

MPLS Traffic Engineering--RSVP Graceful Restart

The MPLS Traffic Engineering--RSVP Graceful Restart feature allows a neighboring Route Processor (RP) to recover from disruption in control plane service (specifically, the Label Distribution Protocol [LDP] component) without losing its Multiprotocol Label Switching (MPLS) forwarding state.

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Prerequisites for MPLS TE--RSVP Graceful Restart

Perform the following tasks on routers before configuring the MPLS Traffic Engineering--RSVP Graceful Restart feature:

- Configure the Resource Reservation Protocol (RSVP).
- Enable MPLS.
- Configure traffic engineering (TE).
- Enable graceful restart.

If you have many tunnels/LSPs (100 or more) or if you have a large-scale network, the following configuration is recommended:

```
ip rsvp signalling refresh reduction
ip rsvp signalling rate-limit period 50 burst 16 maxsize 3000 limit 37
ip rsvp signalling patherr state-removal
ip rsvp signalling initial-retransmit-delay 15000
```

Additional info about these RSVP commands can be found in the *Cisco IOS Quality of Service Command Reference*.

Restrictions for MPLS TE--RSVP Graceful Restart

- Graceful restart supports node failure only.
- Graceful restart does not support restart or recovery on Cisco nodes, but helps in recovering a neighbor that is restart capable. Cisco routers advertise a restart time of 5 milliseconds (ms) and a recovery time of 0 in hello messages.
- Unnumbered interfaces are not supported.

Information About MPLS TE--RSVP Graceful Restart

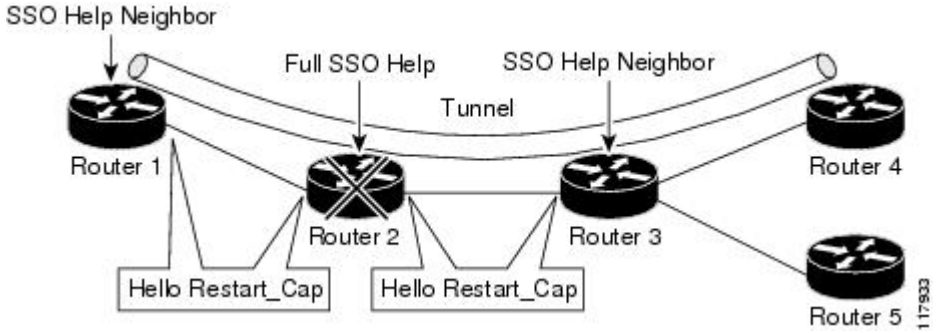
Graceful Restart

Graceful restart allows RSVP TE enabled nodes to start 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 as far as the RSVP state is concerned.

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

Graceful restart depends on RSVP hello messages that include Hello Request or Hello Acknowledgment (ACK) objects between two neighbors.

The figure below shows the graceful restart extension to these messages that an object called Restart_Cap, which tells neighbors that a node, may be capable of restarting if a failure occurs. The time-to-live (TTL) in these messages is set to 255 so that adjacencies can be maintained through alternate paths even if the link between two neighbors goes down.



The 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, graceful restart is enabled on Router 1, Router 2, Router 3, and Router 4. For simplicity, assume that all routers are restart capable. A TE label switched path (LSP) is signaled from Router 1 to Router 4.

Router 2 and Router 3 exchange periodic graceful restart hello messages every 10,000 ms (10 seconds), and so do Router 2 and Router 1 and Router 3 and Router 4. Assume that Router 2 advertises its restart time as 60,000 ms (60 seconds) and its recovery time as 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
```

Note The restart and recovery time are shown in **bold** in the last entry.

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 Route Processor 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 four ACK messages are missed from Router 2 (40 seconds), Router 3 declares communication with Router 2 lost "indicated by LOST" and starts the restart time to wait for the duration advertised in Router 2's restart time previously and recorded (60 seconds). Router 1 and Router 2 suppress all RSVP messages to Router 3 except hellos. Router 3 keeps sending the RSVP Path and Resv refresh messages to Router 4 and Router 5 so that they do not expire the state for the LSP; however, Router 3 suppresses these messages for Router 2.

Note A node restarts if it misses four ACKs or its hello src_instance (last source instance sent to its neighbor) changes so that its restart time = 0.

Before the restart time expires, Router 2 restarts and loads its configuration and graceful restart makes the configuration of router 2 send the hello messages with a new source instance to all the data links attached. However, because Router 2 has lost the neighbor states, it does not know what destination instance it should use in those messages; therefore, all destination instances are set to 0.

When Router 3 sees the hello from Router 2, Router 3 stops the restart time for Router 2 and sends an ACK message back. When Router 3 sees a new source instance value in Router 2's hello message, Router 3 knows that Router 2 had a control plane failure. Router 2 gets Router 3's source instance value and uses it as the destination instance going forward.

Router 3 also checks the recovery time value in the hello message from Router 2. If the recovery time is 0, Router 3 knows that Router 2 was not able to preserve its forwarding information and Router 3 deletes all RSVP state that it 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.

Graceful Restart Benefits

- Graceful restart allows a node to recover state information from its neighbor when there is an RP failure or the device has undergone a stateful switchover (SSO).
- Graceful restart allows session information recovery with minimal disruption to the network.
- A node can perform a graceful restart to help a neighbor recover its state by keeping the label bindings and state information to provide a quick recovery of the failed node and not affect the traffic that is currently forwarded.

How to Configure MPLS TE--RSVP Graceful Restart

Enabling Graceful Restart

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip rsvp signalling hello graceful-restart mode help-neighbor**
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** **Example:** `Router(config)# ip rsvp signalling hello graceful-restart mode help-neighbor`	Sets the number of DSCP hello messages on a neighboring router with restart capability.
Step 4	**exit** **Example:**	Exits to privileged EXEC mode.

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

What to do next

Note

If you have many tunnels/LSPs (100 or more) or if you have a large-scale network, the following configuration is recommended:

```
ip rsvp signalling refresh reduction
ip rsvp signalling rate-limit period 50 burst 16 maxsize 3000 limit 37
ip rsvp signalling patherr state-removal
ip rsvp signalling initial-retransmit-delay 15000
```

Additional info about these RSVP commands can be found in the Cisco IOS Quality of Service Command Reference.

Setting a DSCP Value on a Router for MPLS TE 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 the number of DSCP hello messages on a graceful restart-enabled router.

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

Setting a Hello Refresh Interval for MPLS TE Graceful Restart

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 a hello refresh interval on a router with graceful restart enabled.
Step 4	**exit** **Example:** `Router(config)# end`	Exits to privileged EXEC mode.

Setting a Missed Refresh Limit for MPLS TE Graceful Restart

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`	Sets a refresh limit on a router with graceful restart enabled.
Step 4	**exit** **Example:** `Router(config)# end`	Exits to privileged EXEC mode.

Verifying Graceful Restart Configuration

SUMMARY STEPS

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

DETAILED STEPS

Procedure

Step 1 **enable**

Use this command to enable privileged EXEC mode. Enter your password if prompted. For example:

Example:

```
Router> enable
Router#
```

Step 2 **show ip rsvp hello graceful-restart**

Use this command to display information about the status of graceful restart and related parameters. For example:

Example:

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

Step 3 **exit**

Use this command to exit to user EXEC mode. For example:

Example:

```
Router# exit
Router>
```

Configuration Examples for MPLS TE--RSVP Graceful Restart

Example MPLS TE--RSVP Graceful Restart

In the following example, graceful restart is enabled, and related parameters, including a DSCP value, a refresh interval, and a missed refresh limit are set:

```
Router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# ip rsvp signalling hello graceful-restart mode help-neighbor
Router(config)# ip rsvp signalling hello graceful-restart dscp 30
Router(config)# ip rsvp signalling hello graceful-restart refresh interval 10000
Router(config)# ip rsvp signalling hello graceful-restart refresh misses 4
Router(config)# end
```

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) features including signaling, classification, and congestion management	*Cisco IOS XE Quality of Service Solutions Configuration Guide*, Release 2
Stateful switchover	Stateful Switchover
MPLS Label Distribution Protocol	MPLS Label Distribution Protocol (LDP)
Cisco nonstop forwarding	Cisco Nonstop Forwarding
Information on stateful switchover, Cisco nonstop forwarding, graceful restart	MPLS LDP: SSO/NSF Support and Graceful Restart
Hellos for state timeout	MPLS TE--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

RFCs	Title
RFC 3473	*Generalized Multi-Protocol Label Switching (GMPLS) Signaling Resource Reservation Protocol-Traffic Engineering (RSVP-TE) Extensions*
RFC 3478	Graceful Restart Mechanism for Label Distribution

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 MPLS Traffic Engineering--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 MPLS Traffic Engineering--RSVP Graceful Restart

Feature Name	Releases	Feature Information
MPLS Traffic Engineering--RSVP Graceful Restart	Cisco IOS XE Release 2.3	The MPLS TE--RSVP Graceful Restart feature allows a neighboring Route Processor (RP) to recover from disruption in control plane service (specifically, the Label Distribution Protocol (LDP) component) without losing its MPLS forwarding state. In Cisco IOS XE Release 2.3, this feature was introduced on the Cisco ASR 1000 Series Aggregation Services Routers. The following commands were introduced or modified: **ip rsvp signalling hello graceful-restart dscp**, **ip rsvp signalling hello graceful-restart mode help-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**.

Glossary

autonomous system --A collection of networks that share the same routing protocol and that are under the same system administration.

ASBR --**Autonomous System Boundary Router**. A router that connects and exchanges information between two or more autonomous systems.

backup tunnel --A Multiprotocol Label Switching (MPLS) traffic engineering (TE) tunnel used to protect other (primary) tunnels' traffic when a link or node failure occurs.

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 neighboring 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.

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).

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 label switched paths (LSPs) crossing this neighbor to be fast rerouted.

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

LDP --Label Distribution Protocol. The protocol that supports Multiprotocol Label Switching (MPLS) hop-by-hop forwarding by distributing bindings between labels and network prefixes.

LSP --label switched path. A configured connection between two routers, in which Multiprotocol Label Switching (MPLS) is used to carry packets. A path created by the concatenation of one or more label switched hops, allowing a packet to be forwarded by swapping labels from an MPLS node to another MPLS node.

merge point --The tail of the backup tunnel.

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.

PLR --point of local repair. The headend of the backup tunnel.

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 an 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.

topology --The physical arrangement of network nodes and media within an enterprise networking structure.

tunnel --Secure communications path between two peers, such as two routers.