asr903rsp1-rpcontrol.BLD_V152_4_S_XE37_THROTTLE_LATEST_20120810_070021.pkg
 Found asr903rsp1-rpios-universalk9_npe.BLD_V152_4_S_XE37_THROTTLE_LATEST_20120810_070021.pkg

  Found asr903rsp1-sipbase.BLD_V152_4_S_XE37_THROTTLE_LATEST_20120810_070021.pkg
  Found asr903rsp1-sipspa.BLD_V152_4_S_XE37_THROTTLE_LATEST_20120810_070021.pkg
Verifying image file locations
Inspecting image file types
    WARNING: In-service installation of IOSD package
    WARNING: requires software redundancy on target RP
    WARNING: or on-reboot parameter
    WARNING: Automatically setting the on-reboot flag
    WARNING: In-service installation of RP Base package
    WARNING: requires software reboot of target RP
Processing image file constraints
Creating candidate provisioning file
Finished image file verification
--- Starting candidate package set construction ---
Verifying existing software set
Processing candidate provisioning file
Constructing working set for candidate package set
Constructing working set for running package set
Checking command output
```

```
Constructing merge of running and candidate packages
Checking if resulting candidate package set would be complete
Finished candidate package set construction
--- Starting compatibility testing ---
Determining whether candidate package set is compatible
Determining whether installation is valid
Determining whether installation is valid ... skipped
Verifying image type compatibility
Checking IPC compatibility for candidate software
Checking candidate package set infrastructure compatibility
Checking infrastructure compatibility with running software
Checking infrastructure compatibility with running software ... skipped
Checking package specific compatibility
Finished compatibility testing
--- Starting list of software package changes ---
Old files list:
  Removed asr903rsp1-espbase.2012-08-12_15.26_amprajap.pkg
  Removed asr903rsp1-rpaccess.2012-08-12_15.26_amprajap.pkg
  Removed asr903rsp1-rpbase.2012-08-12_15.26_amprajap.pkg
  Removed asr903rsp1-rpcontrol.2012-08-12_15.26_amprajap.pkg
  Removed asr903rsp1-rpios-universalk9_npe.2012-08-12_15.26_amprajap.pkg
  Removed asr903rsp1-sipbase.2012-08-12_15.26_amprajap.pkg
New files list:
  Added asr903rsp1-espbase.BLD_V152_4_S_XE37_THROTTLE_LATEST_20120810_070021.pkg
  Added asr903rsp1-rpaccess.BLD_V152_4_S_XE37_THROTTLE_LATEST_20120810_070021.pkg
  Added asr903rsp1-rpbase.BLD_V152_4_S_XE37_THROTTLE_LATEST_20120810_070021.pkg
  Added asr903rsp1-rpcontrol.BLD_V152_4_S_XE37_THROTTLE_LATEST_20120810_070021.pkg
 Added asr903rsp1-rpios-universalk9_npe.BLD_V152_4_S_XE37_THROTTLE_LATEST_20120810_070021.pkg

  Added asr903rsp1-sipbase.BLD_V152_4_S_XE37_THROTTLE_LATEST_20120810_070021.pkg
Finished list of software package changes
--- Starting commit of software changes ---
Updating provisioning rollback files
Creating pending provisioning file
Committing provisioning file
Finished commit of software changes
SUCCESS: Software provisioned.  New software will load on reboot.
STAGE 5: Restarting active RP (switchover to stdby)
================================================
--- Starting active reload ---
Finished active reload
SUCCESS: node ISSU finished successfully.
RUDY-1#
RUDY-1#Aug 24 07:54:41.715 R0/0: %PMAN-5-EXITACTION: Process manager is exiting: reload fru
 action requested
System Bootstrap, Version 15.3(1r)S1, RELEASE SOFTWARE (fc1)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 2012 by cisco Systems, Inc.
Compiled Tue 26-Jun-12 12:42 by ccai
Current image running: Boot ROM0UEA platform with 3670016 Kbytes of main memory
Located packages.conf
Image size 7519 inode num 38, bks cnt 2 blk size 8*512
#
Located asr903rsp1-rpbase.BLD_V152_4_S_XE37_THROTTLE_LATEST_20120810_070021.pkg
Image size 34216240 inode num 90631, bks cnt 8354 blk size 8*512
################################################################################
################################################################################
################################################################################
################################################################################
Boot image size = 34216240 (0x20a1930) bytes
Package header rev 0 structure detected
Calculating SHA-1 hash...done
validate_package: SHA-1 hash:
        calculated e7674970:dbc1eb86:325219c7:b3da0e0f:077e5e4d
```

```
        expected   e7674970:dbc1eb86:325219c7:b3da0e0f:077e5e4d
Image validated
%IOSXEBOOT-4-BOOT_ACTIVITY_LONG_TIME: (rp/0): load_crash_kernel took: 2 seconds, expected
max time 2 seconds
%IOSXEBOOT-4-DEBUG_CONF: (rp/0): File /bootflash/debug.conf is absent, ignoring
%IOSXEBOOT-4-BOOT_ACTIVITY_LONG_TIME: (rp/0): Chassis initialization took: 26 seconds,
expected max time 10 seconds
%IOSXEBOOT-4-BOOT_ACTIVITY_LONG_TIME: (rp/0): upgrade hw-programmable took: 2 seconds,
expected max time 2 seconds
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           cisco Systems, Inc.
           170 West Tasman Drive
           San Jose, California 95134-1706
Cisco IOS Software, IOS-XE Software (PPC_LINUX_IOSD-UNIVERSALK9_NPE-M),
Experimental Version 15.2(20120810:081250)
[v152_4_s_xe37_throttle-BLD-BLD_V152_4_S_XE37_THROTTLE_LATEST_20120810_070021-ios 131]
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A summary of U.S. laws governing Cisco cryptographic products may be found at:
http://www.cisco.com/wwl/export/crypto/tool/stqrg.html
If you require further assistance please contact us by sending email to
export@cisco.com.
cisco ASR-903 (RSP1) processor with 540359K/6147K bytes of memory.
Processor board ID FOX1518P0GP
32768K bytes of non-volatile configuration memory.
3670016K bytes of physical memory.
1328927K bytes of SD flash at bootflash:.
Press RETURN to get started!
```

Secure eUSB Configuration

Table 13: Feature History

Feature Name	Release Information	Description
Secure eUSB Configuration	Cisco IOS XE Bengaluru 17.6.1	Use the **platform secure-cfg** command to provide enhanced security to the routers.

Effective with Cisco IOS XE Bengaluru Release 17.6.1, use the **platform secure-cfg** command to provide enhanced security to the routers. When you enable the command, the router does not boot if the eUSB is replaced, swapped, or modified externally. Thus, you cannot format the eUSB externally and this prevents the misuse of the router.

This feature is applicable on the Cisco NCS4216-RSP routers.

To enable the **platform secure-cfg** command:

```
Router#enable
Router#configure terminal
Router(conf)#platform secure-cfg
Router(conf)#end
Router# write memory
```

Use the following command to verify that the **platform secure-cfg** command is enabled.

```
Router#show running-config | i secure-cfg
platform secure-cfg
```

Software Upgrade Process Using Install Commands

Cisco ASR 900 Series Aggregation Services Routers support In-Service Software Upgrades (ISSU) procedure to upgrade the software. The *ISSU-using-install-cmds-for-RSP3* feature introduces a new method of software upgrade process by using the install command for Cisco ASR 903 Series Aggregation Services Routers.

Note Starting with Cisco IOS XE Amsterdam 17.3.1, the Install Workflow based ISSU method is supported on the Cisco RSP3 module .

Prerequisite

- Ensure that the standby RP is in the standby-hot state.
- Enable autoboot when using the install command so that the device is automatically reloaded with the configuration registry using the boot system command.

Guidelines

- Perform software upgrade process only during a maintenance window.

- Do not enable new features during a software upgrade process as it may require configuration changes.

Sub-Package Upgrade

Upgrading Software Using Step-By-Step Workflow

The step-by-step workflow involves, to add, activate, and commit the configuration. After activation, all the cards are upgraded to the new software version but does not commit automatically. You must manually commit using the install commit command. The advantage is that, it allows the system to roll back to a previous software version. The system automatically rolls back if the rollback timer is not stopped using the install abort-timer-stop command. If the rollback timer is stopped, then the new software version could be run on the device for any duration and then roll back to the previous version.

Procedure

Step 1 **enable**

Example:

```
Router> enable
```

Enables privileged EXEC mode.

- Enter your password if prompted.

Step 2 **install add file {bootflash:| tftp:}**

Example:

```
Router# install add tftp bootflash:
```

Downloads the image into the bootflash. The image is copied to the boot directory (boot_dir), the location where Route Processors (RPs) are booted.

Step 3 **install activate issu [linecard-delay seconds]**

Example:

```
Router# install activate issu
```

Provisions the standby RP with the new software and reloads with the new software version.

- linecard-delay *seconds* — Waits for a specified duration before upgrading the next slot.
- The rollback timer will be restarted.

Step 4 **install commit**

Example:

```
Router# install commit
```

Saves the configuration, performs the necessary clean-up, enables the new software as permanent (removing the older version of the software) and stops the rollback timer.

Note There is no rollback when this command is used.

Upgrading Software Using Single-Step Workflow

The single-step workflow involves, to add, activate, and commit the configuration. Rollback is not supported, as the upgrade is committed automatically.

Rollback

You can rollback the system before a commit. You can rollback a device to the initial stage using the **install abort issu** command or after the expiry of the rollback timer before the install commit command is used. If the install commit command is used, then rollback is not allowed.

Rollback involves the following:

- Provision and reset the standby RP.
- Provision and reset the active RP.

If the rollback timer is not stopped by using the **install abort stop-timer** command, the device rolls back to an earlier software version on expiry of the rollback timer. The default value of the rollback timer is 120 minutes.

The rollback timer value can be set via the **install activate location standby auto-abort-timer seconds** command.

Performing Single-Step Workflow

Procedure

Step 1 **enable**

Example:

```
Router> enable
```

Enables privileged EXEC mode.

- Enter your password if prompted.

Step 2 **install add file {bootflash: | tftp: } activate issu [linecard-delay seconds] commit**

Example:

```
Router# install add tftp bootflash: activate issu commit
```

Enables the standby RP with new software and triggers the standby RP to become active RP with new software version.

- linecard-delay *seconds* — Waits for a specified duration before upgrading the next slot.

- commit — Saves the configuration, performs the necessary clean-up, enables the new software as permanent (removes the older version of the software) and stops the rollback timer. Any reboot after the commit, boots with the new software. There is no rollback when this keyword is used.

Tracking Software Upgrade

You can track the ISSU progress using the **show issu state detail** command.

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS master command list	Cisco IOS Master Command List , All Releases
Cisco IOS High Availability commands	*Cisco IOS High Availability Command Reference*

Standards

Standard	Title
No new or modified standards are supported, and support for existing standards has not been modified.	--

MIBs

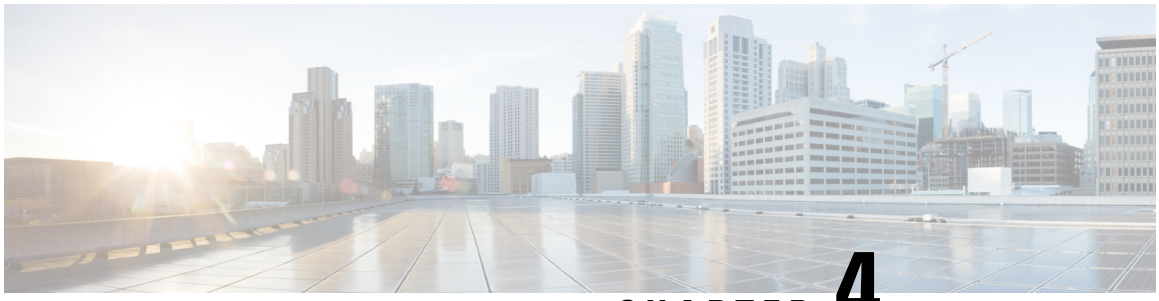
MIB	MIBs Link
No new or modified MIBs are supported, and support for existing MIBs has not been modified.	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFC	Title
No new or modified RFCs are supported, and support for existing RFCs has not been modified.	--

Technical Assistance

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



CHAPTER 4

Configuring Stateful Switchover

The Stateful Switchover (SSO) feature works with Nonstop Forwarding (NSF) in Cisco software to minimize the amount of time a network is unavailable to its users following a switchover. The primary objective of SSO is to improve the availability of networks constructed with Cisco routers. SSO performs the following functions:

- Maintains stateful protocol and application information to retain user session information during a switchover.
- Enables line cards to continue to forward network traffic with no loss of sessions, providing improved network availability.
- Provides a faster switchover relative to high system availability.

- Prerequisites for Stateful Switchover, on page 41
- Restrictions for Stateful Switchover, on page 42
- Information About Stateful Switchover, on page 43
- Enhanced SNMP Support for High Availability, on page 50
- How to Configure Stateful Switchover, on page 53
- Configuration Examples for Stateful Switchover, on page 60

Prerequisites for Stateful Switchover

General Prerequisites

- For hardware-redundant platforms, two Route Processors (RPs) must be installed in the chassis, each running the same version or a compatible version of the Cisco software.Both RSPs must be running the same version of Cisco software.
- Before copying a file to flash memory, be sure that ample space is available in flash memory. Compare the size of the file you are copying to the amount of available flash memory shown. If the space available is less than the space required by the file you will copy, the copy process will not continue and an error message similar to the following will be displayed:

```
%Error copying tftp://image@server/tftpboot/filelocation/imagename (Not enough space on
device).
```

- Distributed Cisco Express Forwarding must be enabled on any networking device configured to run SSO.
- For Nonstop Forwarding (NSF) support, neighbor routers must be running NSF-enabled images, though SSO need not be configured on the neighbor device.

SNMP for Stateful Switchover Prerequisites

SNMP must be configured. See the Configuring SNMP Support module of Cisco IOS XE Network Management Configuration Guide for configuration information. There are no configuration tasks for SNMP for SSO.

Restrictions for Stateful Switchover

General Restrictions for SSO

- Only SSO mode is supported.
- Both RPs must run the same Cisco software image. If the RPs are operating different Cisco software images, the system reverts to RPR mode even if SSO is configured.
- Configuration changes made through SNMP may not be automatically configured on the standby RP after a switchover occurs.
- Load sharing between dual processors is not supported.
- Enhanced Object Tracking (EOT) is not stateful switchover-aware and cannot be used with HSRP, Virtual Router Redundancy Protocol (VRRP), or Gateway Load Balancing Protocol (GLBP) in SSO mode.

Configuration Mode Restrictions

- The configuration registers on both RPs must be set the same for the networking device to behave the same when either RP is rebooted.
- During the startup (bulk) synchronization, configuration changes are not allowed. Before making any configuration changes, wait for a message similar to the following:

```
%HA-5-MODE:Operating mode is sso, configured mode is sso.
HA_CONFIG_SYNC-6-BULK_CFGSYNC_SUCCEED: Bulk Sync succeeded
```

Switchover Process Restrictions

- If the router is configured for SSO mode, and the active RP fails before the standby is ready to switch over, the router will recover through a full system reset.

Restrictions for Stateful Swtichover on NCS 4200

- Only SSO mode is supported.

- All licenses are synced to the standby RSP, when evaluation or permanent licenses are installed on a HA system. However, when a new RSP is inserted in a standby system for HA, the standby RSP resets once before it reaches standby hot state.
- Erasing router configuration using **write erase** command does not work in standby router in HA system when it is applied from an active router or when accessed from telnet.

SNMP for Stateful Switchover Restrictions

- Statistics and counter values will not be synchronized from the active to the standby RP.
- Only the MIBs listed in the SSO MIB Support section are synchronized between the active and the standby RPs.
- SNMP requests can fail during the switchover process, that is, while the standby RP is taking over as the active RP. Data in the unsynchronized MIBs may be out of synchronization, and the information in these MIBs can be lost on a switchover.
- Synchronization of SNMP data between RPs is available only when the networking device is operating in SSO mode.

Information About Stateful Switchover

SSO Overview

SSO provides protection for network edge devices with dual RPs that represent a single point of failure in the network design, and where an outage might result in loss of service for customers.

In Cisco networking devices that support dual RPs, SSO takes advantage of RP redundancy to increase network availability. The feature establishes one of the RPs as the active processor while the other RP is designated as the standby processor, and then synchronizing critical state information between them. Following an initial synchronization between the two processors, SSO dynamically maintains RP state information between them.

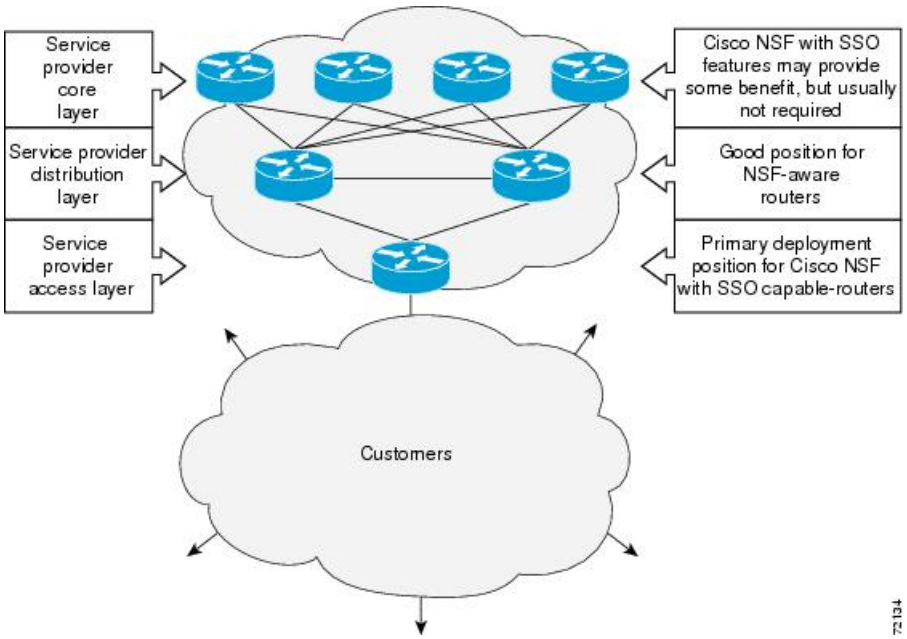
On Cisco ASR 1000 series routers, SSO can also be used to enable a second Cisco software process on the same RP. This second Cisco IOS process acts as a standby process for the active Cisco software process, and also allows certain subpackages to be upgraded without experiencing any router downtime.

A switchover from the active to the standby processor occurs when the active RP fails, is removed from the networking device, or is manually taken down for maintenance.

SSO is used with the Cisco Nonstop Forwarding (NSF) feature. Cisco NSF allows for the forwarding of data packets to continue along known routes while the routing protocol information is being restored following a switchover. With Cisco NSF, peer networking devices do not experience routing flaps, thereby reducing loss of service outages for customers.

The figure below illustrates how SSO is typically deployed in service provider networks. In this example, Cisco NSF with SSO is primarily at the access layer (edge) of the service provider network. A fault at this point could result in loss of service for enterprise customers requiring access to the service provider network.

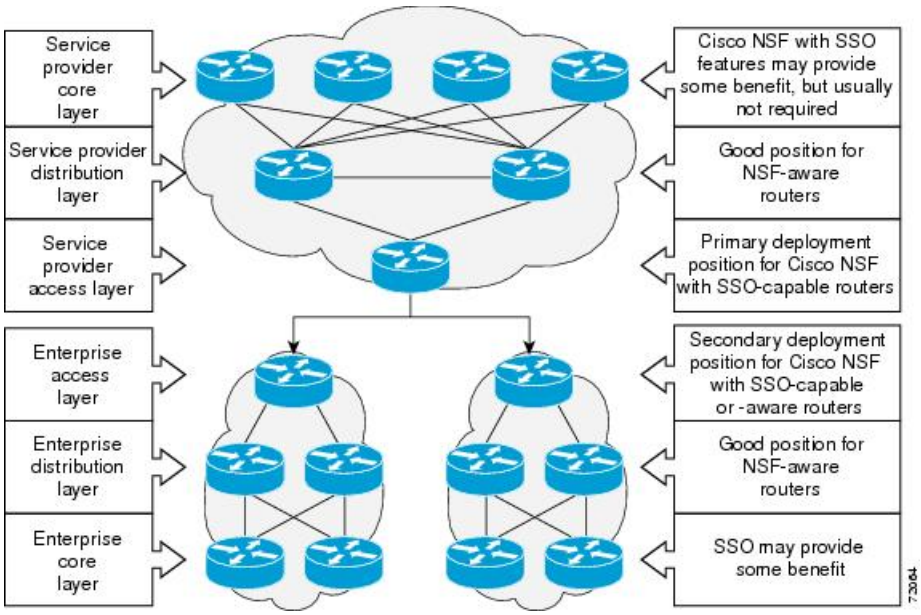
Figure 1: Cisco NSF with SSO Network Deployment: Service Provider Networks



For Cisco NSF protocols that require neighboring devices to participate in Cisco NSF, Cisco NSF-aware software images must be installed on those neighboring distribution layer devices. Additional network availability benefits might be achieved by applying Cisco NSF and SSO features at the core layer of your network; however, consult your network design engineers to evaluate your specific site requirements.

Additional levels of availability may be gained by deploying Cisco NSF with SSO at other points in the network where a single point of failure exists. The figure below illustrates an optional deployment strategy that applies Cisco NSF with SSO at the enterprise network access layer. In this example, each access point in the enterprise network represents another single point of failure in the network design. In the event of a switchover or a planned software upgrade, enterprise customer sessions would continue uninterrupted through the network.

Figure 2: Cisco NSF with SSO Network Deployment: Enterprise Networks



Redundancy Modes

Stateful Switchover Mode

SSO mode provides all the functionality of RPR+ in that Cisco software is fully initialized on the standby RP. In addition, SSO supports synchronization of line card, protocol, and application state information between RPs for supported features and protocols (a hot standby).

SSO supports synchronization of line card, protocol, and application state information between RPs for supported features and protocols (a hot standby).

Route Processor Synchronization

In networking devices running SSO, both RPs must be running the same configuration so that the standby RP is always ready to assume control if the active RP fails.

To achieve the benefits of SSO, synchronize the configuration information from the active RP to the standby RP at startup and whenever changes to the active RP configuration occur. This synchronization occurs in two separate phases:

- While the standby RP is booting, the configuration information is synchronized in bulk from the active RP to the standby RP.
- When configuration or state changes occur, an incremental synchronization is conducted from the active RP to the standby RP.

Note Effective Cisco IOS XE Amsterdam 17.2.1, standby inventory files are automatically created during the bootup of the standby RSP. This process reduces the time taken to send the RF notification to the client protocol by **one** second.

Bulk Synchronization During Initialization

When a system with SSO is initialized, the active RP performs a chassis discovery (discovery of the number and type of line cards and fabric cards, if available, in the system) and parses the startup configuration file.

The active RP then synchronizes this data to the standby RP and instructs the standby RP to complete its initialization. This method ensures that both RPs contain the same configuration information.

Even though the standby RP is fully initialized, it interacts only with the active RP to receive incremental changes to the configuration files as they occur. Executing CLI commands on the standby RP is not supported.

During system startup, the startup configuration file is copied from the active RP to the standby RP. Any existing startup configuration file on the standby RP is overwritten. The startup configuration is a text file stored in the NVRAM of the RP. It is synchronized whenever you perform the following operations:

- The command **copy system:running-config nvram:startup-config** is used.
- The command **copy running-config startup-config** is used.
- The command **write memory** is used.
- The command **copy** *filename* **nvram:startup-config** is used.
- SNMP SET of MIB variable ccCopyEntry in CISCO_CONFIG_COPY MIB is used.
- System configuration is saved using the **reload** command.
- System configuration is saved following entry of a forced switchover command.

Incremental Synchronization

After both RPs are fully initialized, any further changes to the running configuration or active RP states are synchronized to the standby RP as they occur. Active RP states are updated as a result of processing protocol information, external events (such as the interface becoming up or down), or user configuration commands (using Cisco IOS commands or Simple Network Management Protocol [SNMP]) or other internal events.

Changes to the running configuration are synchronized from the active RP to the standby RP. In effect, the command is run on both the active and the standby RP.

Configuration changes caused by an SNMP set operation are synchronized on a case-by-case basis. Only two SNMP configuration set operations are supported:

- **shut** and **no-shut** (of an interface)
- **link up/down trap** *enable/disable*

Routing and forwarding information is synchronized to the standby RP:

- State changes for SSO-aware protocols (ATM, Frame Relay, PPP, High-Level Data Link Control [HDLC]) or applications (SNMP) are synchronized to the standby RP.

- Cisco Express Forwarding (CEF) updates to the Forwarding Information Base (FIB) are synchronized to the standby RP.

Chassis state changes are synchronized to the standby RP. Changes to the chassis state due to line card insertion or removal are synchronized to the standby RP.

Changes to the line card states are synchronized to the standby RP. Line card state information is initially obtained during bulk synchronization of the standby RP. Following bulk synchronization, line card events, such as whether the interface is up or down, received at the active processor are synchronized to the standby RP.

The various counters and statistics maintained in the active RP are not synchronized because they may change often and because the degree of synchronization they require is substantial. The volume of information associated with statistics makes synchronizing them impractical.

Not synchronizing counters and statistics between RPs may create problems for external network management systems that monitor this information.

Switchover Operation

Switchover Conditions

An automatic or manual switchover may occur under the following conditions:

- A fault condition that causes the active RP to crash or reboot--automatic switchover
- The active RP is declared dead (not responding)--automatic switchover
- The command is invoked--manual switchover

The user can force the switchover from the active RP to the standby RP by using a CLI command. This manual procedure allows for a graceful or controlled shutdown of the active RP and switchover to the standby RP. This graceful shutdown allows critical cleanup to occur.

Note This procedure should not be confused with the graceful shutdown procedure for routing protocols in core routers--they are separate mechanisms.

Caution The SSO feature introduces a number of new command and command changes, including commands to manually cause a switchover. The **reload** command does not cause a switchover. The **reload** command causes a full reload of the box, removing all table entries, resetting all line cards, and interrupting nonstop forwarding.

Switchover Time

Switchover time is only a few seconds on the router. Packets that are switched or routed by the ASIC are not impacted by the RP switchover. However, if packets are punted to the RP for further processing, switching and routing will be impacted. The length of time can be due to a number of factors including the time needed for the previously active processor to obtain crash information, load code and microcode, and synchronize configurations between processors and line protocols and Cisco NSF-supported protocols.

Core Dump Operation

In networking devices that support SSO, the newly active primary processor runs the core dump operation after the switchover has taken place. Not having to wait for dump operations effectively decreases the switchover time between processors.

Following the switchover, the newly active RP will wait for a period of time for the core dump to complete before attempting to reload the formerly active RP. The time period is configurable. For example, on some platforms an hour or more may be required for the formerly active RP to perform a coredump, and it might not be site policy to wait that much time before resetting and reloading the formerly active RP. In the event that the core dump does not complete within the time period provided, the standby is reset and reloaded regardless of whether it is still performing a core dump.

The core dump process adds the slot number to the core dump file to identify which processor generated the file content.

Note Core dumps are generally useful only to your technical support representative. The core dump file, which is a very large binary file, must be transferred using the TFTP, FTP, or remote copy protocol (rcp) server and subsequently interpreted by a Cisco Technical Assistance Center (TAC) representative that has access to source code and detailed memory maps.

SSO-Aware Protocols and Applications

SSO-supported line protocols and applications must be SSO-aware. A feature or protocol is SSO-aware if it maintains, either partially or completely, undisturbed operation through an RP switchover. State information for SSO-aware protocols and applications is synchronized from active to standby to achieve stateful switchover for those protocols and applications.

The dynamically created state of SSO-unaware protocols and applications is lost on switchover and must be reinitialized and restarted on switchover.

SSO-aware applications are either platform-independent, such as in the case of line protocols or platform-dependent (such as line card drivers). Enhancements to the routing protocols (Cisco Express Forwarding, Open Shortest Path First, and Border Gateway Protocol [BGP]) have been made in the SSO feature to prevent loss of peer adjacency through a switchover; these enhancements are platform-independent.

Line Protocols

SSO-aware line protocols synchronize session state information between the active and standby RPs to keep session information current for a particular interface. In the event of a switchover, session information need not be renegotiated with the peer. During a switchover, SSO-aware protocols also check the line card state to learn if it matches the session state information. SSO-aware protocols use the line card interface to exchange messages with network peers in an effort to maintain network connectivity.

Quality of Service

The modular QoS CLI (MQS)-based QoS feature maintains a database of various objects created by the user, such as those used to specify traffic classes, actions for those classes in traffic policies, and attachments of those policies to different traffic points such as interfaces. With SSO, QoS synchronizes that database between the primary and secondary RP.

IPv6 Support for Stateful Switchover

IPv6 neighbor discovery supports SSO using Cisco Express Forwarding. When switchover occurs, the Cisco Express Forwarding adjacency state, which is checkpointed, is used to reconstruct the neighbor discovery cache.

Line Card Drivers

Platform-specific line card device drivers are bundled with the Cisco software image for SSO and are correct for a specific image, meaning they are designed to be SSO-aware.

Line cards used with the SSO feature periodically generate status events that are forwarded to the active RP. Information includes the line up or down status, and the alarm status. This information helps SSO support bulk synchronization after standby RP initialization and support state reconciliation and verification after a switchover.

Line cards used with the SSO feature also have the following requirements:

- Line cards must not reset during switchover.
- Line cards must not be reconfigured.
- Subscriber sessions may not be lost.

Note The standby RP communicates only with the active RP, never with the line cards. This function helps to ensure that the active and standby RP always have the same information.

Routing Protocols and Nonstop Forwarding

Cisco nonstop forwarding (NSF) works with SSO to minimize the amount of time a network is unavailable to its users following a switchover. When a networking device restarts, all routing peers of that device usually detect that the device went down and then came back up. This down-to-up transition results in what is called a "routing flap," which could spread across multiple routing domains. Routing flaps caused by routing restarts create routing instabilities, which are detrimental to the overall network performance. Cisco NSF helps to suppress routing flaps, thus improving network stability.

Cisco NSF allows for the forwarding of data packets to continue along known routes while the routing protocol information is being restored following a switchover. With Cisco NSF, peer networking devices do not experience routing flaps. Data traffic is forwarded through intelligent line cards while the standby RP assumes control from the failed active RP during a switchover. The ability of line cards to remain up through a switchover and to be kept current with the FIB on the active RP is key to Cisco NSF operation.

A key element of Cisco NSF is packet forwarding. In Cisco networking devices, packet forwarding is provided by Cisco Express Forwarding. Cisco Express Forwarding 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 eliminates downtime during the switchover.

Cisco NSF supports the BGP, IS-IS, and OSPF routing protocols. In general, these routing protocols must be SSO-aware to detect a switchover and recover state information (converge) from peer devices. Each protocol depends on Cisco Express Forwarding to continue forwarding packets during switchover while the routing protocols rebuild the Routing Information Base (RIB) tables.

Note Distributed Cisco Express Forwarding must be enabled in order to run NSF.

Network Management

Network management support for SSO is provided through the synchronization of specific SNMP data between the active and standby RPs. From a network management perspective, this functionality helps to provide an uninterrupted management interface to the network administrator.

Note Synchronization of SNMP data between RPs is available only when the networking device is operating in SSO mode.

Enhanced SNMP Support for High Availability

SNMP for Stateful Switchover Overview

The SNMP and stateful switchover feature helps to improve the availability of networks made up of Cisco networking devices. Using SSO, a networking device with redundant RPs will continue forwarding traffic, continue operating as a routing protocol peer, and remain manageable under a set of circumstances that ordinarily would cause an interruption in service.

The SSO feature allows one of the processors on the networking device to operate as the active RP, which passes the necessary system, routing, and application state information to the standby RP. Upon switchover, the standby RP quickly assumes the role of active RP. The goal of SNMP network management with SSO functionality is to provide an uninterrupted management interface to the end user during and after a switchover.

SNMP network management with SSO functionality ensures an uninterrupted management interface to the end user. The network administrator can differentiate a switchover from a system restart based on the notification type (for example, ciscoRFSwactNotif for switchover and coldStart or warmStart for system restarts). Uninterrupted service also includes synchronizing the SNMP configuration and data from core MIBs such as IF-MIB and ENTITY-MIB to the standby RP.

Network Management for SSO

Table 14: Feature History

Feature Name	Release Information	Description
Monitoring alarms for standby RSP management interface	Cisco IOS XE 17.15.1b	In addition to Active RSP, alarms are now generated for the management interface of the Stand-by RSP. You can monitor these alarms in Cisco's EPNM (Evolved Programmable Network Manager) and take the appropriate action to fix the problem.

Network management support for SSO is provided through the synchronization of specific SNMP data between the active and standby RPs. From a network management perspective, this synchronization helps to provide an uninterrupted management interface to the network administrator.

Synchronization of SNMP data between RPs is available only when the networking device is operating in SSO mode.

Uninterrupted Service Using SSO

When a networking device uses SSO, the network management engine of the standby RP should be indistinguishable from the network management engine of the active RP. A network management system (NMS) should not interpret a switchover to mean that a new device has come up.

The sysUpTime MIB object reports the system uptime. To prevent a switchover from being flagged as a restart, this object is synchronized between the active and the standby RPs. As a result, no coldStart or warmStart traps will be generated as a result of the switchover--the ciscoRFSwactNotif notification is used to signal a switchover.

Communication with the NMS

Counters and Statistics

The various counters and statistics maintained in the RP are not synchronized because they may change often and the degree of synchronization they require is substantial. They also are not critical to the system operation. Because of this lack of synchronization, counter objects experience a discontinuity after a switchover. The cRFStatusFailoverTime will be the value of sysUpTime when any one or more of the counters experiences a discontinuity.

Switchover Notification

The ciscoRFSwactNotif notification informs the NMS about a switchover. This notification provides information regarding the unit ID of the originator of the notification, the newly active redundant unit, the sysUptime data, and reason codes for why a switchover has occurred. The NMS can then use the ciscoRFSwactNotif notification to resynchronize the counter statistics values, if necessary.

Traps

Only notifications generated on the active RP are sent to the notification destination. None of the notifications generated on the standby RP are sent to the notification destination. Furthermore, notifications can be lost if they were generated on the active RP before a switchover. The NMS should be aware of these constraints.

SSO MIB Support

The CISCO-RF-MIB provides configuration control and status for the redundancy facility (RF) subsystem.

MIBs that are not listed in this section do not synchronize data between the redundant units. MIB synchronization for SSO only occurs when the system is in SSO mode.

All the objects in the following MIBs that contain SNMP configuration data are synchronized between the active and standby RPs:

- SNMP-FRAMEWORK-MIB

- SNMP-TARGET-MIB
- SNMP-USM-MIB
- SNMP-VACM-MIB
- SNMPv2-MIB

The following core MIBs support SSO:

- ENTITY-MIB—After a switchover, there will be no change in the data reported by the ENTITY-MIB object. This lack of change is result of the entPhysicalIndex and its associated objects being synchronized between the active and the standby RPs. The associated objects of the entPhysicalIndex are as follows:
  - entPhysicalAlias
  - entPhysicalSerialNum
  - entPhysicalAssetID
  - entLastChangeTime
- IF-MIB—The ifIndex is synchronized between the active and standby RPs, along with the ifNumber, ifTableLastChange, ifAdminStatus, ifLinkUpDownTrapEnable, ifAlias, ifLastChange, and ifStackLastChange objects.

The following infrastructure MIBs support SSO:

- Community MIB
- Notification MIB
- Notification log MIB
- Field-replaceable unit (FRU) control MIB
- CISCO-ENHANCED-MEMPOOL-MIB

CISCO-RF-MIB Modifications for SSO Support

New cRFHistorySwitchOverTable Table in CISCO-RF-MIB for SSO Support

The cRFHistorySwitchOverTable tracks the history of switchovers that have occurred since system initialization. New objects that have been added as part of this table are as follows:

- cRFHistoryPrevActiveUnitId--A read-only object that indicates the active RP that went down. The value of this object is the unique ID of the active RP that has gone down. The ID can be the slot ID, the physical or logical entity ID, or a unique ID assigned by the RF.
- cRFHistoryCurrActiveUnitId--A read-only object that indicates the standby RP that took over as the active RP. The value of this object is the unique ID of the active RP. The ID can be the slot ID, the physical or logical entity ID, or a unique ID assigned by the RF.
- cRFHistorySwitchOverReason--A read-only object that indicates the reason for the switchover. The reasons for the switchover from the active RP to the standby RP can be any of the following:
  - unsupported—This feature is unsupported.

- none—No switchover has occurred.
- notKnown—The reason is unknown.
- userInitiated—A safe, manual switchover was initiated by the user.
- userForced—A manual switchover was forced by the user. Preconditions, warnings, and safety
- checks were ignored.
- activeUnitFailed—An active RP fault caused an automatic switchover.
- activeUnitRemoved—The active RP was removed, which caused an automatic switchover.
- cRFHistorySwactTime—A read-only object that indicates the date and time the switchover occurred. The value of this object is a time stamp with the date and time the switchover occurred.

New Objects in CISCO-RF-MIB for SSO Support

The object added to the new cRFHistory subgroup are as follows:

- cRFHistoryTableMaxLength--A read-write object that indicates the maximum number of entries permissible in the history table. The value of this object is an integer that is more than 0. A value of 0 results in no history being maintained.
- cRFHistoryColdStarts--A read-only object that indicates the number of system cold starts including the number of system cold starts due to switchover fault and the number of manual restarts.
- cRFHistoryStandByAvailTime--A read-only object that indicates the cumulative time that a standby redundant unit has been available since the last system initialization.

  Two objects related to switchover status have also been added:

- cRFStatusFailoverTime--A read-only object that indicates the sysUpTime value when the primary redundant unit took over as active. The value of this object is 0 until the first switchover.
- cRFStatusPeerStandByEntryTime--A read-only object that indicates the sysUpTime value when the peer redundant unit entered the standbyHot state. The value of this object is 0 on system initialization.

How to Configure Stateful Switchover

Copying an Image onto an RP

To copy an image onto the active and standby RPs, follow these steps:

Procedure

Step 1 **enable**

Example:

```
Router> enable
```

Enables privileged EXEC mode.

- Enter your password if prompted.

Step 2 **copy tftp bootflash:***filename*

Example:

```
Router# copy tftp bootflash:image1.bin
```

Copies a Cisco software image onto the flash device of the active RP.

Step 3 **copy tftp stby-bootflash:** *filename*

Example:

```
Router# copy tftp stby-bootflash:image1.bin
```

Copies a Cisco software image onto the flash device of the standby RP.

Step 4 **exit**

Example:

```
Router# exit
```

Exits to user EXEC mode.

Setting the Configuration Register and Boot Variables

To set the configuration register value and boot variables, follow these steps:

Procedure

Step 1 **enable**

Example:

```
Router> enable
```

Enables privileged EXEC mode.

- Enter your password if prompted.

Step 2 **show version**

Example:

```
Router# show version
```

Obtains the current configuration register setting.

Step 3 **configure terminal**

Example:

```
Router# configure terminal
```

Enters global configuration mode.

Step 4 **no boot system** {**flash** [*filename*] | **tftp** *filename* [*ip-address*]}

Example:

```
Router(config)# no boot system flash
```

(Optional) Clears any existing system flash or TFTP boot image specification.

Step 5 **boot system** {**flash** [*filename*] | **tftp** *filename* [*ip-address*]}

Example:

```
Router(config)# boot system flash
```

Specifies the filename of stored image in flash memory or on a TFTP server.

Step 6 **config-register** *value*

Example:

```
Router(config)# config-register 0x2102
```

Modifies the existing configuration register setting to reflect the way in which you want to load a system image.

Step 7 **exit**

Example:

```
Router(config)# exit
```

Exits global configuration mode and returns the router to privileged EXEC mode.

Step 8 **copy running-config startup-config**

Example:

```
Router# copy running-config startup-config
```

Saves the configuration changes to the startup configuration file.

Step 9 **reload**

Example:

```
Router# reload
```

Reboots both RPs on the device to ensure that changes to the configuration take effect.

Configuring SSO

Before you begin

Image to be used by active or standby RP at initialization must be available on the local flash device.

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**redundancy** **Example:** `Router(config)# redundancy`	Enters redundancy configuration mode.
Step 4	**mode sso** **Example:** `Router(config)# mode sso`	Sets the redundancy configuration mode to SSO on both the active and standby RP. **Note** After configuring SSO mode, the standby RP will automatically reset.
Step 5	**end** **Example:** `Router(config-red)# end`	Exits redundancy configuration mode and returns the router to privileged EXEC mode.
Step 6	**copy running-config startup-config** **Example:** `Router# copy running-config startup-config`	Saves the configuration changes to the startup configuration file.

Verifying SSO Configuration

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**show redundancy** [**clients** | **counters** | **history** | **switchover history** | **states**] **Example:** `Router# show redundancy`	Displays SSO configuration information.
Step 3	**show redundancy states** **Example:** `Router# show redundancy states`	Verifies that the device is running in SSO mode.

Troubleshooting Stateful Switchover

- The standby RP was reset, but there are no messages describing what happened--To display a log of SSO events and clues as to why a switchover or other event occurred, enter the **show redundancy history** command on the newly active RP.
- The show redundancy states command shows an operating mode that is different than what is configured on the networking device--On certain platforms the output of the **show redundancy states** command displays the actual operating redundancy mode running on the device, and not the configured mode as set by the platform. The operating mode of the system can change depending on system events. For example, SSO requires that both RPs on the networking device be running the same software image; if the images are different, the device will not operate in SSO mode, regardless of its configuration.
- Reloading the device disrupts SSO operation--The SSO feature introduces a number of commands, including commands to manually cause a switchover. The reload command is not an SSO command. This command causes a full reload of the box, removing all table entries, resetting all line cards, and thereby interrupting network traffic forwarding. To avoid reloading the box unintentionally, use the **redundancy force-switchover** command.
- During a software upgrade, the networking device appears to be in a mode other than SSO--During the software upgrade process, the show redundancy command indicates that the device is running in a mode other than SSO.

  This is normal behavior. Until the FSU procedure is complete, each RP will be running a different software version. While the RPs are running different software versions, the mode will change to either RPR or RPR+, depending on the device. The device will change to SSO mode once the upgrade has completed.

- On the Cisco 7500 series router, the previously active processor is being reset and reloaded before the core dump completes--Use the **crashdump-timeout** command to set the maximum time that the newly active processor waits before resetting and reloading the previously active processor.
- You can enter ROM monitor mode by restarting the router and then pressing the Break key or issuing a **send break** command from a telnet session during the first 60 seconds of startup.The send break function can be useful for experienced users or for users under the direction of a Cisco Technical Assistance Center (TAC) representative to recover from certain system problems or to evaluate the cause of system problems.
- On the Cisco 7500 series router, issuing a **send break** does not cause a system switchover--This is normal operation on the Cisco 7500 series router. Using **send break** to break or pause the system is not recommended and may cause unpredictable results. To initiate a manual switchover, use the **redundancy force-switchover** command.
- You can enter ROM monitor mode by restarting the router and then pressing the Break key or issuing a **send break** command from a telnet session during the first 60 seconds of startup.The send break function can be useful for experienced users or for users under the direction of a Cisco Technical Assistance Center (TAC) representative to recover from certain system problems or to evaluate the cause of system problems.
- On Cisco 10000 and 12000 series Internet routers, if a standby RP is present, the system will detect the break and complete a switchover; however, this is not the recommended procedure for initiating a switchover. To initiate a manual switchover, use the **redundancy force-switchover** command.

Troubleshooting SSO

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**crashdump-timeout** [*mm* | *hh* **:** *mm*] **Example:** `router(config-red)# crashdump-timeout`	Set the longest time that the newly active RP will wait before reloading the formerly active RP.
Step 3	**debug atm ha-error** **Example:** `Router# debug atm ha-error`	Debugs ATM HA errors on the networking device.
Step 4	**debug atm ha-events** **Example:** `Router# debug atm ha-events`	Debugs ATM HA events on the networking device.

	Command or Action	Purpose
Step 5	**debug atm ha-state** **Example:** `Router# debug atm ha-state`	Debugs ATM high-availability state information on the networking device.
Step 6	**debug frame-relay redundancy** **Example:** `Router# debug frame-relay redundancy`	Debugs Frame Relay redundancy on the networking device.
Step 7	**debug ppp redundancy** [**detailed** | **event**] **Example:** `Router# debug ppp redundancy`	Debugs PPP redundancy on the networking device.
Step 8	**debug redundancy** {**all** | **ui** | **clk** | **hub**} **Example:** `Router# debug redundancy all`	Debugs redundancy on the networking device.
Step 9	**show diag** [*slot-number* | **chassis** | **subslot** *slot* / *subslot*] [**details** | **summary**] **Example:** `Router# show diag`	Displays hardware information for the router.
Step 10	**show redundancy** [**clients** | **counters** | **debug-log** | **handover** | **history** | **switchover history** | **states** | **inter-device**] **Example:** `Router# show redundancy`	Displays the redundancy configuration mode of the RP. Also displays information about the number of switchovers, system uptime, processor uptime, and redundancy state, and reasons for any switchovers.
Step 11	**show version** **Example:** `Router# show version`	Displays image information for each RP.

Troubleshooting SNMP for Stateful Switchover

Procedure

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

	Command or Action	Purpose
	`Router> enable`	
Step 2	**show redundancy history** **Example:** `Router# show redundancy history`	Displays switchover history.
Step 3	**show redundancy switchover history** **Example:** `Router# show redundancy switchover history`	Displays switchover history details.
Step 4	**debug snmp sync** **Example:** `Router# debug snmp sync`	Displays information about SNMP synchronization and faults in synchronization.
Step 5	**exir** **Example:** `Router# exit`	Exits to user EXEC mode.

Configuration Examples for Stateful Switchover

Example Configuring SSO

```
Router> enable
Router# configure terminal
Router(config)# redundancy
Router(config)# mode sso
Router(config-red)# end
Router# copy running-config startup-config
```

Example Verifying that SSO is Configured

In the following example, the **show redundancy** command is used to verify that SSO is configured on the device.

```
Router#show redundancy

Redundant System Information :
------------------------------
       Available system uptime = 6 days, 4 hours, 17 minutes
Switchovers system experienced = 0
              Standby failures = 0
        Last switchover reason = none

                 Hardware Mode = Duplex
    Configured Redundancy Mode = sso
     Operating Redundancy Mode = sso
              Maintenance Mode = Disabled
                Communications = Up
```

```
Current Processor Information :
-------------------------------
               Active Location = slot 6
        Current Software state = ACTIVE
       Uptime in current state = 6 days, 4 hours, 16 minutes
                 Image Version = Cisco IOS Software, IOS-XE Software (PPC_LINUX_
IOSD-UNIVERSALK9_NPE-M), Version 15.2(4)S3, RELEASE SOFTWARE (fc1)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2013 by Cisco Systems, Inc.
Compiled Fri 19-Apr-13 11:49 by mcpre
                          BOOT = bootflash:asr903rsp1-universalk9_npe.03.09.00.S
.153-2.S.bin,1;
        Configuration register = 0x2

Peer Processor Information :
----------------------------
              Standby Location = slot 7
        Current Software state = STANDBY HOT
       Uptime in current state = 6 days, 4 hours, 11 minutes
                 Image Version = Cisco IOS Software, IOS-XE Software (PPC_LINUX_
IOSD-UNIVERSALK9_NPE-M), Version 15.2(4)S3, RELEASE SOFTWARE (fc1)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2013 by Cisco Systems, Inc.
Compiled Mon 19-Apr-13 14:22 by mcpre
                          BOOT = bootflash:asr903rsp1-universalk9_npe.03.09.00.S
.153-2.S.bin,1;
                    CONFIG_FILE =
        Configuration register = 0x2
```

Example Verifying Redundancy-Related States

This is sample output of the **show redundancy states** command to verify the redundancy states.

```
Router#show redundancy states

       my state = 13 -ACTIVE
     peer state = 8  -STANDBY HOT
           Mode = Duplex
           Unit = Primary
        Unit ID = 48

Redundancy Mode (Operational) = sso
Redundancy Mode (Configured)  = sso
Redundancy State              = sso
     Maintenance Mode = Disabled
    Manual Swact = enabled
 Communications = Up

   client count = 96
 client_notification_TMR = 30000 milliseconds
           RF debug mask = 0x0
```

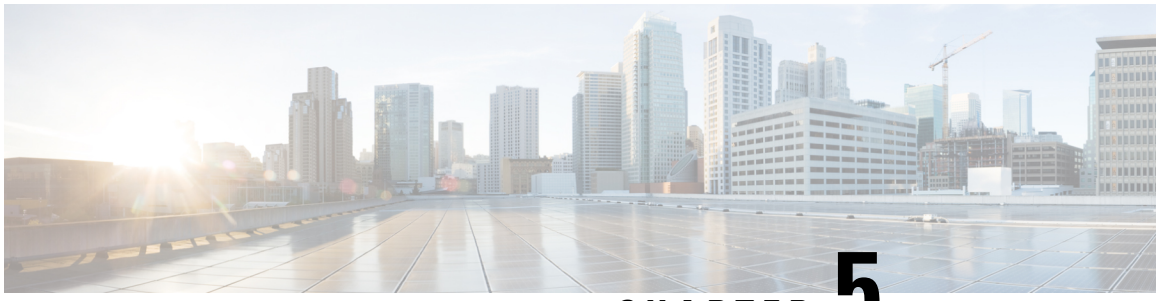
Example Verifying Redundancy-Aware Protocols and Applications

Enter the **show redundancy client** command to display the redundancy-aware applications and protocols.

```
Router# show redundancy client
clientID = 29 group_id = 1 clientSeq = 60 Redundancy Mode RF
clientID = 139 group_id = 1 clientSeq = 61 IfIndex
clientID = 25 group_id = 1 clientSeq = 68 CHKPT RF
```

```
clientID = 77 group_id = 1 clientSeq = 84 Event Manager
clientID = 1340 group_id = 1 clientSeq = 101 RP Platform RF
clientID = 1501 group_id = 1 clientSeq = 102 Cat6k CWAN HA
clientID = 78 group_id = 1 clientSeq = 106 TSPTUN HA
clientID = 305 group_id = 1 clientSeq = 107 Multicast ISSU Consolidation RF
clientID = 304 group_id = 1 clientSeq = 108 IP multicast RF Client
clientID = 22 group_id = 1 clientSeq = 109 Network RF Client
clientID = 88 group_id = 1 clientSeq = 110 HSRP
clientID = 114 group_id = 1 clientSeq = 111 GLBP
clientID = 1341 group_id = 1 clientSeq = 114 IOSXE DPIDX
clientID = 1505 group_id = 1 clientSeq = 115 Cat6k SPA TSM
clientID = 75 group_id = 1 clientSeq = 126 Tableid HA
clientID = 71 group_id = 1 clientSeq = 135 XDR RRP RF Client
clientID = 24 group_id = 1 clientSeq = 136 CEF RRP RF Client
clientID = 146 group_id = 1 clientSeq = 138 BFD RF Client
clientID = 301 group_id = 1 clientSeq = 142 MRIB RP RF Client
clientID = 306 group_id = 1 clientSeq = 146 MFIB RRP RF Client
clientID = 1504 group_id = 1 clientSeq = 153 Cat6k CWAN Interface Events
clientID = 402 group_id = 1 clientSeq = 157 TPM RF client
clientID = 520 group_id = 1 clientSeq = 158 RFS RF
clientID = 5 group_id = 1 clientSeq = 160 Config Sync RF client
clientID = 68 group_id = 1 clientSeq = 188 Virtual Template RF Client
clientID = 23 group_id = 1 clientSeq = 191 Frame Relay
clientID = 49 group_id = 1 clientSeq = 192 HDLC
clientID = 72 group_id = 1 clientSeq = 193 LSD HA Proc
clientID = 113 group_id = 1 clientSeq = 194 MFI STATIC HA Proc
clientID = 290 group_id = 1 clientSeq = 195 MPLS TP HA
clientID = 204 group_id = 1 clientSeq = 200 ETHER INFRA RF
clientID = 200 group_id = 1 clientSeq = 203 ETHERNET OAM RF
clientID = 207 group_id = 1 clientSeq = 205 ECFM RF
clientID = 202 group_id = 1 clientSeq = 206 ETHERNET LMI RF
clientID = 206 group_id = 1 clientSeq = 207 BD MAC SECURITY RF CLIENT
clientID = 208 group_id = 1 clientSeq = 208 LLDP
clientID = 226 group_id = 1 clientSeq = 209 LACP
clientID = 229 group_id = 1 clientSeq = 211 ERP
clientID = 20 group_id = 1 clientSeq = 219 IPROUTING NSF RF client
clientID = 100 group_id = 1 clientSeq = 221 DHCPC
clientID = 101 group_id = 1 clientSeq = 222 DHCPD
clientID = 74 group_id = 1 clientSeq = 232 MPLS VPN HA Client
clientID = 34 group_id = 1 clientSeq = 234 SNMP RF Client
clientID = 1502 group_id = 1 clientSeq = 235 CWAN APS HA RF Client
clientID = 52 group_id = 1 clientSeq = 236 ATM
clientID = 116 group_id = 1 clientSeq = 238 CEM
clientID = 117 group_id = 1 clientSeq = 239 IMA
clientID = 69 group_id = 1 clientSeq = 240 AAA
clientID = 123 group_id = 1 clientSeq = 241 SVM HA
clientID = 118 group_id = 1 clientSeq = 242 L2TP
clientID = 119 group_id = 1 clientSeq = 243 XC L2TP HA manager
clientID = 35 group_id = 1 clientSeq = 244 History RF Client
clientID = 90 group_id = 1 clientSeq = 256 RSVP HA Services
clientID = 48 group_id = 1 clientSeq = 266 Dialer
clientID = 250 group_id = 1 clientSeq = 268 EEM Server RF CLIENT
clientID = 252 group_id = 1 clientSeq = 270 EEM POLICY-DIR RF CLIENT
clientID = 54 group_id = 1 clientSeq = 272 SNMP HA RF Client
clientID = 73 group_id = 1 clientSeq = 273 LDP HA
clientID = 76 group_id = 1 clientSeq = 274 IPRM
clientID = 57 group_id = 1 clientSeq = 275 ARP
clientID = 50 group_id = 1 clientSeq = 282 FH_RF_Event_Detect or_stub
clientID = 1342 group_id = 1 clientSeq = 293 IOSXE SpaFlow
clientID = 1343 group_id = 1 clientSeq = 294 IOSXE IF Flow
clientID = 503 group_id = 1 clientSeq = 298 Spanning-Tree Protocol
clientID = 147 group_id = 1 clientSeq = 309 XC RIB MGR
clientID = 83 group_id = 1 clientSeq = 311 AC RF Client
clientID = 82 group_id = 1 clientSeq = 312 CCM RF
```

```
clientID = 145 group_id = 1 clientSeq = 313 VFI Mgr
clientID = 84 group_id = 1 clientSeq = 314 AToM manager
clientID = 85 group_id = 1 clientSeq = 316 SSM
clientID = 280 group_id = 1 clientSeq = 317 XC ST PW OAM
clientID = 212 group_id = 1 clientSeq = 327 REP Protocol
clientID = 105 group_id = 1 clientSeq = 328 DHCP Snooping
clientID = 102 group_id = 1 clientSeq = 332 MQC QoS
clientID = 154 group_id = 1 clientSeq = 333 QoS Feature
clientID = 1510 group_id = 1 clientSeq = 334 Call-Home RF
clientID = 203 group_id = 1 clientSeq = 337 MVRP
clientID = 1601 group_id = 1 clientSeq = 338 TCP
clientID = 1602 group_id = 1 clientSeq = 339 BGP
clientID = 151 group_id = 1 clientSeq = 340 IP Tunnel RF
clientID = 94 group_id = 1 clientSeq = 341 Config Verify RF client
clientID = 130 group_id = 1 clientSeq = 356 CRYPTO RSA
clientID = 131 group_id = 1 clientSeq = 357 PKI RF Client
clientID = 148 group_id = 1 clientSeq = 362 DHCPv6 Relay
clientID = 4005 group_id = 1 clientSeq = 371 ISSU Test Client
clientID = 93 group_id = 1 clientSeq = 375 Network RF 2 Client
clientID = 205 group_id = 1 clientSeq = 377 FEC Client
clientID = 141 group_id = 1 clientSeq = 385 DATA DESCRIPTOR RF CLIENT
clientID = 4006 group_id = 1 clientSeq = 389 Network Clock
clientID = 4022 group_id = 1 clientSeq = 414 IOS Config SHELL
clientID = 4020 group_id = 1 clientSeq = 415 IOS Config ARCHIVE
clientID = 4021 group_id = 1 clientSeq = 416 IOS Config ROLLBACK
clientID = 20001 group_id = 1 clientSeq = 436 License Core HA Client
clientID = 20011 group_id = 1 clientSeq = 437 License Agent HA Client
clientID = 403 group_id = 1 clientSeq = 450 Netsync RF Client
clientID = 15001 group_id = 1 clientSeq = 463 UEA_IOSD_RF_CLIENT
```



CHAPTER 5

Configuring Nonstop Forwarding

This module describes how to configure Nonstop Forwarding (NSF) in Cisco software to minimize the amount of time a network is unavailable to its users following a switchover. The main objective of NSF is to continue forwarding IP packets following a Route Processor (RP) switchover. NSF is supported by the BGP, EIGRP, IPv6, IS-IS, and OSPF protocols for routing and by CEF for forwarding.

The following terms are used throughout this document:

- NSF-aware device--A device that is running NSF-compatible software
- NSF-capable device--A device that is configured to support NSF. NSF-capable devices can rebuild routing information from either NSF-aware or NSF-capable neighboring devices.

- Prerequisites for Nonstop Forwarding, on page 65
- Restrictions for Nonstop Forwarding, on page 66
- Information About Nonstop Forwarding, on page 67
- How to Configure Nonstop Forwarding, on page 72
- Configuration Examples for Nonstop Forwarding, on page 80
- Additional References, on page 84

Prerequisites for Nonstop Forwarding

- The networking device that is to be configured for NSF must first be configured for SSO. For information, see the Configuring Stateful Switchover section.
- For Border Gateway Protocol (BGP) NSF, all neighboring devices must be NSF-aware and must be configured for BGP graceful restart.
- For Enhanced Interior Gateway Routing Protocol (EIGRP) NSF:
  - All neighboring devices must be NSF-capable or NSF-aware.
  - An NSF-aware device must be completely converged with the network before it can assist an NSF-capable device in an NSF restart operation.
- For Internet Engineering Task Force (IETF) Intermediate System to Intermediate System (IS-IS), all neighboring devices must be NSF-aware.
- For Open Shortest Path First (OSPF) NSF, all networking devices on the same network segment must be NSF-aware.

- For IPv6 NSF, IPv6 must be enabled on your networking device.
- On platforms supporting the Route Switch Processor (RSP), and where the Cisco Express Forwarding (CEF) switching mode is configurable, configure distributed CEF (dCEF) switching mode using the **ip cef distributed** command.

Restrictions for Nonstop Forwarding

General Restrictions

NSF capability is not enabled by default for OSPF, ISIS, or BGP. NSF capability is enabled by default for EIGRP only.

BGP NSF Restrictions

- BGP support in NSF requires that neighbor networking devices be NSF-aware. If an NSF-capable device discovers that a particular BGP neighbor does not have graceful restart capability, it will not establish an NSF-capable session with that neighbor. All other neighbors that have graceful restart capability will continue to have NSF-capable sessions with this NSF-capable networking device.
- All devices must be configured with the same type of NSF helper mode, either IETF graceful restart or Cisco NSF.

EIGRP NSF Restrictions

- An NSF-aware device cannot support two NSF-capable peers performing an NSF restart operation at the same time. However, both neighbors will reestablish peering sessions after the NSF restart operation is complete.
- Distributed platforms that run a supporting version of Cisco software can support full NSF capabilities. These devices can perform a restart operation and can support other NSF capable peers.
- Single processor platforms that run a supporting version of Cisco software support only NSF awareness. These devices maintain adjacency and hold known routes for the NSF-capable neighbor until it signals that it is ready for the NSF-aware device to send its topology table or the route-hold timer expires.

OSPF NSF Restrictions

- OSPF NSF for virtual links is not supported.
- OSPF NSF for sham links is not supported.
- OSPF NSF supports NSF/SSO for IPv4 traffic only.
- OSPFv3 is not supported with NSF/SSO. Only OSPFv2 is supported with NSF/SSO.
- All neighbor networking devices must be NSF-aware. If an NSF-capable device discovers that it has non-NSF-aware neighbors on a particular network segment, it will disable NSF capabilities for that

segment. Other network segments composed entirely of NSF-capable or NSF-aware devices will continue to provide NSF capabilities.

- You can configure strict link state advertisement (LSA) checking on both NSF-aware and NSF-capable devices; however, it is effective only when the device is in helper mode.

Information About Nonstop Forwarding

Nonstop Forwarding

Note In the following content, the term Route Processor (RP) is used to describe the route processing engine on all networking devices, regardless of the platform designation, unless otherwise noted.

NSF works with the SSO feature in Cisco software to minimize the amount of time a network is unavailable to its users following a switchover. The main objective of NSF is to continue forwarding IP packets following an RP switchover.

Usually, when a networking device restarts, all routing peers of that device detect that the device went down and then came back up. This transition results in what is called a routing flap, which could spread across multiple routing domains. Routing flaps caused by routing restarts create routing instabilities, which are detrimental to the overall network performance. NSF helps to suppress routing flaps in SSO-enabled devices, thus reducing network instability.

NSF allows for the forwarding of data packets to continue along known routes while the routing protocol information is being restored following a switchover. With NSF, peer networking devices do not experience routing flaps. Data traffic is forwarded through intelligent line cards or dual forwarding processors (FPs) while the standby RP assumes control from the failed active RP during a switchover. The ability of line cards and FPs to remain up through a switchover and to be kept current with the Forwarding Information Base (FIB) on the active RP is key to NSF operation.

The NSF feature provides the following 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 that had been created when devices in the network failed and lost their routing tables.
- Neighboring devices do not detect link flapping—Because the interfaces remain up across a switchover, neighboring devices do not detect a link flap (that is, the link does not go down and come back up).
- Prevention of routing flaps—Because SSO continues forwarding network traffic in the event of a switchover, routing flaps are avoided.
- No loss of user sessions—User sessions established prior to the switchover are maintained.

NSF always runs together with SSO. SSO supported protocols and applications must be high-availability (HA)-aware. A feature or protocol is HA-aware if it maintains, either partially or completely, undisturbed operation during an RP switchover. For some HA-aware protocols and applications, state information is synchronized from the active to the standby processor.

Cisco NSF Routing and Forwarding

Cisco NSF is supported by the BGP, EIGRP, IPv6, IS-IS, and OSPF protocols for routing and by CEF for forwarding. Of the routing protocols, BGP, EIGRP, IPv6, IS-IS, and OSPF have been enhanced with NSF-capability and awareness, which means that devices 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. The IS-IS protocol can be configured to use state information that has been synchronized between the active and the standby RP to recover route information following a switchover instead of information received from peer devices.

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

Cisco Express Forwarding and NSF

A key element of NSF is packet forwarding. In a Cisco networking device, packet forwarding is provided by 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 RP synchronizes its current FIB and adjacency databases with the FIB and adjacency databases on the standby RP. Upon switchover of the active RP, the standby RP initially has FIB and adjacency databases that are mirror images of those that were current on the active RP. For platforms with intelligent line cards, the line cards will maintain the current forwarding information over a switchover; for platforms with forwarding engines, CEF will keep the forwarding engine on the standby RP current with changes that are sent to it by CEF on the active RP. In this way, the line cards or forwarding engines will be able to 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 in turn cause prefix-by-prefix updates to CEF, which it uses to update the FIB and adjacency databases. Existing and new entries will receive the new version (“epoch”) number, indicating that they have been refreshed. The forwarding information is updated on the line cards or forwarding engine during convergence. The RP 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.

The routing protocols run only on the active RP, and they receive routing updates from their neighbor devices. Routing protocols do not run on the standby RP. Following a switchover, the routing protocols request that the NSF-aware neighbor devices send state information to help rebuild the routing tables. Alternately, the IS-IS protocol can be configured to synchronize state information from the active to the standby RP to help rebuild the routing table on the NSF-capable device in environments where neighbor devices are not NSF-aware.

For NSF operation, the routing protocols depend on CEF to continue forwarding packets while the routing protocols rebuild the routing information. The CEF NSF feature operates by default while the networking device is running in SSO mode. No configuration is necessary.

BGP NSF Operations

When a NSF-capable device begins a BGP session with a BGP peer, it sends an OPEN message to the peer. Included in the message is a declaration 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 device 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 graceful restart capable.

If the BGP session is lost during the RP switchover, the NSF-aware BGP peer marks all the routes associated with the NSF-capable device as stale; however, it continues to use these routes to make forwarding decisions for a set period of time. This functionality means that no packets are lost while the newly active RP is waiting for convergence of the routing information with the BGP peers.

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

At this point, the routing information is exchanged between the two BGP peers. Once 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. Following that, the BGP protocol is fully converged.

If a BGP peer does not support the graceful restart capability, it will ignore the graceful-restart capability in an OPEN message but will establish a BGP session with the NSF-capable device. This function will allow interoperability with non-NSF-aware BGP peers (and without NSF functionality), but the BGP session with non-NSF-aware BGP peers will not be graceful restart-capable.

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 device discovers that a particular BGP neighbor does not have graceful restart capability, it will not establish an NSF-capable session with that neighbor. All other neighbors that have graceful restart capability will continue to have NSF-capable sessions with this NSF-capable networking device.

EIGRP NSF Operations

Cisco NSF is supported by the EIGRP protocol for routing and by CEF for forwarding. EIGRP depends on CEF to continue forwarding packets during switchover while the routing protocols rebuild the Routing Information Base (RIB) tables. Once the routing protocols have converged, CEF updates the FIB table and removes stale route entries. CEF, in turn, updates the line cards with the new FIB information.

EIGRP nonstop forwarding (NSF) capabilities are exchanged by EIGRP peers in hello packets. The NSF-capable device notifies its neighbors that an NSF restart operation has started by setting the restart (RS) bit in a hello packet. When an NSF-aware device receives notification from an NSF-capable neighbor that an NSF-restart operation is in progress, the NSF-capable and NSF-aware devices immediately exchange their topology tables. The NSF-aware device sends an end-of-table (EOT) update packet when the transmission of its topology table is complete. The NSF-aware device then performs the following actions to assist the NSF-capable device:

- The EIGRP hello hold timer is expired to reduce the time interval set for hello packet generation and transmission. This allows the NSF-aware device to reply to the NSF-capable device more quickly reducing the amount of time required for the NSF-capable device to rediscover neighbors and rebuild the topology table.
- The route-hold timer is started. This timer is used to set the period of time that the NSF-aware device will hold known routes for the NSF-capable neighbor.
- The NSF-aware device notes in the peer list that the NSF-capable neighbor is restarting, maintains adjacency, and holds known routes for the NSF-capable neighbor until the neighbor signals that it is ready for the NSF-aware device to send its topology table or the route-hold timer expires. If the route-hold

timer expires on the NSF-aware device, the NSF-aware device will discard held routes and treat the NSF-capable device as a new device joining the network and reestablishing adjacency accordingly.

- The NSF-aware device will continue to send queries to the NSF-capable device that is still converging after switchover, effectively extending the time before a stuck-in-active (SIA) condition can occur.

When the switchover operation is complete, the NSF-capable device notifies its neighbors that it has reconverged and has received all of their topology tables by sending an EOT update packet to the assisting devices. The NSF-capable device then returns to normal operation. The NSF-aware device will look for alternate paths (go active) for any routes that are not refreshed by the NSF-capable (restarting device). The NSF-aware device will then return to normal operation. If all paths are refreshed by the NSF-capable device, the NSF-aware device will immediately return to normal operation.

NSF-aware devices are completely compatible with non-NSF-aware or non-NSF-capable neighbors in an EIGRP network. A non-NSF-aware neighbor will ignore NSF capabilities and reset adjacencies and otherwise maintain the peering sessions normally.

IPv6 support for NSF Operations

Nonstop Forwarding and Graceful Restart for MP-BGP IPv6 Address Family

The graceful restart capability is supported for IPv6 BGP unicast, multicast, and VPNv6 address families, enabling Cisco NSF functionality for BGP IPv6. The BGP graceful restart capability allows the BGP routing table to be recovered from peers without keeping the TCP state.

NSF continues forwarding packets while routing protocols converge, therefore avoiding a route flap on switchover. Forwarding is maintained by synchronizing the FIB between the active and standby RP. On switchover, forwarding is maintained using the FIB. The RIB is not kept synchronized; therefore, the RIB is empty on switchover. The RIB is repopulated by the routing protocols and subsequently informs the FIB about RIB convergence by using the NSF_RIB_CONVERGED registry call. The FIB tables are updated from the RIB, removing any stale entries. The RIB starts a fail-safe timer during RP switchover, in case the routing protocols fail to notify the RIB of convergence.

The Cisco BGP address family identifier (AFI) model is modular and scalable, and supports multiple AFIs and subsequent address family identifier (SAFI) configurations.

Nonstop Forwarding for IPv6 RIP

RIP registers as an IPv6 NSF client. Doing so has the benefit of using RIP routes installed in the Cisco Express Forwarding table until RIP has converged on the standby.

Nonstop Forwarding for Static Routes

Cisco NSF supports IPv6 static routes.

IS-IS NSF Operations

When an IS-IS NSF-capable device performs an RP switchover, it must perform two tasks in order to resynchronize its Link State Database with its IS-IS neighbors. First, it must relearn the available IS-IS neighbors on the network without causing a reset of the neighbor relationship. Second, it must reacquire the contents of the Link State Database for the network.

The IS-IS NSF feature offers two options when configuring NSF:

- IETF IS-IS
- Cisco IS-IS

If neighbor devices on a network segment are NSF-aware, meaning that neighbor devices are running a software version that supports the IETF Internet draft for device restartability, they will assist an IETF NSF device that is restarting. With IETF, neighbor devices provide adjacency and link-state information to help rebuild the routing information following a switchover. A benefit of IETF IS-IS configuration is operation between peer devices based on a proposed standard.

If you configure IETF on the networking device, but neighbor devices are not IETF-compatible, NSF will cancel following a switchover.

If the neighbor devices on a network segment are not NSF-aware, you must use the Cisco configuration option. The Cisco IS-IS configuration transfers both protocol adjacency and link-state information from the active to the standby RP. A benefit of Cisco configuration is that it does not rely on NSF-aware neighbors.

IETF IS-IS Configuration

With the IETF IS-IS configuration, the NSF-capable device sends IS-IS NSF restart requests to neighboring NSF-aware devices as quickly as possible after an RP switchover. Neighbor networking devices recognize this restart request as a cue that the neighbor relationship with this device should not be reset, but that they should initiate database resynchronization with the restarting device. As the restarting device receives restart request responses from devices on the network, it can begin to rebuild its neighbor list.

Once this exchange is complete, the NSF-capable device uses the link-state information to remove stale routes, update the RIB, and update the FIB with the new forwarding information. IS-IS is then fully converged.

The switchover from one RP to the other happens within seconds. IS-IS reestablishes its routing table and resynchronizes with the network within a few additional seconds. At this point, IS-IS waits for a specified interval before it will attempt a second NSF restart. During this time, the new standby RP will boot up and synchronize its configuration with the active RP. The IS-IS NSF operation waits for a specified interval to ensure that connections are stable before attempting another restart of IS-IS NSF. This functionality prevents IS-IS from attempting back-to-back NSF restarts with stale information.

Cisco IS-IS Configuration

With the Cisco configuration option, full adjacency and link-state packet (LSP) information is saved, or “checkpointed,” to the standby RP. Following a switchover, the newly active RP maintains its adjacencies using the checkpointed data, and can quickly rebuild its routing tables.

The switchover from one RP to the other happens within seconds. IS-IS reestablishes its routing table and resynchronizes with the network within a few additional seconds. At this point, IS-IS waits for a specified interval before it will attempt a second NSF restart. During this time, the new standby RP will boot up and synchronize its configuration with the active RP. Once this synchronization is completed, IS-IS adjacency and LSP data is checkpointed to the standby RP; however, a new NSF restart will not be attempted by IS-IS until the interval time expires. This functionality prevents IS-IS from attempting back-to-back NSF restarts. IS-IS NSF provides a command to extend the wait time for interfaces that, for whatever reason, do not come up in a timely fashion.

Following a switchover, Cisco IS-IS NSF has complete neighbor adjacency and LSP information; however, it must wait for all interfaces that had adjacencies prior to the switchover to come up. If an interface does not come up within the allocated interface wait time, the routes learned from these neighbor devices are not considered in routing table recalculation.

NSF-OSPF Operations

For Cisco Nonstop Forwarding (NSF), the Open Shortest Path First (OSPF) routing protocol has been enhanced to support high availability (HA) features in Stateful Switchover (SSO). Before an OSPF NSF-capable device can perform a Route Processor (RP) switchover, the device must be aware of the available OSPF neighbors on the network without resetting the neighbor relationship, and the device must acquire the contents of the link state database for the network. The NSF-capable device sends an OSPF NSF signal to neighboring NSF-aware devices to notify the devices that the neighbor relationship with the sending device must not be reset. The NSF-capable device uses the signals that it receives from other devices on the network to rebuild its neighbor list.

The NSF-capable device synchronizes its database with all the NSF-aware neighbors on its neighbor list. After all neighbors exchange routing information, the NSF-capable device uses the routing information to remove stale routes and update the routing information base (RIB) and the forwarding information base (FIB) with the new forwarding information. The OSPF protocols are then fully converged.

Prior to RFC 3623, Cisco implemented the proprietary Cisco NSF. The RFC 3623 Graceful OSPF Restart feature supports IETF NSF for OSPF processes in multivendor networks. The following are NSF device modes of operation common to Cisco and IETF NSF implementations:

- Restarting mode—In this mode, the OSPF device performs nonstop forwarding recovery because of an RP switchover.
- Helper mode—Also known as NSF-awareness mode. In this mode, the neighboring device is in the restarting state and helps in NSF recovery.

The strict link state advertisement (LSA) checking feature allows a helper device to terminate the graceful restart process if the device detects a changed LSA that would cause flooding during the graceful restart process. Strict LSA checking is disabled by default. You can enable strict LSA checking when there is a change to an LSA that would be flooded to the restarting device.

How to Configure Nonstop Forwarding

Configuring and Verifying BGP NSF

Repeat this procedure on each peer device.

Procedure

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

	Command or Action	Purpose
Step 3	**router bgp** *autonomous-system-number* **Example:** `Router(config)# router bgp 120`	Enables a BGP routing process, and enters router configuration mode.
Step 4	**bgp graceful-restart** [**restart-time** *seconds* | **stalepath-time** *seconds*] **Example:** `Router(config-router)# bgp graceful-restart`	Enables the BGP graceful restart capability, which starts NSF for BGP.
Step 5	**end** **Example:** `Router(config-router)# end`	Exits to privileged EXEC mode.
Step 6	**show ip bgp neighbors** [*ip-address* [**advertised-routes** | **dampened-routes** | **flap-statistics** | **paths** [*reg-exp*] | **received prefix-filter** | **received-routes** | **routes** | **policy**[**detail**]]] **Example:** `Router# show ip bgp neighbors`	Displays information about BGP and TCP connections to neighbors.

Configuring and Verifying EIGRP NSF

Repeat this procedure on each peer device.

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**router eigrp** *as-number* **Example:**	Enables an EIGRP routing process, and enters router configuration mode.

	Command or Action	Purpose
	`Router(config)# router eigrp 109`	
Step 4	**nsf** **Example:** `Router(config)# no nsf`	(Optional) Enables NSF capabilities. • This command is enabled by default.
Step 5	**timers nsf converge** *seconds* **Example:** `Router(config-router)# timers nsf converge 120`	(Optional) Adjusts the maximum time that the restarting device will wait for the EOT notification from an NSF-capable or NSF-aware peer. • Enter this command on NSF-capable devices only.
Step 6	**timers nsf signal** *seconds* **Example:** `Router(config-router)# timers nsf signal 20`	(Optional) Adjusts the maximum time for the initial restart period. • Enter this command on NSF-capable devices only.
Step 7	**timers nsf route-hold** *seconds* **Example:** `Router(config-router)# timers nsf route-hold 240`	(Optional) Sets the route-hold timer to determine how long an NSF-aware EIGRP device will hold routes for an inactive peer.
Step 8	**timers graceful-restart purge-time** *seconds* **Example:** `Router(config-router)# timers graceful-restart purge-time 240`	(Optional) Sets the route-hold timer to determine how long an NSF-aware EIGRP device will hold routes for an inactive peer.
Step 9	**end** **Example:** `Router(config-router)# end`	Exits to privileged EXEC mode.
Step 10	**show ip protocols** **Example:** `Router# show ip protocols`	Displays the parameters and current state of the active routing protocol process.

Configuring NSF-OSPF

Perform only one of the following tasks:

Configuring Cisco NSF-OSPF

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**router ospf** *process-id* [**vrf** *vpn-name*] **Example:** `Device(config)# router ospf 12`	Enables Open Shortest Path First (OSPF) routing process and enters router configuration mode.
Step 4	**nsf cisco** [**enforce global**] **Example:** `Device(config-router)# nsf cisco`	Enables Cisco Nonstop Forwarding (NSF) restarting mode. • This command is not required on devices that operate only in NSF helper mode.
Step 5	**nsf cisco helper** [**disable**] **Example:** `Device(config-router)# nsf cisco helper`	Enables Cisco NSF helper support. • This command shows how to enable Cisco NSF helper mode.
Step 6	**nsf ietf helper** [**disable** | **strict-lsa-checking**] **Example:** `Device(config-router)# nsf ietf helper disable`	(Optional) Disables IETF NSF helper mode on an NSF-aware device.
Step 7	**end** **Example:** `Device(config-router)# end`	Returns to privileged EXEC mode.
Step 8	**show ip ospf nsf** **Example:** `Device# show ip ospf nsf`	Displays OSPF NSF state information.

Configuring IETF NSF-OSPF

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**router ospf** *process-id* [**vrf** *vpn-name*] **Example:** `Device(config)# router ospf 12`	Enables Open Shortest Path First (OSPF) routing process and enters router configuration mode.
Step 4	**nsf ietf** [**restart-interval** *seconds*] **Example:** `Device(config-router)# nsf ietf restart-interval 180`	Enables IETF Nonstop Forwarding (NSF) restarting mode. • This command is not required on devices that operate only in helper mode.
Step 5	**nsf ietf helper** [**disable** | **strict-lsa-checking**] **Example:** `Device(config-router)# nsf ietf helper strict-lsa-checking`	(Optional) Configures IETF NSF helper mode on neighbor devices that operate in helper mode.
Step 6	**nsf cisco helper disable** **Example:** `Device(config-router)# nsf cisco helper disable`	(Optional) Disables Cisco NSF helper mode on an NSF-aware device.
Step 7	**end** **Example:** `Device(config-router)# end`	Returns to privileged EXEC mode.
Step 8	**show ip ospf nsf** **Example:** `Device# show ip ospf nsf`	Displays OSPF NSF state information.

Configuring and Verifying IS-IS NSF

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**router isis** *area-tag* **Example:** `Router(config)# router isis cisco1`	Enables the IS-IS routing protocol to specify an IS-IS process and enters router configuration mode.
Step 4	**nsf** [**cisco** | **ietf**] **Example:** `Router(config-router)# nsf ietf`	Enables IS-IS NSF operations.
Step 5	**nsf interval** *minutes* **Example:** `Router(config-router)# nsf interval 2`	(Optional) Configures the minimum time between NSF restart attempts.
Step 6	**nsf t3** {**manual** *seconds* | **adjacency**} **Example:** `Router(config-router)# nsf t3 manual 40`	(Optional) Specifies the methodology used to determine how long IETF NSF will wait for the link-state packet (LSP) database to synchronize before generating overloaded link-state information. • This command is supported for IETF NSF only.
Step 7	**nsf interface wait** *seconds* **Example:** `Router(config-router)# nsf interface wait 15`	(Optional) Specifies how long a Cisco NSF restart will wait for all interfaces with IS-IS adjacencies to come up before completing the restart. • This command is supported for Cisco NSF only.
Step 8	**end** **Example:**	Exits to privileged EXEC mode.

	Command or Action	Purpose
	`Router(config-router)# end`	
Step 9	**show isis nsf** **Example:** `Router# show isis nsf`	Displays current state information regarding IS-IS NSF.

Troubleshooting Nonstop Forwarding

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**debug eigrp nsf** **Example:** `Device# debug eigrp nsf`	Displays notifications and information about NSF events for an EIGRP routing process.
Step 3	**debug ip eigrp notifications** **Example:** `Device# debug ip eigrp notifications`	Displays information and notifications for an EIGRP routing process. This output includes NSF notifications and events.
Step 4	**debug isis nsf** [**detail**] **Example:** `Device# debug isis nsf [detail]`	Displays information about the IS-IS state during a Cisco NSF restart.
Step 5	**debug ospf nsf** [**detail**] **Example:** `Device# debug ospf nsf [detail]`	Displays debugging messages related to OSPF Cisco NSF commands.
Step 6	**show cef nsf** **Example:** `Device# show cef nsf`	Displays the current NSF state of CEF on both the active and standby RPs.
Step 7	**show cef state** **Example:**	Displays the CEF state on a networking device.

	Command or Action	Purpose
	`Device# show cef state`	
Step 8	**show clns neighbors** **Example:** `Device# show clns neighbors`	Displays both end system and intermediate system neighbors.
Step 9	**show ip bgp** **Example:** `Device# show ip bgp`	Displays entries in the BGP routing table.
Step 10	**show ip bgp neighbor** **Example:** `Device# show ip bgp neighbor`	Displays information about the TCP and BGP connections to neighbor devices.
Step 11	**show ip cef** **Example:** `Device# show ip cef`	Displays entries in the FIB that are unresolved, or displays FIB summary.
Step 12	**show ip eigrp neighbors** [*interface-type* | *as-number* | **static** | **detail**] **Example:** `Device# show ip eigrp neighbors detail`	Displays displayed information about neighbors discovered by EIGRP.
Step 13	**show ip ospf** **Example:** `Device# show ip ospf`	Displays general information about OSPF routing processes.
Step 14	**show ip ospf neighbor** [**detail**] **Example:** `Device# show ip ospf neighbor [detail]`	Displays OSPF-neighbor information on a per-interface basis.
Step 15	**show ip protocols** **Example:** `Device# show ip protocols`	Displays the parameters and current state of the active routing protocol process. • The status of EIGRP NSF configuration and support is displayed in the output.
Step 16	**show isis database** [**detail**] **Example:**	Displays the IS-IS link-state database.

	Command or Action	Purpose
	`Device# show isis database [detail]`	
Step 17	**show isis nsf** **Example:** `Device# show isis nsf`	Displays the current state information regarding IS-IS NSF.

Configuration Examples for Nonstop Forwarding

Example NSF-Capable CEF

The CEF NSF feature operates by default while the router is running in SSO mode. No configuration is necessary. The following sample output shows that CEF is NSF capable:

```
Router# 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 91429870
IPv6 CEF Status:
 CEF enabled/running
 dCEF enabled/running
 universal per-destination load sharing algorithm, id 91429870
RRP state:
 I am standby RRP:                  no
 RF Peer Presence:                  yes
 RF Peer Comm reached:              yes
 RF Peer Config done:               yes
 RF Progression blocked:            never
 Redundancy mode:                   sso(3)
 CEF NSF sync:                      enabled/running

CEF ISSU Status:
  FIBHWIDB broker
    Slot(s): 7 (0x80) (grp 0x3FBE6360) - Nego compatible.
  FIBIDB broker
    Slot(s): 7 (0x80) (grp 0x3FBE6360) - Nego compatible.
  FIBHWIDB Subblock broker
    Slot(s): 7 (0x80) (grp 0x3FBE6360) - Nego compatible.
  FIBIDB Subblock broker
    Slot(s): 7 (0x80) (grp 0x3FBE6360) - Nego compatible.
  Adjacency update
    Slot(s): 7 (0x80) (grp 0x3FBE6360) - Nego compatible.
  IPv4 table broker
    Slot(s): 7 (0x80) (grp 0x3FBE6360) - Nego compatible.
  IPv6 table broker
    Slot(s): 7 (0x80) (grp 0x3FBE6360) - Nego compatible.
  CEF push
    Slot(s): 7 (0x80) (grp 0x3FBE6360) - Nego compatible.
```

Example BGP NSF

The following partial output shows the BGP configuration on the SSO-enabled device:

```
Router# show running-config
router bgp 120
bgp graceful-restart
 neighbor 10.2.2.2 remote-as 300
```

The following sample output shows that the graceful restart function is both advertised and received and that the address families have the graceful restart capability. If no address families were listed, then BGP NSF will not occur.

```
Router# show ip bgp neighbors
 192.168.2.2
BGP neighbor is 192.168.2.2,  remote AS YY, external link
  BGP version 4, remote router ID 192.168.2.2
  BGP state = Established, up for 00:01:18
  Last read 00:00:17, hold time is 180, keepalive interval is 60 seconds
  Neighbor capabilities:
    Route refresh:advertised and received(new)
Address family IPv4 Unicast:advertised and received
    Address family IPv4 Multicast:advertised and received
    Graceful Restart Capabilty:advertised and received
      Remote Restart timer is 120 seconds
      Address families preserved by peer:
        IPv4 Unicast, IPv4 Multicast
  Received 1539 messages, 0 notifications, 0 in queue
  Sent 1544 messages, 0 notifications, 0 in queue
  Default minimum time between advertisement runs is 30 seconds
```

Example: EIGRP NSF

The following sample output shows that EIGRP NSF support is present in the installed software image.

- "EIGRP NSF-aware route hold timer is . . ." is displayed in the output for either NSF-aware or NSF-capable devices, and the default or user-defined value for the route-hold timer is displayed.
- "EIGRP NSF enabled" or "EIGRP NSF disabled" appears in the output only when the NSF capability is supported by the device.

```
Device# show ip protocols

Routing Protocol is "eigrp 100"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Default networks flagged in outgoing updates
  Default networks accepted from incoming updates
  EIGRP metric weight K1=1, K2=0, K3=1, K4=0, K5=0
  EIGRP maximum hopcount 100
  EIGRP maximum metric variance 1
  Redistributing: eigrp 100
  EIGRP NSF-aware route hold timer is 240s
  EIGRP NSF enabled
     NSF signal timer is 20s
     NSF converge timer is 120s
  Automatic network summarization is in effect
  Maximum path: 4
```

```
  Routing for Networks:
    10.4.9.0/24
  Routing Information Sources:
    Gateway         Distance      Last Update
  Distance: internal 90 external 170
```

Example: Configuring Cisco NSF-OSPF

The following example shows how to enable Cisco Nonstop Forwarding (NSF) helper support in the router configuration mode:

```
Device> enable
Device# configure terminal
Device(config)# router ospf 400
Device(config-router)# nsf cisco helper
Device(config-router)# nsf ietf helper disable
Device(config-router)# end
```

The following sample output from the **show ip ospf nsf** command shows that NSF is enabled for Open Shortest Path First (OSPF) process 400. NSF helper mode is enabled by default on devices running NSF-compatible software. In this configuration, IETF helper mode is disabled for process 400.

```
Device> show ip ospf nsf

Routing Process "ospf 400"
Non-Stop Forwarding enabled
IETF NSF helper support disabled
Cisco NSF helper support enabled
  OSPF restart state is NO_RESTART
  Handle 2162698, Router ID 192.168.2.155, checkpoint Router ID 0.0.0.0
  Config wait timer interval 10, timer not running
  Dbase wait timer interval 120, timer not running
```

Example: Configuring IETF NSF-OSPF

The following example shows how to enable IETF Nonstop Forwarding (NSF) helper support in the router configuration mode:

```
Device> enable
Device# configure terminal
Device(config)# router ospf 500
Device(config-router)# nsf ietf helper strict-lsa-checking
Device(config-router)# nsf cisco helper disable
Device(config-router)# end
```

The following sample output from the **show ip ospf nsf** command shows that NSF is enabled for Open Shortest Path First (OSPF) process 500. NSF helper mode is enabled by default on devices running NSF-compatible software. In this configuration, Cisco helper mode is disabled.

```
Device> show ip ospf nsf

Routing Process "ospf 500"
Non-Stop Forwarding enabled
IETF NSF helper support enabled
Cisco NSF helper support disabled
  OSPF restart state is NO_RESTART
  Handle 1786466333, Router ID 10.1.1.1, checkpoint Router ID 0.0.0.0
```

```
  Config wait timer interval 10, timer not running
  Dbase wait timer interval 120, timer not running
```

Example IS-ISNSF

The following partial output shows that this device uses the Cisco implementation of IS-IS NSF. The display will show either Cisco IS-IS or IETF IS-IS configuration.

```
Router# show running-config
router isis
nsf cisco
```

In a Cisco NSF configuration, the display output is different on the active and the standby RPs.

The following sample output on the active RP shows that Cisco NSF is enabled on the device:

```
Router# show isis nsf
NSF is ENABLED, mode 'cisco'
RP is ACTIVE, standby ready, bulk sync complete
NSF interval timer expired (NSF restart enabled)
Checkpointing enabled, no errors
Local state:ACTIVE,  Peer state:STANDBY HOT,  Mode:SSO
```

The following sample output on the standby RP shows that NSF is enabled on the device (NSF restart enabled):

```
Router# show isis nsf
NSF enabled, mode 'cisco'
RP is STANDBY, chkpt msg receive count:ADJ 2, LSP 7
NSF interval timer notification received (NSF restart enabled)
Checkpointing enabled, no errors
Local state:STANDBY HOT,  Peer state:ACTIVE,  Mode:SSO
```

The following sample output shows that IETF NSF is configured for the IS-IS networking device:

```
Router# show isis nsf
NSF is ENABLED, mode IETF
NSF pdb state:Inactive
NSF L1 active interfaces:0
NSF L1 active LSPs:0
NSF interfaces awaiting L1 CSNP:0
Awaiting L1 LSPs:
NSF L2 active interfaces:0
NSF L2 active LSPs:0
NSF interfaces awaiting L2 CSNP:0
Awaiting L2 LSPs:
Interface:Serial3/0/2
    NSF L1 Restart state:Running
    NSF p2p Restart retransmissions:0
    Maximum L1 NSF Restart retransmissions:3
    L1 NSF ACK requested:FALSE
    L1 NSF CSNP requested:FALSE
    NSF L2 Restart state:Running
    NSF p2p Restart retransmissions:0
    Maximum L2 NSF Restart retransmissions:3
    L2 NSF ACK requested:FALSE
Interface:GigabitEthernet2/0/0
    NSF L1 Restart state:Running
    NSF L1 Restart retransmissions:0
    Maximum L1 NSF Restart retransmissions:3
    L1 NSF ACK requested:FALSE
```

```
    L1 NSF CSNP requested:FALSE
    NSF L2 Restart state:Running
    NSF L2 Restart retransmissions:0
    Maximum L2 NSF Restart retransmissions:3
    L2 NSF ACK requested:FALSE
    L2 NSF CSNP requested:FALSE
Interface:Loopback1
    NSF L1 Restart state:Running
    NSF L1 Restart retransmissions:0
    Maximum L1 NSF Restart retransmissions:3
    L1 NSF ACK requested:FALSE
    L1 NSF CSNP requested:FALSE
    NSF L2 Restart state:Running
    NSF L2 Restart retransmissions:0
    Maximum L2 NSF Restart retransmissions:3
    L2 NSF ACK requested:FALSE
    L2 NSF CSNP requested:FALSE
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS master command list	Cisco IOS Master Command List , All Releases
Cisco IOS High Availability commands	*Cisco IOS High Availability Command Reference*

Standards

Standard	Title
No new or modified standards are supported, and support for existing standards has not been modified.	--

MIBs

MIB	MIBs Link
No new or modified MIBs are supported, and support for existing MIBs has not been modified.	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFC	Title
No new or modified RFCs are supported, and support for existing RFCs has not been modified.	--

Technical Assistance

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