

NSF SSO--MPLS TE and RSVP Graceful Restart

The NSF/SSO--MPLS TE and RSVP Graceful Restart feature allows a Route Processor (RP) to recover from disruption in control plane service without losing its Multiprotocol Label Switching (MPLS) forwarding state.

Cisco nonstop forwarding (NSF) with stateful switchover (SSO) provides continuous packet forwarding, even during a network processor hardware or software failure. In a redundant system, the secondary processor recovers control plane service during a critical failure in the primary processor. SSO synchronizes the network state information between the primary and the secondary processor.

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Prerequisites for NSF SSO--MPLS TE and RSVP Graceful Restart

- Configure Resource Reservation Protocol (RSVP) graceful restart in full mode.
- Configure RSVP graceful restart on all interfaces of the neighbor that you want to be restart-capable.
- Configure the redundancy mode as SSO. See the Stateful Switchover feature module for more information.
- Enable NSF on the routing protocols running among the provider routers (P), provider edge (PE) routers, and customer edge (CE) routers. The routing protocols are as follows:
  - Border Gateway Protocol (BGP)
  - Open Shortest Path First (OSPF)
  - Intermediate System-to-Intermediate System (IS-IS)

See the Cisco Nonstop Forwarding feature module for more information.

- Enable MPLS.
- Configure traffic engineering (TE).

Restrictions for NSF SSO--MPLS TE and RSVP Graceful Restart

- RSVP graceful restart supports node failure only.
- Unnumbered interfaces are not supported.
- You cannot enable RSVP fast reroute (FRR) hello messages and RSVP graceful restart on the same router.
- You cannot enable primary one-hop autotunnels, backup autotunnels, or autotunnel mesh groups on a router that is also configured with SSO and Route Processor Redundancy Plus (RPR+). This restriction does not prevent an MPLS TE tunnel that is automatically configured by TE autotunnel from being successfully recovered if any midpoint router along the label-switched path (LSP) of the router experiences an SSO.
- MPLS TE LSPs that are fast reroutable cannot be successfully recovered if the LSPs are FRR active and the Point of Local Repair (PLR) router experiences an SSO.
- When you configure RSVP graceful restart, you must use the neighbor's interface IP address.

Information About NSF SSO--MPLS TE and RSVP Graceful Restart

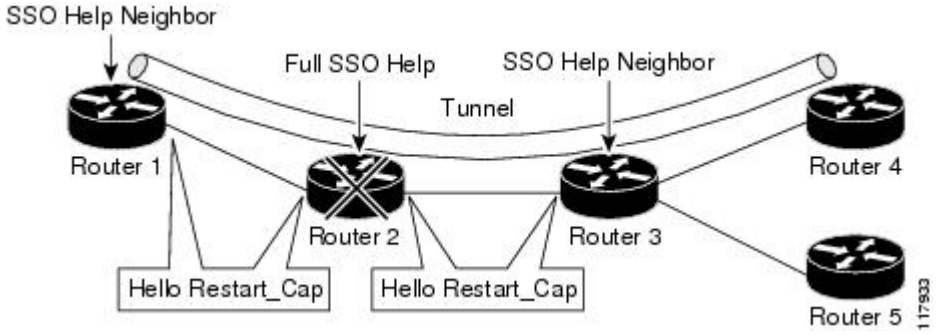
Overview of MPLS TE and RSVP Graceful Restart

RSVP graceful restart allows RSVP TE-enabled nodes to recover gracefully following a node failure in the network such that the RSVP state after the failure is restored as quickly as possible. The node failure may be completely transparent to other nodes in the network.

RSVP graceful restart preserves the label values and forwarding information and works with third-party or Cisco routers seamlessly.

RSVP graceful restart depends on RSVP hello messages to detect that a neighbor went down. Hello messages include Hello Request or Hello Acknowledgment (ACK) objects between two neighbors.

As shown in the figure below, the RSVP graceful restart extension to these messages adds an object called Hello Restart_Cap, which tells neighbors that a node may be capable of recovering if a failure occurs.



The Hello Restart_Cap object has two values: the restart time, which is the sender's time to restart the RSVP_TE component and exchange hello messages after a failure; and the recovery time, which is the desired time that the sender wants the receiver to synchronize the RSVP and MPLS databases.

In the figure above, RSVP graceful restart help neighbor support is enabled on Routers 1 and 3 so that they can help a neighbor recover after a failure, but they cannot perform self recovery. Router 2 has full SSO help support enabled, meaning it can perform self recovery after a failure or help its neighbor to recover. Router 2 has two RPs, one that is active and one that is standby (backup). A TE LSP is signaled from Router 1 to Router 4.

Router 2 performs checkpointing; that is, it copies state information from the active RP to the standby RP, thereby ensuring that the standby RP has the latest information. If an active RP fails, the standby RP can take over.

Routers 2 and 3 exchange periodic graceful restart hello messages every 10,000 milliseconds (ms) (10 seconds), and so do Routers 2 and 1 and Routers 3 and 4. Assume that Router 2 advertises its restart time = 60,000 ms (60 seconds) and its recovery time = 60,000 ms (60 seconds) as shown in the following example:

```
23:33:36: Outgoing Hello:
23:33:36:   version:1 flags:0000 cksum:883C ttl:255 reserved:0 length:32
23:33:36:  HELLO               type HELLO REQUEST length 12:
23:33:36:   Src_Instance: 0x6EDA8BD7, Dst_Instance: 0x00000000
23:33:36:  RESTART_CAP         type 1 length 12:
23:33:36:   Restart_Time: 0x0000EA60, Recovery_Time: 0x0000EA60
```

Router 3 records this into its database. Also, both neighbors maintain the neighbor status as UP. However, Router 3's control plane fails at some point (for example, a primary RP failure). As a result, RSVP and TE lose their signaling information and states although data packets continue to be forwarded by the line cards.

When Router 3 declares communication with Router 2 lost, Router 3 starts the restart time to wait for the duration advertised in Router 2's restart time previously recorded (60 seconds). Routers 1 and 2 suppress all RSVP messages to Router 3 except hellos. Router 3 keeps sending the RSVP PATH and RESV refresh messages to Routers 4 and 5 so that they do not expire the state for the LSP; however, Routers 1 and 3 suppress these messages for Router 2.

When Routers 1 and 3 receive the hello message from Router 2, Routers 1 and 3 check the recovery time value in the message. If the recovery time is 0, Router 3 knows that Router 2 was not able to preserve its forwarding information, and Routers 1 and 3 delete all RSVP state that they had with Router 2.

If the recovery time is greater than 0, Router 1 sends Router 2 PATH messages for each LSP that it had previously sent through Router 2. If these messages were previously refreshed in summary messages, they are sent individually during the recovery time. Each of these PATH messages includes a Recovery_Label object containing the label value received from Router 2 before the failure.

When Router 3 receives a PATH message from Router 2, Router 3 sends a RESV message upstream. However, Router 3 suppresses the RESV message until it receives a PATH message. When Router 2 receives the RESV message, it installs the RSVP state and reprograms the forwarding entry for the LSP.

Benefits of MPLS TE and RSVP Graceful Restart

State Information Recovery

RSVP graceful restart allows a node to perform self recovery or to help its neighbor recover state information when there is an RP failure or the device has undergone an SSO.

Session Information Recovery

RSVP graceful restart allows session information recovery with minimal disruption to the network.

Increased Availability of Network Services

A node can perform a graceful restart to help itself or a neighbor recover its state by keeping the label bindings and state information, thereby providing a faster recovery of the failed node and not affecting currently forwarded traffic.

How to Configure NSF SSO--MPLS TE and RSVP Graceful Restart

Enabling RSVP Graceful Restart Globally

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip rsvp signalling hello graceful-restart mode** (**help-neighbor**| **full**)
4. **exit**

DETAILED STEPS

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	**ip rsvp signalling hello graceful-restart mode** (**help-neighbor**| **full**) **Example:** `Router(config)# ip rsvp signalling hello graceful-restart mode full`	Enables RSVP TE graceful restart capability on an RP. • Enter the **help-neighbor** keyword to enable a neighboring router to restart after a failure. • Enter the **full**keyword to enable a router to perform self recovery or to help a neighbor recover after a failure.
Step 4	**exit** **Example:**	(Optional) Returns to privileged EXEC mode.

	Command or Action	Purpose
	`Router(config)# exit`	

Enabling RSVP Graceful Restart on an Interface

You must repeat this procedure for each of the neighbor router's interfaces.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type slot* **/** *subslot* **/** *port* [**.** *subinterface-number*]
4. Repeat Step 3 as needed to configure additional interfaces.
5. **ip rsvp signalling hello graceful-restart neighbor** *ip-address*
6. Repeat Step 5 as needed to configure additional IP addresses on a neighbor router's interfaces.
7. **exit**
8. **exit**

DETAILED STEPS

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	**interface** *type slot* **/** *subslot* **/** *port* [**.** *subinterface-number*] **Example:** `Router(config)# interface POS 1/0/0`	Configures the interface type and number and enters interface configuration mode.
Step 4	Repeat Step 3 as needed to configure additional interfaces.	(Optional) Configures additional interfaces.
Step 5	**ip rsvp signalling hello graceful-restart neighbor** *ip-address* **Example:**	Enables support for RSVP graceful restart on routers helping their neighbors recover TE tunnels following SSO. **Note** The IP address must be that of the neighbor's interface.

	Command or Action	Purpose
	`Router(config-if)# ip rsvp signalling hello graceful-restart neighbor 10.0.0.0`	
Step 6	Repeat Step 5 as needed to configure additional IP addresses on a neighbor router's interfaces.	(Optional) Configures additional IP addresses on a neighbor router's interfaces.
Step 7	**exit** **Example:** `Router(config-if)# exit`	Exits interface configuration mode and returns to global configuration mode.
Step 8	**exit** **Example:** `Router(config)# exit`	(Optional) Exits global configuration mode and returns to privileged EXEC mode.

Setting a DSCP Value for RSVP Graceful Restart

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip rsvp signalling hello graceful-restart dscp num**
4. **exit**

DETAILED STEPS

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	**ip rsvp signalling hello graceful-restart dscp num** **Example:** `Router(config)# ip rsvp signalling hello graceful-restart dscp 30`	Sets a DSCP value on a router with RSVP graceful restart enabled.

	Command or Action	Purpose
Step 4	**exit** **Example:** `Router(config)# exit`	(Optional) Returns to privileged EXEC mode.

Setting a Value to Control the Refresh Interval for RSVP Hello Messages

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip rsvp signalling hello graceful-restart refresh interval** *interval-value*
4. **exit**

DETAILED STEPS

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	**ip rsvp signalling hello graceful-restart refresh interval** *interval-value* **Example:** `Router(config)# ip rsvp signalling hello graceful-restart refresh interval 5000`	Sets the value to control the request interval in graceful restart hello messages. This interval represents the frequency at which RSVP hello messages are sent to a neighbor; for example, one hello message is sent per each interval. **Note** If you change the default value for this command and you also changed the RSVP refresh interval using the **ip rsvp signalling refresh interval** command, ensure that the value for the **ip rsvp signalling hello graceful-restart refresh interval**command **is less than the value for the ip rsvp signalling hello refresh interval** command. Otherwise, some or all of the label-switched paths (LSPs) may not be recovered after an SSO has occurred.

	Command or Action	Purpose
Step 4	**exit** **Example:** `Router(config)# exit`	(Optional) Returns to privileged EXEC mode.

Setting a Value to Control the Missed Refresh Limit for RSVP Graceful Restart Hello Acknowledgements

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip rsvp signalling hello graceful-restart refresh misses** *msg-count*
4. **exit**

DETAILED STEPS

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	**ip rsvp signalling hello graceful-restart refresh misses** *msg-count* **Example:** `Router(config)# ip rsvp signalling hello graceful-restart refresh misses 5`	Specifies how many sequential RSVP TE graceful restart hello acknowledgments (ACKs) a node can miss before the node considers communication with its neighbor lost. **Note** If you change the default value for this command and you are also using the **ip rsvp signalling hello refresh misses**command, ensure that the value for the **ip rsvp signalling hello graceful-restart refresh misses**command **is less than the value for the ip rsvp signalling hello refresh misses** command. Otherwise, some or all of the LSPs may not be recovered after an SSO has occurred.

	Command or Action	Purpose
Step 4	**exit** **Example:** `Router(config)# exit`	(Optional) Returns to privileged EXEC mode.

Verifying the RSVP Graceful Restart Configuration

SUMMARY STEPS

1. **enable**
2. **show ip rsvp hello graceful-restart**
3. **exit**

DETAILED STEPS

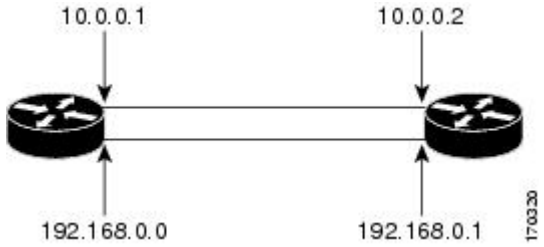
Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	(Optional) Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**show ip rsvp hello graceful-restart** **Example:** `Router# show ip rsvp hello graceful-restart`	Displays information about the status of RSVP graceful restart and related parameters.
Step 3	**exit** **Example:** `Router# exit`	(Optional) Returns to user EXEC mode.

Configuration Examples for NSF SSO--MPLS TE and RSVP Graceful Restart

Example Configuring NSF SSO--MPLS TE and RSVP Graceful Restart

In the following example, RSVP graceful restart is enabled globally and on a neighbor router's interfaces as shown in the figure below. Related parameters, including a DSCP value, a refresh interval, and a missed refresh limit are set.




```
enable
configure terminal
ip rsvp signalling hello graceful-restart mode full
interface POS 1/0/0
 ip rsvp signalling hello graceful-restart neighbor 10.0.0.1
 ip rsvp signalling hello graceful-restart neighbor 10.0.0.2
 exit
ip rsvp signalling hello graceful-restart dscp 30
ip rsvp signalling hello graceful-restart refresh interval 50000
ip rsvp signalling hello graceful-restart refresh misses 5
exit
```

Example Verifying the NSF SSO--MPLS TE and RSVP Graceful Restart Configuration

```
Router# show ip rsvp hello graceful-restart
Graceful Restart: Enabled (full mode)
  Refresh interval: 10000 msecs
  Refresh misses: 4
  DSCP:0x30
  Advertised restart time: 30000 msecs
  Advertised recovery time: 120000 msecs
  Maximum wait for recovery: 3600000 msecs
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
RSVP commands: complete command syntax, command mode, defaults, usage guidelines, and examples	*Cisco IOS Quality of Service Solutions Command Reference*
Quality of service (QoS) classification	Classification Overview
Stateful switchover	Stateful Switchover
Cisco nonstop forwarding	Information about Cisco Nonstop Forwarding
RSVP hello state timer	MPLS Traffic Engineering: RSVP Hello State Timer

Standards

Standards	Title
No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.	--

MIBs

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

RFCs

RFCs	Title
RFC 3209	*RSVP-TE: Extensions to RSVP for LSP Tunnels*
RFC 3473	*Generalized Multi-Protocol Label Switching (GMPLS) Signaling Resource Reservation Protocol-Traffic Engineering (RSVP-TE) Extensions*
RFC 4558	*Node-ID Based Resource Reservation Protocol (RSVP) Hello: A Clarification Statement*

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

Feature Information for NSF SSO--MPLS TE and RSVP Graceful Restart

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

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

Table 1: Feature Information for NSF/SSO--MPLS TE and RSVP Graceful Restart

Feature Name	Releases	Feature Information
NSF/SSO--MPLS TE and RSVP Graceful Restart	Cisco IOS XE Release 3.1S Cisco IOS XE Release 3.5S	The NSF/SSO--MPLS TE and RSVP Graceful Restart feature allows a Route Processor (RP) to recover from disruption in control plane service without losing its Multiprotocol Label Switching (MPLS) forwarding state. Cisco nonstop forwarding (NSF) with stateful switchover (SSO) provides continuous packet forwarding, even during a network processor hardware or software failure. In a redundant system, the secondary processor recovers control plane service during a critical failure in the primary processor. SSO synchronizes the network state information between the primary and the secondary processor. In Cisco IOS XE Release 3.1S, this feature was implemented on the Cisco ASR 1000 Series Aggregation Services Routers.
		The following commands were introduced or modified: **clear ip rsvp high-availability counters**, **debug ip rsvp high-availability**, **debug ip rsvp sso**, **debug mpls traffic-eng ha sso**, **ip rsvp signalling hello graceful-restart dscp**, **ip rsvp signalling hello graceful-restart mode**, **ip rsvp signalling hello graceful-restart mode help-neighbor**, **ip rsvp signalling hello graceful-restart neighbor**, **ip rsvp signalling hello graceful-restart refresh interval**, **ip rsvp signalling hello graceful-restart refresh misses**, **show ip rsvp counters**, **show ip rsvp counters state teardown**, **show ip rsvp hello**, **show ip rsvp hello client lsp detail**, **show ip rsvp hello client lsp summary**, **show ip rsvp hello client neighbor detail**, **show ip rsvp hello client neighbor summary**, **show ip rsvp hello graceful-restart**, **show ip rsvp hello instance detail**, **show ip rsvp hello instance summary**, **show ip rsvp high-availability counters**, **show ip rsvp high-availability database**, **show ip rsvp high-availability summary**.
MPLS TE--RSVP Graceful Restart 12.0S--12.2S Interop	Cisco IOS XE Release 3.5S	In Cisco IOS XE Release 3.5S, this feature was implemented on the Cisco ASR 1000 Series Aggregation Services Routers.
MPLS TE—Autotunnel/Automesh SSO Coexistence	Cisco IOS XE Release 3.5S	In Cisco IOS XE Release 3.5S, this feature was implemented on the Cisco ASR 1000 Series Aggregation Services Routers.

Glossary

DSCP --differentiated services code point. Six bits in the IP header, as defined by the Internet Engineering Task Force (IETF). These bits determine the class of service provided to the IP packet.

Fast Reroute --A mechanism for protecting Multiprotocol Label Switching (MPLS) traffic engineering (TE) label switched paths (LSPs) from link and node failure by locally repairing the LSPs at the point of failure, allowing data to continue to flow on them while their headend routers attempt to establish end-to-end LSPs

to replace them. Fast reroute (FRR) locally repairs the protected LSPs by rerouting them over backup tunnels that bypass failed links or nodes.

graceful restart --A process for helping a Route Processor (RP) restart after a node failure has occurred.

headend --The router that originates and maintains a given label switched path (LSP). This is the first router in the LSP's path.

hello instance --A mechanism that implements the Resource Reservation Protocol (RSVP) hello extensions for a given router interface address and remote IP address. Active hello instances periodically send hello request messages, expecting Hello ACK messages in response. If the expected ACK message is not received, the active hello instance declares that the neighbor (remote IP address) is unreachable (that is, it is lost). This can cause LSPs crossing this neighbor to be fast rerouted.

IGP --Interior Gateway Protocol. Internet protocol used to exchange routing information within an autonomous system. Examples of common Internet IGPs include Interior Gateway Routing Protocol (IGRP), Open Shortest Path First (OSPF), and Routing Information Protocol (RIP).

ISSU --In Service Software Upgrade. Software upgrade without service interruption.

label --A short, fixed-length data identifier that tells switching nodes how to forward data (packets or cells).

LSP --label switched path. A configured connection between two routers, in which Multiprotocol Label Switching (MPLS) is used to carry packets.

MPLS --Multiprotocol Label Switching. A method for forwarding packets (frames) through a network. MPLS enables routers at the edge of a network to apply labels to packets (frames). ATM switches or existing routers in the network core can switch packets according to the labels.

RSVP --Resource Reservation Protocol. A protocol that supports the reservation of resources across an IP network. Applications running on IP end systems can use RSVP to indicate to other nodes the nature (bandwidth, jitter, maximum burst, and so on) of the packet streams they want to receive.

state --Information that a router must maintain about each label switched path (LSP). The information is used for rerouting tunnels.

tailend --The router upon which a label switched path (LSP) is terminated. This is the last router in the LSP's path.

TE --traffic engineering. The techniques and processes used to cause routed traffic to travel through the network on a path other than the one that would have been chosen if standard routing methods had been used.