

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 1
- Restrictions for Stateful Switchover, on page 2
- Information About Stateful Switchover, on page 3
- Enhanced SNMP Support for High Availability, on page 10
- How to Configure Stateful Switchover, on page 13
- Configuration Examples for Stateful Switchover, on page 20

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.

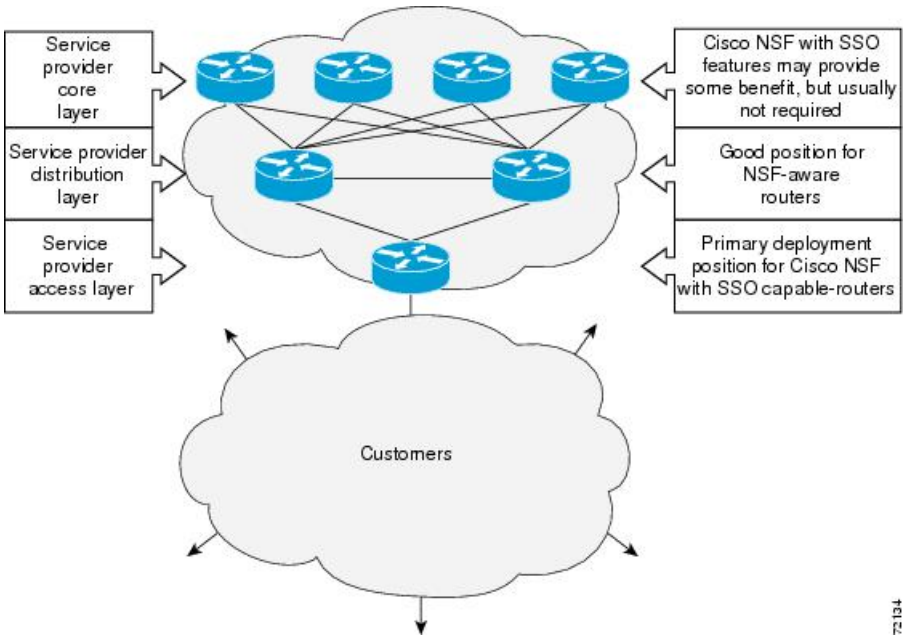
On Cisco ASR 1000 series routers, SSO can also be used to enable a second Cisco software process on the same RP. This second Cisco IOS process acts as a standby process for the active Cisco software process, and also allows certain subpackages to be upgraded without experiencing any router downtime.

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.

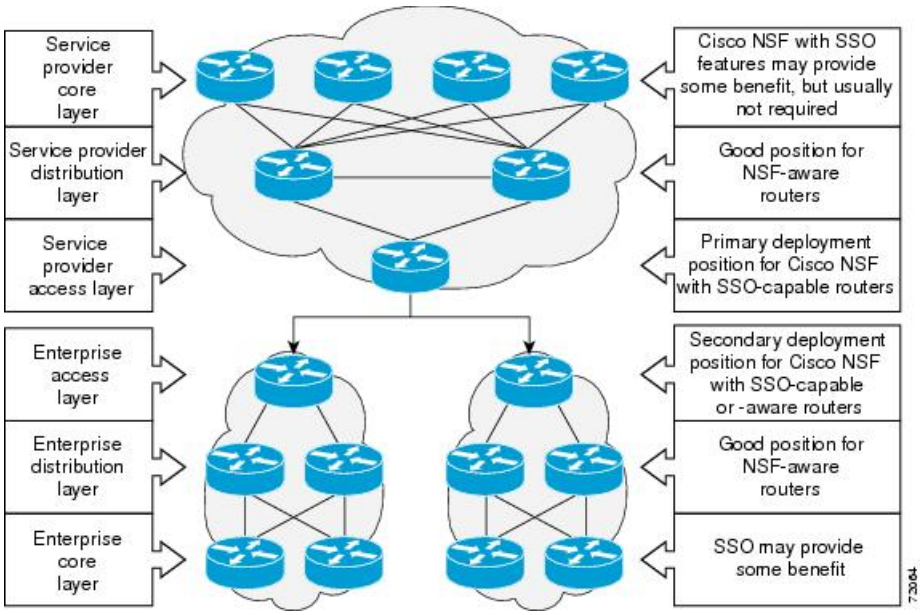
Figure 1: Cisco NSF with SSO Network Deployment: Service Provider Networks



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 1: 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
```