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Preface

About This Guide

This guide describes the services and protocol support provided by the router and presents examples to configure and implement MPLS, RSVP, and LDP protocols.

This document is organized into functional chapters and provides concepts and descriptions of the implementation flow, as well as Command Line Interface (CLI) syntax and command usage.

Audience

This manual is intended for network administrators who are responsible for configuring routers. It is assumed that the network administrators have an understanding of networking principles and configurations. Protocols and concepts described in this manual include the following:

- Multiprotocol Label Switching (MPLS)
- Resource Reservation Protocol (RSVP)
- Label Distribution Protocol (LDP)
List of Technical Publications

- 7710 SR OS Basic System Configuration Guide
  This guide describes basic system configurations and operations.
- 7710 SR OS System Management Guide
  This guide describes system security and access configurations as well as event logging and accounting logs.
- 7710 SR OS Interface Configuration Guide
  This guide describes card, Media Dependent Adapter (MDA) and port provisioning.
- 7710 SR OS Router Configuration Guide
  This guide describes logical IP routing interfaces and associated attributes such as an IP address, as well as IP and MAC-based filtering, and VRRP and Cflowd.
- 7710 SR OS Routing Protocols Guide
  This guide provides an overview of routing concepts and provides configuration examples for RIP, OSPF, IS-IS, BGP, and route policies.
- 7710 SR OS MPLS Guide
  This guide describes how to configure Multiprotocol Label Switching (MPLS) and Label Distribution Protocol (LDP).
- 7710 SR OS Services Guide
  This guide describes how to configure service parameters such as service distribution points (SDPs), customer information, and user services.
- 7710 SR OAM and Diagnostic Guide
  This guide describes how to configure features such as service mirroring and Operations, Administration and Management (OAM) tools.
- 7710 SR OS Triple Play Guide
  This guide describes Triple Play services and support provided by the 7710 SR and presents examples to configure and implement various protocols and services.
- 7710 SR OS Quality of Service Guide
  This guide describes how to configure Quality of Service (QoS) policy management.
Technical Support

If you purchased a service agreement for your router and related products from a distributor or authorized reseller, contact the technical support staff for that distributor or reseller for assistance. If you purchased an Alcatel-Lucent service agreement, contact your welcome center:

Web:  http://www.alcatel-lucent.com/wps/portal/support
In This Chapter

This chapter provides process flow information to configure MPLS, RSVP, and LDP protocols.

Alcatel-Lucent Router Configuration Process

Table 1 lists the tasks necessary to configure MPLS applications functions.

This guide is presented in an overall logical configuration flow. Each section describes a software area and provides CLI syntax and command usage to configure parameters for a functional area.

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MPLS and RSVP

In This Chapter

This chapter provides information to configure MPLS and RSVP.

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  - Label Switching Routers on page 25
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**MPLS**

Multiprotocol Label Switching (MPLS) is a label switching technology that provides the ability to set up connection-oriented paths over a connectionless IP network. MPLS facilitates network traffic flow and provides a mechanism to engineer network traffic patterns independently from routing tables. MPLS sets up a specific path for a sequence of packets. The packets are identified by a label inserted into each packet. MPLS is not enabled by default and must be explicitly enabled.

MPLS is independent of any routing protocol but is considered multiprotocol because it works with the Internet Protocol (IP), Asynchronous Transport Mode (ATM), and frame relay network protocols.
MPLS Label Stack

MPLS requires a set of procedures to enhance network layer packets with label stacks which thereby turns them into labeled packets. Routers that support MPLS are known as Label Switching Routers (LSRs). In order to transmit a labeled packet on a particular data link, an LSR must support the encoding technique which, when given a label stack and a network layer packet, produces a labeled packet.

In MPLS, packets can carry not just one label, but a set of labels in a stack. An LSR can swap the label at the top of the stack, pop the stack, or swap the label and push one or more labels into the stack. The processing of a labeled packet is completely independent of the level of hierarchy. The processing is always based on the top label, without regard for the possibility that some number of other labels may have been above it in the past, or that some number of other labels may be below it at present.

As described in RFC 3032, *MPLS Label Stack Encoding*, the label stack is represented as a sequence of label stack entries. Each label stack entry is represented by 4 octets. Figure 1 displays the label placement in a packet.

![Figure 1: Label Placement](image)

Table 2: Packet/Label Field Description

<table>
<thead>
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<th>Field</th>
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<tr>
<td>Label</td>
<td>This 20-bit field carries the actual value (unstructured) of the label.</td>
</tr>
<tr>
<td>Exp</td>
<td>This 3-bit field is reserved for experimental use. It is currently used for Class of Service (CoS).</td>
</tr>
<tr>
<td>S</td>
<td>This bit is set to 1 for the last entry (bottom) in the label stack, and 0 for all other label stack entries.</td>
</tr>
<tr>
<td>TTL</td>
<td>This 8-bit field is used to encode a TTL value.</td>
</tr>
</tbody>
</table>
A stack can carry several labels, organized in a last in/first out order. The top of the label stack appears first in the packet and the bottom of the stack appears last (Figure 2).

![Layer 2 Header | Top Label | ... | Bottom Label | Data Packet](OSSG014)

**Figure 2: Label Packet Placement**

The label value at the top of the stack is looked up when a labeled packet is received. A successful lookup reveals:

- The next hop where the packet is to be forwarded.
- The operation to be performed on the label stack before forwarding.

In addition, the lookup may reveal outgoing data link encapsulation and other information needed to properly forward the packet.

An empty label stack can be thought of as an unlabeled packet. An empty label stack has zero (0) depth. The label at the bottom of the stack is referred to as the Level 1 label. The label above it (if it exists) is the Level 2 label, and so on. The label at the top of the stack is referred to as the Level \( m \) label.

Labeled packet processing is independent of the level of hierarchy. Processing is always based on the top label in the stack which includes information about the operations to perform on the packet's label stack.
Label Values

Packets travelling along an LSP (see Label Switching Routers on page 25) are identified by its label, the 20-bit, unsigned integer. The range is 0 through 1,048,575. Label values 0-15 are reserved and are defined below as follows:

- A value of 0 represents the IPv4 Explicit NULL Label. This Label value is legal only at the bottom of the Label stack. It indicates that the Label stack must be popped, and the packet forwarding must be based on the IPv4 header.
- A value of 1 represents the router alert Label. This Label value is legal anywhere in the Label stack except at the bottom. When a received packet contains this Label value at the top of the Label stack, it is delivered to a local software module for processing. The actual packet forwarding is determined by the Label beneath it in the stack. However, if the packet is further forwarded, the router alert Label should be pushed back onto the Label stack before forwarding. The use of this Label is analogous to the use of the router alert option in IP packets. Since this Label cannot occur at the bottom of the stack, it is not associated with a particular network layer protocol.
- A value of 3 represents the Implicit NULL Label. This is a Label that a Label Switching Router (LSR) can assign and distribute, but which never actually appears in the encapsulation. When an LSR would otherwise replace the Label at the top of the stack with a new Label, but the new Label is Implicit NULL, the LSR pops the stack instead of doing the replacement. Although this value may never appear in the encapsulation, it needs to be specified in the Label Distribution Protocol (LDP), so a value is reserved.
- Values 4-15 are reserved for future use.

The router uses labels for MPLS, RSVP-TE, and LDP, as well as packet-based services such as VLL and VPLS.

Label values 16 through 1,048,575 are defined as follows:

- Label values 16 through 31 are reserved for future use.
- Label values 32 through 1,023 are available for static LSP label assignments.
- Label values 1,024 through 2,047 are reserved for future use.
- Label values 2,048 through 18,431 are available for static service label assignments.
- Label values 18,432 through 262,143 (131,071 in chassis modes lower than D) are assigned dynamically by RSVP, LDP, and BGP control planes for both MPLS LSP and service labels.
- Label values 262,144 (131,072 in chassis modes lower than D) through 1,048,575 are reserved for future use.
Label Switching Routers

LSRs perform the label switching function. LSRs perform different functions based on it’s position in an LSP. Routers in an LSP do one of the following:

- The router at the beginning of an LSP is the ingress label edge router (ILER). The ingress router can encapsulate packets with an MPLS header and forward it to the next router along the path. An LSP can only have one ingress router.
- A Label Switching Router (LSR) can be any intermediate router in the LSP between the ingress and egress routers. An LSR swaps the incoming label with the outgoing MPLS label and forwards the MPLS packets it receives to the next router in the MPLS path (LSP). An LSP can have 0-253 transit routers.
- The router at the end of an LSP is the egress label edge router (ELER). The egress router strips the MPLS encapsulation which changes it from an MPLS packet to a data packet, and then forwards the packet to its final destination using information in the forwarding table. Each LSP can have only one egress router. The ingress and egress routers in an LSP cannot be the same router.

A router in your network can act as an ingress, egress, or transit router for one or more LSPs, depending on your network design.

An LSP is confined to one IGP area for LSPs using constrained-path. They cannot cross an autonomous system (AS) boundary.

Static LSPs can cross AS boundaries. The intermediate hops are manually configured so the LSP has no dependence on the IGP topology or a local forwarding table.

LSP Types

The following are LSP types:

- Static LSPs — A static LSP specifies a static path. All routers that the LSP traverses must be configured manually with labels. No signaling such as RSVP or LDP is required.
- Signaled LSP — LSPs are set up using a signaling protocol such as RSVP-TE or LDP. The signaling protocol allows labels to be assigned from an ingress router to the egress router. Signaling is triggered by the ingress routers. Configuration is required only on the ingress router and is not required on intermediate routers. Signaling also facilitates path selection.

There are two signaled LSP types:
  - Explicit-path LSPs — MPLS uses RSVP-TE to set up explicit path LSPs. The hops within the LSP are configured manually. The intermediate hops must be configured as either strict or loose meaning that the LSP must take either a direct path from the
previous hop router to this router (strict) or can traverse through other routers (loose). You can control how the path is set up. They are similar to static LSPs but require less configuration. See RSVP on page 39.

→ Constrained-path LSPs — The intermediate hops of the LSP are dynamically assigned. A constrained path LSP relies on the Constrained Shortest Path First (CSPF) routing algorithm to find a path which satisfies the constraints for the LSP. In turn, CSPF relies on the topology database provided by the extended IGP such as OSPF or IS-IS.

Once the path is found by CSPF, RSVP uses the path to request the LSP set up. CSPF calculates the shortest path based on the constraints provided such as bandwidth, class of service, and specified hops.

If fast reroute is configured, the ingress router signals the routers downstream. Each downstream router sets up a detour for the LSP. If a downstream router does not support fast reroute, the request is ignored and the router continues to support the LSP. This can cause some of the detours to fail, but otherwise the LSP is not impacted.

No bandwidth is reserved for the rerouted path. If the user enters a value in the bandwidth parameter in the `config>router>mpls>lsp>fast-reroute` context, it will have no effect on the LSP backup LSP establishment.

Hop-limit parameters specifies the maximum number of hops that an LSP can traverse, including the ingress and egress routers. An LSP is not set up if the hop limit is exceeded. The hop count is set to 255 by default for the primary and secondary paths. It is set to 16 by default for a bypass or detour LSP path.
MPLS Facility Bypass Method of MPLS Fast Re-Route (FRR)

The MPLS facility bypass method of MPLS Fast Re-Route (FRR) functionality is extended to the ingress node.

The behavior of an LSP at an ingress LER with both fast reroute and a standby LSP path configured is as follows:

- When a downstream detour becomes active at a point of local repair (PLR):
  
  The ingress LER switches to the standby LSP path. If the primary LSP path is repaired subsequently at the PLR, the LSP will switch back to the primary path. If the standby goes down, the LSP is switched back to the primary, even though it is still on the detour at the PLR. If the primary goes down at the ingress while the LSP is on the standby, the detour at the ingress is cleaned up and for one-to-one detours a “path tear” is sent for the detour path. In other words, the detour at the ingress does not protect the standby. If and when the primary LSP is again successfully re-signaled, the ingress detour state machine will be restarted.

- When the primary fails at the ingress:

  The LSP switches to the detour path. If a standby is available then LSP would switch to standby on expiration of hold-timer. If hold-timer is disabled then switchover to standby would happen immediately. On successful global revert of primary path, the LSP would switch back to the primary path.

- Admin groups are not taken into account when creating detours for LSPs.

Manual Bypass LSP

In prior releases, the router implemented dynamic bypass tunnels as per RFC 4090, Fast Reroute Extensions to RSVP-TE for LSP Tunnels. When an LSP is signaled and the local protection flag is set in the session_attribute object and/or the FRR object in the path message indicates that facility backup is desired, the PLR will establish a bypass tunnel to provide node and link protection. If a bypass LSP which merges in a downstream node with the protected LSP exist, and if this LSP satisfies the constraints in the FRR object, then this bypass tunnel is selected.

With the manual bypass feature, an LSP can be pre-configured from a PLR which will be used exclusively for bypass protection. When a path message for a new LSP requests bypass protection, the node will first check if a manual bypass tunnel satisfying the path constraints exists. If one is found, it will be selected. If no manual bypass tunnel is found, the router will dynamically signal a bypass LSP in the default behavior. Users can disable the dynamic bypass creation on a per node basis using the CLI.

A maximum of 1000 associations of primary LSP paths can be made with a single manual bypass by default. The max-bypass-associations integer command increases the number of associations.
If dynamic bypass creation is disabled on the node, it is recommended to configure additional manual bypass LSPs to handle the required number of associations.

Refer to Configuring Manual Bypass Tunnels on page 101 for configuration information.

**PLR Bypass LSP Selection Rules**

![Diagram of Bypass Tunnel Nodes](image)

*Figure 3: Bypass Tunnel Nodes*

The PLR uses the following rules to select a bypass LSP among multiple manual and dynamic bypass LSPs at the time of establishment of the primary LSP path or when searching for a bypass for a protected LSP that does not have an association with a bypass tunnel:

1. The MPLS/RSVP task in the PLR node checks if an existing manual bypass satisfies the constraints. If the path message for the primary LSP path indicated node protection desired, which is the default LSP FRR setting at the head end node, MPLS/RSVP task searches for a node-protect bypass LSP. If the path message for the primary LSP path indicated link protection desired, then it searches for a link-protect bypass LSP.

2. If multiple manual bypass LSPs satisfying the path constraints exist, it will prefer a manual-bypass terminating closer to the PLR over a manual bypass terminating further away. If multiple manual bypass LSPs satisfying the path constraints terminate on the same downstream node, it selects one with the lowest IGP path cost or if in a tie, picks the first one available.

3. If none satisfies the constraints and dynamic bypass tunnels have not been disabled on PLR node, then the MPLS/RSVP task in the PLR will check if any of the already established dynamic bypasses of the requested type satisfies the constraints.

4. If none do, then the MPLS/RSVP task will ask CSPF to check if a new dynamic bypass of the requested type, node-protect or link-protect, can be established.

5. If the path message for the primary LSP path indicated node protection desired, and no manual bypass was found after Step 1, and/or no dynamic bypass LSP was found after 3 attempts of performing Step 3, the MPLS/RSVP task will repeat Steps 1-3 looking for a suitable link-protect bypass LSP. If none are found, the primary LSP will have no protection and the PLR node must clear the “local protection available” flag in the IPv4 address sub-object of the RRO starting in the next Resv refresh message it sends upstream.
6. If the path message for the primary LSP path indicated link protection desired, and no manual bypass was found after step 1, and/or no dynamic bypass LSP was found after performing Step 3, the primary LSP will have no protection and the PLR node must clear the “local protection available” flag in the IPv4 address sub-object of the RRO starting in the next RESV refresh message it sends upstream. The PLR will not search for a node-protect’ bypass LSP in this case.

7. If the PLR node successfully makes an association, it must set the “local protection available” flag in the IPv4 address sub-object of the RRO starting in the next RESV refresh message it sends upstream.

8. For all primary LSP that requested FRR protection but are not currently associated with a bypass tunnel, the PLR node on reception of RESV refresh on the primary LSP path repeats Steps 1-7.

If the user disables dynamic-bypass tunnels on a node while dynamic bypass tunnels were activated and were passing traffic, traffic loss will occur on the protected LSP. Furthermore, if no manual bypass exist that satisfy the constraints of the protected LSP, the LSP will remain without protection.

If the user configures a bypass tunnel on node B and dynamic bypass tunnels have been disabled, LSPs which have been previously signaled and which were not associated with any manual bypass tunnel, for example, none existed, will be associated with the manual bypass tunnel if suitable. The node checks for the availability of a suitable bypass tunnel for each of the outstanding LSPs every time a RESV message is received for these LSPs.

If the user configures a bypass tunnel on node B and dynamic bypass tunnels have not been disabled, LSPs which have been previously signaled over dynamic bypass tunnels will not automatically be switched into the manual bypass tunnel even if the manual bypass is a more optimized path. The user will have to perform a make before break at the head end of these LSPs.

If the manual bypass goes into the down state in node B and dynamic bypass tunnels have been disabled, node B (PLR) will clear the “protection available” flag in the RRO IPv4 sub-object in the next RESV refresh message for each affected LSP. It will then try to associate each of these LSPs with one of the manual bypass tunnels that are still up. If it finds one, it will make the association and set again the “protection available” flag in the next RESV refresh message for each of these LSPs. If it could not find one, it will keep checking for one every time a RESV message is received for each of the remaining LSPs. When the manual bypass tunnel is back UP, the LSPs which did not find a match will be associated back to this tunnel and the protection available flag is set starting in the next RESV refresh message.

If the manual bypass goes into the down state in node B and dynamic bypass tunnels have not been disabled, node B will automatically signal a dynamic bypass to protect the LSPs if a suitable one does not exist. Similarly, if an LSP is signaled while the manual bypass is in the down state, the node will only signal a dynamic bypass tunnel if the user has not disabled dynamic tunnels. When the manual bypass tunnel is back into the UP state, the node will not switch the protected LSPs from the dynamic bypass tunnel into the manual bypass tunnel.
FRR Node-Protection (Facility)

The MPLS Fast Re-Route (FRR) functionality enables PLRs to be aware of the missing node protection and lets them regularly probe for a node-bypass. The following describes an LSP scenario:

![Figure 4: FRR Node-Protection Example](image)

Where:

- LSP 1: between PE_1 to PE_2, with CSPF, FRR facility node-protect enabled.
- P_1 protects P_2 with bypass-nodes P_1 - P_3 - P_4 - PE_4 - PE_3.
- If P_4 fails, P_1 tries to establish the bypass-node three times.
- When the bypass-node creation fails, P_1 will protect link P_1-P_2.
- P_1 protects the link to P_2 through P_1 - P_5 - P_2.
- P_4 returns online.

Since LSP 1 had requested node protection, but due to lack of any available path, it could only obtain link protection. Therefore, every 60 seconds the PLR for LSP 1 will search for a new path that might be able to provide node protection. Once P_4 is back online and such a path is available, a new bypass tunnel will be signalled and LSP 1 will get associated with this new bypass tunnel.
Uniform FRR Failover Time

The failover time during FRR consists of a detection time and a switchover time. The detection time corresponds to the time it takes for the RSVP control plane protocol to detect that a network IP interface is down or that a neighbor/next-hop over a network IP interface is down. The control plane can be informed of an interface down event when event is due to a failure in a lower layer such in the physical layer. The control plane can also detect the failure of a neighbor/next-hop on its own by running a protocol such as Hello, Keep-Alive, or BFD.

The switchover time is measured from the time the control plane detected the failure of the interface or neighbor/next-hop to the time the IOM completed the reprogramming of all the impacted ILM or service records in the data path. This includes the time it takes for the control plane to send a down notification to all IOMs to request a switch to the backup NHLFE.

Uniform Fast-Reroute (FRR) failover enables the switchover of MPLS and service packets from the outgoing interface of the primary LSP path to that of the FRR backup LSP within the same amount of time regardless of the number of LSPs or service records. This is achieved by updating Ingress Label Map (ILM) records and service records to point to the backup Next-Hop Label to Forwarding Entry (NHLFE) in a single operation.
Automatic Bandwidth Allocation for RSVP LSPs

Enabling and Disabling Auto-Bandwidth Allocation on an LSP

This section discusses an auto-bandwidth hierarchy configurable in the config>router>mpls>lsp context.

Adding auto-bandwidth at the LSP level starts the measurement of LSP bandwidth described in Measurement of LSP Bandwidth on page 33 and allows auto-bandwidth adjustments to take place based on the triggers described in Periodic Automatic Bandwidth Adjustment on page 35.

When an LSP is first established, the bandwidth reserved along its primary path is controlled by the bandwidth parameter in the config>router>mpls>lsp>primary context, whether or not the LSP has auto-bandwidth enabled. When auto-bandwidth is enabled and a trigger occurs, the system will attempt to change the bandwidth of the LSP to a value between min-bandwidth and max-bandwidth, which are configurable values in the lsp>auto-bandwidth context. min-bandwidth is the minimum bandwidth that auto-bandwidth can signal for the LSP and max-bandwidth is the maximum bandwidth that can be signaled. The user can set the min-bandwidth to the same value as the primary path bandwidth but the system will not enforce this restriction. The system will allow:

- No min-bandwidth to be configured. In this case, the implicit minimum is 0 Mbps
- No max-bandwidth to be configured, as long as overflow-triggered auto-bandwidth is not configured. In this case, the implicit maximum is infinite (effectively 100 Gbps).
- The configured primary path bandwidth to be outside the range of min-bandwidth to max-bandwidth.
- auto-bandwidth parameters can be changed at any time on an operational LSP; in most cases the changes have no immediate impact but subsequent sections will describe some exceptions

All of the auto-bandwidth adjustments discussed are performed using MBB procedures.

Auto bandwidth can be added to an operational LSP at any time (without the need to shut down the LSP or path), but no bandwidth change occurs until a future trigger event. Auto bandwidth may also be removed from an operational LSP at any time and this causes an immediate MBB bandwidth change to be attempted using the configured primary path bandwidth.

Note that changing the configured bandwidth of an auto-bandwidth LSP has no immediate affect, it will only matters if the LSP/path goes down (due to failure or administrative action) and comes back up or if auto-bandwidth is removed from the LSP. The operator can force an auto-bandwidth LSP to be resized immediately to an arbitrary bandwidth using the appropriate tools commands.
Measurement of LSP Bandwidth

Automatic adjustment of RSVP LSP bandwidth based on measured traffic rate into the tunnel requires the LSP to be configured for egress statistics collection at the ingress LER. The following CLI shows an example:

```
config router mpls lsp name
    egress-statistics
    accounting-policy 99
    collect-stats
    no shutdown
exit
```

All LSPs configured for accounting, including any configured for auto-bandwidth based on traffic measurements, must reference the same accounting policy. An example configuration of such an accounting-policy is shown below: in the CLI example below.

```
config log
    accounting-policy 99
    collection-interval 5
    record combined-mpls-lsp-egress
exit
```

Note that the record `combined-mpls-lsp-egress` command in the accounting policy has the effect of recording both egress packet and byte counts and bandwidth measurements based on the byte counts if auto-bandwidth is enabled on the LSP.

When egress statistics are enabled the CPM collects stats from of all IOMs involved in forwarding traffic belonging to the LSP (whether the traffic is currently leaving the ingress LER via the primary LSP path, a secondary LSP path, an FRR detour path or an FRR bypass path). The egress statistics have counts for the number of packets and bytes forwarded per LSP on a per-forwarding class, per-priority (in-profile vs. out-of-profile) basis. When auto-bandwidth is configured for an LSP the ingress LER calculates a traffic rate for the LSP as follows:

Average data rate of LSP[x] during interval[i] = \( F(x, i) - F(x, i-1) / \text{sample interval} \)

\( F(x, i) \) — The total number of bytes belonging to LSP[x], regardless of forwarding-class or priority, at time[i]

sample interval = time[i] — time [i-1], time[i+1] — time[i], etc.

The sample interval is the product of sample-multiplier and the collection-interval specified in the auto-bandwidth accounting policy. A default sample-multiplier for all LSPs may be configured using the `config>router>mpls>auto-bandwidth-defaults` command but this value can be overridden on a per-LSP basis at the `config>router>mpls>lsp>auto-bandwidth` context. The
default value of sample-multiplier (the value that would result from the no auto-bandwidth-defaults command) is 1, which means the default sample interval is 300 seconds.

Over a longer period of time called the adjust interval the router keeps track of the maximum average data rate recorded during any constituent sample interval. The adjust interval is the product of adjust-multiplier and the collection-interval specified in the auto-bandwidth accounting-policy. A default adjust-multiplier for all LSPs may be configured using the `config>router>mpls>auto-bandwidth-multiplier` command but this value can be overridden on a per-LSP basis at the `config>router>mpls>lsp>auto-bandwidth` context. The default value of adjust-multiplier (the value that would result from the no auto-bandwidth-multiplier command) is 288, which means the default adjust interval is 86400 seconds or 24 hours. The system enforces the restriction that adjust-multiplier is equal to or greater than sample-multiplier. It is recommended that the `adjust-multiplier` be an integer multiple of the `sample-multiplier`.

The collection-interval in the auto-bandwidth accounting policy can be changed at any time, without disabling any of the LSPs that rely on that policy for statistics collection.

The sample-multiplier (at the `mpls>auto-bandwidth` level or the `lsp>auto-bandwidth` level) can be changed at any time. This will have no effect until the beginning of the next sample interval. In this case the adjust-interval does not change and information about the current adjust interval (such as the remaining adjust-multiplier, the maximum average data rate) is not lost when the sample-multiplier change takes effect.

The system allows adjust-multiplier (at the `mpls` level or the `lsp>auto-bandwidth` level) to be changed at any time as well but in this case the new value shall have no effect until the beginning of the next adjust interval.

Byte counts collected for LSP statistics include layer 2 encapsulation (Ethernet headers and trailers) and therefore average data rates measured by this feature include Layer 2 overhead as well.

---

**Passive Monitoring of LSP Bandwidth**

The system offers the option to measure the bandwidth of an RSVP LSP (see Measurement of LSP Bandwidth on page 33) without taking any action to adjust the bandwidth reservation, regardless of how different the measured bandwidth is from the current reservation. Passive monitoring is enabled using the `config>router>mpls>lsp>auto-bandwidth>monitor-bandwidth` command.

The `show>router>mpls>lsp detail` command can be used to view the maximum average data rate in the current adjust interval and the remaining time in the current adjust interval.
Periodic Automatic Bandwidth Adjustment

Automatic bandwidth allocation is supported on any RSVP LSP that has MBB enabled. MBB is enabled in the `config>router>mpls>lsp` context using the `adaptive` command. For automatic adjustments of LSP bandwidth to occur the monitor-bandwidth command must not be present at `config>router>mpls>lsp>auto-bandwidth` context, otherwise only passive measurements will occur.

If an eligible RSVP LSP is configured for auto-bandwidth, by entering auto-bandwidth at the `config>router>mpls>lsp` context, then the ingress LER decides every adjust interval whether to attempt auto-bandwidth adjustment. The following parameters are defined:

- `current_bw` — The currently reserved bandwidth of the LSP; this is the operational bandwidth that is already maintained in the MIB.
- `measured_bw` — The maximum average data rate in the current adjust interval.
- `signaled_bw` — The bandwidth that is provided to the CSPF algorithm and signaled in the SENDER_TSPEC and FLOWSPEC objects when an auto-bandwidth adjustment is attempted.
- `min` — The configured min-bandwidth of the LSP.
- `max` — The configured max-bandwidth of the LSP.
- `up%` — The minimum difference between measured_bw and current_bw, expressed as a percentage of current_bw, for increasing the bandwidth of the LSP.
- `up` — The minimum difference between measured_bw and current_bw, expressed as an absolute bandwidth relative to current_bw, for increasing the bandwidth of the LSP. This is an optional parameter; if not defined the value is 0.
- `down%` — The minimum difference between current_bw and measured_bw, expressed as a percentage of current_bw, for decreasing the bandwidth of the LSP.
- `down` — The minimum difference between current_bw and measured_bw, expressed as an absolute bandwidth relative to current_bw, for decreasing the bandwidth of the LSP. This is an optional parameter; if not defined the value is 0.

At the end of every adjust interval the system decides if an auto-bandwidth adjustment should be attempted. The heuristics are as follows:

- If the measured bandwidth exceeds the current bandwidth by more than the percentage threshold and also by more than the absolute threshold then the bandwidth is re-signaled to the measured bandwidth (subject to min and max constraints).
- If the measured bandwidth is less than the current bandwidth by more than the percentage threshold and also by more than the absolute threshold then the bandwidth is re-signaled to the measured bandwidth (subject to min and max constraints).
• If the current bandwidth is greater than the max bandwidth then the LSP bandwidth is re-signaled to max bandwidth, even if the thresholds have not been triggered.

• If the current bandwidth is greater than the min bandwidth then the LSP bandwidth is re-signaled to min bandwidth, even if the thresholds have not been triggered.

Changes to min-bandwidth, max-bandwidth and any of the threshold values (up, up%, down, down%) are permitted at any time on an operational LSP but the changes have no effect until the next auto-bandwidth trigger (for example, adjust interval expiry).

If the measured bandwidth exceeds the current bandwidth by more than the percentage threshold and also by more than the absolute threshold then the bandwidth is re-signaled to the measured bandwidth (subject to min and max constraints).

The adjust-interval and maximum average data rate are reset whether the adjustment succeeds or fails. If the bandwidth adjustment fails (for example, CSPF cannot find a path) then the existing LSP is maintained with its existing bandwidth reservation. The system does not retry the bandwidth adjustment (for example, per the configuration of the LSP retry-timer and retry-limit).
Overflow-Triggered Auto-Bandwidth Adjustment

For cases where the measured bandwidth of an LSP has increased significantly since the start of the current adjust interval it may be desirable for the system to preemptively adjust the bandwidth of the LSP and not wait until the end of the adjust interval.

The following parameters are defined:

- current_bw — The currently reserved bandwidth of the LSP.
- sampled_bw — The average data rate of the sample interval that just ended.
- measured_bw — The maximum average data rate in the current adjust interval.
- signaled_bw — The bandwidth that is provided to the CSPF algorithm and signaled in the SENDER_TSPEC and FLOWSPEC objects when an auto-bandwidth adjustment is attempted.
- max — The configured max-bandwidth of the LSP.
- %_threshold — The minimum difference between sampled_bw and current_bw, expressed as a percentage of the current_bw, for counting an overflow event.
- min_threshold — The minimum difference between sampled_bw and current_bw, expressed as an absolute bandwidth relative to current_bw, for counting an overflow event. This is an optional parameter; if not defined the value is 0.

When a sample interval ends it is counted as an overflow if:

- The sampled bandwidth exceeds the current bandwidth by more than the percentage threshold and by more than the absolute bandwidth threshold (if defined).
- When the number of overflow samples reaches a configured limit, an immediate attempt is made to adjust the bandwidth to the measured bandwidth (subject to the min and max constraints).

If the bandwidth adjustment is successful then the adjust-interval, maximum average data rate and overflow count are all reset. If the bandwidth adjustment fails then the overflow count is reset but the adjust-interval and maximum average data rate continue with current values. It is possible that the overflow count will once again reach the configured limit before the end of adjust-interval is reached and this will once again trigger an immediate auto-bandwidth adjustment attempt.

The overflow configuration command fails if the max-bandwidth of the LSP has not been defined.

The threshold limit can be changed on an operational auto-bandwidth LSP at any time and the change should take effect at the end of the current sample interval (for example, if the user decreases the overflow limit to a value lower than the current overflow count then auto-bandwidth adjustment will take place as soon as the sample interval ends). The threshold values can also be changed at any time (for example, %_threshold and min_threshold) but the new values will not take effect until the end of the current sample interval.
Manually-Triggered Auto-Bandwidth Adjustment

Manually-triggered auto-bandwidth adjustment feature is configured with the 
\texttt{tools>perform>router>mpls adjust-autobandwidth [lsp lsp-name [force [bandwidth mbps]]]} 
command to attempt immediate auto-bandwidth adjustment for either one specific LSP or all active LSPs. If the LSP is not specified then the system assumes the command applies to all LSPs. If an LSP name is provided then the command applies to that specific LSP only and the optional \texttt{force} parameter (with or without a bandwidth) can be used.

If \texttt{force} is not specified (or the command is not LSP-specific) then \texttt{measured_bw} is compared to \texttt{current_bw} and bandwidth adjustment may or may not occur.

If \texttt{force} is specified and a bandwidth is not provided then the threshold checking is bypassed but the min and max bandwidth constraints are still enforced.

If \texttt{force} is specified with a bandwidth (in Mbps) then \texttt{signaled_bw} is set to this bandwidth. There is no requirement that the bandwidth entered as part of the command fall within the range of min-bandwidth to max-bandwidth.

The adjust-interval, maximum average data rate and overflow count are not reset by the manual auto-bandwidth command, whether or not the bandwidth adjustment succeeds or fails. The overflow count is reset only if the manual auto-bandwidth adjustment is successful.
The Resource Reservation Protocol (RSVP) is a network control protocol used by a host to request specific qualities of service from the network for particular application data streams or flows. RSVP is also used by routers to deliver quality of service (QoS) requests to all nodes along the path(s) of the flows and to establish and maintain state to provide the requested service. RSVP requests generally result in resources reserved in each node along the data path. MPLS leverages this RSVP mechanism to set up traffic engineered LSPs. RSVP is not enabled by default and must be explicitly enabled.

RSVP requests resources for simplex flows. It requests resources only in one direction (unidirectional). Therefore, RSVP treats a sender as logically distinct from a receiver, although the same application process may act as both a sender and a receiver at the same time. Duplex flows require two LSPs, to carry traffic in each direction.

RSVP is not a routing protocol. RSVP operates with unicast and multicast routing protocols. Routing protocols determine where packets are forwarded. RSVP consults local routing tables to relay RSVP messages.

RSVP uses two message types to set up LSPs, PATH and RESV. Figure 5 depicts the process to establish an LSP.

- The sender (the ingress LER (ILER)), sends PATH messages toward the receiver, (the egress LER (ELER)) to indicate the FEC for which label bindings are desired. PATH messages are used to signal and request label bindings required to establish the LSP from ingress to egress. Each router along the path observes the traffic type.
  
  PATH messages facilitate the routers along the path to make the necessary bandwidth reservations and distribute the label binding to the router upstream.

- The ELER sends label binding information in the RESV messages in response to PATH messages received.

- The LSP is considered operational when the ILER receives the label binding information.

![Figure 5: Establishing LSPs](image-url)
Figure 6 displays an example of an LSP path set up using RSVP. The ingress label edge router (ILER 1) transmits an RSVP path message (path: 30.30.30.1) downstream to the egress label edge router (ELER 4). The path message contains a label request object that requests intermediate LSRs and the ELER to provide a label binding for this path.

In addition to the label request object, an RSVP PATH message can also contain a number of optional objects:

- Explicit route object (ERO) — When the ERO is present, the RSVP path message is forced to follow the path specified by the ERO (independent of the IGP shortest path).
- Record route object (RRO) — Allows the ILER to receive a listing of the LSRs that the LSP tunnel actually traverses.
- A session attribute object controls the path set up priority, holding priority, and local-rerouting features.

Upon receiving a path message containing a label request object, the ELER transmits a RESV message that contains a label object. The label object contains the label binding that the downstream LSR communicates to its upstream neighbor. The RESV message is sent upstream towards the ILER, in a direction opposite to that followed by the path message. Each LSR that processes the RESV message carrying a label object uses the received label for outgoing traffic associated with the specific LSP. When the RESV message arrives at the ingress LSR, the LSP is established.
Using RSVP for MPLS

Hosts and routers that support both MPLS and RSVP can associate labels with RSVP flows. When MPLS and RSVP are combined, the definition of a flow can be made more flexible. Once an LSP is established, the traffic through the path is defined by the label applied at the ingress node of the LSP. The mapping of label to traffic can be accomplished using a variety of criteria. The set of packets that are assigned the same label value by a specific node are considered to belong to the same FEC which defines the RSVP flow.

For use with MPLS, RSVP already has the resource reservation component built-in which makes it ideal to reserve resources for LSPs.

RSVP Traffic Engineering Extensions for MPLS

RSVP has been extended for MPLS to support automatic signaling of LSPs. To enhance the scalability, latency, and reliability of RSVP signaling, several extensions have been defined. Refresh messages are still transmitted but the volume of traffic, the amount of CPU utilization, and response latency are reduced while reliability is supported. None of these extensions result in backward compatibility problems with traditional RSVP implementations.

- Hello Protocol on page 41
- MD5 Authentication of RSVP Interface on page 42
- RSVP Overhead Refresh Reduction on page 44

Hello Protocol

The Hello protocol detects the loss of a neighbor node or the reset of a neighbor’s RSVP state information. In standard RSVP, neighbor monitoring occurs as part of RSVP’s soft-state model. The reservation state is maintained as cached information that is first installed and then periodically refreshed by the ingress and egress LSRs. If the state is not refreshed within a specified time interval, the LSR discards the state because it assumes that either the neighbor node has been lost or its RSVP state information has been reset.

The Hello protocol extension is composed of a hello message, a hello request object and a hello ACK object. Hello processing between two neighbors supports independent selection of failure detection intervals. Each neighbor can automatically issue hello request objects. Each hello request object is answered by a hello ACK object.
MD5 Authentication of RSVP Interface

When enabled on an RSVP interface, authentication of RSVP messages operates in both directions of the interface.

A node maintains a security association with its neighbors for each authentication key. The following items are stored in the context of this security association:

- The HMAC-MD5 authentication algorithm.
- Key used with the authentication algorithm.
- Lifetime of the key. A key is user-generated key using a third party software/hardware and enters the value as static string into CLI configuration of the RSVP interface. The key will continue to be valid until it is removed from that RSVP interface.
- Source Address of the sending system.
- Latest sending sequence number used with this key identifier.

The RSVP sender transmits an authenticating digest of the RSVP message, computed using the shared authentication key and a keyed-hash algorithm. The message digest is included in an Integrity object which also contains a Flags field, a Key Identifier field, and a Sequence Number field. The RSVP sender complies to the procedures for RSVP message generation in RFC 2747, RSVP Cryptographic Authentication.

An RSVP receiver uses the key together with the authentication algorithm to process received RSVP messages.

When a PLR node switches the path of the LSP to a bypass LSP, it does not send the Integrity object in the RSVP messages over the bypass tunnel. If an integrity object is received from the MP node, then the message is discarded since there is no security association with the next-next-hop MP node.

The MD5 implementation does not support the authentication challenge procedures in RFC 2747.
Reservation Styles

LSPs can be signaled with explicit reservation styles. A reservation style is a set of control options that specify a number of supported parameters. The style information is part of the LSP configuration. SR OS supports two reservation styles:

- **Fixed Filter (FF)** — The Fixed Filter (FF) reservation style specifies an explicit list of senders and a distinct reservation for each of them. Each sender has a dedicated reservation that is not shared with other senders. Each sender is identified by an IP address and a local identification number, the LSP ID. Because each sender has its own reservation, a unique label and a separate LSP can be constructed for each sender-receiver pair. For traditional RSVP applications, the FF reservation style is ideal for a video distribution application in which each channel (or source) requires a separate pipe for each of the individual video streams.

- **Shared Explicit (SE)** — The Shared Explicit (SE) reservation style creates a single reservation over a link that is shared by an explicit list of senders. Because each sender is explicitly listed in the RESV message, different labels can be assigned to different sender-receiver pairs, thereby creating separate LSPs.

Note that if FRR option is enabled for the LSP and selects the facility FRR method at the head-end node, only the SE reservation style is allowed. Furthermore, if a PLR node receives a path message with fast-reroute requested with facility method and the FF reservation style, it will reject the reservation. The one-to-one detour method supports both FF and SE styles.

RSVP Message Pacing

When a flood of signaling messages arrive because of topology changes in the network, signaling messages can be dropped which results in longer set up times for LSPs. RSVP message pacing controls the transmission rate for RSVP messages, allowing the messages to be sent in timed intervals. Pacing reduces the number of dropped messages that can occur from bursts of signaling messages in large networks.
RSVP Overhead Refresh Reduction

The RSVP refresh reduction feature consists of the following capabilities implemented in accordance to RFC 2961, *RSVP Refresh Overhead Reduction Extensions*:

- RSVP message bundling — This capability is intended to reduce overall message handling load. The system supports receipt and processing of bundled message only, but no transmission of bundled messages.

- Reliable message delivery: — This capability consists of sending a message-id and returning a message-ack for each RSVP message. It can be used to detect message loss and support reliable RSVP message delivery on a per hop basis. It also helps reduce the refresh rate since the delivery becomes more reliable.

- Summary refresh — This capability consists of refreshing multiples states with a single message-id list and sending negative ACKs (NACKs) for a message-id which could not be matched. The summary refresh capability reduce the amount of messaging exchanged and the corresponding message processing between peers. It does not however reduce the amount of soft state to be stored in the node.

These capabilities can be enabled on a per-RSVP-interface basis are referred to collectively as “refresh overhead reduction extensions”. When the refresh-reduction is enabled on a system RSVP interface, the node indicates this to its peer by setting a refresh-reduction-capable bit in the flags field of the common RSVP header. If both peers of an RSVP interface set this bit, all the above three capabilities can be used. Furthermore, the node monitors the settings of this bit in received RSVP messages from the peer on the interface. As soon as this bit is cleared, the node stops sending summary refresh messages. If a peer did not set the “refresh-reduction-capable” bit, a node does not attempt to send summary refresh messages.

The RSVP Overhead Refresh Reduction is supported with both RSVP P2P LSP path and the S2L path of an RSVP P2MP LSP instance over the same RSVP interface.
RSVP Graceful Restart Helper

This `gr-helper` command enables the RSVP Graceful Restart Helper feature.

The RSVP-TE Graceful Restart helper mode allows the SR OS based system (the helper node) to provide another router that has requested it (the restarting node) a grace period, during which the system will continue to use RSVP sessions to neighbors requesting the grace period. This is typically used when another router is rebooting its control plane but its forwarding plane is expected to continue to forward traffic based on the previously available Path and Resv states.

The user can enable Graceful Restart helper on each RSVP interface separately. When the GR helper feature is enabled on an RSVP interface, the node starts inserting a new Restart_Cap Object in the Hello packets to its neighbor. The restarting node does the same and indicates to the helper node the desired Restart Time and Recovery Time.

The GR Restart helper consists of a couple of phases. Once it loses Hello communication with its neighbor, the helper node enters the Restart phase. During this phase, it preserves the state of all RSVP sessions to its neighbor and waits for a new Hello message.

Once the Hello message is received indicating the restarting node preserved state, the helper node enters the recovery phase in which it starts refreshing all the sessions that were preserved. The restarting node will activate all the stale sessions that are refreshed by the helper node. Any Path state that did not get a Resv message from the restarting node once the Recovery Phase time is over is considered to have expired and is deleted by the helper node causing the proper Path Tear generation downstream.

The duration of the restart phase (recovery phase) is equal to the minimum of the neighbor’s advertised Restart Time (Recovery Time) in its last Hello message and the locally configured value of the max-restart (max-recovery) parameter.

When GR helper is enabled on an RSVP interface, its procedures apply to the state of both P2P and P2MP RSVP LSP to a neighbor over this interface.
Enhancements to RSVP control plane congestion control

The RSVP control plane makes use of a global flow control mechanism to adjust the rate of Path messages for unmapped LSP paths sent to the network under congestion conditions. When a Path message for establishing a new LSP path or retrying an LSP path that failed is sent out, the control plane keeps track of the rate of successful establishment of these paths and adjusts the number of Path messages it sends per second to reflect the success ratio.

In addition, an option to enable an exponential back-off retry-timer is available. When an LSP path establishment attempt fails, the path is put into retry procedures and a new attempt will be performed at the expiry of the user-configurable retry-timer. By default, the retry time is constant. The exponential back-off timer procedures will double the value of the user configurable retry-timer value at every failure of the attempt to adjust to the potential network congestion that caused the failure. An LSP establishment fails if no Resv message was received and the Path message retry-timer expired, or a PathErr message was received before the timer expired.

Three enhancements to this flow-control mechanism to improve congestion handling in the rest of the network are supported.

The first enhancement is the change to the LSP path retry procedure. If the establishment attempt failed due to a Path message timeout and no Resv was received, the next attempt will be performed at the expiry of a new LSP path initial retry-timer instead of the existing retry-timer. While the LSP path initial retry-timer is still running, a refresh of the Path message using the same path and the same LSP-id is performed according to the configuration of the refresh-timer. Once the LSP path initial retry-timer expires, the ingress LER then puts this path on the regular retry-timer to schedule the next path signaling using a new computed path by CSPF and a new LSP-id.

The benefits of this enhancement is that the user can now control how many refreshes of the pending PATH state can be performed before starting a new retry-cycle with a new LSP-id. This is all done without affecting the ability to react faster to failures of the LSP path, which will continue to be governed by the existing retry-timer. By configuring the LSP path initial retry-timer to values that are larger than the retry-timer, the ingress LER will decrease the probability of overwhelming a congested LSR with new state while the previous states installed by the same LSP are lingering and will only be removed after the refresh timeout period expires.

The second enhancement consists of applying a jitter +/- 25% to the value of the retry-timer similar to how it is currently done for the refresh timer. This will further decrease the probability that ingress LER nodes synchronize their sending of Path messages during the retry-procedure in response to a congestion event in the network.

The third enhances the RSVP flow control mechanism by taking into account new parameters: outstanding CSPF requests, Resv timeouts and Path timeouts.
RSVP LSP Statistics

This feature provides the following counters:

- Per forwarding class forwarded in-profile packet count
- Per forwarding class forwarded in-profile byte count
- Per forwarding class forwarded out of profile packet count
- Per forwarding class forwarded out of profile byte count

The counters are available for an RSVP LSP at the egress datapath of an ingress LER and at the ingress datapath of an egress LER. No LSR statistics are provided.

This feature is supported on IOM-2 and IOM-3 and requires chassis mode C or higher.
Configuring Implicit Null

The implicit null label option allows a 7x50 egress LER to receive MPLS packets from the previous hop without the outer LSP label. The operation of the previous hop is referred to as penultimate hop popping (PHP).

This option is signaled by the egress LER to the previous hop during the LSP signaling with RSVP control protocol. In addition, the egress LER can be configured to receive MPLS packet with the implicit null label on a static LSP.

The user can configure your router to signal the implicit null label value over all RSVP interfaces and for all RSVP LSPs for which this node is the egress LER using the `implicit-null-label` command in the `config>router>rsvp` context.

The user must shutdown RSVP before being able to change the implicit null configuration option.

The user can also override the RSVP level configuration for a specific RSVP interface:

```
config>router>rsvp>interface>implicit-null-label {enable | disable}
```

All LSPs for which this node is the egress LER and for which the path message is received from the previous hop node over this RSVP interface will signal the implicit null label. This means that if the egress LER is also the merge-point (MP) node, then the incoming interface for the path refresh message over the bypass dictates if the packet will use the implicit null label or not. The same for a 1-to-1 detour LSP.

By default, an RSVP interface inherits the RSVP level configuration. The user must shutdown the RSVP interface before being able to change the implicit null configuration option. Note that the RSVP interface must be shutdown regardless if the new value for the interface is the same or different than the one it is currently using.

The egress LER does not signal the implicit null label value on P2MP RSVP LSPs. However, the PHP node can honor a Resv message with the label value set to the implicit null value when the egress LER is a third party implementation.

The implicit null label option is also supported on a static label LSP. The following commands can be used to cause the node to push or to swap to an implicit null label on the MPLS packet:

```
config>router>mpls>static-lsp>push implicit-null-label nexthop ip-address
```
```
config>router>mpls>interface>label-map>swap implicit-null-label nexthop ip-address
```
Traffic Engineering

Without traffic engineering, routers route traffic according to the SPF algorithm, disregarding congestion or packet types.

With traffic engineering, network traffic is routed efficiently to maximize throughput and minimize delay. Traffic engineering facilitates traffic flows to be mapped to the destination through a different (less congested) path other than the one selected by the SPF algorithm.

MPLS directs a flow of IP packets along a label switched path (LSP). LSPs are simplex, meaning that the traffic flows in one direction (unidirectional) from an ingress router to an egress router. Two LSPs are required for duplex traffic. Each LSP carries traffic in a specific direction, forwarding packets from one router to the next across the MPLS domain.

When an ingress router receives a packet, it adds an MPLS header to the packet and forwards it to the next hop in the LSP. The labeled packet is forwarded along the LSP path until it reaches the destination point. The MPLS header is removed and the packet is forwarded based on Layer 3 information such as the IP destination address. The physical path of the LSP is not constrained to the shortest path that the IGP would choose to reach the destination IP address.
TE Metric (IS-IS and OSPF)

When the use of the TE metric is selected for an LSP, the shortest path computation after the TE constraints are applied will select an LSP path based on the TE metric instead of the IGP metric. The user configures the TE metric under the MPLS interface. Both the TE and IGP metrics are advertised by OSPF and IS-IS for each link in the network. The TE metric is part of the traffic engineering extensions of both IGP protocols.

A typical application of the TE metric is to allow CSPF to represent a dual TE topology for the purpose of computing LSP paths.

An LSP dedicated for real-time and delay sensitive user and control traffic has its path computed by CSPF using the TE metric. The user configures the TE metric to represent the delay figure, or a combined delay/jitter figure, of the link. In this case, the shortest path satisfying the constraints of the LSP path will effectively represent the shortest delay path.

An LSP dedicated for non delay sensitive user and control traffic has its path computed by CSPF using the IGP metric. The IGP metric could represent the link bandwidth or some other figure as required.

When the use of the TE metric is enabled for an LSP, CSPF will first prune all links in the network topology that do not meet the constraints specified for the LSP path. These constraints include bandwidth, admin-groups, and hop limit. CSPF will then run an SPF on the remaining links. The shortest path among the all SPF paths will be selected based on the TE metric instead of the IGP metric which is used by default. Note that the TE metric is only used in CSPF computations for MPLS paths and not in the regular SPF computation for IP reachability.
Diff-Serv Traffic Engineering

Diff-Serv traffic engineering provides the ability to manage bandwidth on a per Traffic Engineering (TE) class basis as per RFC 4124. In the base traffic engineering, LER computes LSP paths based on available BW of links on the path. Diff-Serv TE adds ability to perform this on a per TE class basis.

A TE class is a combination of Class Type and LSP priority. A Class Type is mapped to one or more system Forwarding Classes using a configuration profile. The operator sets different limits for admission control of LSPs in each TE class over each TE link. Eight TE classes are supported. Admission control of LSP paths bandwidth reservation is performed using the Maximum Allocation Bandwidth Constraint Model as per RFC 4125.

Mapping of Traffic to a Diff-Serv LSP

An LER will allow the operator to map traffic to a Diff-Serv LSP through one of the following methods:

1. Explicit RSVP SDP configuration of a VLL, VPLS, or VPRN service.
2. Class-based forwarding in an RSVP SDP. The operator can enable the checking by RSVP that a Forwarding Class (FC) mapping to an LSP under the SDP configuration is compatible with the Diff-Serv Class Type (CT) configuration for this LSP.
3. Auto-bind RSVP-TE option in a VPRN service.
4. Static routes with indirect next-hop being an RSVP LSP name.

Admission Control of Classes

There are a couple of admission control decisions made when an LSP with a specified bandwidth is to be signaled. The first is in the head-end node. CSPF will only consider network links that have sufficient bandwidth. Link bandwidth information is provided by IGP TE advertisement by all nodes in that network.

Another decision made is local CAC and is performed when the RESV message for the LSP path is received in the reverse direction by a SR OS node in that path. The bandwidth value selected by the egress LER will be checked against link bandwidth, otherwise the reservation is rejected. If accepted, the new value for the remaining link bandwidth will be advertised by IGP at the next advertisement event.

Both of these admission decisions are enhanced to be performed at the TE class level when Diff-Serv TE is enabled. In other words, CSPF in the head-end node will need to check the LSP...
bandwidth against the ‘unreserved bandwidth’ advertised for all links in the path of the LSP for that TE class which consists of a combination of a CT and a priority. Same for the admission control at SR OS node receiving the Resv message.

---

**Maximum Allocation Model**

The admission control rules for this model are described in RFC 4125. Each CT shares a percentage of the Maximum Reservable Link Bandwidth through the user-configured BC for this CT. The Maximum Reservable Link Bandwidth is the link bandwidth multiplied by the RSVP interface subscription factor.

The sum of all BC values across all CTs will not exceed the Maximum Reservable Link Bandwidth. In other words, the following rule is enforced:

\[
\text{SUM (BC}_c\text{)} <= \text{Max-Reservable-Bandwidth, } 0 <= c <= 7
\]

An LSP of class-type CTc, setup priority p, holding priority h (h<=p), and bandwidth B is admitted into a link if the following condition is satisfied:

\[
B <= \text{Unreserved Bandwidth for TE-Class}[i]
\]

where TE-Class [i] maps to < CTc, p > in the definition of the TE classes on the node. The bandwidth reservation is effected at the holding priority, i.e., in TE-class [j] = <CTc, h>. Thus, the reserved bandwidth for CTc and the unreserved bandwidth for the TE classes using CTc are updated as follows:

\[
\text{Reserved}(\text{CTc}) = \text{Reserved}(\text{CTc}) + B
\]

\[
\text{Unreserved TE-Class } [j] = \text{BC}_c - \text{SUM (Reserved(CTc,q)) for } 0 <= q <= h
\]

\[
\text{Unreserved TE-Class } [i] = \text{BC}_c - \text{SUM (Reserved(CTc,q)) for } 0 <= q <= p
\]

The same is done to update the unreserved bandwidth for any other TE class making use of the same CTc. These new values are advertised to the rest of the network at the next IGP-TE flooding.

When Diff-Serv is disabled on the node, this model degenerates into a single default CT internally with eight pre-emption priorities and a non-configurable BC equal to the Maximum Reservable Link Bandwidth. This would behave exactly like CT0 with eight pre-emption priorities and BC= Maximum Reservable Link Bandwidth if Diff-Serv was enabled.
Russian Doll Model

The RDM model is defined using the following equations:

$$\text{SUM (Reserved (CTc))} \leq B_{Cb},$$

where the SUM is across all values of $c$ in the range $b \leq c \leq (\text{MaxCT} - 1)$, and $B_{Cb}$ is the bandwidth constraint of $CT_b$.

$B_{C0} = \text{Max-Reservable-Bandwidth}$, so that:

$$\text{SUM (Reserved(CTc))} \leq \text{Max-Reservable-Bandwidth},$$

where the SUM is across all values of $c$ in the range $0 \leq c \leq (\text{MaxCT} - 1)$.

An LSP of class-type $CT_c$, setup priority $p$, holding priority $h$ ($h < p$), and bandwidth $B$ is admitted into a link if the following condition is satisfied:

$$B \leq \text{Unreserved Bandwidth for TE-Class[i]},$$

where $\text{TE-Class [i]}$ maps to $<CT_c, p>$ in the definition of the TE classes on the node. The bandwidth reservation is effectuated at the holding priority, i.e., in $\text{TE-class [j]} = <CT_c, h>$. Thus, the reserved bandwidth for $CT_c$ and the unreserved bandwidth for the TE classes using $CT_c$ are updated as follows:

$$\text{Reserved(CTc)} = \text{Reserved(CTc)} + B$$

$$\text{Unreserved TE-Class [j]} = \text{Unreserved (CTc, h)} = \text{Min} [$$

$$B_{Cc} - \text{SUM (Reserved (CTb, q) for 0<=q <= h, e <= b <= 7,}$$

$$B_{C(c-1)} - \text{SUM (Reserved (CTb, q) for 0<=q <= h, (c-1) <= b <= 7,}$$

$$\text{Unreserved TE-Class [i]} = \text{Unreserved (CTc, p)} = \text{Min} [$$

$$B_{Cc} - \text{SUM (Reserved (CTb, q) for 0<=q <= p, e <= b <= 7,}$$

$$B_{C(c-1)} - \text{SUM (Reserved (CTb, q) for 0<=q <= p, (c-1) <= b <= 7,}$$

$$\text{The same is done to update the unreserved bandwidth for any other TE class making use of the same CTc. These new values are advertised to the rest of the network at the next IGP-TE flooding.}$$
Example CT Bandwidth Sharing with RDM

Below is a simple example with two CT values (CT0, CT1) and one priority 0 as shown in Figure 7.

Suppose CT1 bandwidth, or the CT1 percentage of Maximum Reservable Bandwidth to be more accurate is 100 Mbps and CT2 bandwidth is 100 Mbps and link bandwidth is 200 Mbps. BC constraints can be calculated as follows.

BC1 = CT1 Bandwidth = 100 Mbps.

BC0 = {CT1 Bandwidth} + {CT0 Bandwidth} = 200 Mbps.

Suppose an LSP comes with CT1, setup and holding priorities of 0 and a bandwidth of 50 Mbps.
According to the RDM admission control policy:

Reserved (CT1, 0) = 50 <= 100 Mbps

Reserved (CT0, 0) + Reserved (CT1, 0) = 50 <= 200 Mbps

This results in the following unreserved bandwidth calculation.

Unreserved (CT1, 0) = BC1 – Reserved (CT1, 0) = 100 – 50 = 50 Mbps

Unreserved (CT0, 0) = BC0 – Reserved (CT0, 0) – Reserved (CT1, 0) = 200 – 0 – 50 = 150 Mbps.

Note that bandwidth reserved by a doll is not available to itself as well any of the outer dolls.

Suppose now another LSP comes with CT0, setup and holding priorities of 0 and a bandwidth 120 Mbps.
120 MB, Reserved, 20MB taken from CT1

Reserved (CT0, 0) = 120 <= 150 Mbps

Reserved (CT0, 0) + Reserved (CT1, 0) = 120 + 50 = 170 <= 200 Mbps

Unreserved (CT0, 0) = 150 - 120 = 30 Mbps

If we simply checked BC1, the formula would yield the wrong results:

Unreserved (CT1, 0) = BC1 – Reserved (CT1, 0) = 100 - 50 = 50 Mbps

Because of the encroaching of CT0 into CT1, we would need to deduct the overlapping reservation. This would then yield:

Unreserved (CT1, 0) = BC0 – Reserved (CT0, 0) – Reserved (CT1, 0) = 200 – 120 - 50 = 30 Mbps, which is the correct figure.

Extending the formula with both equations:

Unreserved (CT1, 0) = Min [BC1 – Reserved (CT1, 0), BC0 – Reserved (CT0, 0) – Reserved (CT1, 0)] = Min [100 – 50, 200 – 120 – 50] = 30 Mbps

Note that an outer doll can encroach into inner doll reducing the bandwidth available for inner dolls.
RSVP Control Plane Extensions

RSVP will use the Class Type object to carry LSP class-type information during path setup. Eight values will be supported for class-types 0 through 7 as per RFC 4124. Class type 0 is the default class which is supported today on the router.

One or more forwarding classes will map to a Diff-Serv class type through a system level configuration.

IGP Extensions

IGP extensions are defined in RFC 4124. Diff-Serv TE advertises link available bandwidth, referred to as unreserved bandwidth, by OSPF TE or IS-IS TE on a per TE class basis. A TE class is a combination of a class type and an LSP priority. In order to reduce the amount of per TE class flooding required in the network, the number of TE classes is set to eight. This means that eight class types can be supported with a single priority or four class types with two priorities, etc. In that case, the operator configures the desired class type on the LSP such that RSVP-TE can signal it in the class-type object in the path message.

IGP will continue to advertise the existing Maximum Reservable Link Bandwidth TE parameter to mean the maximum bandwidth that can be booked on a given interface by all classes. The value advertised is adjusted with the link subscription factor.
Diff-Serv TE Configuration and Operation

RSVP Protocol Level

The following are the configuration steps at the RSVP protocol level:

1. The operator enables Diff-Serv TE by executing the `diffserv-te` command in the `config>router>rsvp` context. When this command is enabled, IS-IS and OSPF will start advertising available bandwidth for each TE class configured under the `diffserv-te` node. The operator can disable Diff-Serv TE globally by using the `no` form of the command.

2. The enabling or disabling of Diff-Serv on the system requires that the RSVP and MPLS protocol be shutdown. The operator must execute the `no shutdown` command in each context once all parameters under both protocols are defined. When saved in the configuration file, the `no shutdown` command is automatically inserted under both protocols to make sure they come up after a node reboot.

3. IGP will advertise the available bandwidth in each TE class in the unreserved bandwidth TE parameter for that class for each RSVP interface in the system.

4. In addition, IGP will continue to advertise the existing Maximum Reservable Link Bandwidth TE parameter so the maximum bandwidth that can be booked on a given interface by all classes. The value advertised is adjusted with the link subscription factor configured in the `config>router>rsvp>interface>subscription percentage` context.

5. The operator can overbook (underbook) the maximum reservable bandwidth of a given CT by overbooking (underbooking) the interface maximum reservable bandwidth by configuring the appropriate value for the `subscription percentage` parameter.

6. The `diffserv-te` command will only have effect if the operator has already enabled traffic engineering at the IS-IS and/or OSPF routing protocol levels:
   
   ```
   config>router>isis>traffic-engineering
   and/or:
   config>router>ospf>traffic-engineering
   ```

7. The following Diff-Serv TE parameters are configured globally under the `diffserv-te` node. They apply to all RSVP interfaces on the system. Once configured, these parameters can only be changed after shutting down the MPLS and RSVP protocols:
   
   a. Definition of TE classes, TE Class = {Class Type (CT), LSP priority}. Eight TE classes can be supported. There is no default TE class once Diff-Serv is enabled. The operator must explicitly define each TE class. However, when Diff-Serv is disabled there will be an internal use of the default CT (CT0) and eight pre-emption priorities as shown in Table 3.
b. A mapping of the system forwarding class to CT. The default settings are shown in Table 4.

Table 3: Internal TE Class Definition when Diff-Serv TE is Disabled

<table>
<thead>
<tr>
<th>Class Type (CT internal)</th>
<th>LSP Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 4: Default Mapping of Forwarding Class to TE Class

<table>
<thead>
<tr>
<th>FC ID</th>
<th>FC Name</th>
<th>FC Designation</th>
<th>Class Type (CT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Network Control</td>
<td>NC</td>
<td>7</td>
</tr>
<tr>
<td>6</td>
<td>High-1</td>
<td>H1</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>Expedited</td>
<td>EF</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>High-2</td>
<td>H2</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>Low-1</td>
<td>L1</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Assured</td>
<td>AF</td>
<td>2</td>
</tr>
<tr>
<td>1</td>
<td>Low-2</td>
<td>L2</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>Best Effort</td>
<td>BE</td>
<td>0</td>
</tr>
</tbody>
</table>

c. Configuration of the percentage of RSVP interface bandwidth each CT shares, for example, the Bandwidth Constraint (BC), using the `class-type-bw` command. The absolute value of the CT share of the interface bandwidth is derived as the percentage of the bandwidth advertised by IGP in the maximum reservable link bandwidth TE parameter, for example, the link bandwidth multiplied by the RSVP interface subscription `percentage` parameter. Note that this configuration also exists at the RSVP.
interface level and the interface specific configured value overrides the global configured value. The BC value can be changed at any time. The operator can specify the BC for a CT which is not used in any of the TE class definition but that does not get used by any LSP originating or transiting this node.

d. Configuration of the Admission Control Policy to be used: only the Maximum Allocation Model (MAM) is supported. The MAM value represents the bandwidth constraint models for the admission control of an LSP reservation to a link.

RSVP Interface Level

The following are the configuration steps at the RSVP interface level:

1. The operator configures the percentage of RSVP interface bandwidth each CT shares, for example, the BC, using the class-type-bw command. The value entered at the interface level overrides the global value configured under the diffserv-te node.

2. The operator can overbook (underbook) the maximum reservable bandwidth of a given CT by overbooking (underbooking) the interface maximum reservable bandwidth via configuring the appropriate value for the subscription percentage parameter in the config>router>rsvp>interface context.

3. Both the BC value and the subscription parameter can be changed at any time.

LSP and LSP Path Levels

The following are the configuration steps at the LSP and LSP path levels:

1. The operator configures the CT in which the LSP belongs by configuring the class-type ct-number command at the LSP level and/or the path level. The path level value overrides the LSP level value. By default, an LSP belongs to CT0.

2. Only one CT per LSP path is allowed per RFC 4124, Protocol Extensions for Support of Diffserv-aware MPLS Traffic Engineering. A multi-class LSP path is achieved through mapping multiple system Forwarding Classes to a CT.

3. The signaled CT of a dynamic bypass must always be CT0 regardless of the CT of the primary LSP path. The setup and hold priorities must be set to default values, for example, 7 and 0 respectively. This assumes that the operator configured a couple of TE classes, one which combines CT0 and a priority of 7 and the other which combines CTO and a priority of 0. If not, the bypass LSP will not be signaled and will go into the down state.

4. The operator cannot configure the CT, setup priority, and holding priority of a manual bypass. They are always signaled with CT0 and the default setup and holding priorities.
5. The signaled CT, setup priority and holding priority of a detour LSP matches those of the primary LSP path it is associated with.

6. The operator can also configure the setup and holding priorities for each LSP path.

7. An LSP which does not have the CT explicitly configured will behave like a CT0 LSP when Diff-Serv is enabled.

If the operator configured a combination of a CT and a setup priority and/or a combination of a CT and a holding priority for an LSP path that are not supported by the user-defined TE classes, the LSP path will be kept in a down state and error code will be shown within the show command output for the LSP path.
Diff-Serv TE LSP Class Type Change under Failure

An option to configure a main Class Type (CT) and a backup CT for the primary path of a Diff-Serv TE LSP is provided. The main CT is used under normal operating conditions, for example, when the LSP is established the first time and when it gets re-optimized due to timer based or manual re-signal. The backup CT is used when the LSP retries under failure.

The use of backup Class Type (CT) by an LSP is enabled by executing the `config>router>mpls>lsp>primary>backup-class-type ct-number` command at the LSP primary path level.

When this option is enabled, the LSP will use the CT configured using the following commands (whichever is inherited at the primary path level) as the main CT:

- `config>router>mpls>lsp>class-type ct-number`
- `config>router>mpls>lsp>primary>class-type ct-number`

The main CT is used at initial establishment and during a manual or a timer based re-signal Make-Before-Break (MBB) of the LSP primary path. The backup CT is used temporarily to signal the LSP primary path when it fails and goes into retry.

Note that any valid values may be entered for the backup CT and main CT, but they cannot be the same. No check is performed to make sure that the backup CT is a lower CT in Diff-Serv Russian-Doll Model (RDM) admission control context.

The secondary paths of the same LSP are always signaled using the main CT as in existing implementation.

LSP Primary Path Retry Procedures

This feature behaves according to the following procedures.

- When a LSP primary path retries due a failure, for example, it fails after being in the up state, or undergoes any type of MBB, MPLS will retry a new path for the LSP using the main CT. If the first attempt failed, the head-end node performs subsequent retries using the backup CT. This procedure must be followed regardless if the currently used CT by this path is the main or backup CT. This applies to both CSPF and non-CSPF LSPs.
- The triggers for using the backup CT after the first retry attempt are:
  - A local interface failure or a control plane failure (hello timeout, etc.).
  - Receipt of a PathErr message with a notification of a FRR protection becoming active downstream and/or receipt of a Resv message with a ‘Local-Protection-In-Use’ flag set. This invokes the FRR Global Revertive MBB.
→ Receipt of a PathErr message with error code=25 (Notify) and sub-code=7 (Local link maintenance required) or a sub-code=8 (Local node maintenance required). This invokes the TE Graceful Shutdown MBB. Note that in this case, only a single attempt is performed by MBB as in current implementation; only the main CT will be retried.

→ Receipt of a Resv refresh message with the ‘Preemption pending’ flag set or a PathErr message with error code=34 (Reroute) and a value=1 (Reroute request soft pre-emption). This invokes the soft pre-emption MBB.

→ Receipt of a ResvTear message.

→ A configuration change MBB.

• When an unmapped LSP primary path goes into retry, it uses the main CT until the number of retries reaches the value of the new main-ct-retry-limit parameter. If the path did not come up, it must start using the backup CT at that point in time. By default, this parameter is set to infinite value. The new main-ct-retry-limit parameter has no effect on an LSP primary path, which retries due to a failure event. This parameter is configured using the `main-ct-retry-limit` command in the `config>router>mpls>lsp` context. If the user entered a value of the `main-ct-retry-limit` parameter that is greater than the LSP retry-limit, the number of retries will still stop when the LSP primary path reaches the value of the LSP retry-limit. In other words, the meaning of the LSP retry-limit parameter is not changed and always represents the upper bound on the number of retries. The unmapped LSP primary path behavior applies to both CSPF and non-CSPF LSPs.

• An unmapped LSP primary path is a path that never received a Resv in response to the first path message sent. This can occur when performing a “shut/no-shut” on the LSP or LSP primary path or when the node reboots. An unmapped LSP primary path goes into retry if the retry timer expired or the head-end node received a PathErr message before the retry timer expired.

• When the `clear>router>mpls>lsp` command is executed, the retry behavior for this LSP is the same as in the case of an unmapped LSP.

• If the value of the parameter main-ct-retry-limit is changed, the new value will only be used at the next time the LSP path is put into a “no-shut” state.

• The following is the behavior when the user changes the main or backup CT:

  → If the user changes the LSP level CT, all paths of the LSP are torn down and re-signaled in a break-before-make fashion. Specifically, the LSP primary path will be torn down and re-signaled even if it is currently using the backup CT.

  → If the user changes the main CT of the LSP primary path, the path will be torn down and re-signaled even if it is currently using the backup CT.

  → If the user changes the backup CT of an LSP primary path when the backup CT is in use, the path is torn down and is re-signaled.

  → If the user changes the backup CT of an LSP primary path when the backup CT is not in use, no action is taken. If however, the path was in global Revertive, gshut, or soft pre-emption MBB, the MBB is restarted. This actually means the first attempt will be with the main CT and subsequent ones, if any, with the new value of the backup CT.
Consider the following priority of the various MBB types from highest to lowest: Delayed Retry, Preemption, Global Revertive, Configuration Change, and TE Graceful Shutdown. If an MBB request occurs while a higher priority MBB is in progress, the latter MBB will be restarted. This actually means the first attempt will be with the main CT and subsequent ones, if any, with the new value of the backup CT.

- If the least-fill option is enabled at the LSP level, then CSPF must use least-fill equal cost path selection when the main or backup CT is used on the primary path.
- When the re-signal timer expires, CSPF will try to find a path with the main CT. The head-end node must re-signal the LSP even if the new path found by CSPF is identical to the existing one since the idea is to restore the main CT for the primary path. If a path with main CT is not found, the LSP remains on its current primary path using the backup CT. This means that the LSP primary path with the backup CT may no longer be the most optimal one. Furthermore, if the least-fill option was enabled at the LSP level, CSPF will not check if there is a more optimal path, with the backup CT, according to the least-fill criterion and will thus raise no trap to indicate the LSP path is eligible for least-fill re-optimization.
- When the user performs a manual re-signal of the primary path, CSPF will try to find a path with the main CT. The head-end node must re-signal the LSP as in current implementation.
- If a CPM switchover occurs while an the LSP primary path was in retry using the main or backup CT, for example, was still in operationally down state, the path retry will be restarted with the main CT until it comes up. This is because the LSP path retry count is not synchronized between the active and standby CPMs until the path becomes up.
- When the user configured secondary standby and non-standby paths on the same LSP, the switchover behavior between primary and secondary is the same as in existing implementation.

This feature is not supported on a P2MP LSP.
Bandwidth Sharing Across Class Types

In order to allow different levels of booking of network links under normal operating conditions and under failure conditions, it is necessary to allow sharing of bandwidth across class types.

This feature introduces the Russian-Doll Model (RDM) Diff-Serv TE admission control policy described in RFC 4127, Russian Dolls Bandwidth Constraints Model for Diffserv-aware MPLS Traffic Engineering. This mode is enabled using the following command:
\[
\text{config}\gt\text{router}\gt\text{rsvp}\gt\text{diffserv-te rdm}.
\]

The Russian Doll Model (RDM) LSP admission control policy allows bandwidth sharing across Class Types (CTs). It provides a hierarchical model by which the reserved bandwidth of a CT is the sum of the reserved bandwidths of the numerically equal and higher CTs.

CT2 has a bandwidth constraint BC2 which represents a percentage of the maximum reservable link bandwidth. Both CT2 and CT1 can share BC1 which is the sum of the percentage of the maximum reservable bandwidth values configured for CT2 and CT1 respectively. Finally, CT2, CT1, and CT0 together can share BC0 which is the sum of the percentage of the maximum reservable bandwidth values configured for CT2, CT1, and CT0 respectively. The maximum value for BC0 is of course the maximum reservable link bandwidth.

What this means in practice is that CT0 LSPs can use up to BC0 in the absence of LSPs in CT1 and CT2. When this occurs and a CT2 LSP with a reservation less than or equal to BC2 requests admission, it is only admitted by preempting one or more CT0 LSPs of lower holding priority than this LSP setup priority. Otherwise, the reservation request for the CT2 LSP will be rejected.
It is required that multiple paths of the same LSP share common link bandwidth since they are signaled using the Shared Explicit (SE) style. Specifically, two instances of a primary path, one with the main CT and the other with the backup CT, must temporarily share bandwidth while MBB is in progress. Also, a primary path and one or many secondary paths of the same LSP must share bandwidth whether they are configured with the same or different CTs.
Downgrading the CT of Bandwidth Sharing LSP Paths

Consider a link configured with two class types CT0 and CT1 and making use of the RDM admission control model as shown in Figure 11.

![Diagram showing bandwidth sharing](image)

**Figure 11: Sharing bandwidth when an LSP primary path is downgraded to backup CT**

Consider an LSP path Z occupying bandwidth B at CT1. BC0 being the sum of all CTs below it, the bandwidth occupied in CT1 is guaranteed to be available in CT0. Thus when new path X of the same LSP for CT0 is setup, it will use the same bandwidth B as used by path Z as shown in Figure 11 (a). When path Z is torn down the same bandwidth now occupies CT0 as shown in Figure 11 (b). Even if there were no new BW available in CT0 as can be seen in Figure 11 (c), path X can always share the bandwidth with path Z.

CSPF at the head-end node and CAC at the transit LSR node will share bandwidth of an existing path when its CT is downgraded in the new path of the same LSP.
Upgrading the CT of Bandwidth Sharing LSP Paths

When upgrading the CT the following issue can be apparent. Assume an LSP path X exists with CT0. An attempt is made to upgrade this path to a new path Z with CT1 using an MBB.

![Figure 12: Sharing Bandwidth When an LSP Primary Path is Upgraded to Main CT](image)

In Figure 12 (a), if the path X occupies the bandwidth as shown it can not share the bandwidth with the new path Z being setup. If a condition exists, as shown in Figure 12, (b) the path Z can never be setup on this particular link.

Consider Figure 12 (c). The CT0 has a region that overlaps with CT1 as CT0 has incursion into CT1. This overlap can be shared. However, in order to find whether such an incursion has occurred and how large the region is, it is required to know the reserved bandwidths in each class. Currently, IGP-TE advertises only the unreserved bandwidths. Hence, it is not possible to compute these overlap regions at the head end during CSPF. Moreover, the head end needs to then try and mimic each of the traversed links exactly which increases the complexity.

CSPF at the head-end node will only attempt to signal the LSP path with an upgraded CT if the advertised bandwidth for that CT can accommodate the bandwidth. In other words, it will assume that in the worst case this path will not share bandwidth with another path of the same LSP using a lower CT.
Advanced MPLS/RSVP Features

- Extending RSVP LSP to use Loopback Interfaces Other Than router-id on page 69
- LSP Path Change on page 69
- RSVP-TE LSP Shortcut for IGP Resolution on page 74
- Shared Risk Link Groups on page 80
- TE Graceful Shutdown on page 84
- Soft Pre-emption of Diff-Serv RSVP LSP on page 84
- Least-Fill Bandwidth Rule in CSPF ECMP Selection on page 85

Extending RSVP LSP to use Loopback Interfaces Other Than router-id

It is possible to configure the address of a loopback interface, other than the router-id, as the destination of an RSVP LSP, or a P2MP S2L sub-LSP. In the case of a CSPF LSP, CSPF searches for the best path that matches the constraints across all areas and levels of the IGP where this address is reachable. If the address is the router-id of the destination node, then CSPF selects the best path across all areas and levels of the IGP for that router-id; regardless of which area and level the router-id is reachable as an interface.

In addition, the user can now configure the address of a loopback interface, other than the router-id, as a hop in the LSP path hop definition. If the hop is strict and corresponds to the router-id of the node, the CSPF path can use any TE enabled link to the downstream node, based on best cost. If the hop is strict and does not correspond to the router-id of the node, then CSPF will fail.

LSP Path Change

The tools perform router mpls update-path {lsp lsp-name path current-path-name new-path new-path-name} command instructs MPLS to replace the path of the primary or secondary LSP.

The primary or secondary LSP path is indirectly identified via the current-path-name value. In existing implementation, the same path name cannot be used more than once in a given LSP name.

This command is also supported on an SNMP interface.

This command applies to both CSPF LSP and to a non-CSPF LSP. However, it will only be honored when the specified current-path-name has the adaptive option enabled. The adaptive option can be enabled the LSP level or at the path level.
The new path must be first configured in CLI or provided via SNMP. The **configure router mpls path path-name** CLI command is used to enter the path.

The command fails if any of the following conditions are satisfied:

- The specified current-path-name of this LSP does not have the adaptive option enabled.
- The specified new-path-name value does not correspond to a previously defined path.
- The specified new-path-name value exists but is being used by any path of the same LSP, including this one.

When the command is executed, MPLS performs the following procedures:

- MPLS performs a single MBB attempt to move the LSP path to the new path.
- If the MBB is successful, MPLS updates the new path.
  - MPLS writes the corresponding NHLFE in the data path if this path is the current backup path for the primary.
  - If the current path is the active LSP path, it will update the path, write the new NHLFE in the data path, which will cause traffic to switch to the new path.
- If the MBB is not successful, the path retains its current value.
- The update-path MBB has the same priority as the manual re-signal MBB.
Manual LSP Path Switch

This feature provides a new command to move the path of an LSP from a standby secondary to another standby secondary.

The base version of the command allows the path of the LSP to move from a standby (or an active secondary) to another standby of the same priority. If a new standby path with a higher priority or a primary path comes up after the `tools perform` command is executed, the path re-evaluation command runs and the path is moved to the path specified by the outcome of the re-evaluation.

The CLI command for the base version is:

```
tools perform router mpls switch-path lsp lsp-name path path-name
```

The sticky version of the command can be used to move from a standby path to any other standby path regardless of priority. The LSP remains in the specified path until this path goes down or the user performs the no form of the `tools perform` command.

The CLI commands for the sticky version are:

```
tools perform router mpls force-switch-path lsp lsp-name path path-name
```

```
tools perform router mpls no force-switch-path lsp lsp-name
```

Make-Before-Break (MBB) Procedures for LSP/Path Parameter Configuration Change

When an LSP is switched from an existing working path to a new path, it is desirable to perform this in a hitless fashion. The Make-Before-Break (MBB) procedure consist of first signaling the new path when it is up, and having the ingress LER move the traffic to the new path. Only then the ingress LER tears down the original path.

MBB procedure is invoked during the following operations:

1. Timer based and manual re-signal of an LSP path.
2. Fast-ReRoute (FRR) global revertive procedures.
3. Soft Pre-emption of an LSP path.
4. Traffic-Engineering (TE) graceful shutdown procedures.
5. Update of secondary path due to an update to primary path SRLG.
6. LSP primary or secondary path name change.
7. LSP or path configuration parameter change.

In a prior implementation, item (7) covers the following parameters:

1. Changing the primary or secondary path bandwidth parameter on the fly.
2. Enabling the frr option for an LSP.

This feature extends the coverage of the MBB procedure to most of the other LSP level and Path level parameters as follows:

1. Changes to include/exclude of admin groups at LSP and path levels.
2. Enabling/disabling LSP level cs pf option.
3. Enabling/disabling LSP level use-te-metric parameter when cs pf option is enabled.
4. Enabling/disabling LSP level propagate-admin-group option.
5. Enabling/disabling LSP level hop-limit option in the fast-reroute context.
6. Enabling the LSP level least-fill option.
7. Enabling/disabling LSP level adspec option.
8. Enabling/disabling the LSP level cs pf-to-first-loose option.
9. Changing between node-protect and “no node-protect” (link-protect) values in the LSP level fast-reroute option.
10. Changing LSP primary or secondary path priority values (setup-priority and hold-priority).
11. Changing LSP primary or secondary path class-type value and primary path backup-class-type value.
12. Changing LSP level and path level hop-limit parameter value.
13. Enabling/disabling primary or secondary path record and record-label options.

This feature is not supported on a manual bypass LSP.

This release supports P2MP Tree Level Make-before-break operation if you change the following parameters on LSP-Template:

2. Enabling Fast-Re-Route on P2MP LSP-Template.
RSVP-TE LSP Shortcut for IGP Resolution

RSVP-TE LSP shortcut for IGP route resolution allows forwarding of packets to IGP learned routes using an RSVP-TE LSP. This is also referred to as IGP shortcut. The use of RSVP-TE shortcut for resolving IGP routes is enabled by entering the following command at the IS-IS routing protocol level or at the OSPF routing protocol instance level:

```
config>router>isis>rsvp-shortcut
config>router>ospf>rsvp-shortcut
```

These commands will instruct IS-IS and OSPF to include RSVP LSPs originating on this node and terminating on the router-id of a remote node as direct links with a metric equal to the operational metric provided by MPLS. By default, rsvp-shortcut is disabled in all IGP instances.

When rsvp-shortcut is enabled at the IGP instance level, all RSVP LSPs originating on this node are eligible by default as long as the destination address of the LSP as configured in config>router>mpls>lsp>to corresponds to a router-id of a remote node. RSVP LSPs with a destination address corresponding to an interface address of a remote node are automatically not considered by IS-IS or OSPF. It is possible to exclude a specific RSVP LSP from being used as a shortcut for resolving IGP routes by entering the `config>router>mpls>lsp>no igp-shortcut` command:

```
config>router>mpls>lsp>no igp-shortcut
```

Also, the SPF in OSPF or IS-IS will only use RSVP LSPs as IGP shortcuts or as endpoints for LDP-over-RSVP. These applications of RSVP LSPs are mutually exclusive at the IGP instance level. If the user enabled both options at the IGP instance level, then the shortcut application takes precedence when the LSP level configuration has both options enabled.

The user can enable LDP-over-RSVP in IGP using the following commands:

```
config>router>isis>ldp-over-rsvp
config>router>ospf>ldp-over-rsvp
```

LDP-over-RSVP can be enabled/disabled at the RSVP LSP level using the following command:

```
config>router>mpls>lsp>[no] ldp-over-rsvp
```

Table 5 provides the outcome of the configuration of the ldp-over-rsvp and rsvp-shortcut or igp-shortcut options at both the IGP instance level and at the LSP level. Whenever both options are enabled, the RSVP shortcut feature takes precedence and the RSVP LSP is used as a shortcut.
Table 5: Outcome of Configuration of LDP-over-LSP and RSVP-Shortcut or IGP-Shortcut

<table>
<thead>
<tr>
<th>LSP</th>
<th>Shortcut (Override case)</th>
<th>Shortcut (Override case)</th>
<th>LDP-over-RSVP</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>LSP</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LSP</td>
<td>Shortcut</td>
<td>Shortcut</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>LSP</td>
<td>None</td>
<td>None</td>
<td>LDP-over-RSVP</td>
<td>None</td>
</tr>
<tr>
<td>LSP</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>
RSVP-TE LSP Shortcut Forwarding Plane

When an IPv4 packet is received on an ingress network interface, a subscriber IES interface, or a regular IES interface, the lookup of the packet in RTM will result in the resolution of the packet to an RSVP LSP if all the following conditions are satisfied:

- RSVP shortcut is enabled on the IGP routing protocol which has a route for the packet’s destination address.
- SPF has pre-determined that the IGP path cost using the RSVP LSP shortcut is the best.

In this case, the packet is sent labeled with the label stack corresponding to the NHLFE of the RSVP LSP.

The failure of an RSVP LSP shortcut or of a local interface triggers a full SPF computation which may result in installing a new route over another RSVP LSP shortcut or a regular IP next-hop.

Note that if FRR is enabled on the RSVP LSP, the switchover of the shortcut packets from the failed primary path to the FRR bypass or detour backup path must be compatible with the ingress LER performance for service packets.

ECMP Considerations

When ECMP is enabled and multiple equal-cost paths exist for the IGP route, the ingress IOM will spray the packets for this route based on hashing routine currently supported for IPv4 packets. Spraying will be performed across a regular IP next-hop and across an RSVP shortcut next-hop as long as the IP path does not go over the tail-end of the RSVP LSP.

Handling of Control Packets

All control plane packets which require an RTM lookup and which destination is reachable over the RSVP shortcut will be forwarded over the shortcut. This is because RTM keeps a single route entry for each prefix except if there is ECMP over different outgoing interfaces.

Interface bound control packets are not impacted by the RSVP shortcut since RSVP LSPs with a destination address different than the router-id are not included by IGP in its SPF calculation.
Handling of Multicast Packets

Multicast packets cannot be forwarded or received from a P2P RSVP LSP. This is because there is no support for the configuration of such an LSP as a tunnel interfaces in PIM. Only an RSVP P2MP LSP is currently allowed. If a multicast packet is received over the physical interface and the RPF check indicates the source is reachable over an RSVP shortcut, the RPF check.

Thus, it is important to make sure that RSVP shortcuts are not enabled in the path to the multicast source.

Advertise LSP Tunnel Links in IGP

If configured, LSP shortcut must also be advertised into IGP similar to regular links such that other routers in the network can include it into their SPF computations. An LSP must exist in the reverse direction in order for the advertised link to pass the bi-directional link check and be usable by other routers in the network. However, this is not required for the node which originates the LSP. The LSP is advertised as an unnumbered point-to-point link and the link LSP/LSA has no Traffic Engineering opaque sub-TLVs as per RFC 3906, Calculating Interior Gateway Protocol (IGP) Routes Over Traffic Engineering Tunnels.

The advertisement of RSVP LSP shortcuts into IGP is configured using the following commands:

```
config>router>isis>advertise-tunnel-links
config>router>ospf>advertise-tunnel-links
```

By default, RSVP LSP shortcuts are not advertised into IGP.

LDP Forwarding over RSVP LSP Shortcut

The user can enable LDP FECs over RSVP-TE shortcuts by configuring T-LDP sessions to the destination of the RSVP LSP shortcuts. In this case, LDP FEC is tunneled over the RSVP LSP, effectively implementing LDP-over-RSVP without having to enable the ldp-over-rsvp feature in OSPF or IS-IS. The ldp-over-rsvp and igp-shortcut options are mutually exclusive under OSFP or IS-IS.
Disabling TTL Propagation in an LSP Shortcut

This feature provides the option for disabling TTL propagation from a transit or a locally generated IP packet header into the LSP label stack when an RSVP LSP is used as a shortcut for BGP next-hop resolution, a static-route next-hop resolution, or for an IGP route resolution.

A transit packet is a packet received from an IP interface and forwarded over the LSP shortcut at ingress LER.

A locally-generated IP packet is any control plane packet generated from the CPM and forwarded over the LSP shortcut at ingress LER.

TTL handling can be configured for all RSVP LSP shortcuts originating on an ingress LER using the following global commands:

```
config>router>mpls>[no] shortcut-transit-ttl-propagate
config>router>mpls>[no] shortcut-local-ttl-propagate
```

These commands apply to all RSVP LSPs which are used to resolve static routes, BGP routes, and IGP routes.

When the `no` form of the above command is enabled for local packets, TTL propagation is disabled on all locally generated IP packets, including ICMP Ping, trace route, and OAM packets that are destined to a route that is resolved to the LSP shortcut. In this case, a TTL of 255 is programmed onto the pushed label stack. This is referred to as pipe mode.

Similarly, when the `no` form is enabled for transit packets, TTL propagation is disabled on all IP packets received on any IES interface and destined to a route that is resolved to the LSP shortcut. In this case, a TTL of 255 is programmed onto the pushed label stack.
RSVP-TE LSP Signaling using LSP Template

LSP template can be used for signaling RSVP-TE LSP to far-end PE node that is detected based on auto-discovery method by a client application. RSVP-TE P2MP LSP signaling based on LSP template is supported for Multicast VPN application on SROS platform. LSP template avoids an explicit LSP or LSP S2L configuration for a node that is dynamically added as a receiver.

LSP template has option to configure traffic engineering parameters that apply to LSP that is setup using the template. Traffic engineering options that are currently supported are:

- adaptive
- admin-group
- bandwidth
- CSPF calculation
- fast-reroute
- hop-limit
- record-label
- retry-timer
Shared Risk Link Groups

Shared Risk Link Groups (SRLGs) is a feature that allows the user to establish a backup secondary LSP path or a FRR LSP path which is disjoint from the path of the primary LSP. Links that are members of the same SRLG represent resources sharing the same risk, for example, fiber links sharing the same conduit or multiple wavelengths sharing the same fiber.

When the SRLG option is enabled on a secondary path, CSPF includes the SRLG constraint in the computation of the secondary LSP path. This requires that the primary LSP already be established and up since the head-end LER needs the most current ERO computed by CSPF for the primary path. CSPF would return the list of SRLG groups along with the ERO during primary path CSPF computation. At a subsequent establishment of a secondary path with the SRLG constraint, the MPLS/RSVP task will query again CSPF providing the list of SRLG group numbers to be avoided. CSPF prunes all links with interfaces which belong to the same SRLGs as the interfaces included in the ERO of the primary path. If CSPF finds a path, the secondary is setup. If not, MPLS/RSVP will keep retrying the requests to CSPF.

When the SRLG option is enabled on FRR, CSPF includes the SRLG constraint in the computation of a FRR detour or bypass for protecting the primary LSP path. CSPF prunes all links with interfaces which belong to the same SRLG as the interface which is being protected, for example, the outgoing interface at the PLR the primary path is using. If one or more paths are found, the MPLS/RSVP task will select one based on best cost and will signal the bypass/detour. If not and the user included the strict option, the bypass/detour is not setup and the MPLS/RSVP task will keep retrying the request to CSPF. Otherwise, if a path exists which meets the other TE constraints, other than the SRLG one, the bypass/detour is setup.

A bypass or a detour LSP path is not guaranteed to be SRLG disjoint from the primary path. This is because only the SRLG constraint of the outgoing interface at the PLR that the primary path is using is avoided.

Enabling Disjoint Backup Paths

A typical application of the SRLG feature is to provide for an automatic placement of secondary backup LSPs or FRR bypass/detour LSPs that minimizes the probability of fate sharing with the path of the primary LSP (Figure 13).

The following details the steps necessary to create shared risk link groups:

- For primary/standby SRLG disjoint configuration:
  - Create an SRLG-group, similar to admin groups.
  - Link the SRLG-group to MPLS interfaces.
Configure primary and secondary LSP paths and enable SRLG on the secondary LSP path. Note that the SRLG secondary LSP path(s) will always perform a strict CSPF query. The `srlg-frr` command is irrelevant in this case (see `srlg-frr` on page 132).

- For FRR detours/bypass SRLG disjoint configuration:
  - Create an SRLG group, similar to admin groups.
  - Link the SRLG group to MPLS interfaces.
  - Enable the `srlg-frr` (strict/non-strict) option, which is a system-wide parameter, and it force every LSP path CSPF calculation, to take the configured SRLG membership(s) (and propagated through the IGP opaque-te-database) into account.
  - Configure primary FRR (one-to-one/facility) LSP path(s). Consider that each PLR will create a detour/bypass that will only avoid the SRLG membership(s) configured on the primary LSP path egress interface. In a one-to-one case, detour-detour merging is out of the control of the PLR, thus the latter will not ensure that its detour will be prohibited to merge with a colliding one. For facility bypass, with the presence of several bypass type to bind to, the following priority rules will be followed:
    1. Manual bypass disjoint
    2. Manual bypass non-disjoint (eligible only if srlg-frr is non-strict)
    3. Dynamic disjoint
    4. Dynamic non-disjoint (eligible only if srlg-frr is non-strict)

Non-CSPF manual bypass is not considered.
This feature is supported on OSPF and IS-IS interfaces on which RSVP is enabled.
Static Configurations of SRLG Memberships

This feature provides operations with the ability to manually enter the link members of SRLG groups for the entire network at any SR OS node which will need to signal LSP paths (for example, a head-end node).

The operator may explicitly enables the use by CSPF of the SRLG database. In that case, CSPF will not query the TE database for IGP advertised interface SRLG information.

Note, however, that the SRLG secondary path computation and FRR bypass/detour path computation remains unchanged.

There are deployments where the SR OS will interoperate with routers that do not implement the SRLG membership advertisement via IGP SRLG TLV or sub-TLV.

In these situations, the user is provided with the ability to enter manually the link members of SRLG groups for the entire network at any SR OS node which will need to signal LSP paths, for example, a head-end node.

The user enters the SRLG membership information for any link in the network by using the `interface ip-int-name srlg-group group-name` command in the `config>router>mpls> srlg-database>router-id` context. An interface can be associated with up to 5 SRLG groups for each execution of this command. The user can associate an interface with up to 64 SRLG groups by executing the command multiple times. The user must also use this command to enter the local interface SRLG membership into the user SRLG database. The user deletes a specific interface entry in this database by executing the `no` form of this command.

The `group-name` must have been previously defined in the SRLG `srlg-group group-name value group-value` command in the `config>router>mpls`. The maximum number of distinct SRLG groups the user can configure on the system is 1024.

The parameter value for `router-id` must correspond to the router ID configured under the base router instance, the base OSPF instance or the base IS-IS instance of a given node. Note however that a single user SRLG database is maintained per node regardless if the listed interfaces participate in static routing, OSPF, IS-IS, or both routing protocols. The user can temporarily disable the use by CSPF of all interface membership information of a specific router ID by executing the `shutdown` command in the `config>router>mpls> srlg-database> router-id` context. In this case, CSPF will assume these interfaces have no SRLG membership association. The operator can delete all interface entries of a specific router ID entry in this database by executing the `no router-id router-address` command in the `config>router>mpls> srlg-database` context.

CSPF will not use entered SRLG membership if an interface is not listed as part of a router ID in the TE database. If an interface was not entered into the user SRLG database, it will be assumed that it does not have any SRLG membership. CSPF will not query the TE database for IGP advertised interface SRLG information.
The operator enables the use by CSPF of the user SRLG database by entering the user-srlg-db enable command in the `config>router>mpls` context. When the MPLS module makes a request to CSPF for the computation of an SRLG secondary path, CSPF will query the local SRLG and computes a path after pruning links which are members of the SRLG IDs of the associated primary path. Similarly, when MPLS makes a request to CSPF for a FRR bypass or detour path to associate with the primary path, CSPF queries the user SRLG database and computes a path after pruning links which are members of the SRLG IDs of the PLR outgoing interface.

The operator can disable the use of the user SRLG database by entering the user-srlg-db disable in command in the `config>router>mpls` context. CSPF will then resumes queries into the TE database for SRLG membership information. However, the user SRLG database is maintained.

The operator can delete the entire SRLG database by entering the `no srlg-database` command in the `config>router>mpls` context. In this case, CSPF will assume all interfaces have no SRLG membership association if the user has not disabled the use of this database.

---

**TE Graceful Shutdown**

Graceful shutdown provides a method to bulk re-route transit LSPs away from the node during software upgrade of a node. A solution is described in RFC 5817, *Graceful Shutdown in MPLS and Generalized MPLS Traffic Engineering Networks*. This is achieved in this RFC by using a PathErr message with a specific error code Local Maintenance on TE link required flag. When a LER gets this message, it performs a make-before-break on the LSP path to move the LSP away from the links/nodes which IP addresses were indicated in the PathErr message.

Graceful shutdown can flag the affected link/node resources in the TE database so other routers will signal LSPs using the affected resources only as a last resort. This is achieved by flooding an IGP TE LSA/LSP containing link TLV for the links under graceful shutdown with the traffic engineering metric set to 0xffffffff and 0 as unreserved bandwidth.

---

**Soft Pre-emption of Diff-Serv RSVP LSP**

A Diff-Serv LSP can pre-empt another LSP of the same or of a different CT if its setup priority is strictly higher (numerically lower) than the holding priority of that other LSP.
Least-Fill Bandwidth Rule in CSPF ECMP Selection

When multiples equal-cost paths satisfy the constraints of a given RSVP LSP path, CSPF in the router head-end node will select a path so that LSP bandwidth is balanced across the network links. In releases prior to R7.0, CSPF used a random number generator to select the path and returned it to MPLS. In the course of time, this method actually balances the number of LSP paths over the links in the network; it does not necessarily balance the bandwidth across those links.

The least-fill path selection algorithm identifies the single link in each of the equal cost paths which has the least available bandwidth in proportion to its maximum reserved bandwidth. It then selects the path which has the largest value of this figure. The net affect of this algorithm is that LSP paths will be spread over the network links over time such that percentage link utilization is balanced. When the least-fill option is enabled on an LSP, during a manual reset CSPF will apply this method to all path calculations of the LSP, also at the time of the initial configuration.

Inter Area TE LSP (ERO Expansion Method)

Inter area contiguous LSP scheme provides end-to-end TE path. Each transit node in a domain can setup a TE path LSP based on TE information available within its local domain.

A PE node initiating an inter area contiguous TE LSP does partial CSPF calculation to include its local area border router as a loose node. To enable partial CSPF calculation to the domain border node, each domain border router must be configured as loose node in path hop list on ingress LER. Domain border router on receiving a PATH message with loose hop ERO does a partial CSPF calculation to the next domain border router as loose hop or CSPF to reach the final destination. 'cspf-on-loose-hop' must be enabled on LSR to allow CSPF calculation for the next segment on receiving a PATH message with loose hop in ERO.

Area Border Node FRR Protection for Inter Area LSP

For protection of domain border router, the upstream node of the domain border router acts as a point-of-local-repair (PLR), and the next-hop node to the protected domain border router is the merge-point (MP).

Only Manual bypass protection is available to protect area border node. Dynamic bypass is available for link or node protection of inter-area LSP segments that have PLR and MP in same area. Manual bypass protection works only when a proper completely strict path is provisioned that avoids the area border node. ‘cspf-to-first-loose’ is allowed on manual bypass to transit via an alternate ABR as loose hop. If ‘cspf-to-first-loose’ is configured on manual bypass then it would not assure protection. This may be due to the loose hops in bypass path that may overlap
with LSP to go via link/node that needs to be protected. One-to-one FRR method is not supported for inter-area LSP.

Inter Area Traffic Engineering Parameters

Following section describes traffic engineering support on inter area LSP.

- **TE path calculation** - A user can configure partial hop list that includes domain border routers as a loose hops for CSPF calculation. This allows setting up end-to-end CSPF path based on TE path calculation per domain segment.

- **Admin Groups** - Admin-group information configured on ingress LER and an optional CLI configuration (‘propagate-admin-group’) allows propagation of session-attribute with admin-group in PATH message. Admin-group information propagated in LSP is used on transit LSR to do CSPF calculation with admin-group in next segment.

- **Bandwidth** - Transit LSR doing CSPF calculation on receiving a loose hop calculates the next segment of loose hop using bandwidth information received in PATH message from upstream node. Lease fill rule is not supported beyond the first area segment.

- **Path Priority/Preemption** - Path priority and preemption is supported for inter-area LSP.

- **TE Metric** - TE metric is not supported for inter-area LSP.

- **Graceful Shutdown** - Graceful shutdown is supported for inter-area LSP.

- **SRLG** - SRLG calculation is not supported on secondary path for inter-area LSP.
MPLS Service Usage

Alcatel-Lucent routers enable service providers to deliver virtual private networks (VPNs) and Internet access using Generic Routing Encapsulation (GRE) and/or MPLS tunnels, with Ethernet and/or SONET/SDH interfaces.

Service Distribution Paths

A service distribution path (SDP) acts as a logical way of directing traffic from one router to another through a uni-directional (one-way) service tunnel. The SDP terminates at the far-end router which directs packets to the correct service egress service access point (SAP) on that device. All services mapped to an SDP use the same transport encapsulation type defined for the SDP (either GRE or MPLS).

For information about service transport tunnels, refer to the Service Distribution Paths (SDPs) section in the OS Services Guide. They can support up to eight forwarding classes and can be used by multiple services. Multiple LSPs with the same destination can be used to load-balance traffic.
MPLS/RSVP Configuration Process Overview

Figure 14 displays the process to configure MPLS and RSVP parameters.

START

ENABLE MPLS

CONFIGURE MPLS INTERFACE PARAMETERS

CONFIGURE RSVP INTERFACE PARAMETERS

CONFIGURE PATH PARAMETERS

CONFIGURE LSP PARAMETERS

CONFIGURE LSP-PATH PARAMETERS

RUN

Figure 14: MPLS and RSVP Configuration and Implementation Flow
**Configuration Notes**

This section describes MPLS and RSVP caveats.

- Interfaces must already be configured in the `config>router>interface` context before they can be specified in MPLS and RSVP.
- A router interface must be specified in the `config>router>mpls` context in order to apply it or modify parameters in the `config>router>rsvp` context.
- A system interface must be configured and specified in the `config>router>mpls` context.
- Paths must be created before they can be applied to an LSP.
Configuring MPLS and RSVP with CLI

This section provides information to configure MPLS and RSVP using the command line interface.

Topics in this section include:

- MPLS Configuration Overview on page 92
  - LSPs on page 92
  - Paths on page 92
  - Router Interface on page 93
  - Choosing the Signaling Protocol on page 93
- Basic MPLS Configuration on page 94
- Common Configuration Tasks on page 95
  - Configuring MPLS Components on page 96
  - Configuring Global MPLS Parameters on page 96
  - Configuring an MPLS Interface on page 97
  - Configuring MPLS Paths on page 98
  - Configuring an MPLS LSP on page 99
  - Configuring Manual Bypass Tunnels on page 101
- Configuring RSVP Parameters on page 103
  - Configuring RSVP Message Pacing Parameters on page 104
  - Configuring Graceful Shutdown on page 105
- MPLS Configuration Management Tasks on page 106
- RSVP Configuration Management Tasks on page 111
MPLS Configuration Overview

Multiprotocol Label Switching (MPLS) enables routers to forward traffic based on a simple label embedded into the packet header. A router examines the label to determine the next hop for the packet, saving time for router address lookups to the next node when forwarding packets. MPLS is not enabled by default and must be explicitly enabled.

In order to implement MPLS, the following entities must be configured:

- LSPs on page 92
- Paths on page 92
- Router Interface on page 93

LSPs

To configure MPLS-signaled label-switched paths (LSPs), an LSP must run from an ingress router to an egress router. Configure only the ingress router and configure LSPs to allow the software to make the forwarding decisions or statically configure some or all routers in the path. The LSP is set up by Resource Reservation Protocol (RSVP), through RSVP signaling messages. The router automatically manages label values. Labels that are automatically assigned have values ranging from 1,024 through 1,048,575 (see Label Values on page 24).

A static LSP is a manually set up LSP where the nexthop IP address and the outgoing label are explicitly specified.

Paths

To configure signaled LSPs, you must first create one or more named paths on the ingress router. For each path, the transit routers (hops) in the path are specified.
Router Interface

At least one router interface and one system interface must be defined in the `config>router>interface` context in order to configure MPLS on an interface.

Choosing the Signaling Protocol

If only static label switched paths are used in your configurations, then you must manually define the paths through the MPLS network. Label mappings and actions configured at each hop must be specified. You do not need to enable RSVP or LDP if you are configuring static LSPs.

If dynamic LSP signaling is implemented in your network, then one of the two supported signaling protocols, RSVP or LDP, must be specified. Enable signaling protocols only on the links where the functionality is required.

In order to implement MPLS, the following entities must be enabled:

- MPLS must be enabled on all routers that are part of an LSP.
- RSVP or LDP must be enabled on the same routers.

When MPLS is enabled and either RSVP or LDP is also enabled, MPLS uses RSVP or LDP to set up the configured LSPs. For example, when you configure an LSP with both MPLS and RSVP running, RSVP initiates a session for the LSP. RSVP uses the local router as the RSVP session sender and the LSP destination as the RSVP session receiver. When the RSVP session is created, the LSP is set up on the path created by the session. If the session is not successfully created, RSVP notifies MPLS; MPLS can then either initiate backup paths or retry the initial path.
Basic MPLS Configuration

This section provides information to configure MPLS and configuration examples of common configuration tasks. To enable MPLS, you must configure at least one MPLS interface. The other MPLS configuration parameters are optional. This follow displays an example of an MPLS configuration.

A:ALA-1>config>router>mpls# info
------------------------------------------
admin-group "green" 15
  admin-group "yellow" 20
  admin-group "red" 25
  interface "system"
  exit
interface "StaticLabelPop"
  admin-group "green"
  label-map 50
  pop
  no shutdown
  exit
exit
interface "StaticLabelPop"
  label-map 35
  swap 36 nexthop 10.10.10.91
  no shutdown
  exit
exit
path "secondary-path"
  no shutdown
  exit
path "to-NYC"
  hop 1 10.10.10.104  strict
  no shutdown
  exit
lsp "lsp-to-eastcoast"
  to 10.10.10.104
  from 10.10.10.103
  fast-reroute one-to-one
  exit
primary "to-NYC"
  exit
secondary "secondary-path"
  exit
  no shutdown
  exit
static-lsp "StaticLabelPush"
  to 10.10.11.105
  push 60 nexthop 10.10.11.105
  no shutdown
  exit
  no shutdown
------------------------------------------
A:ALA-1>config>router>mpls#
Common Configuration Tasks

This section provides a brief overview of the tasks to configure MPLS and provides the CLI commands.

The following protocols must be enabled on each participating router.

- MPLS
- RSVP (for RSVP-signaled MPLS only)
- LDP

In order for MPLS to run, you must configure at least one MPLS interface in the config>router>mpls context.

- An interface must be created in the config>router>interface context before it can be applied to MPLS.
- In the config>router>mpls context, configure path parameters for configuring LSP parameters. A path specifies some or all hops from ingress to egress. A path can be used by multiple LSPs.
- When an LSP is created, the egress router must be specified in the to command and at least one primary or secondary path must be specified. All other statements under the LSP hierarchy are optional.
Configuring MPLS Components

Use the MPLS and RSVP CLI syntax displayed below for:

- Configuring Global MPLS Parameters on page 96
- Configuring an MPLS Interface on page 97
- Configuring MPLS Paths on page 98
- Configuring an MPLS LSP on page 99
- Configuring a Static LSP on page 100
- Configuring Manual Bypass Tunnels on page 101
- Configuring RSVP Parameters on page 103
- Configuring RSVP Message Pacing Parameters on page 104
- Configuring Graceful Shutdown on page 105

Configuring Global MPLS Parameters

Admin groups can signify link colors, such as red, yellow, or green. MPLS interfaces advertise the link colors it supports. CSPF uses the information when paths are computed for constrained-based LSPs. CSPF must be enabled in order for admin groups to be relevant.

To configure MPLS admin-group parameters, enter the following commands:

**CLI Syntax:**
```
mls
    admin-group group-name group-value
    frr-object
    resignal-timer minutes
```

The following displays an admin group configuration example:

```
A:ALA-1>config-router>mls# info
-------------------------------
resignal-timer 500
admin-group "green" 15
admin-group "yellow" 20
admin-group "red" 25
...
-------------------------------
A:ALA-1>config-router>mls#
```
Configuring an MPLS Interface

Configure the label-map parameters if the interface is used in a static LSP. To configure an MPLS interface on a router, enter the following commands:

**CLI Syntax:**
```
cfg>router>mpls
interface
   no shutdown
admin-group group-name [group-name...(up to 32 max)]
label-map
   pop
   swap
   no shutdown
srlg-group group-name [group-name...(up to 5 max)]
te-metric value
```

The following displays an interface configuration example:

```
A:ALA-1>cfg>router>mpls# info
---------------------------------------------
... interface "to-104"
   admin-group "green"
   admin-group "red"
   admin-group "yellow"
   label-map 35
      swap 36 nexthop 10.10.10.91
      no shutdown
exit
exit
no shutdown
...---------------------------------------------
A:ALA-1>cfg>router>mpls#
```
Configuring MPLS Paths

Configure an LSP path to use in MPLS. When configuring an LSP, the IP address of the hops that the LSP should traverse on its way to the egress router must be specified. The intermediate hops must be configured as either strict or loose meaning that the LSP must take either a direct path from the previous hop router to this router (strict) or can traverse through other routers (loose).

Use the following CLI syntax to configure a path:

**CLI Syntax:**
```
config>router> mpls
    path path-name
        hop hop-index ip-address {strict|loose}
        no shutdown
```

The following displays a path configuration example:

```
A:ALA-1>config>router>mpls# info
------------------------------------------
interface "system"
    exit
path "secondary-path"
    hop 1 10.10.0.121  strict
    hop 2 10.10.0.145 strict
    hop 3 10.10.0.1 strict
    no shutdown
    exit
path "to-NYC"
    hop 1 10.10.10.103 strict
    hop 2 10.10.0.210  strict
    hop 3 10.10.0.215  loose
    exit
------------------------------------------
A:ALA-1>config>router>mpls#
```
Configuring an MPLS LSP

Configure an LSP path for MPLS. When configuring an LSP, you must specify the IP address of the egress router in the `to` statement. Specify the primary path to be used. Secondary paths can be explicitly configured or signaled upon the failure of the primary path. All other statements are optional.

The following displays an MPLS LSP configuration:

```
A:ALA-1>config>router>mplsp# info
----------------------------------------------
... lsp "lsp-to-eastcoast"
    to 192.168.200.41
    rsvp-resv-style ff
cspf
    include "red"
    exclude "green"
adspec
    fast-reroute one-to-one
    exit
    primary "to-NYC"
        hop-limit 10
    exit
    secondary "secondary-path"
        bandwidth 50000
    exit
    no shutdown
exit
no shutdown
----------------------------------------------
A:ALA-1>config>router>mplsp#
```
Configuring a Static LSP

An LSP can be explicitly (statically) configured. Static LSPs are configured on every node along the path. The label’s forwarding information includes the address of the next hop router.

Use the following CLI syntax to configure a static LSP:

**CLI Syntax:**
```
config>router>mpls
    static-lsp lsp-name
        to ip-address
        push out-label nexthop ip-addr
        no shutdown
```

The following displays a static LSP configuration example:

```
A:ALA-1>config>router>mpls# info
----------------------------------------------
...  
static-lsp "static-LSP"
    to 10.10.124
    push 60 nexthop 10.10.42.3
    no shutdown
    exit
...
----------------------------------------------
A:ALA-1>config>router>mpls#
```
Configuring Manual Bypass Tunnels

Consider the following network setup.

A----B----C----D
     |     |
     E----F

The user first configures the option to disable the dynamic bypass tunnels on node B if required. The CLI for this configuration is:

config>router>mpls>dynamic-bypass [disable | enable]

By default, dynamic bypass tunnels are enabled.

Next, the user configures an LSP on node B, such as B-E-F-C to be used only as bypass. The user specifies each hop in the path, for example, the bypass LSP has a strict path.

Note that including the bypass-only keyword disables the following options under the LSP configuration:

- bandwidth
- fast-reroute
- secondary

The following LSP configuration options are allowed:

- adaptive
- adspec
- cspf
- exclude
- hop-limit
- include
- metric
The following example displays a bypass tunnel configuration:

```
A:ALA-48>config>router>mpls>path# info
-------------------------------------------
... path "BEFC"
    hop 10 10.10.10.11 strict
    hop 20 10.10.10.12 strict
    hop 30 10.10.10.13 strict
    no shutdown
    exit

lsp "bypass-BC"
    to 10.10.10.15
    primary "BEFC"
    exit
    no shutdown
...
-------------------------------------------
A:ALA-48>config>router>mpls>path#
```

Next, the configures an LSP from A to D and indicates fast-reroute bypass protection by selecting facility as the FRR method (`config>router>mpls{lsp>fast-reroute facility}`). If the LSP goes through B, and bypass is requested, and the next hop is C, and there is a manually configured bypass-only tunnel from B to C, excluding link BC, then node B uses that.
Configuring RSVP Parameters

RSVP is used to set up LSPs. RSVP must be enabled on the router interfaces that are participating in signaled LSPs. The keep-multiplier and refresh-time default values can be modified in the RSVP context.

Initially, interfaces are configured in the config>router>mpls>interface context. Only these existing (MPLS) interfaces are available to modify in the config>router> rsvp context. Interfaces cannot be directly added in the RSVP context.

The following example displays an RSVP configuration example:

```
A:ALA-1>config>router>rsvp# info
----------------------------------------------
    interface "system"
       no shutdown
    exit
    interface to-104
       hello-interval 4000
       no shutdown
    exit
    no shutdown
----------------------------------------------
A:ALA-1>config>router>rsvp#
```
Configuring RSVP Message Pacing Parameters

RSVP message pacing maintains a count of the messages that were dropped because the output queue for the egress interface was full.

Use the following CLI syntax to configure RSVP parameters:

**CLI Syntax:**
```
config>router>rsvp
   no shutdown
   msg-pacing
       period milli-seconds
       max-burst number
```

The following example displays a RSVP message pacing configuration example:

```
A:ALA-1>config>router>rsvp# info
----------------------------------------------
   keep-multiplier 5
   refresh-time 60
   msg-pacing
       period 400
       max-burst 400
   exit
   interface "system"
       no shutdown
   exit
   interface to-104
       hello-interval 4000
       no shutdown
   exit
   no shutdown
----------------------------------------------
A:ALA-1>config>router>rsvp#
```
Configuring Graceful Shutdown

TE graceful shutdown can be enabled on a specific interface using the `config/router/rsvp/interface/graceful-shutdown` command. This interface is referred to as the maintenance interface.

Graceful shutdown can be disabled by executing the `no` form of the command at the RSVP interface level or at the RSVP level. In this case, the user configured TE parameters of the maintenance links are restored and the maintenance node floods them.
MPLS Configuration Management Tasks

This section discusses the following MPLS configuration management tasks:

- Modifying MPLS Parameters on page 106
- Modifying MPLS Path Parameters on page 108
- Modifying MPLS Static LSP Parameters on page 109
- Deleting an MPLS Interface on page 110

Deleting MPLS

NOTE: In order to remove the MPLS instance, MPLS must be disabled (shutdown) and all SDP bindings to LSPs removed. If MPLS is not shutdown first, when the no mpls command is executed, a warning message on the console displays indicating that MPLS is still administratively up.

When MPLS is shut down, the no mpls command deletes the protocol instance and removes all configuration parameters for the MPLS instance.
To disable MPLS, use the shutdown command.

To remove MPLS on a router, enter the following command:

CLI Syntax: config-router# no mpls

Modifying MPLS Parameters

NOTE: You must shut down MPLS entities in order to modify parameters. Re-enable (no shutdown) the entity for the change to take effect.
Modifying an MPLS LSP

Some MPLS LSP parameters such as primary and secondary, must be shut down before they can be edited or deleted from the configuration.

The following displays a MPLS LSP configuration example. Refer to the LSP configuration on page 99.

```
A:ALA-1>>config>router>mpls>lsp# info
---------------------------------------------------------------
  shutdown
  to 10.10.10.104
  from 10.10.10.103
  rsvp-resv-style ff
  include "red"
  exclude "green"
  fast-reroute one-to-one
  exit
  primary "to-NYC"
    hop-limit 50
  exit
  secondary "secondary-path"
  exit
---------------------------------------------------------------
A:ALA-1>config>router>mpls#
```
Modifying MPLS Path Parameters

In order to modify path parameters, the `config>router>mpls>path` context must be shut down first.

The following displays a path configuration example. Refer to the LSP configuration on page 98.

```
A:ALA-1>config>router>mpls# info
#------------------------------------------
echo "MPLS"
#------------------------------------------
... 
path "secondary-path"
  hop 1 10.10.0.111  strict
  hop 2 10.10.0.222  strict
  hop 3 10.10.0.123  strict
  no shutdown
exit
path "to-NYC"
  hop 1 10.10.10.104  strict
  hop 2 10.10.0.210  strict
  no shutdown
exit
... 
#------------------------------------------
A:ALA-1>config>router>mpls#
```
Modifying MPLS Static LSP Parameters

In order to modify static LSP parameters, the `config>router>mpls>path` context must be shut down first.

The following displays a static LSP configuration example. Refer to the static LSP configuration on page 100.

```
A:ALA-1>config>router>mpls# info
----------------------------------------------
... static-lsp "static-LSP"
   to 10.10.10.234
   push 102704 nexthop 10.10.8.114
   no shutdown
   exit
no shutdown
----------------------------------------------
A:ALA-1>config>router>mpls#
```
Deleting an MPLS Interface

In order to delete an interface from the MPLS configuration, the interface must be shut down first.

Use the following CLI syntax to delete an interface from the MPLS configuration:

**CLI Syntax:**
```
mpls
[no] interface ip-int-name
    shutdown
```

A:ALA-1>config>router>mpls# info
----------------------------------------------
...  
  admin-group "green" 15
  admin-group "red" 25
  admin-group "yellow" 20
  interface "system"
  exit
  no shutdown
----------------------------------------------
A:ALA-1>config>router>mpls#
RSVP Configuration Management Tasks

This section discusses the following RSVP configuration management tasks:

- Modifying RSVP Parameters on page 111
- Modifying RSVP Message Pacing Parameters on page 112
- Deleting an Interface from RSVP on page 112

Modifying RSVP Parameters

Only interfaces configured in the MPLS context can be modified in the RSVP context.

The `no rsvp` command deletes this RSVP protocol instance and removes all configuration parameters for this RSVP instance.

The `shutdown` command suspends the execution and maintains the existing configuration.

The following example displays a modified RSVP configuration example:

```
A:ALA-1>config>router>rsvp# info
----------------------------------------------
keep-multiplier 5
refresh-time 60
msg-pacing
  period 400
  max-burst 400
exit
interface "system"
exit
interface "test1"
  hello-interval 5000
exit
no shutdown
----------------------------------------------
A:ALA-1>config>router>rsvp#
```
Modifying RSVP Message Pacing Parameters

RSVP message pacing maintains a count of the messages that were dropped because the output queue for the egress interface was full.

The following example displays command usage to modify RSVP parameters:

The following example displays a modified RSVP message pacing configuration example. Refer to the RSVP message pacing configuration on page 103.

```
A:ALA-1>config>router>rsvp# info
----------------------------------------------
keep-multiplier 5
refresh-time 60
msg-pacing
    period 200
    max-burst 200
exit
interface "system"
exit
interface "to-104"
exit
no shutdown
----------------------------------------------
A:ALA-1>config>router>rsvp#
```

Deleting an Interface from RSVP

Interfaces cannot be deleted directly from the RSVP configuration. An interface must have been configured in the MPLS context and then the RSVP context. The interface must first be deleted from the MPLS context. This removes the association from RSVP.

See Deleting an MPLS Interface on page 110 for information on deleting an MPLS interface.
MPLS/RSVP Command Reference

Command Hierarchies

- MPLS Commands on page 113
- MPLS Path Commands on page 117
- LSP Commands on page 115
- RSVP Commands on page 117
- Show Commands on page 119
- Tools Commands on page 120
- Clear Commands on page 120
- Debug Commands on page 121

MPLS Commands

```
config
    router
        [no] mpls
            [no] admin-group group-name group-value
            [no] admin-group group-name
            auto-bandwidth-multipliers sample-multiplier number1 adjust-multiplier number2
            [no] auto-bandwidth-multipliers
            [no] cspf-on-loose-hop
            [no] dynamic-bypass [enable | disable]
            exponential-backoff-retry
            [no] frr-object
            hold-timer seconds
            [no] hold-timer
            ingress-statistics
                [no] lsp lsp-name sender ip-address
                    accounting-policy policy-id
                    [no] accounting-policy
                    [no] collect-stats
                    [no] shutdown
                [no] interface ip-int-name
                    [no] admin-group group-name [group-name...(up to 5 max)]
                    [no] label-map in-label
                        [no] pop
                        [no] shutdown
                        swap [out-label | implicit-null-label] nexthop ip-addr
                        [no] swap [out-label | implicit-null-label]
                    [no] shutdown
                    [no] srlg-group group-name [group-name...(up to 5 max)]
```
— te-metric metric
— no te-metric
— ldp-over-rsvp [include | exclude]
— least-fill-min-thd percent
— no least-fill-min-thd
— least-fill-reoptim-thd percent
— no least-fill-reoptim-thd
— lsp-init-retry-timeout seconds
— no lsp-init-retry-timeout
— [no] logger-event-bundling
— max-bypass-associations integer
— no max-bypass-associations
— p2p-active-path-fast-retry seconds [1..10] seconds
— no p2p-active-path-fast-retry
— p2mp-s21-fast-retry seconds [1..10] seconds
— no p2mp-s21-fast-retry
— preemption-timer seconds
— no preemption-timer
— p2mp-resignal-timer minutes
— no p2mp-resignal-timer
— resignal-timer minutes
— no resignal-timer
— secondary-fast-retry-timer seconds
— no secondary-fast-retry-timer
— [no] shutdown
— [no] srlg-database
— [no] router-id router-addr
— [no] interface ip-addr srlg-group group-name [group-name..(up to 5 max)]
— [no] shutdown
— [no] srlg-frr [strict]
— srlg-group group-name {value group-value}
— no srlg-group group-name
— [no] static-lsp lsp-name
— push {label | implicit-null-label} nexthop ip-address
— push {out-label | implicit-null-label}
— [no] shutdown
— toip-address
— static-lsp-fast-retry seconds
— [no] static-lsp-fast-retry
— user-srlg-db [enable | disable]
LSP Commands

```
config
  | router
  |   [no] mpls
  |     [no] lsp lsp-name [bypass-only ]
  |       [no] adaptive
  |       [no] adspec
  |       [no] auto-bandwidth
  |         | adjust-down percent [bw mbps]
  |         | no adjust-down
  |         | adjust-up percent [bw mbps]
  |         | no adjust-up
  |         | max-bandwidth mbps
  |         | no max-bandwidth
  |         | min-bandwidth mbps
  |         | no min-bandwidth
  |         | [no] monitor-bandwidth
  |         | multipliers sample-multiplier num1 adjust-multiplier num2
  |         | no multipliers
  |         | overflow-limit number threshold percent [bw mbps]
  |         | no overflow-limit

0bgp-transport-tunnel bgp-transport-tunnel config>router>mpls>lsp-
This command allows or blocks RSVP-TE LSP to be used as a trans-
port LSP for BGP tunnel routes.bgtp-transport-tunnel
include include Allows RSVP-TE LSP to be used as transport LSP from
the ASBR to local PE router, from ingress PE to ASBR in the local AS
or between multi-hop eBGP peers with ASBR to ASBR adja-
cency.Blocks RSVP-TE LSP to be used as transport LSP from the
ASBR to local PE router, from ingress PE to ASBR in the local AS or
between multi-hop eBGP peers with ASBR to ASBR adjacency, include
| exclude

  | class-type ct-number
  | no class-type
  | [no] csf [use-te-metric]
  | [no] collect-stats csf-to-first-loose
  | [no] egress-statistics
  | | accounting-policy policy-id
  | | no accounting-policy
  | | no collect-stats
  | | [no] shutdown

  | [no] exclude group-name [group-name...(up to 5 max)]
  | [no] exclude-node ip-address
  | fast-reroute frr-method
  | no fast-reroute
  | | bandwidth rate-in-mbps
  | | no bandwidth
  | | hop-limit number
  | | no hop-limit
  | | [no] node-protect
  | | from ip-address
  | | hop-limit number
  | | no hop-limit
```
— igp-shortcut [lfa-protect | lfa-only]
— [no] igp-shortcut
— [no] include group-name [group-name...(up to 5 max)]
— ldp-over-rsvp [include | exclude]
— [no] least-fill
— [no] ldp-over-rsvp [include | exclude]
— main-ct-retry-limit number
— no main-ct-retry-limit
— metric metric
— p2mp-id id
— [no] primary path-name
  — [no] adaptive
  — backup-class-type ct-number
  — no backup-class-type
  — bandwidth rate-in-mpbs
  — no bandwidth
  — class-type ct-number
  — no class-type
  — [no] exclude group-name [group-name...(up to 5 max)]
  — hop-limit number
  — no hop-limit
  — [no] include group-name [group-name...(up to 5 max)]
  — priority setup-priority hold-priority
  — no priority
  — [no] record
  — [no] record-label
  — [no] shutdown
— [no] primary-p2mp-instance instance-name
  — [no] adaptive
  — bandwidth rate-in-mpbs
  — no bandwidth
  — [no] exclude group-name [group-name...(up to 5 max)]
  — [no] hop-limit
  — hop-limit number
  — no hop-limit
  — [no] include group-name [group-name...(up to 5 max)]
  — [no] record
  — [no] record-label
  — [no] s2l-path path-name to ip-address
    — [no] shutdown
  — [no] shutdown
— [no] propagate-admin-group
— retry-limit number
— no retry-limit
— retry-timer seconds
— no retry-timer
— rsvp-resv-style [se | ff]
— [no] secondary path-name
  — [no] adaptive
  — bandwidth rate-in-mpbs
  — no bandwidth
  — class-type ct-number
  — no class-type
  — [no] exclude group-name [group-name...(up to 5 max)]
  — hop-limit number
MPLS and RSVP

---

**MPLS Path Commands**

```plaintext
config
  --- router
  --- [no] mpls
       --- [no] path path-name
       --- hop hop-index ip-address {strict | loose}
       --- no hop hop-index
       --- [no] shutdown
  --- [no] static-lsp lsp-name
       --- push label next-hop ip-address
       --- no push out-label
       --- to ip-addr
       --- [no] shutdown
```

---

**RSVP Commands**

```plaintext
config
  --- router
  --- [no] rsvp
       --- diffserv-te [mam | rdm]
       --- no diffserv-te
```
— **class-type-bw** ct0 %-link-bandwidth ct1 %-link-bandwidth ct2 %-link-bandwidth ct3 %-link-bandwidth ct4 %-link-bandwidth ct5 %-link-bandwidth ct6 %-link-bandwidth ct7 %-link-bandwidth

— **no class-type-bw**

— **fc** fc-name **class-type** ct-number

— **no fc** fc-name

— **te-class** te-class-number **class-type** ct-number **priority** priority

— **no te-class** te-class-number

— **gr-helper-time** max-recovery recovery-interval [1..1800] seconds max-restart restart-interval [1..300] seconds

— **no gr-helper-time**

— [no] graceful-shutdown

— [no] implicit-null-label

— [no] interface ip-int-name

— **authentication-key** [authentication-key | hash-key] [hash | hash2]

— **no authentication-key**

— [no] bfd-enable

— [no] graceful-shutdown

— **class-type-bw** ct0 %-link-bandwidth ct1 %-link-bandwidth ct2 %-link-bandwidth ct3 %-link-bandwidth ct4 %-link-bandwidth ct5 %-link-bandwidth ct6 %-link-bandwidth ct7 %-link-bandwidth

— **no class-type-bw**

— **gr-helper** [enable | disable]

— [no] graceful-shutdown

— **hello-interval** milli-seconds

— **no hello-interval**

— **implicit-null-label** [enable | disable]

— **no implicit-null-label**

— [no] refresh-reduction

— [no] reliable-delivery

— [no] shutdown

— **subscription** percentage

— **no subscription**

— **te-up-threshold** threshold-level [threshold-level,...,(up to 16 max)]

— **no te-up-threshold**

— **te-down-threshold** threshold-level [threshold-level,...,(up to 16 max)]

— **no te-down-threshold**

— **keep-multiplier** number

— **no keep-multiplier**

— [no] msg-pacing

— **max-burst** number

— **no max-burst**

— **period** milli-seconds

— [no] period

— **node-id-in-rro** <include|exclude>

— **p2p-merge-point-abort-timer** [1..65535] seconds

— **no p2p-merge-point-abort-timer**

— **p2mp-merge-point-abort-timer** [1..65535] seconds

— **no p2mp-merge-point-abort-timer**

— **preemption-timer** seconds

— **no preemption-timer**

— **rapid-retransmit-time** hundred-milliseconds

— **no rapid-retransmit-time**

— **rapid-retry-limit** number

— **no rapid-retry-limit**
— refresh-reduction-over-bypass [enable | disable]
— refresh-time seconds
— no refresh-time
— [no] graceful-shutdown
— [no] shutdown
— te-threshold-update
— no te-threshold-update
    — on-cac-failure
    — update-timer seconds
— te-up-threshold threshold-level [threshold-level...(up to 16 max)]
— te-down-threshold threshold-level [threshold-level...(up to 16 max)]

Show Commands

show
    — router
    — mpls
        — admin-group group-name
        — bypass-tunnel [to ip-address] [protected-lsp name] [dynamic | manual | p2mp]
            [detail]
        — interface [ip-int-name] [ip-address] [label-map label]
        — interface [ip-int-name] [ip-address] statistics
        — label start-label [end-label | in-use | owner]
        — label-range
        — lsp [lsp-name] [status {up | down}] [from ip-address] to ip-address [detail]
        — lsp {transit | terminate} [status {up | down}] [from ip-address] to ip-address lsp-name name [detail]
        — lsp count
        — lsp lsp-name activepath
        — lsp lsp-name path path-name [status {up | down}] [detail]
        — lsp lsp-name path path-name mbb
        — srlg-database [router-id ip-address] [interface ip-address]
        — srlg-group [group-name]
        — static-lsp lsp-name
        — static-lsp {transit | terminate}
        — static-lsp count
        — statistics-summary
        — status

show
    — router
    — rsvp
        — interface [interface [ip-int-name]] statistics [detail]
        — neighbor [ip-address] [detail]
        — session [session-type] [from ip-address] to ip-address lsp-name name [status {up | down}] [detail]
        — statistics
        — status
Tools Commands

```
tools
  — dump
  — router
    — mpls
      — bypass-tunnel
      — ftn
      — ilm
      — lspinfo
      — memory-usage

  — perform
    — router
      — mpls
        — force-switch-path [lsp lsp-name] [path path-name]
        — [no] force-switch-path [lsp lsp-name]
        — pir to ip-addr [from ip-addr] [bandwidth bandwidth] [include-bitmap bitmap] [exclude-bitmap bitmap] [hop-limit limit] [exclude-address excl-addr (up to 8 max)] [use-te-metric] [strict-srg] [srlg-group grp-id (up to 8 max)] [exclude-node excl-node-id [excl-node-id (up to 8 max)]] [skip-interface interface-name] [ds-class-type class-type] [cspf-rectype req-type] [least-fill-min-thd thd] [setup-priority val] [hold-priority val]
        — resignal {lsp lsp-name path path-name | delay minutes}
        — resignal {p2mp-lsp p2mp-lsp-name p2mp-instance p2mp-instance-name | p2mp-delay p2mp-minutes}

switch-path [lsp lsp-name] [path path-name] [trap-suppress number-of-traps time-interval] update-path [lsp lsp-name path current-path-name new-path new-path-name]

Clear Commands

```

```
clear
  — router
    — mpls
      — interface [ip-int-name] [statistics]
      — lsp lsp-name
    — rsvp
      — interface
      — statistics
```
Debug Commands

debug
  — router
    — mpls [lsp lsp-name] [sender source-address] [endpoint endpoint-address] [tunnel-id tunnel-id] [lsp-id lsp-id] [interface ip-int-name]
    — no mpls
      — [no] event
        — all [detail]
        — no all
        — frr [detail]
        — no frr
        — iom [detail]
        — no iom
        — lsp-setup [detail]
        — no lsp-setup
        — mbb [detail]
        — no mbb
        — misc [detail]
        — no misc
        — xc [detail]
        — no xc
    — rsvp [lsp lsp-name] [sender source-address] [endpoint endpoint-address] [tunnel-id tunnel-id] [lsp-id lsp-id] [interface ip-int-name]
    — no rsvp
      — [no] event
        — all [detail]
        — no all
        — misc [detail]
        — no misc
        — nbr [detail]
        — no nbr
        — path [detail]
        — no path
        — resv [detail]
        — no resv
        — te-threshold-update
        — no te-threshold-update
    — [no] packet
      — all [detail]
      — no all
      — hello [detail]
      — no hello
      — path [detail]
      — no path
      — patherr [detail]
      — no patherr
      — pathtear [detail]
      — no pathtear
      — resv [detail]
      — no resv
      — resverr [detail]
      — no resverr
      — resvtear [detail]
      — no resvtear
MPLS Configuration Commands

Generic Commands

shutdown

Syntax    [no] shutdown

Context    config>router>mpls
           config>router>mpls>interface
           config>router>mpls>lsp>primary
           config>router>mpls>lsp>secondary

Description This command administratively disables an entity. When disabled, an entity does not change, reset, or remove any configuration settings or statistics.

MPLS is not enabled by default and must be explicitly enabled (no shutdown).

The operational state of the entity is disabled as well as the operational state of any entities contained within. Many objects must be shut down before they may be deleted.

The no form of this command places the entity into an administratively enabled state.

Default    no shutdown
MPLS Commands

mpls

Syntax
[no] mpls

Context
config>router

Description
This command enables the context to configure MPLS parameters. MPLS is not enabled by default and must be explicitly enabled (no shutdown). The shutdown command administratively disables MPLS.

The no form of this command deletes this MPLS protocol instance; this will remove all configuration parameters for this MPLS instance.

MPLS must be shutdown and all SDP bindings to LSPs removed before the MPLS instance can be deleted. If MPLS is not shutdown, when the no mpls command is executed, a warning message on the console displays indicating that MPLS is still administratively up.

admin-group

Syntax
admin-group group-name group-value
no admin-group group-name

Context
config>router>mpls

Description
This command is used to define administrative groups or link coloring for an interface. The admin group names can signify link colors, such as red, yellow, or green. MPLS interfaces advertise the link colors the support. CSPF uses the information when paths are computed for constraint-based LSPs. CSPF must be enabled in order for admin groups to be relevant.

Network resources (links) based on zones, geographic location, link location, etc., can be classified using admin groups. MPLS interfaces must be explicitly assigned to an admin group.

Admin groups must be defined in the config>router>mpls context before they can be assigned to an MPLS interface. The IGP communicates the information throughout the area.

Up to 32 group names can be defined in the config>router>mpls context. The admin-group names must be identical across all routers in a single domain.

The no form of this command deletes the administrative group. All configuration information associated with this LSP is lost.

Default
none

Parameters

- group-name — Specify the name of the administrative group within a virtual router instance.

- group-value — Specify the group value associated with this administrative group. This value is unique within a virtual router instance.

Values

0 — 31
accounting-policy

Syntax  accounting-policy  acct-policy-id
       no  accounting-policy

Context  config>router>mpls>ingr-stats
         config>router>mpls>lsp>e-gr-stats

Description  This command associates an accounting policy to the MPLS instance.
              An accounting policy must be defined before it can be associated else an error message is generated.
              The no form of this command removes the accounting policy association.

Default  none

Parameters  acct-policy-id — Enter the accounting policy-id as configured in the config>log>accounting-policy context.

Values  1 — 99

collect-stats

Syntax  [no]  collect-stats

Context  config>router>mpls>ingr-stats
         config>router>mpls>lsp>e-gr-stats

Description  This command enables accounting and statistical data collection. When applying accounting policies
              the data, by default, is collected in the appropriate records and written to the designated billing file.
              When the no collect-stats command is issued the statistics are still accumulated by the forwarding
              engine. However, the CPU will not obtain the results and write them to the billing file. If a subsequent
              collect-stats command is issued then the counters written to the billing file include all the traffic
              while the no collect-stats command was in effect.

Default

collect-stats  cspf-to-first-loose

Syntax  [no]  cspf-to-first-loose

Context  config>router>mpls>lsp

Description  This command enables the option to perform CSPF calculation only until the first loose hop on
              ingress LER. If there are multiple loose hops in the path list, then the ingress node will perform CSPF
              calculation until the first non-local loose hop. On successful completion of CSPF calculation, ERO in
              PATH message will be modified to include the newly calculated intermediate hops and propagate it
              forward to the next hop.
              If an end-to-end CSPF path is required, then “cspf-on-loose-hop” must be configured on the LSR that
              is configured as loose hop. With both options enabled, instead of ingress calculating the complete
              path, it is partially calculated by each loose hop that is traversed by LSP.
If this option is disabled, then CSPF calculation is performed to the destination of LSP.

“cspf-to-first-loose” can be changed dynamically, in which case LSP would do “break-before-make” on the changing configuration. If CSPF is disabled and configuration is changed, then there is no action.

Default: no cspf-to-first-loose

**dynamic-bypass**

**Syntax**

dynamic-bypass [enable | disable]

no dynamic-bypass

**Context**

config>router>mpls

**Description**

This command disables the creation of dynamic bypass LSPs in FRR. One or more manual bypass LSPs must be configured to protect the primary LSP path at the PLR nodes.

Default: enable

**egress-statistics**

**Syntax**

[no] egress-statistics

**Context**

config>router>mpls>lsp

**Description**

This command configures statistics in the egress data path of an originating LSP at a head-end node. The user must execute the no shutdown for this command to effectively enable statistics.

The same set of counters is updated for packets forwarded over any path of the LSP and over the lifetime of the LSP. In steady state, the counters are updated for packets forwarded over the active path of the LSP. The active path can be the primary path, one of the secondary paths, the FRR detour path, or the FRR bypass path when the head-end node is also the PLR.

LSP statistics are not collected on a dynamic or a static bypass tunnel itself.

When a hierarchy of LSPs is in use, statistics collection on the outermost label corresponding to the tunneling LSP and on the inner labels, corresponding to the tunneled LSPs, are mutually exclusive. A consequence of this is that when the user enables statistics collection on an RSVP LSP which is also used for tunneling LDP FECs with the LDP over RSVP feature, then statistics will be collected on the RSVP LSP only. There will be no statistics collected from an LDP FEC tunneled over this RSVP LSP regardless if the user enabled statistics collection on this FEC. When, the user disables statistics collection on the RSVP LSP, then statistics collection, if enabled, will be performed on a tunneled LDP FEC.

The no form of this command disables the statistics in the egress data path and removes the accounting policy association from the RSVP LSP.

Default: no egress-statistics
exponential-backoff-retry

Syntax

```
exponential-backoff-retry
no exponential-backoff-retry
```

Context

`configure>router>mpls`

Description

This command enables the use of an exponential back-off timer when re-trying an LSP. When an LSP path establishment attempt fails, the path is put into retry procedures and a new attempt will be performed at the expiry of the user-configurable retry timer (config>router>mpls>lsp>retry-timer). By default, the retry time is constant for every attempt. The exponential back-off timer procedures will double the value of the user configured retry timer value at every failure of the attempt to adjust to the potential network congestion that caused the failure. An LSP establishment fails if no Resv message was received and the Path message retry timer expired or a PathErr message was received before the timer expired.

frr-object

Syntax

```
[no] frr-object
```

Context

`config>router>mpls`

Description

This command specifies whether fast reroute for LSPs using the facility bypass method is signalled with or without the fast reroute object using the one-to-one keyword. The value is ignored if fast reroute is disabled for the LSP or if the LSP is using one-to-one Backup.

Default

frr-object — The value is by default inherited by all LSPs.

hold-timer

Syntax

```
hold-timer seconds
no hold-timer
```

Context

`config>router>mpls`

Description

This command specifies the amount of time that the ingress node holds before programming its data plane and declaring the LSP up to the service module. This occurs anytime the ingress node brings up an LSP path or switches traffic from a working path to another working path of the same LSP.

The no form of the command reverts the hold-timer to the default value.

Parameters

```
seconds — Specifies the time, in seconds, for which the ingress node holds before programming its data plane and declaring the LSP up to the service module.
```

Values

```
0 — 10
```

Default

1 second
ingress-statistics

Syntax    ingress-statistics
Context    config>router>mpls
Description  This command provides the context for the user to enter the LSP names for the purpose of enabling ingress data path statistics at the terminating node of the LSP, for example, egress LER.
Default none

least-fill-min-thd

Syntax    least-fill-min-thd percent
no least-fill-min-thd
Context    config>router>mpls
Description  This parameter is used in the least-fill path selection process. When comparing the percentage of least available link bandwidth across the sorted paths, whenever two percentages differ by less than the value configured as the least-fill-min-thresh, CSPF will consider them equal and will apply a random number generator to select the path among these paths. The no form of the command resets this parameter to its default value.
Default 5
Parameters  percentage — Specifies the least fill minimum threshold value as a percentage.
Values  1 — 100%

least-fill-reoptim-thd

Syntax    least-fill-reoptim-thd percent
no least-fill-reoptim-thd
Context    config>router>mpls
Description  This parameter is used in the least-fill path selection method. During a timer-based re-signaling of an LSP path which has the least-fill option enabled, CSPF will first update the least-available bandwidth figure for the current path of this LSP. It then applies the least-fill path selection method to select a new path for this LSP. If the new computed path has the same cost as the current path, it will compare the least-available bandwidth figures of the two paths and if the difference exceeds the user configured optimization threshold, MPLS will generate a trap to indicate that a better least-fill path is available for this LSP. This trap can be used by an external SNMP based device to trigger a manual re-signaling of the LSP path since the timer-based re-signaling will not re-signal the path in this case. MPLS will generate a path update trap at the first MBB event which results in the re-signaling of the LSP path. This should clear the eligibility status of the path at the SNMP device. The no form of this command resets this parameter to its default value.
Default 10
Parameters  
**percentage** — Specifies the least fill reoptimization threshold value as a percentage.

**Values**

1 — 100%

### lsp

**Syntax**

```
[no] lsp lsp-name sender sender-address
```

**Context**

config>router>mpls>ingress-statistics

**Description**

This command configures statistics in the ingress data path of a terminating RSVP LSP at an egress LER. The LSP name must correspond to the name configured by the operator at the ingress LER. It must not contain the special character “:" which is used as a field separator by the ingress LER for encoding the LSP and path names into the RSVP session name field in the session_attribute object. The operator must execute the **no shutdown** for this command to effectively enable statistics.

The same set of counters is updated for packets received over any path of this LSP and over the lifetime of the LSP. In steady-state, the counters are updated for packets received over the active path of the LSP. The active path can be the primary path, one of the secondary paths, the FRR detour path, or the FRR bypass path when the tail-end node is also the MP.

When a hierarchy of LSPs is in use, statistics collection on the outermost label corresponding to the tunneling LSP and on the inner labels, corresponding to the tunneled LSPs are mutually exclusive. A consequence of this is that when the operator enables statistics collection on an RSVP LSP which is also used for tunneling LDP FECs with the LDP over RSVP feature, then statistics will be collected on the RSVP LSP only. There will be no statistics collected for an LDP FEC tunneled over this RSVP LSP and also egressing on the same node regardless if the operator enabled statistics collection on this FEC. When, the operator disables statistics collection on the RSVP LSP, then statistics collection, if enabled, will be performed on a tunneled LDP FEC.

The operator can enable statistics collection on a manual bypass terminating on the egress LER. However all LSPs which primary path is protected by the manual bypass will not collect statistics when they activate forwarding over the manual bypass. When, the operator disables statistics collection on the manual bypass LSP, then statistics collection on the protected LSP, if enabled, will continue when the bypass LSP is activated.

The **no** form of this command disables statistics for this RSVP LSP in the ingress data path and removes the accounting policy association from the LSP.

**Default**

none

**Parameters**

**sender-address ip-address** — A string of 15 characters representing the IP address of the ingress LER for the LSP.

**lsp-name** — A string of up to 32 characters identifying the LSP name as configured at the ingress LER.
logger-event-bundling

Syntax  [no] logger-event-bundling

Context  configure>router>mpls

Description  This feature merges two of the most commonly generated MPLS traps, vRtrMplsXCCreate and vRtrMplsXCDelete, which can be generated at both LER and LSR into a new specific trap vRtrMplsSessionsModified. In addition, this feature will perform bundling of traps of multiple RSVP sessions, i.e., LSPs, into this new specific trap.

The intent is to provide a tool for the user to minimize trap generation in an MPLS network. Note that the MPLS trap throttling will not be applied to this new trap.

The no version of this command disables the merging and bundling of the above MPLS traps.

lsp-init-retry-timeout

Syntax  lsp-init-retry-timeout seconds
        no lsp-init-retry-timeout

Context  config>router>mpls

Description  This command configures the initial LSP path retry-timer.

The new LSP path initial retry-timer is used instead of the retry-timer to abort the retry cycle when no RESV is received. The retry-timer will govern exclusively the time between two retry cycles and to handle retrying of an LSP path in a failure case with PATH errors or RESVTear.

The intent is that the user can now control how many refreshes of the pending PATH state can be performed before starting a new retry-cycle with a new LSP-id. This is all done without affecting the ability to react faster to failures of the LSP path, which will continue to be governed by the retry-timer.

The no form of this command returns the timer to the default value.

Parameters  seconds — Specifies the value, in seconds, used as the fast retry timer for a secondary path.

Values  10—600

Default  30

max-bypass-associations

Syntax  max-bypass-associations integer
        no max-bypass-associations

Context  config>router>mpls

Description  This command allows the user to set a maximum number of LSP primary path associations with each manual or dynamic bypass LSP that is created in the system.
By default, a Point of Local Repair (PLR) node will associate a maximum of 1000 primary LSP paths with a given bypass before using the next available manual bypass or signaling a new dynamic bypass.

Note that a new bypass LSP may need to be signaled if the constraint of a given primary LSP path is not met by an existing bypass LSP even if the max-bypass-associations for this bypass LSP has not been reached.

The no form of the command re-instates the default value of this parameter.

**Default**

no max-bypass-associations

**Values**

1—131,072

---

### resignal-timer

**Syntax**

resignal-timer minutes

no resignal-timer

**Context**

config>router>mpls

**Description**

This command specifies the value for the LSP resignal timer. The resignal timer is the time, in minutes, the software waits before attempting to resignal the LSPs.

When the resignal timer expires, if the new computed path for an LSP has a better metric than the current recorded hop list, an attempt is made to resignal that LSP using the make-before-break mechanism. If the attempt to resignal an LSP fails, the LSP will continue to use the existing path and a resignal will be attempted the next time the timer expires.

The no form of the command disables timer-based LSP resignalling.

**Default**

no resignal-timer

**Parameters**

*minutes* — The time the software waits before attempting to resignal the LSPs.

**Values**

30 — 10080

---

### secondary-fast-retry-timer

**Syntax**

secondary-fast-retry-timer seconds

no secondary-fast-retry-timer

**Context**

config>router>mpls

**Description**

This command specifies the value used as the fast retry timer for a secondary path. If the first attempt to set up a secondary path fails due to a path error, the fast retry timer will be started for the secondary path so that the path can be retried sooner. If the next attempt also fails, further retries for the path will use the configured value for LSP retry timer.

If retry-timer for the LSP is configured to be less than the MPLS secondary-fast-retry-timer, all retries for the secondary path will use the LSP retry-timer.

The no form of the command reverts to the default.
Default  no secondary-fast-retry-timer

Parameters  seconds — specifies the value, in seconds, used as the fast retry timer for a secondary path

Values  1 — 10

srlg-frr

Syntax  srlg-frr [strict]

no srlg-frr

Context  config>router>mpls

Description  This command enables the use of the Shared Risk Loss Group (SRLG) constraint in the computation of FRR bypass or detour to be associated with any primary LSP path on this system.

When this option is enabled, CSPF includes the SRLG constraint in the computation of a FRR detour or bypass for protecting the primary LSP path.

CSPF prunes all links with interfaces which belong to the same SRLG as the interface which is being protected, i.e., the outgoing interface at the PLR the primary path is using. If one or more paths are found, the MPLS/RSVP task will select one based on best cost and will signal the bypass/detour. If not and the user included the strict option, the bypass/detour is not setup and the MPLS/RSVP task will keep retrying the request to CSPF. Otherwise, if a path exists which meets the other TE constraints, other than the SRLG one, the bypass/detour is setup.

A bypass or a detour LSP path is not guaranteed to be SRLG disjoint from the primary path. This is because only the SRLG constraint of the outgoing interface at the PLR the primary path is using is checked.

When the MPLS/RSVP task is searching for a SRLG bypass tunnel to associate with the primary path of the protected LSP, it will first check if any configured manual bypass LSP with CSPF enabled satisfies the SRLG constraints. The MPLS/RSVP skips any non-CSPF bypass LSP in the search as there is no ERO returned to check the SRLG constraint. If no path is found, it will check if an existing dynamic bypass LSP satisfies the SRLG and other primary path constraints. If not, then it will make a request to CSPF.

Once the primary path of the LSP is set up and is operationally up, any subsequent changes to the SRLG group membership of an interface the primary path is using would not be considered by the MPLS/RSVP task at the PLR for bypass/detour association until the next opportunity the primary path is re-signal. The path may be re-signal due to a failure or to a make-before break operation. Make-before break occurs as a result of a global revertive operation, a timer based or manual re-optimization of the LSP path, or a user change to any of the path constraints.

Once the bypass or detour path is setup and is operationally UP, any subsequent changes to the SRLG group membership of an interface the bypass/detour path is using would not be considered by the MPLS/RSVP task at the PLR until the next opportunity the association with the primary LSP path is re-checked. The association is re-checked if the bypass path is re-optimized. Detour paths are not re-optimized and are re-signal if the primary path is down.

Enabling or disabling srlg-frr only takes effect after LSP paths are resigaled. This can be achieved by shutting down and re-enabling MPLS. Another option is using the tools perform router mpls resignal command. However, note that while the latter might be less service impacting, only originating LSPs can be resigaled with the tools command. If also local transit and bypass LSPs are to be resigaled, the tools command must be executed on all ingress nodes in the network. The same
might be locally achieved by disabling and enabling using the `configure router mpls dynamic-bypass` command, but this can trigger the LSP to go down and traffic loss to occur in case detour or bypass LSP is in use.

An RSVP interface can belong to a maximum of 64 SRLG groups. The user configures the SRLG groups using the command `config>router>mpls>srlg-group`. The user configures the SRLG groups an RSVP interface belongs to using the `srlg-group` command in the `config>router>mpls>interface` context.

The `no` form of the command reverts to the default value.

**Default**

no srlg-frr

**Parameters**

`strict` — Specifies the name of the SRLG group within a virtual router instance.

**Values**

- no srlg-frr (default)
- srlg-frr (non-strict)
- srlg-frr strict (strict)

### srlg-group

**Syntax**

```
srlg-group group-name \{value group-value\}
no srlg-group group-name
```

**Context**

`config>router>mpls`

**Description**

This command is used to define shared risk loss groups (SRLGs). An SRLG group represents a set of interfaces which could be subject to the same failures or defects and thus share the same risk of failing.

RSVP interfaces must be explicitly assigned to an SRLG group. SRLG groups must be defined in the `config>router>mpls` context before they can be assigned to an RSVP interface. Two different SRLG group names cannot share the same value. Once an SRLG group has been bound to an MPLS interface, its value cannot be changed until the binding is removed.

The IGP communicates the information throughout the area using the TE link state advertisement. CSPF uses the information when paths are computed for constraint-based LSPs. CSPF must be enabled in order for SRLG groups to be relevant.

Up to 1024 group names can be defined in the `config>router>mpls` context. The SRLG group names must be identical across all routers in a single domain.

The `no` form of this command deletes the SRLG group.

**Default**

none

**Parameters**

`group-name` — Specifies the name of up to 32 characters of the SRLG group within a virtual router instance.

`value group-value` — Specifies the group value associated with this SRLG group. This value is unique within a virtual router instance.

**Values**

- 0 — 4294967295
user-srlg-db

**Syntax**

```
user-srlg-db [enable | disable]
```

**Context**

```
config>router>mpls
```

**Description**

This command enables the use of CSPF by the user SRLG database. When the MPLS module makes a request to CSPF for the computation of an SRLG secondary path, CSPF will query the local SRLG and compute a path after pruning links that are members of the SRLG IDs of the associated primary path. When MPLS makes a request to CSPF for an FRR bypass or detour path to associate with the primary path, CSPF queries the user SRLG database and computes a path after pruning links that are members of the SRLG IDs of the PLR outgoing interface.

If an interface was not entered into the user SRLG database, it is assumed that it does not have any SRLG membership. CSPF will not query the TE database for IGP advertised interface SRLG information.

The disable keyword disables the use of the user SRLG database. CSPF will then resume queries into the TE database for SRLG membership information. The user SRLG database is maintained.

**Default**

```
user-srlg-db disable
```

srlg-database

**Syntax**

```
[no] srlg-database
```

**Context**

```
config>router>mpls
```

**Description**

This command provides the context for the user to enter manually the link members of SRLG groups for the entire network at any node that needs to signal LSP paths (for example, a head-end node). The no form of the command deletes the entire SRLG database. CSPF will assume all interfaces have no SRLG membership association if the database was not disabled with the command `config>router>mpls>user-srlg-db disable`.

```
```

router-id

**Syntax**

```
[no] router-id ip
```

**Context**

```
config>router>mpls>srlg-database
```

**Description**

This command provides the context for the user to manually enter the link members of SRLG groups for a specific router in the network. The user must also use this command to enter the local interface SRLG membership into the user SRLG database. Use by CSPF of all interface SRLG membership information of a specific router ID may be temporarily disabled by shutting down the node. If this occurs, CSPF will assume these interfaces have no SRLG membership association.

The no form of this command will delete all interface entries under the router ID.

**Parameters**

```
ip-address — Specifies the router ID for this system. This must be the router ID configured under the base router instance, the base OSPF instance or the base IS-IS instance.
```

```
```
### interface

**Syntax**

```plaintext
interface ip-address srlg-group group-name [group-name...(up to 5 max)]
no interface ip-address [srlg-group group-name...(up to 5 max)]
```

**Context**

`config>router>mpls>srlg-database>router-id`

**Description**

This command allows the operator to manually enter the SRLG membership information for any link in the network, including links on this node, into the user SRLG database.

An interface can be associated with up to 5 SRLG groups for each execution of this command. The operator can associate an interface with up to 64 SRLG groups by executing the command multiple times.

CSPF will not use entered SRLG membership if an interface is not validated as part of a router ID in the routing table.

The `no` form of the command deletes a specific interface entry in this user SRLG database. The `group-name` must already exist in the `config>router>mpls>srlg-group` context.

**Default**

`none`

**Parameters**

- `ip-int-name` — The name of the network IP interface. An interface name cannot be in the form of an IP address.

- `srlg-group group-name` — Specifies the SRLG group name. Up to 1024 group names can be defined in the `config>router>mpls` context. The SRLG group names must be identical across all routers in a single domain.
**MPLS Interface Commands**

**interface**

**Syntax**

```
[no] interface ip-int-name
```

**Context**

```
config>router>mpls
```

**Description**

This command specifies MPLS protocol support on an IP interface. No MPLS commands are executed on an IP interface where MPLS is not enabled. An MPLS interface must be explicitly enabled (**no shutdown**).

The **no** form of this command deletes all MPLS commands such as **label-map** which are defined under the interface. The MPLS interface must be shutdown first in order to delete the interface definition. If the interface is not shutdown, the **no interface ip-int-name** command does nothing except issue a warning message on the console indicating that the interface is administratively up.

**Default**

```
shutdown
```

**Parameters**

- **ip-int-name** — The name of the network IP interface. An interface name cannot be in the form of an IP address. If the string contains special characters (#, $, spaces, etc.), the entire string must be enclosed within double quotes.

**Values**

1 to 32 alphanumeric characters.

**admin-group**

**Syntax**

```
[no] admin-group group-name [group-name...(up to 5 max)]
```

**Context**

```
config>router>mpls>interface
```

**Description**

This command defines admin groups that this interface supports. This information is advertised as part of OSPF and IS-IS to help CSPF compute constrained LSPs that must include or exclude certain admin groups. An MPLS interface is assumed to belong to all the admin groups unless the 'admin-group' command is issued under the interface config. Once an 'admin-group' command is issued the interface is assumed to belong to only the specifically listed groups for that command.

Each single operation of the admin-group command allows a maximum of 5 groups to be specified at a time. However, a maximum of 32 groups can be specified per interface through multiple operations.

**Default**

```
no admin-group
```

**Parameters**

- **group-name** — Name of the group. The group names should be the same across all routers in the MPLS domain.
auto-bandwidth-multipliers

Syntax

auto-bandwidth-multipliers sample-multiplier number1 adjust-multiplier number2
no auto-bandwidth-multipliers

Context
config>router>mpls>

Description
This command specifies the number of collection intervals in the adjust interval.

Parameters

sample-multiplier number1 — Specifies the multiplier for collection intervals in a sample interval.

Values
1 — 511
Default
1

adjust-multiplier number2 — Specifies the number of collection intervals in the adjust interval.

Values
1 — 16383
Default
288

cspf-on-loose-hop

Syntax
[no] cspf-on-loose-hop

Context
config>router>mpls>

Description
This command enables option to do CSPF calculation till the next loose hop or the final destination of LSP on LSR. On receiving a PATH message on LSR and processing of all local hops in the received ERO, if the next hop is loose then the LSR node will first do a CSPF calculation till the next loose hop. On successful completion of CSPF calculation, ERO in PATH message is modified to include newly calculated intermediate hops and propagate it forward to the next hop. This allows setting up inter-area LSPs based on ERO expansion method.

NOTE: LSP may fail to setup if this option is enabled on LSR that is not an area border router and receives a PATH message without proper next loose hop in ERO.

‘cspf-on-loose-hop’ configuration is allowed to change dynamically and applied to new LSP setup after change.

Default
no cspf-on-loose-hop

srlg-group

Syntax
[no] srlg-group group-name [group-name...(up to 5 max)]

Context
config>router>mpls>interface

Description
This command defines the association of RSVP interface to an SRLG group. An interface can belong to up to 64 SRLG groups. However, each single operation of the srlg-group command allows a maximum of 5 groups to be specified at a time.

The no form of this command deletes the association of the interface to the SRLG group.
MPLS Commands

### Default

Default

none

### Parameters

**group-name** — Specifies the name of the SRLG group within a virtual router instance up to 32 characters.

---

### te-metric

**Syntax**

```
te-metric value
no te-metric
```

**Context**

```
config>router>mpls>interface
```

**Description**

This command configures the traffic engineering metric used on the interface. This metric is in addition to the interface metric used by IGP for the shortest path computation.

This metric is flooded as part of the TE parameters for the interface using an opaque LSA or an LSP. The IS-IS TE metric is encoded as sub-TLV 18 as part of the extended IS reachability TLV. The metric value is encoded as a 24-bit unsigned integer. The OSPF TE metric is encoded as a sub-TLV Type 5 in the Link TLV. The metric value is encoded as a 32-bit unsigned integer.

When the use of the TE metric is enabled for an LSP, CSPF will first prune all links in the network topology which do not meet the constraints specified for the LSP path. Such constraints include bandwidth, admin-groups, and hop limit. Then, CSPF will run an SPF on the remaining links. The shortest path among the all SPF paths will be selected based on the TE metric instead of the IGP metric which is used by default.

The TE metric in CSPF LSP path computation can be configured by entering the command

```
config>router>mpls>lsp>cspf>use-te-metric
```

Note that the TE metric is only used in CSPF computations for MPLS paths and not in the regular SPF computation for IP reachability.

The **no** form of the command reverts to the default value.

**Default**

no te-metric

The value of the IGP metric is advertised in the TE metric sub-TLV by IS-IS and OSPF.

**Parameters**

**value** — Specifies the metric value.

**Values**

1 — 16777215

---

### node-id-in-rro

**Syntax**

```
[no] node-id-in-rro <include | exclude>
```

**Context**

```
config>router>rsvp>
```

**Description**

This command enables the option to include node-id sub-object in RRO. Node-ID sub-object propagation is required to provide fast reroute protection for LSP that spans across multiple area domains.

If this option is disabled, then node-id is not included in RRO object.

**Default**

node-id-in-rro exclude
p2p-merge-point-abort-timer

Syntax:  
`p2p-merge-point-abort-timer [1.. 65535] seconds`

`no p2p-merge-point-abort-timer`

Context:  
`config-router-rsvp`

Description:  
Default: 0 (disabled)

p2mp-merge-point-abort-timer

Syntax:  
`p2mp-merge-point-abort-timer [1.. 65535] seconds`

`no p2mp-merge-point-abort-timer`

Context:  
`config-router-rsvp`

Description:  
Default: 0 (disabled)

p2p-active-path-fast-retry

Syntax:  
`p2p-active-path-fast-retry seconds [1..10] seconds`

`no p2p-active-path-fast-retry`

Context:  
`config-router-rsvp`

Description:  
Default: 0 (disabled)

p2mp-s21-fast-retry

Syntax:  
`p2mp-s21-fast-retry seconds [1..10] seconds`

`no p2mp-s21-fast-retry`

Context:  
`config-router-rsvp`

Description:  
Default: 0 (disabled)
preemption-timer

**Syntax**

```
preemption-timer seconds
no preemption-timer
```

**Context**

```
config>router>rsvp
```

**Description**

This parameter configures the time in seconds a node holds to a reservation for which it triggered the soft pre-emption procedure.

The pre-empting node starts a separate preemption timer for each pre-empted LSP path. While this timer is on, the node should continue to refresh the Path and Resv for the pre-empted LSP paths. When the preemption timer expires, the node tears down the reservation if the head-end node has not already done so.

A value of zero means the LSP should be pre-empted immediately; hard pre-empted.

The `no` form of this command reverts to the default value.

**Default**

300

**Parameters**

- `seconds` — Specifies the time, in seconds, of the preemption timer.

**Values**

- 0 — 1800 seconds

label-map

**Syntax**

```
[no] label-map in-label
```

**Context**

```
config>router>mpls>interface
```

**Description**

This command is used on transit routers when a static LSP is defined. The static LSP on the ingress router is initiated using the `config router mpls static-lsp lsp-name` command. An `in-label` can be associated with either a `pop` or a `swap` action, but not both. If both actions are specified, the last action specified takes effect.

The `no` form of this command deletes the static LSP configuration associated with the `in-label`.

**Parameters**

- `in-label` — Specifies the incoming MPLS label on which to match.

**Values**

- 32 — 1023
pop

Syntax  [no] pop
Context  config>router>mpls>if>label-map
Description  This command specifies that the incoming label must be popped (removed). No label stacking is supported for a static LSP. The service header follows the top label. Once the label is popped, the packet is forwarded based on the service header.

The **no** form of this command removes the **pop** action for the **in-label**.

Default  none

shutdown

Syntax  [no] shutdown
Context  config>router>mpls>if>label-map
Description  This command disables the label map definition. This drops all packets that match the specified **in-label** specified in the **label-map in-label** command.

The **no** form of this command administratively enables the defined label map action.

Default  **no shutdown**
swap

Syntax

\texttt{swap \{out-label | implicit-null-label\} nexthop ip-address}

\texttt{no swap \{out-label | implicit-null-label\}}

Context

\texttt{config>router>mpls>interface>label-map}

Description

This command swaps the incoming label and specifies the outgoing label and next hop IP address on an LSR for a static LSP.

The \texttt{no} form of this command removes the swap action associated with the \texttt{in-label}.

Default

\texttt{none}

Parameters

\texttt{implicit-null-label} — Specifies the use of the implicit label value for the outgoing label of the swap operation.

\texttt{out-label} — Specifies the label value to be swapped with the in-label. Label values 16 through 1,048,575 are defined as follows:

- Label values 16 through 31 are reserved.
- Label values 32 through 1,023 are available for static assignment.
- Label values 1,024 through 2,047 are reserved for future use.
- Label values 2,048 through 18,431 are statically assigned for services.
- Label values 28,672 through 131,071 are dynamically assigned for both MPLS and services.
- Label values 131,072 through 1,048,575 are reserved for future use.

\texttt{Values} 16 — 1048575

\texttt{nexthop ip-address} — The IP address to forward to. If an ARP entry for the next hop exists, then the static LSP will be marked operational. If an ARP entry does not exist, software will set the operational status of the static LSP to down and continue to ARP for the configured nexthop. Software will continuously try to ARP for the configured nexthop at a fixed interval.
LSP Commands

lsp

Syntax
[no] lsp lsp-name [bypass-only]

Context
config>router>mpls

Description
This command creates an LSP that is signaled dynamically by the router.

When the LSP is created, the egress router must be specified using the to command and at least one primary or secondary path must be specified. All other statements under the LSP hierarchy are optional. Note that the maximum number of static configurable LSPs is 4.

LSPs are created in the administratively down (shutdown) state.

The no form of this command deletes the LSP. All configuration information associated with this LSP is lost. The LSP must be administratively shutdown and unbound from all SDPs before it can be deleted.

Default
none

Parameters
lsp-name — Name that identifies the LSP. The LSP name can be up to 32 characters long and must be unique.

bypass-only — Defines an LSP as a manual bypass LSP exclusively. When a path message for a new LSP requests bypass protection, the PLR first checks if a manual bypass tunnel satisfying the path constraints exists. If one is found, the router selects it. If no manual bypass tunnel is found, the router dynamically signals a bypass LSP in the default behavior. The CLI for this feature includes a knob that provides the user with the option to disable dynamic bypass creation on a per node basis.

adaptive

Syntax
[no] adaptive

Context
config>router>mpls>lsp
config>router>mpls>lsp-template

Description
This command enables the make-before-break functionality for an LSP or LSP path. When enabled for the LSP, make-before-break will be performed for primary path and all the secondary paths of the LSP.

Default
adaptive
adspec

Syntax  
```
[no] adspec
```

Context  
```
config>router>mpls>lsp
```

Description  
When enabled, the ADSPEC object will be included in RSVP messages for this LSP. The ADSPEC object is used by the ingress LER to discover the minimum value of the MTU for links in the path of the LSP. By default, the ingress LER derives the LSP MTU from that of the outgoing interface of the LSP path.

Note that a bypass LSP always signals the ADSPEC object since it protects both primary paths which signal the ADSPEC object and primary paths which do not. This means that MTU of LSP at ingress LER may change to a different value from that derived from the outgoing interface even if the primary path has ADSPEC disabled.

Default  
```
no adspec — No ADSPEC objects are included in RSVP messages.
```

auto-bandwidth

Syntax  
```
[no] auto-bandwidth
```

Context  
```
config>router>mpls>lsp
```

Description  
This command enables automatic adjustments of LSP or SDP bandwidth.

Auto-bandwidth at the LSP level cannot be executed unless cspf and adaptive are configured in the `config>router>mpls>lsp` context.

Auto-bandwidth at the SDP level cannot be executed unless the SDP type is MPLS, the SDP is comprised of only RSVP LSPs, all of the RSVP LSPs have auto-bandwidth enabled and the adjust-up, adjust-down and overflow-limit commands are not present in the auto-bandwidth configuration of any of the RSVP LSPs.

The `no` form of the command disables the automatic adjustments of LSP or SDP bandwidth.

adjust-down

Syntax  
```
adjust-down percent [bw mbps]
```

```
no adjust-down
```

Context  
```
config>router>mpls>lsp>auto-bandwidth
```

Description  
This command configures the minimum threshold for decreasing the bandwidth of an LSP based on active measurement of LSP bandwidth.

The `no` form of this command is equivalent to adjust-down 5.

Default  
```
no adjust-down
```

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Parameters

**percent** — Specifies the minimum difference between the current bandwidth reservation of the LSP and the (measured) maximum average data rate, expressed as a percentage of the current bandwidth, for decreasing the bandwidth of the LSP.

**Values**

1 — 100

**Default**

5

**mbps** — Specifies the minimum difference between the current bandwidth reservation of the LSP and the (measured) maximum average data rate, expressed as an absolute bandwidth (mbps), for decreasing the bandwidth of the LSP.

**Values**

0 — 100000

**Default**

0

**adjust-up**

**Syntax**

```
adjust-up percent [bw mbps]
```

```
no adjust-up
```

**Context**

```
config>router>mpls>lsp>auto-bandwidth
```

**Description**

This command configures the minimum threshold for increasing the bandwidth of an LSP based on active measurement of LSP bandwidth.

The **no** form of this command is equivalent to `adjust-up 5`.

**Default**

no adjust-up

**Parameters**

**percent** — Specifies the minimum difference between the current bandwidth reservation of the LSP and the (measured) maximum average data rate, expressed as a percentage of the current bandwidth, for increasing the bandwidth of the LSP.

1-100

**Default**

5

**mbps** — Specifies the minimum difference between the current bandwidth reservation of the LSP and the (measured) maximum average data rate, expressed as an absolute bandwidth (mbps), for increasing the bandwidth of the LSP.

**Values**

0 — 100000

**Default**

0

**max-bandwidth**

**Syntax**

```
max-bandwidth mbps
```

```
no max-bandwidth
```

**Context**

```
config>router>mpls>lsp>auto-bandwidth
```

**Description**

This command configures the maximum bandwidth that auto-bandwidth allocation is allowed to request for an LSP or SDP.
The LSP maximum applies whether the bandwidth adjustment is triggered by normal adjust-timer expiry, the overflow limit having been reached, or manual request or SDP auto-bandwidth adjustment.

The SDP maximum applies to bandwidth adjustment caused by VLL CAC. The SDP maximum bandwidth must be less than or equal to the sum of the max-bandwidth parameters of the LSPs in the SDP.

This command is mandatory at the LSP level if an overflow-limit is configured.

The no form of the command means max-bandwidth is infinite (equivalent to 100 Gbps).

**Default**

no max-bandwidth

**Parameters**

*mbps* — Specifies the maximum bandwidth in mbps.

**Values**

0 — 100000

**Default**

0

### min-bandwidth

**Syntax**

```
min-bandwidth mbps
no min-bandwidth
```

**Context**

`config>router>mpls>lsp/auto-bandwidth`

**Description**

This command configures the minimum bandwidth that auto-bandwidth allocation is allowed to request for an LSP or SDP.

The LSP minimum applies whether the bandwidth adjustment is triggered by normal adjust-timer expiry or, manual request or SDP auto-bandwidth adjustment.

The no form of the command means min-bandwidth is zero.

**Default**

no min-bandwidth

**Parameters**

*mbps* — Specifies the minimum bandwidth in mbps.

**Values**

0 — 100000

**Default**

0

### monitor-bandwidth

**Syntax**

```
[no] monitor-bandwidth
```

**Context**

`config>router>mpls>lsp/auto-bandwidth`

**Description**

This command enables the collection and display of auto-bandwidth measurements, but prevents any automatic bandwidth adjustments from taking place, other than those caused by VLL CAC (through an SDP bandwidth change).

This command is mutually exclusive with the *overflow-limit* command.

The no form of the command the collection and display of auto-bandwidth measurements.
multipliers

Syntax  multipliers sample-multiplier num1 adjust-multiplier num2
no multipliers

Context  config>router>mpls>lsp>auto-bandwidth

Description  This command configures the number of collection intervals between measurements of the number of bytes that have been transmitted on the LSP. The byte counts include the layer 2 encapsulation of MPLS packets and represent traffic of all forwarding classes and priorities (in-profile vs, out-of-profile) belonging to the LSP.

The router calculates the average data rate in each sample interval. The maximum of this average data rate over multiple sample intervals is the measured bandwidth input to the auto-bandwidth adjustment algorithms.

The count is not allowed to be set a value greater than adjust-count.

The no form of this command instructs the system to take the value from the auto-bandwidth-defaults command.

Default  no sample-count

Parameters  

number  — The number of collection intervals in a sample interval.

Values  1 — 511

Default  1

overflow-limit

Syntax  overflow-limit number threshold percent [bw mbps]
no overflow-limit

Context  config>router>mpls>lsp>auto-bandwidth

Description  This command configures overflow-triggered auto-bandwidth adjustment. It sets the threshold at which bandwidth adjustment is initiated due to the configured number of overflow samples having been reached, regardless of how much time remains until the adjust interval ends.

A sample interval is counted as an overflow if the average data rate during the sample interval is higher than the currently reserved bandwidth by at least the thresholds configured as part of this command.

If overflow-triggered auto-bandwidth adjustment is successful the overflow count and adjust-timer are reset. If overflow-triggered auto-bandwidth adjustment fails then the overflow count is reset but the adjust-timer continues.

This command is mutually exclusive with the monitor-bandwidth command.

This command will fail if the max-bandwidth value at the config>router>mpls>lsp>auto-bandwidth level is not configured or if it is set to infinite (100 Gbps) zero.

The no form of this command disables overflow-triggered automatic bandwidth adjustment.

Default  no overflow-limit
Parameters

- **number** — The number of overflow samples that triggers an overflow auto-bandwidth adjustment attempt.
  - **Values** 1 — 10
  - **Default** none

- **percent** — The minimum difference between the current bandwidth of the LSP and the sampled data rate, expressed as a percentage of the current bandwidth, for counting an overflow sample.
  - **Values** 1 — 100
  - **Default** none

- **mbps** — The minimum difference between the current bandwidth of the LSP and the sampled data rate, expressed as an absolute bandwidth (Mbps) relative to the current bandwidth, for counting an overflow sample.
  - **Values** 1— 100000
  - **Default** 0

```
0bgp-transport-tunnelbgp-transport-tunnel
```

This command allows or blocks RSVP-TE LSP to be used as a transport LSP for BGP tunnel routes. bgp-transport-tunnel include

- **include** Allows RSVP-TE LSP to be used as transport LSP from the ASBR to local PE router, from ingress PE to ASBR in the local AS or between multi-hop eBGP peers with ASBR to ASBR adjacency.
- **include** Blocks RSVP-TE LSP to be used as transport LSP from the ASBR to local PE router, from ingress PE to ASBR in the local AS or between multi-hop eBGP peers with ASBR to ASBR adjacency.

**class-type**

**Syntax**

- `class-type ct-number`
- `no class-type`

**Context**

- `config>router>mpls>lsp`
- `config>router>mpls>lsp>primary`
- `config>router>mpls>lsp>secondary`

**Description**

This command configures the Diff-Serv Class Type (CT) for an LSP, the LSP primary path, or the LSP secondary path. The path level configuration overrides the LSP level configuration. However, only one CT per LSP path will be allowed as per RFC 4124.

The signaled CT of a dynamic bypass is always be CT0 regardless of the CT of the primary LSP path. The setup and hold priorities must be set to default values, i.e., 7 and 0 respectively. This assumes that the operator configured a couple of TE classes, one which combines CT0 and a priority of 7 and the other which combines CTO and a priority of 0. If not, the bypass LSP will not be signaled and will go into the down state.

The operator cannot configure the CT, setup priority, and hold priority of a manual bypass. They are always signaled with CT0 and the default setup and holding priorities.

The signaled CT and setup priority of a detour LSP must match those of the primary LSP path it is associated with.

If the operator changes the CT of an LSP or of an LSP path, or changes the setup and holding priorities of an LSP path, the path will be torn down and retried.
An LSP which does not have the CT explicitly configured will behave like a CT0 LSP when Diff-Serv is enabled.

If the operator configured a combination of a CT and a setup priority and/or a combination of a CT and a holding priority for an LSP path that are not supported by the user-defined TE classes, the LSP path will be kept in a down state and an error code will be displayed in the show command output for the LSP path.

The `no` form of this command reverts to the default value.

**Default**

```
no class-type.
```

**Parameters**

- `ct-number` — The Diff-Serv Class Type number.
  - **Values**
    - 0 – 7
  - **Default**
    - 0

**bandwidth**

**Syntax**

```
bandwidth rate-in-mbps
```

**Context**

```
config>router>mpls>lsp
config>router>mpls>lsp-template
```

**Description**

This command specifies the amount of bandwidth to be reserved for the P2MP instance.

**Parameters**

- `rate-in-mbps` — specifies the bandwidth, in Mbps.
  - **Values**
    - 0 — 100000

**cspf**

**Syntax**

```
[no] cspf [use-te-metric]
```

**Context**

```
config>router>mpls>lsp
config>router>mpls>lsp-template
```

**Description**

This command enables Constrained Shortest Path First (CSPF) computation for constrained-path LSPs. Constrained-path LSPs are the ones that take configuration constraints into account. CSPF is also used to calculate the detour routes when fast-reroute is enabled.

Explicitly configured LSPs where each hop from ingress to egress is specified do not use CSPF. The LSP will be set up using RSVP signaling from ingress to egress.

If an LSP is configured with `fast-reroute frr-method` specified but does not enable CSPF, then neither global revertive nor local revertive will be available for the LSP to recover.

**Default**

```
no cspf
```

**Parameters**

- `use-te-metric` — Specifies to use the use of the TE metric for the purpose of the LSP path computation by CSPF.
cspf-to-first-loose

**Syntax**  
```plaintext
[no] cspf-to-first-loose
```

**Context**  
```
config>router>mpls>lsp>
```

**Description**  
This command enables option to do CSPF calculation only till the first loose hop on ingress LER. If there are multiple loose hops in path list then the ingress node will do CSPF calculation till the first loose hop. On successful completion of CSPF calculation, ERO in PATH message must be modified to include locally calculated intermediate hops and propagate it forward to the next hop.

If an end-to-end CSPF path is required then ‘cspf-on-loose-hop’ must be configured on LSR that is configured as loose hop. With both options enabled, instead of ingress calculating the complete path, it is partially calculated by each loose hop that is traversed by LSP.

If this option is disabled then CSPF calculation is done to the destination of LSP. ‘cspf-to-first-loose’ is allowed to change dynamically. LSP would do ‘break-before-make’ on changing configuration. If CSPF is disabled and configuration is changed then there is no action.

**Default**  
no cspf-to-first-loose

---

exclude

**Syntax**  
```plaintext
[no] exclude group-name [group-name...(up to 5 max)]
```

**Context**  
```
config>router>mpls>lsp
config>router>mpls>lsp-template
```

**Description**  
This command specifies the admin groups to be excluded when an LSP is set up in the primary or secondary contexts. Each single operation of the exclude command allows a maximum of 5 groups to be specified at a time. However, a maximum of 32 groups can be specified per LSP through multiple operations. The admin groups are defined in the `config>router>mpls>admin-group` context.

Use the `no` form of the command to remove the exclude command.

**Default**  
no exclude

**Parameters**  
`group-name` — Specify the existing group-name to be excluded when an LSP is set up.

---

exclude-node

**Syntax**  
```plaintext
[no] exclude-node ip-address
```

**Context**  
```
config>router>mpls>lsp
```

**Description**  
This command enables the option to include XRO object in the bypass LSP PATH message object. The exclude-node option is required for manual bypass LSP with XRO to FRR protect ABR node in a multi-vendor network deployment. This command must be configured on the PLR node that protects the ABR node. The ABR node IP address must be configured as exclude-node.

**Default**  
no exclude-node
fast-reroute

**Syntax**

```
fast-reroute frr-method
no fast-reroute
```

**Context**

```
config>router>mpls>lsp
config>router>mpls>lsp-template
```

**Description**

This command creates a pre-computed detour LSP from each node in the path of the LSP. In case of failure of a link or LSP between two nodes, traffic is immediately rerouted on the pre-computed detour LSP, thus avoiding packet-loss.

When `fast-reroute` is enabled, each node along the path of the LSP tries to establish a detour LSP as follows:

- Each upstream node sets up a detour LSP that avoids only the immediate downstream node, and merges back on to the actual path of the LSP as soon as possible.
  
  If it is not possible to set up a detour LSP that avoids the immediate downstream node, a detour can be set up to the downstream node on a different interface.

- The detour LSP may take one or more hops (see `hop-limit`) before merging back on to the main LSP path.

- When the upstream node detects a downstream link or node failure, the ingress router switches traffic to a standby path if one was set up for the LSP.

Fast reroute is available only for the primary path. No configuration is required on the transit hops of the LSP. The ingress router will signal all intermediate routers using RSVP to set up their detours. TE must be enabled for fast-reroute to work.

If an LSP is configured with `fast-reroute frr-method` specified but does not enable CSPF, then neither global revertive nor local revertive will be available for the LSP to recover.

The `no` form of the `fast-reroute` command removes the detour LSP from each node on the primary path. This command will also remove configuration information about the hop-limit and the bandwidth for the detour routes.

The `no` form of `fast-reroute hop-limit` command reverts to the default value.

**Default**

```
no fast-reroute — When fast-reroute is specified, the default fast-reroute method is one-to-one.
```

**Parameters**

- `one-to-one` — In the one-to-one technique, a label switched path is established which intersects the original LSP somewhere downstream of the point of link or node failure. For each LSP which is backed up, a separate backup LSP is `facility`.

- `many-to-one` — This option, sometimes called `many-to-one`, takes advantage of the MPLS label stack. Instead of creating a separate LSP for every backed-up LSP, a single LSP is created which serves to backup up a set of LSPs. This LSP tunnel is called a bypass tunnel.

The bypass tunnel must intersect the path of the original LSP(s) somewhere downstream of the point of local repair (PLR). Naturally, this constrains the set of LSPs being backed-up via that bypass tunnel to those that pass through a common downstream node. All LSPs which pass through the PLR and through this common node which do not also use the facilities involved in the bypass tunnel are candidates for this set of LSPs.
**bandwidth**

**Syntax**
```
bandwidth rate-in-mbps
no bandwidth
```

**Context**
```
config>router>mpls>lsp>fast-reroute
config>router>mpls>lsp-template>fast-reroute
```

**Description**
This command is used to request reserved bandwidth on the detour path. When configuring an LSP, specify the traffic rate associated with the LSP.

When configuring fast reroute, allocate bandwidth for the rerouted path. The bandwidth rate does not need to be the same as the bandwidth allocated for the LSP.

**Default**
no bandwidth — Bandwidth is not reserved for a rerouted path.

**Parameters**
- `rate-in-mbps` — Specifies the amount of bandwidth in Mbps to be reserved for the LSP path.

---

**hop-limit**

**Syntax**
```
hop-limit limit
no hop-limit
```

**Context**
```
config>router>mpls>lsp>fast-reroute
config>router>mpls>lsp-template>fast-reroute
```

**Description**
For fast reroute, how many more routers a detour is allowed to traverse compared to the LSP itself. For example, if an LSP traverses four routers, any detour for the LSP can be no more than ten router hops, including the ingress and egress routers.

**Default**
16

**Parameters**
- `limit` — Specify the maximum number of hops.

  **Values**
  0 — 255

---

**node-protect**

**Syntax**
```
[no] node-protect
```

**Context**
```
config>router>mpls>lsp>fast-reroute
```

**Description**
This command enables or disables node and link protection on the specified LSP. Node protection ensures that traffic from an LSP traversing a neighboring router will reach its destination even if the neighboring router fails.

**Default**
node-protect
from

Syntax   from ip-address

Context  config>router>mpls>lsp

Description This optional command specifies the IP address of the ingress router for the LSP. When this command is not specified, the system IP address is used. IP addresses that are not defined in the system are allowed. If an invalid IP address is entered, LSP bring-up fails and an error is logged.

If an interface IP address is specified as the from address, and the egress interface of the nexthop IP address is a different interface, the LSP is not signaled. As the egress interface changes due to changes in the routing topology, an LSP recovers if the from IP address is the system IP address and not a specific interface IP address.

Only one from address can be configured.

Default The system IP address

Parameters   ip-address — This is the IP address of the ingress router. This can be either the interface or the system IP address. If the IP address is local, the LSP must egress through that local interface which ensures local strictness.

   Default System IP address

   Values System IP or network interface IP addresses

hop-limit

Syntax   hop-limit number

no hop-limit

Context  config>router>mpls>lsp

config>router>mpls>lsp>fast-reroute

config>router>mpls>lsp-template

Description This command specifies the maximum number of hops that an LSP can traverse, including the ingress and egress routers. An LSP is not set up if the hop limit is exceeded. This value can be changed dynamically for an LSP that is already set up with the following implications:

   If the new value is less than the current number of hops of the established LSP, the LSP is brought down. Software then tries to re-establish the LSP within the new hop-limit number. If the new value is equal to or greater than the current number hops of the established LSP, then the LSP is not affected.

The no form of this command returns the parameter to the default value.

Default 255

Parameters   number — The number of hops the LSP can traverse, expressed as an integer.

   Values  2 — 255

   Values  0 — 255
**ldp-over-rsvp**

**Syntax**  
ldp-over-rsvp [include | exclude]

**Context**  
config>router>mpls>lsp

**Description**  
This command specifies if this LSP will be included in LDP over RSVP.

**Parameters**  
include — Specifies that this LSP will be included in LDP over RSVP.

exclude — Specifies that this LSP will be excluded from LDP over RSVP.

**igp-shortcut**

**Syntax**  
igp-shortcut [lfa-protect | lfa-only]  
[no] igp-shortcut

**Context**  
config>router>mpls>lsp

**Description**  
This command enables the use of a specific RSVP LSP by IS-IS and OSPF routing protocols as a shortcut for resolving IGP routes.

When rsvp-shortcut is enabled at the IGP instance level, all RSVP LSPs originating on this node are eligible by default as long as the destination address of the LSP, as configured in config>router>mpls>lsp>to, corresponds to a router-id of a remote node.

The **lfa-protect** option allows an LSP to be included in both the main SPF and the Loop-Free Alternate (LFA) SPF. For a given prefix, the LSP can be used either as a primary next-hop or as an LFA next-hop but not both. If the main SPF computation selected a tunneled primary next-hop for a prefix, the LFA SPF will not select an LFA next-hop for this prefix and the protection of this prefix will rely on the RSVP LSP FRR protection. If the main SPF computation selected a direct primary next-hop, then the LFA SPF will select an LFA next-hop for this prefix but will prefer a direct LFA next-hop over a tunneled LFA next-hop.

The **lfa-only** option allows an LSP to be included in the LFA SPF only such that the introduction of IGP shortcuts does not impact the main SPF decision. For a given prefix, the main SPF always selects a direct primary next-hop. The LFA SPF will select a an LFA next-hop for this prefix but will prefer a direct LFA next-hop over a tunneled LFA next-hop.

The **no** form of this command disables the use of a specific RSVP LSP by IS-IS and OSPF routing protocols as a shortcut for resolving IGP routes.

**Default**  
igp-shortcut

**least-fill**

**Syntax**  
[no] least-fill

**Context**  
config>router>mpls>lsp

**Description**  
This command enables the use of the least-fill path selection method for the computation of the path of this LSP.
When MPLS requests the computation of a path for this LSP, CSPF will find all equal cost shortest paths which satisfy the constraints of this path. Then, CSPF identifies the single link in each of these paths which has the least available bandwidth as a percentage of its maximum reservable bandwidth. It then selects the path which has the largest value of this percentage least available bandwidth figure. CSPF identifies the least available bandwidth link in each equal cost path after it has accounted for the bandwidth of the new requested path of this LSP.

CSPF applies the least-fill path selection method to all requests for a path, primary and secondary, of an LSP for which this option is enabled. The bandwidth of the path can be any value, including zero.

CSPF applies the least-fill criterion separately to each pre-emption priority in the base TE. A higher setup priority path can pre-empt lower holding priority paths.

CSPF also applies the least-fill criterion separately to each Diff-Serv TE class if Diff-Serv TE is enabled on this node. A higher setup priority path can pre-empt lower holding priority paths within a Class Type.

MPLS will re-signal and move the LSP to the new path in the following cases:

- Initial LSP path signaling.
- Re-try of an LSP path after failure.
- Make-before-break (MBB) due to pending soft pre-emption of the LSP path.
- MBB due to LSP path configuration change, i.e., a user change to bandwidth parameter of primary or secondary path, or a user enabling of fast-reroute option for the LSP.
- MBB of secondary path due to an update to primary path SRLG.
- MBB due to FRR Global Revertive procedures on the primary path.
- Manual re-signaling of an LSP path or of all LSP paths by the user.

During a manual re-signaling of an LSP path, MPLS will always re-signal the path regardless of whether the new path is exactly the same or different than the current path and regardless or whether the metric of the new path is different from that of the current path.

During a timer-based re-signaling of an LSP path which has the least-fill option enabled, MPLS will only re-signal the path if the metric of the new path is different than the one of the current path.

The user deletes a specific node entry in this database by executing the no form of this command.

**Default**

no least-fill. The path of an LSP is randomly chosen among a set of equal cost paths.

### ldp-over-rsvp

**Syntax**

```
[no] ldp-over-rsvp [include | exclude]
```

**Context**

`config>router>mpls>lsp`

**Description**

This command configures an LSP so that it can be used by the IGP to calculate its SPF tree.

The IGP (OSPF/ISIS) will subsequently provide LDP with all ECMP IGP next-hops and tunnel endpoints that it considers to be the lowest cost path to its destination.

If an IGP calculation and an LDP-over-RSVP indicate the same cost then LDP will always prefer an LDP-over-RSVP tunnel over an IGP route and ECMP between the two types is not considered.
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The type and number of tunnels considered by LDP depends on the IGP metrics (the lowest metric between the tunnel endpoint and the target is selected) assuming that each LSP has a TLDP session established between the endpoints.

Enter the command `ldporsvp include` to make the associated LSP available to be used by the LDP-over-RSVP feature.

The no form of the command reverts to default operation.

Default: `ldporsvp exclude`

include

**Syntax**

```
[no] include group-name [group-name...(up to 5max)]
```

**Context**

```
config>router>mpls>lsp
config>router>mpls>lsp>primary
config>router>mpls>lsp>secondary
config>router>mpls>lsp-template
```

**Description**

This command specifies the admin groups to be included when an LSP is set up. Up to 5 groups per operation can be specified, up to 32 maximum.

The `no` form of the command deletes the specified groups in the specified context.

Default: `no include`

**Parameters**

`group-name` — Specifies admin groups to be included when an LSP is set up.

priority

**Syntax**

```
priority setup-priority hold-priority
no priority
```

**Context**

```
config>router>mpls>lsp>primary
config>router>mpls>lsp>secondary
```

**Description**

This command enables the soft pre-emption procedures for this LSP path. The operator enables the soft pre-emption mechanism on a specific LSP name by explicitly configuring the setup and holding priorities for the primary path at the 7x50 head-end node. The operator can similarly configure priority values for a secondary path for this LSP name. Different values could be used for the primary and for any of the secondary paths. In the absence of explicit user configuration, the setup priority is internally set to the default value of 7 and the holding priority is set to the default value of 0. Note however that valid user-entered values for these two parameters require that the holding priority be numerically lower than or equal to the setup priority, otherwise pre-emption loops can occur.

Pre-emption is effected when a 7x50 pre-empting node processes a new RSVP session reservation and there is not enough available bandwidth on the RSVP interface, or the Class Type (CT) when Diff-Serv is enabled, to satisfy the bandwidth in the Flowspec object while there exist other session reservations for LSP paths with a strictly lower holding priority (numerically higher holding priority value) than the setup priority of the new LSP reservation. If enough available bandwidth is freed on the link or CT to accommodate the new reservation by pre-empting one or more lower priority LSP
paths, the pre-empting node allows temporary overbooking of the RSVP interface and honors the new reservation.

The 7x50 pre-empting node will immediately set the ‘Preemption pending’ flag (0x10) in the IPv4 Sub-Object in the RRO object in the Resv refresh for each of the pre-empted LSP paths. The IPv4 Sub-Object corresponds to the outgoing interface being used by the pre-empting and pre-empted LSP paths. Note however that the bandwidth value in the Flowspec object is not changed. The Resv flag must also be set if the pre-empting node is a merge point for the primary LSP path and the backup bypass LSP or detour LSP and the backup LSP is activated.

When evaluating if enough available bandwidth will be freed, the 7x50 pre-empting node considers the reservations in order from the lowest holding priority (numerically higher holding priority value) to the holding priority just below the setup priority of the new reservation. A new reservation cannot pre-empt a reservation which has a value of the holding priority equal to the new reservation setup priority.

When Diff-Serv is enabled on the pre-empting node and the MAM bandwidth allocation model is used, a new reservation can only pre-empt a reservation in the same Class Type (CT).

LSP paths which were not flagged at the head-end for soft pre-emption will be hard pre-empted. LSP paths with the default holding priority of 0 cannot be pre-empted. LSP paths with zero bandwidth do not pre-empt other LSP paths regardless of the values of the path setup priority and the path holding priority. They can also not be pre-empted.

When evaluating if enough available bandwidth will be freed, the 7x50 pre-empting node considers the reservations in order from the lowest holding priority (numerically higher holding priority) to the holding priority just below the setup priority of the new reservation. There is no specific order in which the reservations in the same holding priority are considered. Furthermore, LSP paths which were not flagged at the head-end for soft pre-emption cannot be pre-empted because their holding priority is set internally to 0.

The 7x50 pre-empting node starts a preemption timer for each of the pre-empted LSP paths. While this timer is on, the node should continue to refresh the Path and Resv for the pre-empted LSP paths. When the preemption timer expires, the node tears down the reservation if the head-end node has not already done so.

A 7x50 head-end node upon receipt of the Resv refresh message with the ‘Preemption pending’ flag must immediately perform a make-before-break on the affected adaptive CSPF LSP. Both IGP metric and TE metric based CSPF LSPs are included. If an alternative path that excludes the flagged interface is not found, then the LSP is put on a retry in a similar way to the Global Revertive procedure at a 7x50 head-end node. However, the number of retries and the retry timer are governed by the values of the retry-limit and retry-timer parameters: config>router>mpls>lsp>retry-limit; config>router>mpls>lsp>retry-timer.

Note that MPLS will keep the address list of flagged interfaces for a maximum of 60 seconds (not user-configurable) from the time the first Resv message with the ‘Preemption pending’ flag is received. This actually means that MPLS will request CSPF to find a path that excludes the flagged interfaces in the first few retries until success or until 60 seconds have elapsed. Subsequent retries after the 60 seconds will not exclude the flagged interfaces as it is assumed IGP has converged by then and the Unreserved Bandwidth sub-TLV for that priority, or TE Class, in the TE database will show the updated value taking into account the pre-empting LSP path reservation or a value of zero if overbooked.

If the LSP has a configured secondary standby which is operationally UP, the 7x50 will switch the path of the LSP to it and then start the MBB. If no standby path is available and a secondary non-
standby is configured, the 7x50 will start the MBB and signal the path of the secondary. The LSP path will be switched to either the secondary or the new primary, whichever comes up first.

The no form of the command reverts the LSP path priority to the default values and results in setting the setup priority to 7, in setting the holding priority to 0, and in clearing the ‘soft preemption desired’ flag in the RRO in the Resv refresh message.

**Default**

no priority.

**Parameters**

- **setup-priority** — The priority of the reservation for this session at setup time.
  - **Values**
    - 0 — 7 (0 is the highest priority and 7 is the lowest priority.)
  - **Default**
    - 7 — This session does not pre-empt any other session.

- **holding-priority** — The priority of the reservation for this session at pre-emption action.
  - **Values**
    - 0 — 7 (0 is the highest priority and 7 is the lowest priority.)
  - **Default**
    - 0 — This session does not get pre-empted by any other session.

**main-ct-retry-limit**

**Syntax**

```
main-ct-retry-limit number
no main-ct-retry-limit
```

**Context**

```
config>router>mpls>lsp
```

**Description**

This command configures the maximum number of retries the LSP primary path should be retried with the LSP Diff-Serv main Class Type (CT).

When an unmapped LSP primary path goes into retry, it uses the main CT until the number of retries reaches the value of the new main-ct-retry-limit parameter. If the path did not come up, it must start using the backup CT at that point in time. By default, this parameter is set to infinite value. The new main-ct-retry-limit parameter has no effect on an LSP primary path which retries due to a failure event.

An unmapped LSP primary path is a path which has never received a Resv in response to the first Path message sent. This can occur when performing a “shut/no-shut” on the LSP or LSP primary path or when the node reboots. An unmapped LSP primary path goes into retry if the retry timer expired or the head-end node received a PathErr message before the retry timer expired.

If the user entered a value of the main-ct-retry-limit parameter that is greater than the value of the LSP retry-limit, the number of retries will still stop when the LSP primary path reaches the value of the LSP retry-limit. In other words, the meaning of the LSP retry-limit parameter is not changed and always represents the upper bound on the number of retries. The unmapped LSP primary path behavior applies to both CSPF and non-CSPF LSPs.

The **no** form of this command sets the parameter to the default value of zero (0) which means the LSP primary path will retry forever.

**Default**

no main-ct-retry-limit
Parameters

number — The number of times MPLS will attempt to re-establish the LSP primary path using the Diff-Serv main CT. Allowed values are integers in the range of zero (0) to 10,000, where zero indicates to retry infinitely.

Values 0-1000, integer

metric

Syntax metric metric

Context config>router>mpls>lsp

Description This command specifies the metric for this LSP which is used to select an LSP among a set of LSPs which are destined to the same egress router. The LSP with the lowest metric will be selected.

In LDP-over-RSVP, LDP performs a lookup in the Routing Table Manager (RTM) which provides the next hop to the destination PE and the advertising router (ABR or destination PE itself). If the advertising router matches the targeted LDP peer, LDP then performs a second lookup for the advertising router in the Tunnel Table Manager (TTM). This lookup returns the best RSVP LSP to use to forward packets for an LDP FEC learned through the targeted LDP session. The lookup returns the LSP with the lowest metric. If multiple LSPs have the same metric, then the result of the lookup will be to select the first one available in the TTM.

Default 1

Parameters metric — Specifies the metric for this LSP which is used to select an LSP among a set of LSPs which are destined to the same egress router.

Values 1 — 65535

to

Syntax to ip-address

Context config>router>mpls>lsp

Description This command specifies the system IP address of the egress router for the LSP. This command is mandatory to create an LSP.

An IP address for which a route does not exist is allowed in the configuration. If the LSP signaling fails because the destination is not reachable, an error is logged and the LSP operational status is set to down.

The to ip-address must be the system IP address of the egress router. If the to address does not match the SDP address, the LSP is not included in the SDP definition.

Default No default

Parameters ip-address — The system IP address of the egress router.
propagate-admin-group

**Syntax**  
[no] propagate-admin-group

**Context**  
config>router>mpls>lsp

**Description**  
This command enables propagation of session attribute object with resource affinity (C-type 1) in PATH message. If session attribute with resource affinity is received on an LSR then it will check compatibility of admin-groups received in PATH against configured admin-groups on egress interface of LSP.

To support admin-group for inter-area LSP, ingress node must configure propagating admin-groups within session attribute object. If PATH message is received with admin-groups on LSR then CSPF calculation to next loose hop must be done based on admin-groups received from ingress node.

If option is disabled then the session attribute object without resource affinity (C-Type 7) must be propagated in PATH message and CSPF on LSR must ignore admin-groups.

‘propagate-admin-group’ is allowed to change dynamically. LSP would do ‘break-before-make’ on changing configuration.

**Default**  
no propagate-admin-group

vprn-auto-bind

**Syntax**  
vprn-auto-bind [include | exclude]

**Context**  
config>router>mpls>lsp

**Description**  
This command determines whether the associated names LSP can be used or no as part of the auto-bind feature for VPRN services. By default a names LSP is available for inclusion to used for the auto-bind feature.

By configuring the command vprn-auto-bind exclude, the associated LSP will not be used by the auto-bind feature within VPRN services.

The **no** form of the command resets the flag back to the default value.

**Default**  
include

**Parameters**

- **include** — Allows an associated LSP to be used by auto-bin for vprn services
- **exclude** — Disables the use of the associated LSP to be used with the auto-bind feature for VPRN services.
retry-limit

**Syntax**

retry-limit *number*

no retry-limit

**Context**

config>router>mpls>lsp
config>router>mpls>lsp-template

**Description**

This optional command specifies the number of attempts software should make to re-establish the LSP after it has failed LSP. After each successful attempt, the counter is reset to zero.

When the specified number is reached, no more attempts are made and the LSP path is put into the shutdown state.

Use the config router mpls lsp lsp-name no shutdown command to bring up the path after the retry-limit is exceeded.

For P2MP LSP created based on LSP template, all S2Ls must attempt to retry-limit before client application is informed of failure.

The no form of this command revert the parameter to the default value.

**Default**

0 (no limit, retries forever)

**Parameters**

*number* — The number of times software will attempt to re-establish the LSP after it has failed.

Allowed values are integers in the range of 0 to 10000 where 0 indicates to retry forever.

**Values**

0 — 10000

retry-timer

**Syntax**

retry-timer *seconds*

no retry-timer

**Context**

config>router>mpls>lsp
config>router>mpls>lsp-template

**Description**

This command configures the time, in seconds, for LSP re-establishment attempts after it has failed.

For P2MP LSP created based on LSP template, all S2Ls must attempt to retry-limit before client application is informed of failure.

The no form of this command reverts to the default value.

**Default**

30

**Parameters**

*seconds* — The amount of time, in seconds, between attempts to re-establish the LSP after it has failed. Allowed values are integers in the range of 1 to 600.

**Values**

1 — 600
rsvp-resv-style

Syntax: `rsvp-resv-style [se | ff]`

Context: `config>router>mpls>lsp`

Description: This command specifies the RSVP reservation style, shared explicit (se) or fixed filter (ff). A reservation style is a set of control options that specify a number of supported parameters. The style information is part of the LSP configuration.

Default: `se`

Parameters:
- `ff` — Fixed filter is single reservation with an explicit scope. This reservation style specifies an explicit list of senders and a distinct reservation for each of them. A specific reservation request is created for data packets from a particular sender. The reservation scope is determined by an explicit list of senders.
- `se` — Shared explicit is shared reservation with a limited scope. This reservation style specifies a shared reservation environment with an explicit reservation scope. This reservation style creates a single reservation over a link that is shared by an explicit list of senders. Because each sender is explicitly listed in the RESV message, different labels can be assigned to different sender-receiver pairs, thereby creating separate LSPs.

shutdown

Syntax: `[no] shutdown`

Context: `config>router>mpls>lsp`

Description: This command disables the existing LSP including the primary and any standby secondary paths. To shutdown only the primary enter the `config router mpls lsp lsp-name primary path-name shutdown` command.

To shutdown a specific standby secondary enter the `config router mpls lsp lsp-name secondary path-name shutdown` command. The existing configuration of the LSP is preserved.

Use the `no` form of this command to restart the LSP. LSPs are created in a shutdown state. Use this command to administratively bring up the LSP.

Default: `shutdown`

lsp-template

Syntax: `[no] lsp-template lsp-template-name p2mp-lsp`

Context: `config>router>mpls`

Description: This command creates a template construct that can be referenced by client application where dynamic LSP creation is required. ‘p2mp-lsp’ keyword is mandatory.
The no form of command deletes LSP template. LSP template cannot be deleted if a client application is using it.

**Default** none

**Parameters**

- `lsp-template-name` — Name to identify LSP template. Any LSP template name and LSP name must not be same.

---

**default-path**

**Syntax** `[no] default-path path-name`

**Context** `config>router>mpls>lsp-template`

**Description**

A default path binding must be provided before LSP template can be used for signaling LSP. LSP template must be shutdown to modify default-path binding.

The no form of command should delete path binding.

**Default** none

**Parameters** `path-name`
Primary and Secondary Path Commands

**primary**

**Syntax**

```
primary path-name
no primary
```

**Context**

`config>router>mpls>`

**Description**

This command specifies a preferred path for the LSP. This command is optional only if the `secondary path-name` is included in the LSP definition. Only one primary path can be defined for an LSP.

Some of the attributes of the LSP such as the bandwidth, and hop-limit can be optionally specified as the attributes of the primary path. The attributes specified in the `primary path path-name` command, override the LSP attributes.

The `no` form of this command deletes the association of this `path-name` from the LSP `lsp-name`. All configurations specific to this primary path, such as record, bandwidth, and hop limit, are deleted.

The primary path must be shutdown first in order to delete it. The `no primary` command will not result in any action except a warning message on the console indicating that the primary path is administratively up.

**Default**

none

**Parameters**

`path-name` — The case-sensitive alphanumeric name label for the LSP path up to 32 characters in length.

**secondary**

**Syntax**

```
[no] secondary path-name
```

**Context**

`config>router>mpls>`

**Description**

This command specifies an alternative path that the LSP uses if the primary path is not available. This command is optional and is not required if the `config router mpls lsp lsp-name primary path-name` command is specified. After the switch over from the primary to the secondary, the software continuously tries to revert to the primary path. The switch back to the primary path is based on the `retry-timer` interval.

Up to eight secondary paths can be specified. All the secondary paths are considered equal and the first available path is used. The software will not switch back among secondary paths.

Software starts the signaling of all non-standby secondary paths at the same time. Retry counters are maintained for each unsuccessful attempt. Once the retry limit is reached on a path, software will not attempt to signal the path and administratively shuts down the path. The first successfully established path is made the active path for the LSP.

The `no` form of this command removes the association between this `path-name` and `lsp-name`. All specific configurations for this association are deleted. The secondary path must be shutdown first in
order to delete it. The **no secondary** `path-name` command will not result in any action except a warning message on the console indicating that the secondary path is administratively up.

**Default** none

**Parameters** `path-name` — The case-sensitive alphanumeric name label for the LSP path up to 32 characters in length.

### adaptive

**Syntax** `[no] adaptive

**Context** `config>router>mpls>lsp>primary`
`config>router>mpls>lsp>secondary`

**Description** This command enables the make-before-break functionality for an LSP or a primary or secondary LSP path. When enabled for the LSP, make-before-break will be performed for primary path and all the secondary paths of the LSP.

**Default** adaptive

### backup-class-type

**Syntax** `backup-class-type ct-number`
`no backup-class-type`

**Context** `config>router>mpls>lsp>primary`

**Description** This command enables the use of the Diff-Serv backup Class-Type (CT), instead of the Diff-Serv main CT, to signal the LSP primary path when it fails and goes into retry. The Diff-Serv main CT is configured at the LSP level or at the primary path level using the following commands:

```
config>router>mpls>lsp<class-type ct-number
config>router>mpls>lsp>primary<class-type ct-number
```

When a LSP primary path retries due a failure, for example, it fails after being in the UP state, or undergoes any type of Make-Before-Break (MBB), MPLS will retry a new path for the LSP using the main CT. If the first attempt failed, the head-end node performs subsequent retries using the backup CT. This procedure must be followed regardless if the currently used CT by this path is the main or backup CT. This applies to both CSPF and non-CSPF LSPs.

The triggers for using the backup CT after the first retry attempt are:

1. A local interface failure or a control plane failure (hello timeout etc.).
2. Receipt of a PathErr message with a notification of a FRR protection becoming active downstream and/or Receipt of a Resv message with a ‘Local-Protection-In-Use’ flag set. This invokes the FRR Global Revertive MBB.
3. Receipt of a PathErr message with error code=25 ("Notify") and sub-code=7 ("Local link maintenance required") or a sub-code=8 ("Local node maintenance required"). This invokes the TE Graceful Shutdown MBB.
4. Receipt of a Resv refresh message with the ‘Preemption pending’ flag set or a PathErr message with error code=34 (“Reroute”) and a value=1 (“Reroute request soft preemption”). This invokes the soft preemption MBB.

5. Receipt of a ResvTear message.

6. A configuration change MBB.

7. The user executing the clear>router>mpls>lsp command.

When an unmapped LSP primary path goes into retry, it uses the main CT until the number of retries reaches the value of the new main-ct-retry-limit parameter. If the path did not come up, it must start using the backup CT at that point in time. By default, this parameter is set to infinite value. The new main-ct-retry-limit parameter has no effect on an LSP primary path which retries due to a failure event.

An unmapped LSP primary path is a path which has never received a Resv in response to the first Path message sent. This can occur when performing a ‘shut/no-shut’ on the LSP or LSP primary path or when the node reboots. An unmapped LSP primary path goes into retry if the retry timer expired or the head-end node received a PathErr message before the retry timer expired.

When the re-signal timer expires, CSPF will try to find a path with the main CT. The head-end node must re-signal the LSP even if the new path found by CSPF is identical to the existing one since the idea is to restore the main CT for the primary path. A path with main CT is not found, the LSP remains on its current primary path using the backup CT.

When the user performs a manual re-signal of the primary path, CSPF will try to find a path with the main CT. The head-end node must re-signal the LSP as in current implementation.

The no form of this command disables the use of the Diff-Serv backup CT.

Default
no backup-class-type

Parameters
ct-number — The Diff-Serv Class Type number. One or more system forwarding classes can be mapped to a CT.

Values 0-7, integer

**bandwidth**

Syntax  
bandwidth rate-in-mbps
no bandwidth

Context  
config>router>mpls>lsp>primary
config>router>mpls>lsp>secondary
config>router>mpls>lsp-template>fast-reroute

Description  
This command specifies the amount of bandwidth to be reserved for the LSP path. The no form of this command resets bandwidth parameters (no bandwidth is reserved).

Default  
no bandwidth (bandwidth setting in the global LSP configuration)

Parameters  
rate-in-mbps — The amount of bandwidth reserved for the LSP path in Mbps. Allowed values are integers in the range of 1 to 100000.

Values 0 — 100000
exclude

Syntax: [no] exclude group-name [group-name...(up to 5 max)]

Context: config>router>mpls>lsp>primary
config>router>mpls>lsp>secondary

Description: This command specifies the admin groups to be excluded when an LSP is set up. Up to 5 groups per operation can be specified, up to 32 maximum. The admin groups are defined in the config>router>mpls>admin-group context.

Use the no form of the command to remove the exclude command.

Default: no exclude

Parameters:

- group-name: Specifies the existing group-name to be excluded when an LSP is set up.

hop-limit

Syntax: hop-limit number
no hop-limit

Context: config>router>mpls>lsp>primary
config>router>mpls>lsp>secondary

Description: This optional command overrides the config router mpls lsp lsp-name hop-limit command. This command specifies the total number of hops that an LSP traverses, including the ingress and egress routers.

This value can be changed dynamically for an LSP that is already set up with the following implications:

If the new value is less than the current hops of the established LSP, the LSP is brought down. MPLS then tries to re-establish the LSP within the new hop-limit number. If the new value is equal or more than the current hops of the established LSP then the LSP will be unaffected.

The no form of this command reverts the values defined under the LSP definition using the config router mpls lsp lsp-name hop-limit command.

Default: no hop-limit

Parameters:

- number: The number of hops the LSP can traverse, expressed as an integer.
  - Values: 2 — 255
record

Syntax  [no] record

Context config>router>mpls>lsp>primary
       config>router>mpls>lsp>secondary

Description This command enables recording of all the hops that an LSP path traverses. Enabling `record` increases the size of the PATH and RESV refresh messages for the LSP since this information is carried end-to-end along the path of the LSP. The increase in control traffic per LSP may impact scalability.

The `no` form of this command disables the recording of all the hops for the given LSP. There are no restrictions as to when the `no` command can be used. The `no` form of this command also disables the `record-label` command.

Default record

record-label

Syntax  [no] record-label

Context config>router>mpls>lsp>primary
       config>router>mpls>lsp>secondary

Description This command enables recording of all the labels at each node that an LSP path traverses. Enabling the `record-label` command will also enable the `record` command if it is not already enabled.

The `no` form of this command disables the recording of the hops that an LSP path traverses.

Default record-label

srlg

Syntax  [no] srlg

Context config>router>mpls>lsp>secondary

Description This command enables the use of the SRLG constraint in the computation of a secondary path for an LSP at the head-end LER.

When this feature is enabled, CSPF includes the SRLG constraint in the computation of the secondary LSP path. This requires that the primary LSP already be established and is up since the head-end LER needs the most current ERO computed by CSPF for the primary path. CSPF would return the list of SRLG groups along with the ERO during primary path CSPF computation. At a subsequent establishment of a secondary path with the SRLG constraint, the MPLS/RSVP task will query again CSPF providing the list of SRLG group numbers to be avoided. CSPF prunes all links with interfaces which belong to the same SRLGs as the interfaces included in the ERO of the primary path. If CSPF finds a path, the secondary is setup. If not, MPLS/RSVP will keep retrying the requests to CSPF.
If CSPF is not enabled on the LSP name, then a secondary path of that LSP which has the SRLG constraint included will be shut down and a specific failure code will indicate the exact reason for the failure in `show>router>mpls>lsp>path>detail` output.

At initial primary LSP path establishment, if primary does not come up or primary is not configured, SRLG secondary will not be signaled and will put to down state. A specific failure code will indicate the exact reason for the failure in `show>router>mpls>lsp>path>detail` output. However, if a non-SRLG secondary path was configured, such as a secondary path with the SRLG option disabled, MPLS/RSVP task will signal it and the LSP use it.

As soon as the primary path is configured and successfully established, MPLS/RSVP moves the LSP to the primary and signals all SRLG secondary paths.

Any time the primary path is re-optimized, has undergone MBB, or has come back up after being down, MPLS/RSVP task checks with CSPF if the SRLG secondary should be re-signaled. If MPLS/RSVP finds that current secondary path is no longer SRLG disjoint, for example, it became ineligible, it puts it on a delayed MBB immediately after the expiry of the retry timer. If MBB fails at the first try, the secondary path is torn down and the path is put on retry.

At the next opportunity the primary goes down, the LSP will use the path of an eligible SRLG secondary if it is UP. If all secondary eligible SRLG paths are Down, MPLS/RSVP will use a non SRLG secondary if configured and UP. If while the LSP is using a non SRLG secondary, an eligible SRLG secondary came back up, MPLS/RSVP will not switch the path of the LSP to it. As soon as primary is re-signaled and comes up with a new SRLG list, MPLS/RSVP will re-signal the secondary using the new SRLG list.

A secondary path which becomes ineligible as a result of an update to the SRLG membership list of the primary path will have the ineligibility status removed on any of the following events:

8. A successful MBB of the standby SRLG path which makes it eligible again.

9. The standby path goes down. MPLS/RSVP puts the standby on retry at the expiry of the retry timer. If successful, it becomes eligible. If not successful after the retry-timer expired or the number of retries reached the number configured under the retry-limit parameter, it is left down.

10. The primary path goes down. In this case, the ineligible secondary path is immediately torn down and will only be re-signaled when the primary comes back up with a new SRLG list.

Once primary path of the LSP is setup and is operationally up, any subsequent changes to the SRLG group membership of an interface the primary path is using would not be considered until the next opportunity the primary path is re-signaled. The primary path may be re-signaled due to a failure or to a make-before-break operation. Make-before-break occurs as a result of a global revertive operation, a timer based or manual re-optimization of the LSP path, or an operator change to any of the path constraints.

One an SRLG secondary path is setup and is operationally UP, any subsequent changes to the SRLG group membership of an interface the secondary path is using would not be considered until the next opportunity secondary path is re-signaled. The secondary path is re-signaled due to a failure, to a re-signaling of the primary path, or to a make before break operation. Make-before break occurs as a result of a timer based or manual re-optimization of the secondary path, or an operator change to any of the path constraints of the secondary path, including enabling or disabling the SRLG constraint itself.

Also, the user-configured include/exclude admin group statements for this secondary path are also checked together with the SRLG constraints by CSPF.

The `no` form of the command reverts to the default value.
standby

Syntax  [no] standby

Context  config>router>mpls>lsp>secondary

Description  The secondary path LSP is normally signaled once the primary path LSP fails. The standby keyword ensures that the secondary path LSP is signaled and maintained indefinitely in a hot-standby state. When the primary path is re-established then the traffic is switched back to the primary path LSP.

The no form of this command specifies that the secondary LSP is signaled when the primary path LSP fails.

Default  none

path-preference

Syntax  [no] path-preference value

Context  config>router>mpls>lsp>secondary

Description  This command enables use of path preference among configured standby secondary paths per LSP. If all standby secondary paths have a default path-preference value then a non-standby secondary path will remain the active path while a standby secondary is available. A standby secondary path configured with highest priority (lowest path-preference value) must be made the active path when the primary is not in use. Path preference can be configured on standby secondary path.

The no form of this command resets the path-preference to the default value.

Default  255

Parameters  value — Specifies an alternate path for the LSP if the primary path is not available, 1–255
LSP Path Commands

hop

**Syntax**
```
hop hop-index ip-address {strict | loose}
no hop hop-index
```

**Context**
```
config>router>mpls>path
```

**Description**
This command specifies the IP address of the hops that the LSP should traverse on its way to the egress router. The IP address can be the interface IP address or the system IP address. If the system IP address is specified then the LSP can choose the best available interface.

Optionally, the LSP ingress and egress IP address can be included as the first and the last hop. A hop list can include the ingress interface IP address, the system IP address, and the egress IP address of any of the hops being specified.

The **no** form of this command deletes hop list entries for the path. All the LSPs currently using this path are affected. Additionally, all services actively using these LSPs are affected. The path must be shutdown first in order to delete the hop from the hop list. The **no hop hop-index** command will not result in any action except a warning message on the console indicating that the path is administratively up.

**Default**
none

**Parameters**

- **hop-index** — The hop index is used to order the hops specified. The LSP always traverses from the lowest hop index to the highest. The hop index does not need to be sequential.

  **Values**
  
  | 1 — 1024 |

- **ip-address** — The system or network interface IP address of the transit router. The IP address can be the interface IP address or the system IP address. If the system IP address is specified then the LSP can choose the best available interface. A hop list can also include the ingress interface IP address, the system IP address, and the egress IP address of any of the specified hops.

- **loose** — This keyword specifies that the route taken by the LSP from the previous hop to this hop can traverse through other routers. Multiple hop entries with the same IP address are flagged as errors. Either the **loose** or **strict** keyword must be specified.

- **strict** — This keyword specifies that the LSP must take a direct path from the previous hop router to this router. No transit routers between the previous router and this router are allowed. If the IP address specified is the interface address, then that is the interface the LSP must use. If there are direct parallel links between the previous router and this router and if system IP address is specified, then any one of the available interfaces can be used by the LSP. The user must ensure that the previous router and this router have a direct link. Multiple hop entries with the same IP address are flagged as errors. Either the **loose** or **strict** keyword must be specified.
path

Syntax  
\[
[\text{no}] \text{path} \ \text{path-name}
\]

Context  
config>router>mpls

Description  
This command creates the path to be used for an LSP. A path can be used by multiple LSPs. A path can specify some or all hops from ingress to egress and they can be either strict or loose. A path can also be empty (no path-name specified) in which case the LSP is set up based on IGP (best effort) calculated shortest path to the egress router. Paths are created in a shutdown state. A path must be shutdown before making any changes (adding or deleting hops) to the path. When a path is shutdown, any LSP using the path becomes operationally down.

To create a strict path from the ingress to the egress router, the ingress and the egress routers must be included in the path statement.

The no form of this command deletes the path and all its associated configuration information. All the LSPs that are currently using this path will be affected. Additionally all the services that are actively using these LSPs will be affected. A path must be shutdown and unbound from all LSPs using the path before it can be deleted. The no path path-name command will not result in any action except a warning message on the console indicating that the path may be in use.

Parameters  
path-name — Specify a unique case-sensitive alphanumeric name label for the LSP path up to 32 characters in length.

shutdown

Syntax  
\[
[\text{no}] \text{shutdown}
\]

Context  
config>router>mpls>path

Description  
This command disables the existing LSPs using this path. All services using these LSPs are affected. Binding information, however, is retained in those LSPs. Paths are created in the shutdown state.

The no form of this command administratively enables the path. All LSPs, where this path is defined as primary or defined as standby secondary, are (re)established.

Default  
shutdown
Static LSP Commands

static-lsp

Syntax    [no] static-lsp lsp-name

Context   config>router>mpls

Description This command is used to configure a static LSP on the ingress router. The static LSP is a manually set up LSP where the nexthop IP address and the outgoing label (push) must be specified. The no form of this command deletes this static LSP and associated information. The LSP must be shutdown first in order to delete it. If the LSP is not shut down, the no static-lsp lsp-name command does nothing except generate a warning message on the console indicating that the LSP is administratively up.

Parameters lsp-name — Name that identifies the LSP.

Values    Up to 32 alphanumeric characters.

static-lsp-fast-retry

Syntax    static-lsp-fast-retry seconds
            [no] static-lsp-fast-retry

Context   config>router>mpls

Description This command specifies the value used as the fast retry timer for a static LSP.

When a static LSP is trying to come up, the MPLS request for the ARP entry of the LSP next-hop may fail when it is made while the next-hop is still down or unavailable. In that case, MPLS starts a retry timer before making the next request. This enhancement allows the user to configure the retry timer, so that the LSP comes up as soon as the next-hop is up.

The no form of the command reverts to the default.

Default   no static-fast-retry-timer

Parameters seconds — specifies the value, in seconds, used as the fast retry timer for a static LSP.

Values    1-30
MPLS Commands

push

**Syntax**
```
push {label | implicit-null-label} nexthop ip-address
no push {out-label | implicit-null-label}
```

**Context**
config>router>mpls>static-lsp

**Description**
This command specifies the label to be pushed on the label stack and the next hop IP address for the static LSP.

The **no** form of this command removes the association of the label to push for the static LSP.

**Parameters**
- **implicit-null-label** — Specifies the use of the implicit label value for the push operation.
- **label** — The label to push on the label stack. Label values 16 through 1,048,575 are defined as follows:
  - Label values 16 through 31 are reserved.
  - Label values 32 through 1,023 are available for static assignment.
  - Label values 1,024 through 2,047 are reserved for future use.
  - Label values 2,048 through 18,431 are statically assigned for services.
  - Label values 28,672 through 131,071 are dynamically assigned for both MPLS and services.
  - Label values 131,072 through 1,048,575 are reserved for future use.
- **Values**
  - 16 — 1048575
- **nexthop ip-address** — This command specifies the IP address of the next hop towards the LSP egress router. If an ARP entry for the next hop exists, then the static LSP is marked operational. If ARP entry does not exist, software sets the operational status of the static LSP to down and continues to ARP for the configured nexthop. Software continuously tries to ARP for the configured nexthop at a fixed interval.

shutdown

**Syntax**
```
[no] shutdown
```

**Context**
config>router>mpls>static-lsp

**Description**
This command is used to administratively disable the static LSP.

The **no** form of this command administratively enables the static LSP.

**Default**
shutdown
**to**

**Syntax**  
*to ip-address*

**Context**  
config>router>mpls>static-lsp

**Description**  
This command specifies the system IP address of the egress router for the static LSP. When creating an LSP this command is required. For LSPs that are used as transport tunnels for services, the to IP address *must* be the system IP address. If the to address does not match the SDP address, the LSP is not included in the SDP definition.

**Parameters**  
*ip-address* — The system IP address of the egress router.

**Default**  
none
Point-to-Multipoint MPLS (P2MP) Commands

p2mp-id

Syntax  

p2mp-id id

Context  

config>router>mpls>lsp

Description  

This command configures the identifier of an RSVP P2MP LSP. An RSVP P2MP LSP is fully identified by the combination of: <P2MP ID, tunnel ID, extended tunnel ID> part of the P2MP session object, and <tunnel sender address, LSP ID> fields in the p2mp sender_template object. The p2mp-id is a 32-bit identifier used in the session object that remains constant over the life of the P2MP tunnel. It is unique within the scope of the ingress LER. The no form restores the default value of this parameter.

Default  

0

Parameters  

id — Specifies a P2MP identifier.

Values  

0 — 65535

primary-p2mp-instance

Syntax  

[no] primary-p2mp-instance instance-name

Context  

config>router>mpls>lsp

Description  

This command creates the primary instance of a P2MP LSP. The primary instance of a P2MP LSP is modeled as a set of root-to-leaf (S2L) sub-LSP’s. The root, for example a head-end node triggers signaling using one path message per S2L path. The leaf sub-LSP paths are merged at branching points.

Default  

none

Parameters  

instance-name — Specifies a name that identifies the P2MP LSP instance. The instance name can be up to 32 characters long and must be unique.

s2l-path

Syntax  

[no] s2l-path path-name to ip-address

Context  

config>router>mpls>lsp>primary-inst

Description  

This command creates a root-to-leaf (S2L) sub-LSP path for the primary instance of a P2MP LSP. The primary instance of a P2MP LSP is modeled as a set of root-to-leaf (S2L) sub-LSPs. The root, for example, head-end node, triggers signaling using one path message per S2L path. The leaf sub-LSP paths are merged at branching points.
Each S2L sub-LSP is signaled in a separate path message. Each leaf node will respond with its own RESV message. A branch LSR node will forward the path message of each S2L sub-LSP to the downstream LSR without replicating it. It will also forward the RESV message of each S2L sub-LSP to the upstream LSR without merging it with the RESV messages of other S2L sub-LSPs of the same P2MP LSP. The same is done for subsequent refreshes of the path and RESV states.

The S2L paths can be empty paths or can specify a list of explicit hops. The path name must exist and must have been defined using the `config>router>mpls>path` command. The same path name can be re-used by more than one S2L of the primary P2MP instance. However, the `to` keyword must have a unique argument per S2L as it corresponds to the address of the egress LER node.

**Default** none

**Parameters**

- `path-name` — Specifies the name of the path which consists of up to 32 alphanumeric characters.
- `to ip-address` — Specifies the system IP address of the egress router.

---

**p2mp-resignal-timer**

**Syntax**

```
p2mp-resignal-timer minutes
no p2mp-resignal-timer
```

**Context**

`config>router>mpls`

**Description**

This command configures the re-signal timer for a P2MP LSP instance. MPLS will request CSPF to re-compute the whole set of S2L paths of a given active P2MP instance each time the P2MP re-signal timer expires. The P2MP re-signal timer is configured separately from the P2P LSP parameter. MPLS performs a global MBB and moves each S2L sub-LSP in the instance into its new path using a new P2MP LSP ID if the global MBB is successful, regardless of the cost of the new S2L path.

The `no` form of this command disables the timer-based re-signaling of P2MP LSPs on this system.

**Parameters**

- `minutes` — Specifies the time MPLS waits before attempting to re-signal the P2MP LSP instance.

  **Values**

  60 — 10080
**shutdown**

<table>
<thead>
<tr>
<th>Syntax</th>
<th>[no] shutdown</th>
</tr>
</thead>
</table>
| Context  | config>router>rsvp  
|          | config>router>rsvp>interface |
| Description | This command disables the RSVP protocol instance or the RSVP-related functions for the interface. The RSVP configuration information associated with this interface is retained. When RSVP is administratively disabled, all the RSVP sessions are torn down. The existing configuration is retained.  
|          | The no form of this command administratively enables RSVP on the interface. |
| Default  | shutdown      |
RSVP Commands

rsvp

Syntax  
[no] rsvp

Context  
config>router

Description  
This command enables the context to configure RSVP protocol parameters. RSVP is not enabled by default and must be explicitly enabled (no shutdown).

RSVP is used to set up LSPs. RSVP should be enabled on all router interfaces that participate in signaled LSPs.

The no form of this command deletes this RSVP protocol instance and removes all configuration parameters for this RSVP instance. To suspend the execution and maintain the existing configuration, use the shutdown command. RSVP must be shutdown before the RSVP instance can be deleted. If RSVP is not shutdown, the no rsvp command does nothing except issue a warning message on the console indicating that RSVP is still administratively enabled.

Default  
no shutdown

diffserv-te

Syntax  
diffserv-te [mam | rdm]

no diffserv-te

Context  
config>router>rserv

Description  
This command enabled Diff-Serv Traffic Engineering on the node.

When this command is enabled, IS-IS and OSPF will start advertising available bandwidth for each TE class configured under the diffserv-te node. This command will only have effect if the operator has already enabled traffic engineering at the IS-IS and/or OSPF routing protocol levels:

```
cfg>router>isis>traffic-engineering
```

and/or:

```
cfg>router>ospf>traffic-engineering
```

IGP will advertise for each RSVP interface in the system the available bandwidth in each TE class in the unreserved bandwidth TE parameter for that class. In addition, IGP will continue to advertise the existing Maximum Reservable Link Bandwidth TE parameter to mean the maximum bandwidth that can be booked on a given interface by all classes. The value advertised is adjusted with the link subscription percentage factor configured in the config>router>rserv>interface context.

The user configures the following parameters for the operation of Diff-Serv:

- Definition of TE classes, TE Class = {Class Type (CT), LSP priority}.
- Mapping of the system forwarding classes to the Diff-Serv Class Type (CT).
RSVP Commands

- Configuration of the percentage of RSVP interface bandwidth each CT shares, i.e., the Bandwidth Constraint (BC).

When Diff-Serv TE is enabled, the system will automatically enable the Max Allocation Model (MAM) Admission Control Policy. MAM represents the bandwidth constraint model for the admission control of an LSP reservation to a link. This is the only Admission Control Policy supported in this release.

Each CT shares a percentage of the Maximum Reservable Link Bandwidth via the user configured Bandwidth Constraint (BC) for this CT. The Maximum Reservable Link Bandwidth is the link bandwidth multiplied by the RSVP interface subscription factor.

The sum of all BC values across all CTs will not exceed the Maximum Reservable Link Bandwidth. In other words, the following rule is enforced:

\[
\text{SUM (BCc)} \leq \text{Max-Reservable-Bandwidth}, \quad 0 \leq c \leq 7
\]

An LSP of class-type CTc, setup priority p, holding priority h (h <= p), and bandwidth B is admitted into a link if the following condition is satisfied:

\[
B \leq \text{Unreserved Bandwidth for TE-Class[i]}
\]

where TE-Class [i] maps to < CTc, p > in the definition of the TE classes on the node. The bandwidth reservation is effected at the holding priority, i.e., in TE-class [j] = < CTc, h >. Thus, the reserved bandwidth for CTc and the unreserved bandwidth for the TE classes using CTc are updated as follows:

\[
\text{Reserved(CTc)} = \text{Reserved(CTc)} + B
\]

\[
\text{Unreserved TE-Class [j]} = \text{BCc} - \text{SUM (Reserved(CTc,q)) for 0<= q<= h}
\]

\[
\text{Unreserved TE-Class [i]} = \text{BCc} - \text{SUM (Reserved(CTc,q)) for 0<= q<= p}
\]

The same is done to update the unreserved bandwidth for any other TE class making use of the same CTc. These new values are advertised to the rest of the network at the next IGP-TE flooding.

The Russian Doll Model (RDM) LSP admission control policy allows bandwidth sharing across Class Types. It provides a hierarchical model by which the reserved bandwidth of a CT is the sum of the reserved bandwidths of the numerically equal and higher CTs.

The RDM model is defined using the following equations:

\[
\text{SUM (Reserved (CTc))} \leq \text{BCb},
\]

where the SUM is across all values of c in the range b <= c <= (MaxCT - 1), and BCb is the bandwidth constraint of CTb.

BC0 = Max-Reservable-Bandwidth, so that

\[
\text{SUM (Reserved(CTc))} \leq \text{Max-Reservable-Bandwidth},
\]

where the SUM is across all values of c in the range 0 <= c <= (MaxCT - 1).

When Diff-Serv is disabled on the node, this model degenerates into a single default CT internally with eight pre-emption priorities and a non-configurable BC equal to the Maximum Reservable Link Bandwidth. This would behave exactly like CT0 with eight pre-emption priorities and BC = Maximum Reservable Link Bandwidth if Diff-Serv was enabled.

The enabling or disabling of Diff-Serv TE on the system requires the RSVP and MPLS protocol be shutdown.

The no form of this command reverts to the default value.
Default

no diffserv-te

Parameters

**mam** — Defines the default admission control policy for Diff-Serv LSPs.

**rdm** — Defines Russian doll model for the admission control policy of Diff-Serv LSPs.

class-type-bw

**Syntax**

class-type-bw ct0 % link-bandwidth ct1 % link-bandwidth ct2 % link-bandwidth ct3 % link-bandwidth ct4 % link-bandwidth ct5 % link-bandwidth ct6 % link-bandwidth ct7 % link-bandwidth

no class-type-bw

**Context**

config>router>rsvp>diffserv-te
config>router>rsvp>interface

**Description**

This command configures the percentage of RSVP interface bandwidth each CT shares, for example, the Bandwidth Constraint (BC).

The absolute value of the CT share of the interface bandwidth is derived as the percentage of the bandwidth advertised by IGP in the Maximum Reservable Link Bandwidth TE parameter, for example, the link bandwidth multiplied by the RSVP interface \textit{subscription percentage} parameter.

Note this configuration also exists at RSVP interface level and the interface specific configured value overrides the global configured value. The BC value can be changed at any time.

The RSVP interface \textit{subscription percentage} parameter is configured in the \texttt{config>router>rsvp>interface} context.

The operator can specify the Bandwidth Constraint (BC) for a CT which is not used in any of the TE class definition but that does not get used by any LSP originating or transiting this node.

When Diff-Serv is disabled on the node, this model degenerates into a single default CT internally with eight pre-emption priorities and a non configurable BC equal to the Maximum Reservable Link Bandwidth. This would behave exactly like CT0 with eight pre-emption priorities and BC= Maximum Reservable Link Bandwidth if Diff-Serv was enabled.

The \texttt{no} form of this command reverts to the default value.

**Parameters**

ct0 (ct1/ct2/... ct7) % link-bandwidth — The Diff-Serv Class Type number. One or more system forwading classes can be mapped to a CT.

**Values**

0 — 100 %

**Default**

0
RSVP Commands

fc

Syntax  
```
fcc  fc-name  class-type  ct-number  
no fc  fc-name
```

Context  config>router>rsvp>diffserv-te

Description  This command maps one or more system forwarding classes to a Diff-Serv Class Type (CT).

The default mapping is shown in the following table.

<table>
<thead>
<tr>
<th>FC ID</th>
<th>FC Name</th>
<th>FC Designation</th>
<th>Class Type (CT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Network Control</td>
<td>NC</td>
<td>7</td>
</tr>
<tr>
<td>6</td>
<td>High-1</td>
<td>H1</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>Expedited</td>
<td>EF</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>High-2</td>
<td>H2</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>Low-1</td>
<td>L1</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Assured</td>
<td>AF</td>
<td>2</td>
</tr>
<tr>
<td>1</td>
<td>Low-2</td>
<td>L2</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>Best Effort</td>
<td>BE</td>
<td>0</td>
</tr>
</tbody>
</table>

The `no` form of this command reverts to the default mapping for the forwarding class name.

Parameters  class-type  ct-number  — The Diff-Serv Class Type number. One or more system forwarding classes can be mapped to a CT.

Values  0 — 7

te-class

Syntax  
```
te-class  te-class-number  class-type  ct-number  priority  priority
no te-class  te-class-number
```

Context  config>router>rsvp>diffserv-te

Description  This command configures a traffic engineering class. A TE class is defined as:

TE Class = {Class Type (CT), LSP priority}

Eight TE classes are supported. There is no default TE class once Diff-Serv is enabled. The user has to explicitly define each TE class.

When when Diff-Serv is disabled there will be an internal use of the default CT (CT0) and eight pre-emption priorities as shown in the following table.
no form of this command deletes the TE class.

Parameters

- **te-class te-class-number** — The traffic engineering class number.
  
  **Values**
  
  0 — 7

- **class-type ct-number** — The Diff-Serv Class Type number. One or more system forwarding classes can be mapped to a CT.
  
  **Values**
  
  0 — 7

- **priority priority** — The LSP priority.
  
  **Values**
  
  0 — 7

gr-helper

**Syntax**

```
gr-helper [enable | disable]
```

**Context**

```
config>router>rsvp>if
```

**Description**

This command enables the RSVP Graceful Restart Helper feature.

The RSVP-TE Graceful Restart helper mode allows the SR OS based system (the helper node) to provide another router that has requested it (the restarting node) a grace period, during which the system will continue to use RSVP sessions to neighbors requesting the grace period. This is typically used when another router is rebooting its control plane but its forwarding plane is expected to continue to forward traffic based on the previously available Path and Resv states.

The user can enable Graceful Restart helper on each RSVP interface separately. When the GR helper feature is enabled on an RSVP interface, the node starts inserting a new Restart_Cap Object in the Hello packets to its neighbor. The restarting node does the same and indicates to the helper node the desired Restart Time and Recovery Time.
RSVP Commands

The GR Restart helper consists of a couple of phases. Once it loses Hello communication with its neighbor, the helper node enters the Restart phase. During this phase, it preserves the state of all RSVP sessions to its neighbor and waits for a new Hello message.

Once the Hello message is received indicating the restarting node preserved state, the helper node enters the recovery phase in which it starts refreshing all the sessions that were preserved. The restarting node will activate all the stale sessions that are refreshed by the helper node. Any Path state which did not get a Resv message from the restarting node once the Recovery Phase time is over is considered to have expired and is deleted by the helper node causing the proper Path Tear generation downstream.

The duration of the restart phase (recovery phase) is equal to the minimum of the neighbor’s advertised Restart Time (Recovery Time) in its last Hello message and the locally configured value of the max-restart (max-recovery) parameter.

When GR helper is enabled on an RSVP interface, its procedures apply to the state of both P2P and P2MP RSVP LSP to a neighbor over this interface.

**Default**

disable

**graceful-shutdown**

**Syntax**

[no] graceful-shutdown

**Context**

config>router>rsvp
config>router>rsvp>interface

**Description**

This command initiates a graceful shutdown of the specified RSVP interface or all RSVP interfaces on the node if applied at the RSVP level. These are referred to as maintenance interface and maintenance node, respectively.

To initiate a graceful shutdown the maintenance node generates a PathErr message with a specific error sub-code of Local Maintenance on TE Link required for each LSP that is exiting the maintenance interface.

The node performs a single make-before-break attempt for all adaptive CSPF LSPs it originates and LSP paths using the maintenance interfaces. If an alternative path for an affected LSP is not found, then the LSP is maintained on its current path. The maintenance node also tears down and re-signals any detour LSP path using listed maintenance interfaces as soon as they are not active.

The maintenance node floods an IGP TE LSA/LSP containing Link TLV for the links under graceful shutdown with Traffic Engineering metric set to 0xffffffff and Unreserved Bandwidth parameter set to zero (0).

A head-end LER node, upon receipt of the PathErr message performs a single make-before-break attempt on the affected adaptive CSPF LSP. If an alternative path is not found, then the LSP is maintained on its current path.

A node does not take any action on the paths of the following originating LSPs after receiving the PathErr message:

a. An adaptive CSPF LSP for which the PathErr indicates a node address in the address list and the node corresponds to the destination of the LSP. In this case, there are no alternative paths which can be found.
b. An adaptive CSPF LSP whose path has explicit hops defined using the listed maintenance interface(s)/node(s).

c. A CSPF LSP with the adaptive option disabled and which current path is over the listed maintenance interfaces in the PathErr message. These are not subject to make-before-break.

d. A non CSPF LSP which current path is over the listed maintenance interfaces in the PathErr message.

The head-end LER node upon receipt of the updates IPG TE LSA/LSP for the maintenance interfaces updates the TE database. This information will be used at the next scheduled CSPF computation for any LSP which path may traverse any of the maintenance interfaces.

The no form of the command disables the graceful shutdown operation at the RSVP interface level or at the RSVP level. The configured TE parameters of the maintenance links are restored and the maintenance node floods the links.

**Default** none

---

**gr-helper-time**

**Syntax**

gr-helper-time max-recovery recovery-interval [1..1800] seconds max-restart restart-interval [1..300] seconds

no gr-helper-time

**Context**

config>router>rsvp

**Description**

This command configures the local values for the max-recovery and the max-restart intervals used in the RSVP Graceful Restart Helper feature.

The values are configured globally in RSVP but separate instances of the timers are applied to each RSVP interface that has the RSVP Graceful Restart Helper enabled.

The no version of this command re-instates the default value for the delay timer.

**Parameters**

- **recovery-interval** — Specifies the max recovery interval value in seconds.
  - **Values** 1—1800
  - **Default** 300

- **restart-interval** — Specifies the max restart interval value in seconds.
  - **Values** 1—300
  - **Default** 120

---

**implicit-null-label**

**Syntax**

[no] implicit-null-label

implicit-null-label

**Context**

config>router>rsvp

**Description**

This command enables the use of the implicit null label.
RSVP Commands

Signalling the IMPLICIT NULL label value for all RSVP LSPs can be enabled for which this node is the egress LER. RSVP must be shutdown before being able to change this configuration option.

The egress LER does not signal the implicit null label value on P2MP RSVP LSPs. However, the Penultimate Hop Popping (PHP) node can honor a resv message with the label value set to the implicit null.

The **no** form of this command disables the signaling of the implicit null label.

**Default**

```
no implicit-null-label
```

**keep-multiplier**

**Syntax**

```
[no] keep-multiplier number
no keep-multiplier
```

**Context**

```
config>router>rsvp
```

**Description**

The `keep-multiplier` command is an integer used by RSVP to declare that a reservation is down or the neighbor is down.

The **no** form of this command reverts to the default value.

**Default**

3

**Parameters**

- `number` — The `keep-multiplier` value.

**Values**

```
1 — 255
```

**refresh-reduction-over-bypass**

**Syntax**

```
refresh-reduction-over-bypass [enable | disable]
```

**Context**

```
config>router>rsvp
```

**Description**

This command enables the refresh reduction capabilities over all bypass tunnels originating on this PLR node or terminating on this Merge Point (MP) node.

By default, this is disabled. Since a bypass tunnel may merge with the primary LSP path in a node downstream of the next-hop, there is no direct interface between the PLR and the MP node and it is possible the latter will not accept summary refresh messages received over the bypass.

When disabled, the node as a PLR or MP will not set the “Refresh-Reduction-Capable” bit on RSVP messages pertaining to LSP paths tunneled over the bypass. It will also not send Message-ID in RSVP messages. This effectively disables summary refresh.

**Default**

disable
**rapid-retransmit-time**

**Syntax**  
rapid-retransmit-time *hundred-milliseconds*  
norapid-retransmit-time

**Context**  
config>router>rsvp

**Description**  
This command defines the value of the Rapid Retransmission Interval. It is used in the retransmission mechanism to handle unacknowledged message_id objects and is based on an exponential back-off timer.

Re-transmission interval of a RSVP message with the same message_id = 2 * rapid-retransmit-time interval of time.

The node stops re-transmission of unacknowledged RSVP messages:
  - If the updated back-off interval exceeds the value of the regular refresh interval.
  - If the number of re-transmissions reaches the value of the rapid-retry-limit parameter, whichever comes first.

The Rapid Retransmission Interval must be smaller than the regular refresh interval configured in config>router>rsvp>refresh-time.

The no form of this command reverts to the default value.

**Default**  
5

**Parameters**  
*hundred-milliseconds* — Specifies the rapid retransmission interval.

**Values**  
1 – 100, in units of 100 msec.

**rapid-retry-limit**

**Syntax**  
rapid-retry-limit *number*  
norapid-retry-limit

**Context**  
config>router>rsvp

**Description**  
This command is used to define the value of the Rapid Retry Limit. This is used in the retransmission mechanism based on an exponential backoff timer in order to handle unacknowledged message_id objects. The RSVP message with the same message_id is retransmitted every 2 * rapid-retransmit-time interval of time. The node will stop retransmission of unacknowledged RSVP messages whenever the updated backoff interval exceeds the value of the regular refresh interval or the number of retransmissions reaches the value of the rapid-retry-limit parameter, whichever comes first.

The no form of this command reverts to the default value.

**Default**  
3

**Parameters**  
*number* — Specifies the value of the Rapid Retry Limit.

**Values**  
1 – 6, integer values
RSVP Commands

refresh-time

**Syntax**
```
refresh-time seconds
no refresh-time
```

**Context**
```
config>router>rsvp
```

**Description**
The `refresh-time` controls the interval, in seconds, between the successive Path and Resv refresh messages. RSVP declares the session down after it misses `keep-multiplier number` consecutive refresh messages.

The **no** form of this command reverts to the default value.

**Default**
30 seconds

**Parameters**
- `seconds` — The refresh time in seconds.

**Values**
- `1 — 65535`

---

te-threshold-update

**Syntax**
```
te-threshold-update
no te-threshold-update
```

**Context**
```
config>router>rsvp
```

**Description**
This command is used to control threshold-based IGP TE updates. The `te-threshold-update` command must enable IGP TE update based only on bandwidth reservation thresholds per interface and must block IGP TE update on bandwidth changes for each reservation. Threshold levels can be defined using the `te-up-threshold` and `te-down-threshold` commands at the global RSVP or per-interface level.

The **no** form of this command should reset te-threshold-update to the default value and disable threshold based update.

**Default**
no te-threshold-update

---

on-cac-failure

**Syntax**
```
on-cac-failure
no on-cac-failure
```

**Context**
```
config>router>rsvp>te-threshold-update
```

**Description**
This command is used to enable a CAC failure-triggered IGP update.

The **no** form of this command should reset on-cac-failure to the default value and disable the CAC failure-triggered IGP update.

**Default**
no on-cac-failure
update-timer

Syntax    update-timer seconds
           no update-timer

Context   config>router>rsvp>te-threshold-update

Description  This command is to control timer-based IGP TE updates. Timer-based IGP updates can be enabled by specifying a non-zero time value. Default value of update-timer is 0.

The no form of this command should reset update-timer to the default value and disable timer-based IGP update.

Default   no update-timer (time - 0 seconds)

Parameters  seconds — The time in seconds.

   Values   0-300

---

te-up-threshold

Syntax    te-up-threshold threshold-level [threshold-level...(up to 16 max)]

Context   config>router>rsvp
           config>router>rsvp@interface

Description  This command configures the specific threshold levels per node and per interface. Threshold levels are for reserved bandwidth per interface. The te-threshold-update command is used to enable or disable threshold-based IGP TE updates. Any reserved bandwidth change per interface is compared with all the threshold levels and trigger an IGP TE update if a defined threshold level is crossed in either direction (LSP setup or teardown). Threshold-based updates must be supported with both ISIS and OSPF. A minimum of one and a maximum of 16 threshold levels must be supported.

Threshold levels configured per node is inherited by all configured RSVP interfaces. Threshold levels defined under the RSVP interface is used to trigger IGP updates if non-default threshold levels are configured.

The no form of this command resets te-up-threshold to its default value.

Default   0 15 30 45 60 75 80 85 90 95 96 98 99 100

Parameters  threshold-level — Integer value

   Values   0 — 100
RSVP Commands

te-down-threshold

Syntax  
te-down-threshold  threshold-level  [threshold-level...(up to 16 max)]

Context  
config>router>rsvp
config>router>rsvp>interface

Description  
This command configures the specific threshold levels per node and per interface. Threshold levels are for reserved bandwidth per interface. The te-threshold-update command is used to enable or disable threshold-based IGP TE updates. Any reserved bandwidth change per interface is compared with all the threshold levels and trigger an IGP TE update if a defined threshold level is crossed in either direction (LSP setup or teardown). Threshold-based updates must be supported with both ISIS and OSPF. A minimum of one and a maximum of 16 threshold levels is supported.

Threshold levels configured per node is inherited by all configured RSVP interfaces. Threshold levels defined under the RSVP interface is used to trigger IGP updates if non-default threshold levels are configured.

The no form of this command resets te-down-threshold to its default value.

Default  
100 99 98 97 96 95 90 85 80 75 60 45 30 15 0

Parameters  
threshold-level — Integer value

Values  
0 — 100
Interface Commands

interface

Syntax  

[no] interface ip-int-name

Context  

config>router>rsvp

Description  

This command enables RSVP protocol support on an IP interface. No RSVP commands are executed on an IP interface where RSVP is not enabled.

The no form of this command deletes all RSVP commands such as hello-interval and subscription, which are defined for the interface. The RSVP interface must be shutdown it can be deleted. If the interface is not shut down, the no interface ip-int-name command does nothing except issue a warning message on the console indicating that the interface is administratively up.

Default  shutdown

Parameters  

ip-int-name — The name of the network IP interface. An interface name cannot be in the form of an IP address. If the string contains special characters (#, $, spaces, etc.), the entire string must be enclosed within double quotes.

Values  1 — 32 alphanumeric characters.

authentication-key

Syntax  

authentication-key [authentication-key | hash-key] [hash | hash2]

no authentication-key

Context  

config>router>rsvp>interface

Description  

his command specifies the authentication key to be used between RSVP neighbors to authenticate RSVP messages. Authentication uses the MD-5 message-based digest.

When enabled on an RSVP interface, authentication of RSVP messages operates in both directions of the interface.

A node maintains a security association using one authentication key for each interface to a neighbor. The following items are stored in the context of this security association:

• The HMAC-MD5 authentication algorithm.
• Key used with the authentication algorithm.
• Lifetime of the key. The user-entered key is valid until the user deletes it from the interface.
• Source Address of the sending system.
• Latest sending sequence number used with this key identifier.

A router RSVP sender transmits an authenticating digest of the RSVP message, computed using the shared authentication key and a keyed-hash algorithm. The message digest is included in an integrity object which also contains a flags field, a key identifier field, and a sequence number field. The
RSVP sender complies to the procedures for RSVP message generation in RFC 2747, RSVP Cryptographic Authentication.

A RSVP receiver uses the key together with the authentication algorithm to process received RSVP messages.

When a PLR node switches the path of the LSP to a bypass LSP, it does not send the Integrity object in the RSVP messages sent over the bypass tunnel. If the PLR receives an RSVP message with an Integrity object, it will perform the digest verification for the key of the interface over which the packet was received. If this fails, the packet is dropped. If the received RSVP message is a RESV message and does not have an Integrity object, then the PLR node will accept it only if it originated from the MP node.

An MP node will accept RSVP messages received over the bypass tunnel with and without the Integrity object. If an Integrity object is present, the proper digest verification for the key of the interface over which the packet was received is performed. If this fails, the packet is dropped.

The MD5 implementation does not support the authentication challenge procedures in RFC 2747.

The no form of this command disables authentication.

**Default**

```
no authentication-key
```

- The authentication key value is the null string.

**Parameters**

- `authentication-key` — The authentication key. The key can be any combination of ASCII characters up to 16 characters in length (unencrypted). If the string contains special characters (#, $, spaces, etc.), the entire string must be enclosed within double quotes.

- `hash-key` — The hash key. The key can be any combination of up 33 alphanumeric characters. If spaces are used in the string, enclose the entire string in quotation marks (" ").

  This is useful when a user must configure the parameter, but for security purposes, the actual unencrypted key value is not provided.

- `hash` — Specifies the key is entered in an encrypted form. If the `hash` parameter is not used, the key is assumed to be in a non-encrypted, clear text form. For security, all keys are stored in encrypted form in the configuration file with the `hash` parameter specified.

- `hash2` — Specifies the key is entered in a more complex encrypted form. If the `hash2` parameter is not used, the less encrypted `hash` form is assumed.

### bfd-enable

**Syntax**

```
[no] bfd-enable
```

**Context**

`config>router>rsvp>interface`

**Description**

This command enables the use of bi-directional forwarding (BFD) to control the state of the associated RSVP interface. This causes RSVP to register the interface with the BFD session on that interface.

The user configures the BFD session parameters, such as, `transmit-interval`, `receive-interval`, and `multiplier`, under the IP interface in the `config>router>interface>bfd` context.

Note that it is possible that the BFD session on the interface was started because of a prior registration with another protocol, for example, OSPF or IS-IS.
The registration of an RSVP interface with BFD is performed at the time of neighbor gets its first session. This means when this node sends or receives a new Path message over the interface. If however the session did not come up, due to not receiving a Resv for a new path message sent after the maximum number of re-tries, the LSP is shutdown and the node de-registers with BFD. In general, the registration of RSVP with BFD is removed as soon as the last RSVP session is cleared.

The registration of an RSVP interface with BFD is performed independent of whether RSVP hello is enabled on the interface or not. However, hello timeout will clear all sessions towards the neighbor and RSVP de-registers with BFD at clearing of the last session.

Note that an RSVP session is associated with a neighbor based on the interface address the path message is sent to. If multiple interfaces exist to the same node, then each interface is treated as a separate RSVP neighbor. The user will have to enable BFD on each interface and RSVP will register with the BFD session running with each of those neighbors independently.

Similarly the disabling of BFD on the interface results in removing registration of the interface with BFD.

When a BFD session transitions to DOWN state, the following actions are triggered. For RSVP signaled LSPs, this triggers activation of FRR bypass/detour backup (PLR role), global revertive (head-end role), and switchover to secondary if any (head-end role) for affected LSPs with FRR enabled. It triggers switchover to secondary if any and scheduling of re-tries for signaling the primary path of the non-FRR affected LSPs (head-end role).

The **no** form of this command removes BFD from the associated RSVP protocol adjacency.

**Default**

no bfd-enable

### hello-interval

**Syntax**

```
hello-interval milliseconds
no hello-interval
```

**Context**

```
config>router>rsvp>interface
```

**Description**

This command configures the time interval between RSVP hello messages.

RSVP hello packets are used to detect loss of RSVP connectivity with the neighboring node. Hello packets detect the loss of neighbor far quicker than it would take for the RSVP session to time out based on the refresh interval. After the loss of the of number keep-multiplier consecutive hello packets, the neighbor is declared to be in a down state.

The **no** form of this command reverts to the default value of the hello-interval. To disable sending hello messages, set the value to zero.

**Default**

3000 milliseconds

**Parameters**

`milliseconds` — Specifies the RSVP hello interval in milliseconds, in multiples of 1000. A 0 (zero) value disables the sending of RSVP hello messages.

**Values**

0 — 60000 milliseconds (in multiples of 1000)
Interface Commands

**implicit-null-label**

**Syntax**

```
implicit-null-label [enable | disable]
no implicit-null-label
```

**Context**

```
config>router>rsvp>interface
```

**Description**

This command enables the use of the implicit null label over a specific RSVP interface.

All LSPs for which this node is the egress LER and for which the path message is received from the previous hop node over this RSVP interface will signal the implicit null label. This means that if the egress LER is also the merge-point (MP) node, then the incoming interface for the path refresh message over the bypass dictates if the packet will use the implicit null label or not. The same for a 1-to-1 detour LSP.

The user must shutdown the RSVP interface before being able to change the implicit null configuration option.

The **no** form of this command returns the RSVP interface to use the RSVP level configuration value.

**Default**

disable

**Parameters**

- `enable` — This parameter enables the implicit null label.
- `disable` — This parameter disables the implicit null label.

**refresh-reduction**

**Syntax**

```
[no] refresh-reduction
```

**Context**

```
config>router>rsvp>interface
```

**Description**

This command enables the use of the RSVP overhead refresh reduction capabilities on this RSVP interface.

When this option is enabled, a node will enable support for three capabilities. It will accept bundles RSVP messages from its peer over this interface, it will attempt to perform reliable RSVP message delivery to its peer, and will use summary refresh messages to refresh path and resv states. The reliable message delivery must be explicitly enabled by the user after refresh reduction is enabled. The other two capabilities are enabled immediately.

A bundle message is intended to reduce overall message handling load. A bundle message consists of a bundle header followed by one or more bundle sub-messages. A sub-message can be any regular RSVP message except another bundle message. A node will only process received bundled RSVP messages but will not generate them.

When reliable message delivery is supported by both the node and its peer over the RSVP interface, an RSVP message is sent with a message_id object. A message_id object can be added to any RSVP message when sent individually or as a sub-message of a bundled message.

if the sender sets the ack_desired flag in the message_id object, the receiver acknowledges the receipt of the RSVP message by piggy-backing a message_ack object to the next RSVP message it sends to its peer. Alternatively, an ACK message can also be used to send the message_ack object. In both cases, one or many message_ack objects could be included in the same message.
The routers support the sending of separate ACK messages only but is capable of processing received message_ack objects piggy-backed to hop-by-hop RSVP messages, such as path and resv.

The router sets the ack_desired flag only in non refresh RSVP messages and in refresh messages which contain new state information.

A retransmission mechanism based on an exponential backoff timer is supported in order to handle unacknowledged message_id objects. The RSVP message with the same message_id is retransmitted every 2 * rapid-retransmit-time interval of time. The rapid-retransmit-time is referred to as the rapid retransmission interval as it must be smaller than the regular refresh interval configured in the config>router>rsvp>refresh-time context. There is also a maximum number of retransmissions of an unacknowledged RSVP message rapid-retry-limit. The node will stop retransmission of unacknowledged RSVP messages whenever the updated backoff interval exceeds the value of the regular refresh interval or the number of retransmissions reaches the value of the rapid-retry-limit parameter, whichever comes first. These two parameters are configurable globally on a system in the config>router>rsvp context.

Refresh summary consists of sending a summary refresh message containing a message_id list object. The fields of this object are populated each with the value of the message_identifier field in the message_id object of a previously sent individual path or resv message. The summary refresh message is sent every refresh regular interval as configured by the user using the refresh-time command in the config>router>rsvp context. The receiver checks each message_id object against the saved path and resv states. If a match is found, the state is updated as if a regular path or resv refresh message was received from the peer. If a specific message_identifier field does not match, then the node sends a message_id_nack object to the originator of the message.

The above capabilities are referred to collectively as “refresh overhead reduction extensions”. When the refresh-reduction is enabled on an RSVP interface, the node indicates this to its peer by setting a “refresh-reduction-capable” bit in the flags field of the common RSVP header. If both peers of an RSVP interface set this bit, all the above three capabilities can be used. Furthermore, the node monitors the settings of this bit in received RSVP messages from the peer on the interface. As soon as this bit is cleared, the router stops sending summary refresh messages. If a peer did not set the “refresh-reduction-capable” bit, a node does not attempt to send summary refresh messages.

However, if the peer did not set the “refresh-reduction-capable” bit, a node, with refresh reduction enabled and reliable message delivery enabled, will still attempt to perform reliable message delivery with this peer. If the peer does not support the message_id object, it returns an error message “unknown object class”. In this case, the node retransmits the RSVP message without the message_id object and reverts to using this method for future messages destined to this peer.

The no form of the command reverts to the default value.

Default: no refresh-reduction

**reliable-delivery**

**Syntax**

[no] reliable-delivery

**Context**

config>router>rsvp>interface>refresh-reduction

**Description**

This command enables reliable delivery of RSVP messages over the RSVP interface. When refresh-reduction is enabled on an interface and reliable-delivery is disabled, then the router will send a message_id and not set ACK desired in the RSVP messages over the interface. Thus 7710 does not
Interface Commands

expect an ACK and but will accept it if received. The node will also accept message ID and reply with an ACK when requested. In this case, if the neighbor set the “refresh-reduction-capable” bit in the flags field of the common RSVP header, the node will enter summary refresh for a specific message_id it sent regardless if it received an ACK or not to this message from the neighbor.

Finally, when ‘reliable-delivery’ option is enabled on any interface, RSVP message pacing is disabled on all RSVP interfaces of the system, for example, the user cannot enable the msg-pacing option in the config>router>rsvp context, and error message is returned in CLI. Conversely, when the msg-pacing option is enabled, the user cannot enable the reliable delivery option on any interface on this system. An error message will also generated in CLI after such an attempt.

The no form of the command reverts to the default value.

Default no reliable-delivery

subscription

Syntax subscription percentage
no subscription

Context config>router>rsvp>interface

Description This command configures the percentage of the link bandwidth that RSVP can use for reservation and sets a limit for the amount of over-subscription or under-subscription allowed on the interface.

When the subscription is set to zero, no new sessions are permitted on this interface. If the percentage is exceeded, the reservation is rejected and a log message is generated.

The no form of this command reverts the percentage to the default value.

Default 100

Parameters percentage — The percentage of the interface's bandwidth that RSVP allows to be used for reservations.

Values 0 — 1000

te-up-threshold

Syntax te-up-threshold threshold-level [threshold-level...(up to 16 max)]
no te-up-threshold

Context config>router>rsvp
config>router>rsvp>interface

Description This command configures the specific threshold levels per node and per interface. Threshold levels are for reserved bandwidth per interface. The te-threshold-update command is used to enable or disable threshold-based IGP TE updates. Any reserved bandwidth change per interface is compared with all the threshold levels and trigger an IGP TE update if a defined threshold level is crossed in either direction (LSP setup or teardown). Threshold-based updates must be supported with both ISIS and OSPF. A minimum of one and a maximum of 16 threshold levels must be supported.
Threshold levels configured per node is inherited by all configured RSVP interfaces. Threshold levels defined under the RSVP interface is used to trigger IGP updates if non-default threshold levels are configured.

The `no` form of this command resets the default value.

**Default**

0 15 30 45 60 75 80 85 90 95 96 97 98 99 100

**Parameters**

`threshold-level` — Integer value

**Values**

0 — 100

**te-down-threshold**

**Syntax**

`te-down-threshold threshold-level [threshold-level...(up to 16 max)]`

`no te-down-threshold`

**Context**

`config>router>rsvp`

`config>router>rsvp>interface`

**Description**

This command configures the specific threshold levels per node and per interface. Threshold levels are for reserved bandwidth per interface. The `te-threshold-update` command is used to enable or disable threshold-based IGP TE updates. Any reserved bandwidth change per interface is compared with all the threshold levels and trigger an IGP TE update if a defined threshold level is crossed in either direction (LSP setup or teardown). Threshold-based updates is supported with both ISIS and OSPF. A minimum of one and a maximum of 16 threshold levels is supported.

Threshold levels configured per node is inherited by all configured RSVP interfaces. Threshold levels defined under the RSVP interface must be used to trigger IGP updates if non-default threshold levels are configured.

The `no` form of this command resets the default value.

**Default**

100 99 98 97 96 95 90 85 80 75 60 45 30 15 0

**Parameters**

`threshold-level` — Integer value

**Values**

0 — 100
## Message Pacing Commands

### msg-pacing

**Syntax**

```plaintext
[no] msg-pacing
```

**Context**

```
cfg>router>rsvp
```

**Description**

This command enables RSVP message pacing in which the specified number of RSVP messages, specified in the `max-burst` command, are sent in a configured interval, specified in the `period` command. A count is kept of the messages that were dropped because the output queue for the interface used for message pacing was full.

**Default**

`no msg-pacing`

### max-burst

**Syntax**

```plaintext
max-burst number
no max-burst
```

**Context**

```
cfg>router>rsvp>msg-pacing
```

**Description**

This command specifies the maximum number of RSVP messages that are sent in the specified period under normal operating conditions.

**Default**

650

**Parameters**

`number` —

**Values**

100 — 1000 in increments of 10

### period

**Syntax**

```plaintext
period milli-seconds
no period
```

**Context**

```
cfg>router>rsvp>msg-pacing
```

**Description**

This command specifies the time interval, in milliseconds, when the router can send the specified number of RSVP messages which is specified in the `max-burst` command.

**Default**

100

**Parameters**

`milli-seconds` —

**Values**

100 — 1000 milliseconds in increments of 10 milliseconds
Label Distribution Protocol

In This Chapter

This chapter provides information to enable Label Distribution Protocol (LDP).

Topics in this chapter include:

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  - LDP and MPLS on page 200
  - LDP Architecture on page 201
  - Subsystem Interrelationships on page 202
  - Execution Flow on page 204
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  - Multicast P2MP LDP for GRT on page 236
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  - Multi-Area and Multi-Instance Extensions to LDP on page 238
- LDP Process Overview on page 243
Label Distribution Protocol

Label Distribution Protocol (LDP) is a protocol used to distribute labels in non-traffic-engineered applications. LDP allows routers to establish label switched paths (LSPs) through a network by mapping network-layer routing information directly to data link layer-switched paths.

An LSP is defined by the set of labels from the ingress Label Switching Router (LSR) to the egress LSR. LDP associates a Forwarding Equivalence Class (FEC) with each LSP it creates. A FEC is a collection of common actions associated with a class of packets. When an LSR assigns a label to a FEC, it must let other LSRs in the path know about the label. LDP helps to establish the LSP by providing a set of procedures that LSRs can use to distribute labels.

The FEC associated with an LSP specifies which packets are mapped to that LSP. LSPs are extended through a network as each LSR splices incoming labels for a FEC to the outgoing label assigned to the next hop for the given FEC.

LDP allows an LSR to request a label from a downstream LSR so it can bind the label to a specific FEC. The downstream LSR responds to the request from the upstream LSR by sending the requested label.

LSRs can distribute a FEC label binding in response to an explicit request from another LSR. This is known as Downstream On Demand (DOD) label distribution. LSRs can also distribute label bindings to LSRs that have not explicitly requested them. This is called Downstream Unsolicited (DUS).

LDP and MPLS

LDP performs the label distribution only in MPLS environments. The LDP operation begins with a hello discovery process to find LDP peers in the network. LDP peers are two LSRs that use LDP to exchange label/FEC mapping information. An LDP session is created between LDP peers. A single LDP session allows each peer to learn the other's label mappings (LDP is bi-directional) and to exchange label binding information.

LDP signaling works with the MPLS label manager to manage the relationships between labels and the corresponding FEC. For service-based FECs, LDP works in tandem with the Service Manager to identify the virtual leased lines (VLLs) and Virtual Private LAN Services (VPLSs) to signal.

An MPLS label identifies a set of actions that the forwarding plane performs on an incoming packet before discarding it. The FEC is identified through the signaling protocol (in this case, LDP) and allocated a label. The mapping between the label and the FEC is communicated to the forwarding plane. In order for this processing on the packet to occur at high speeds, optimized tables are maintained in the forwarding plane that enable fast access and packet identification.
When an unlabeled packet ingresses the router, classification policies associate it with a FEC. The appropriate label is imposed on the packet, and the packet is forwarded. Other actions that can take place before a packet is forwarded are imposing additional labels, other encapsulations, learning actions, etc. When all actions associated with the packet are completed, the packet is forwarded.

When a labeled packet ingresses the router, the label or stack of labels indicates the set of actions associated with the FEC for that label or label stack. The actions are performed on the packet and then the packet is forwarded.

The LDP implementation provides DOD, DUS, ordered control, liberal label retention mode support.

---

**LDP Architecture**

LDP comprises a few processes that handle the protocol PDU transmission, timer-related issues, and protocol state machine. The number of processes is kept to a minimum to simplify the architecture and to allow for scalability. Scheduling within each process prevents starvation of any particular LDP session, while buffering alleviates TCP-related congestion issues.

The LDP subsystems and their relationships to other subsystems are illustrated in Figure 15. This illustration shows the interaction of the LDP subsystem with other subsystems, including memory management, label management, service management, SNMP, interface management, and RTM. In addition, debugging capabilities are provided through the logger.

Communication within LDP tasks is typically done by inter-process communication through the event queue, as well as through updates to the various data structures. The primary data structures that LDP maintains are:

- **FEC/label database** — This database contains all the FEC to label mappings that include, both sent and received. It also contains both address FECs (prefixes and host addresses) as well as service FECs (L2 VLLs and VPLS).
- **Timer database** — This database contains all the timers for maintaining sessions and adjacencies.
- **Session database** — This database contains all the session and adjacency records, and serves as a repository for the LDP MIB objects.
Subsystem Interrelationships

The sections below describe how LDP and the other subsystems work to provide services.

Figure 15: Subsystem Interrelationships
Memory Manager and LDP

LDP does not use any memory until it is instantiated. It pre-allocates some amount of fixed memory so that initial startup actions can be performed. Memory allocation for LDP comes out of a pool reserved for LDP that can grow dynamically as needed. Fragmentation is minimized by allocating memory in larger chunks and managing the memory internally to LDP. When LDP is shut down, it releases all memory allocated to it.

Label Manager

LDP assumes that the label manager is up and running. LDP will abort initialization if the label manager is not running. The label manager is initialized at system boot-up; hence, anything that causes it to fail will likely imply that the system is not functional. The router uses a label range from 28672 (28K) to 131071 (128K-1) to allocate all dynamic labels, including RSVP allocated labels and VC labels.

LDP Configuration

The router uses a single consistent interface to configure all protocols and services. CLI commands are translated to SNMP requests and are handled through an agent-LDP interface. LDP can be instantiated or deleted through SNMP. Also, LDP targeted sessions can be set up to specific endpoints. Targeted-session parameters are configurable.

Logger

LDP uses the logger interface to generate debug information relating to session setup and teardown, LDP events, label exchanges, and packet dumps. Per-session tracing can be performed.

Service Manager

All interaction occurs between LDP and the service manager, since LDP is used primarily to exchange labels for Layer 2 services. In this context, the service manager informs LDP when an LDP session is to be set up or torn down, and when labels are to be exchanged or withdrawn. In turn, LDP informs service manager of relevant LDP events, such as connection setups and failures, timeouts, labels signaled/withdrawn.
Execution Flow

LDP activity in the operating system is limited to service-related signaling. Therefore, the configurable parameters are restricted to system-wide parameters, such as hello and keepalive timeouts.

Initialization

MPLS must be enabled when LDP is initialized. LDP makes sure that the various prerequisites, such as ensuring the system IP interface is operational, the label manager is operational, and there is memory available, are met. It then allocates itself a pool of memory and initializes its databases.

Session Lifetime

In order for a targeted LDP (T-LDP) session to be established, an adjacency must be created. The LDP extended discovery mechanism requires hello messages to be exchanged between two peers for session establishment. After the adjacency establishment, session setup is attempted.

Adjacency Establishment

In the router, the adjacency management is done through the establishment of a Service Distribution Path (SDP) object, which is a service entity in the Alcatel-Lucent service model.

The Alcatel-Lucent service model uses logical entities that interact to provide a service. The service model requires the service provider to create configurations for four main entities:

- Customers
- Services
- Service Access Paths (SAPs) on the local routers
- Service Distribution Points (SDPs) that connect to one or more remote routers.

An SDP is the network-side termination point for a tunnel to a remote router. An SDP defines a local entity that includes the system IP address of the remote routers and a path type. Each SDP comprises:

- The SDP ID
- The transport encapsulation type, either MPLS or GRE
- The far-end system IP address
If the SDP is identified as using LDP signaling, then an LDP extended hello adjacency is attempted.

If another SDP is created to the same remote destination, and if LDP signaling is enabled, no further action is taken, since only one adjacency and one LDP session exists between the pair of nodes.

An SDP is a uni-directional object, so a pair of SDPs pointing at each other must be configured in order for an LDP adjacency to be established. Once an adjacency is established, it is maintained through periodic hello messages.

---

### Session Establishment

When the LDP adjacency is established, the session setup follows as per the LDP specification. Initialization and keepalive messages complete the session setup, followed by address messages to exchange all interface IP addresses. Periodic keepalives or other session messages maintain the session liveliness.

Since TCP is back-pressured by the receiver, it is necessary to be able to push that back-pressure all the way into the protocol. Packets that cannot be sent are buffered on the session object and re-attempted as the back-pressure eases.
Label Exchange

Label exchange is initiated by the service manager. When an SDP is attached to a service (for example, the service gets a transport tunnel), a message is sent from the service manager to LDP. This causes a label mapping message to be sent. Additionally, when the SDP binding is removed from the service, the VC label is withdrawn. The peer must send a label release to confirm that the label is not in use.

Other Reasons for Label Actions

Other reasons for label actions include:

- MTU changes: LDP withdraws the previously assigned label, and re-signals the FEC with the new MTU in the interface parameter.
- Clear labels: When a service manager command is issued to clear the labels, the labels are withdrawn, and new label mappings are issued.
- SDP down: When an SDP goes administratively down, the VC label associated with that SDP for each service is withdrawn.
- Memory allocation failure: If there is no memory to store a received label, it is released.
- VC type unsupported: When an unsupported VC type is received, the received label is released.

Cleanup

LDP closes all sockets, frees all memory, and shuts down all its tasks when it is deleted, so its memory usage is 0 when it is not running.
Configuring Implicit Null Label

The implicit null label option allows an egress LER to receive MPLS packets from the previous hop without the outer LSP label. The user can configure to signal the implicit operation of the previous hop is referred to as penultimate hop popping (PHP). This option is signaled by the egress LER to the previous hop during the FEC signaling by the LDP control protocol.

To enable the implicit null option for all LDP FECs for which this node is the egress LER, use the following command:

```
config>router>ldp>implicit-null-label
```

When the user changes the implicit null configuration option, LDP withdraws all the FECs and re-advertises them using the new label value.
Global LDP Filters

Both inbound and outbound LDP label binding filtering are supported.

Inbound filtering is performed by way of the configuration of an import policy to control the label bindings an LSR accepts from its peers. Label bindings can be filtered based on:

- Neighbor: Match on bindings received from the specified peer.
- Prefix-list: Match on bindings with the specified prefix/prefixes.

The default import policy is to accept all FECs received from peers.

Outbound filtering is performed by way of the configuration of an export policy. The Global LDP export policy can be used to explicitly originate label bindings for local interfaces. The Global LDP export policy does not filter out or stop propagation of any FEC received from neighbors. Use the LDP peer export prefix policy for this purpose. It must also be noted that the system IP address AND static FECs cannot be blocked using an export policy.

Export policy enables configuration of a policy to advertise label bindings based on:

- Direct: All local subnets.
- Prefix-list: Match on bindings with the specified prefix or prefixes.

The default export policy is to originate label bindings for system address only and to propagate all FECs received from other LDP peers.

Finally, it must be noted that the 'neighbor' statement inside a global import or export policy is not considered by LDP. Use the LDP peer import or export prefix policy for this purpose.

Per LDP Peer FEC Import and Export Policies

The FEC prefix export policy provides a way to control which FEC prefixes received from prefixes received from other LDP and T-LDP peers are re-distributed to this LDP peer.

The user configures the FEC prefix export policy using the following command:

```plaintext
config>router>ldp>peer-parameters>peer>export-prefixes policy-name
```

By default, all FEC prefixes are exported to this peer.

The FEC prefix import policy provides a mean of controlling which FEC prefixes received from this LDP peer are imported and installed by LDP on this node. If resolved these FEC prefixes are then re-distributed to other LDP and T-LDP peers.
The user configures the FEC prefix export policy using the following command:

```
config>router>ldp>peer-parameters>peer>import-prefixes policy-name
```

By default, all FEC prefixes are imported from this peer.

---

**Configuring Multiple LDP LSR ID**

The multiple LDP LSR-ID feature provides the ability to configure and initiate multiple T-LDP sessions on the same system using different LDP LSR-IDs. In the current implementation, all T-LDP sessions must have the LSR-ID match the system interface address. This feature continues to allow the use of the system interface but also any other loopback interface or local interface address on a per T-LDP session basis. Note that LDP control plane will not allow more than a single T-LDP session with the same local LSR ID to two different LSR-IDS on the same remote node.

An SDP of type LDP will use the source address configured as the local LSR-ID for the T-LDP session to the peer matching a specific SDP far-end address. If no targeted session has been explicitly pre-provisioned to the far-end node under LDP, then the SDP will auto-establish one using the system interface address as the LSR-ID.

An SDP of type RSVP must have the local LSR-ID as the destination of the RSVP LSP from the peer. The local LSR-ID must be a local interface which is not a loopback if CSPF is enabled on the RSVP LSP.

An SDP of type GRE can only use a T-LDP session with a local LSR-ID set to the system interface.

The multiple LDP LSR-ID also provides the ability to use the LDP local interface address instead of the system address as the LSR-ID for the LDP adjacency to the peer over the local interface. In this case, the transport interface will automatically be set to use the same local interface address.

This feature can be configured for any I-LDP session. When used as such, the I-LDP transport-address parameter is ignored and the session is forced to use the interface as transport-address.
Tracking a T-LDP Peer with BFD

BFD tracking of an LDP session associated with a T-LDP adjacency allows for faster detection of the liveliness of the session by registering the transport address of a LDP session with a BFD session.

By enabling BFD for a selected targeted session, the state of that session is tied to the state of the underneath BFD session between the two nodes. The parameters used for the BFD are set with the BFD command under the IP interface.

Tracking a Link LDP Peer with BFD

Tracking of the Hello adjacency to an LDP peer using BFD is supported.

Hello adjacency tracking with BFD is enabled by enabling BFD on an LDP interface:

- `config>router>ldp>interface-parameters>interface>enable-bfd`

The parameters used for the BFD session, for example, transmit-interval, receive-interval, and multiplier, are those configured under the IP interface in the existing `config>router>interface>bfd` context.

When this command is enabled on an LDP interface, LDP registers with BFD and starts tracking the LSR-id of all peers it forms Hello adjacencies with over that LDP interface.

The parameters used for the BFD session, for example, transmit-interval, receive-interval, and multiplier, are those configured under the IP interface in the existing `config>router>interface>bfd` context.

When enabled, the LDP hello mechanism is used to determine the remote address to be used for the BFD session. If a BFD session fails, then the associated LDP adjacency is also declared down and LDP will immediately begin its reconvergence.
TTL Security for BGP and LDP

The BGP TTL Security Hack (BTSH) was originally designed to protect the BGP infrastructure from CPU utilization-based attacks. It is derived from the fact that the vast majority of ISP eBGP peerings are established between adjacent routers. Since TTL spoofing is considered nearly impossible, a mechanism based on an expected TTL value can provide a simple and reasonably robust defense from infrastructure attacks based on forged BGP packets.

While TTL Security Hack (TSH) is most effective in protecting directly connected peers, it can also provide a lower level of protection to multi-hop sessions. When a multi-hop BGP session is required, the expected TTL value can be set to 255 minus the configured range-of-hops. This approach can provide a qualitatively lower degree of security for BGP (such as a DoS attack could, theoretically, be launched by compromising a box in the path). However, BTSH will catch a vast majority of observed distributed DoS (DDoS) attacks against eBGP.

TSH can be used to protect LDP peering sessions as well. For details, see draft-chen-ldp-ttl-xx.txt, TTL-Based Security Option for LDP Hello Message.

The TSH implementation supports the ability to configure TTL security per BGP/LDP peer and evaluate (in hardware) the incoming TTL value against the configured TTL value. If the incoming TTL value is less than the configured TTL value, the packets are discarded and a log is generated.
**ECMP Support for LDP**

ECMP support for LDP performs load balancing for LDP based LSPs by having multiple outgoing next-hops for a given IP prefix on ingress and transit LSRs.

An LSR that has multiple equal cost paths to a given IP prefix can receive an LDP label mapping for this prefix from each of the downstream next-hop peers. As the LDP implementation uses the liberal label retention mode, it retains all the labels for an IP prefix received from multiple next-hop peers.

Without ECMP support for LDP, only one of these next-hop peers will be selected and installed in the forwarding plane. The algorithm used to determine the next-hop peer to be selected involves looking up the route information obtained from the RTM for this prefix and finding the first valid LDP next-hop peer (for example, the first neighbor in the RTM entry from which a label mapping was received). If, for some reason, the outgoing label to the installed next-hop is no longer valid, say the session to the peer is lost or the peer withdraws the label, a new valid LDP next-hop peer will be selected out of the existing next-hop peers and LDP will reprogram the forwarding plane to use the label sent by this peer.

With ECMP support, all the valid LDP next-hop peers, those that sent a label mapping for a given IP prefix, will be installed in the forwarding plane. In both cases, ingress LER and transit LSR, an ingress label will be mapped to the next hops that are in the RTM and from which a valid mapping label has been received. The forwarding plane will then use an internal hashing algorithm to determine how the traffic will be distributed amongst these multiple next-hops, assigning each “flow” to a particular next-hop.

The hash algorithm at LER and transit LSR are described in the LAG and ECMP Hashing section of the 7710 SR OS Interface Guide.

---

**Label Operations**

If an LSR is the ingress for a given IP prefix, LDP programs a push operation for the prefix in the forwarding engine. This creates an LSP ID to the Next Hop Label Forwarding Entry (NHLFE) (LTN) mapping and an LDP tunnel entry in the forwarding plane. LDP will also inform the Tunnel Table Manager (TTM) of this tunnel. Both the LTN entry and the tunnel entry will have a NHLFE for the label mapping that the LSR received from each of its next-hop peers.

If the LSR is to behave as a transit for a given IP prefix, LDP will program a swap operation for the prefix in the forwarding engine. This involves creating an Incoming Label Map (ILM) entry in the forwarding plane. The ILM entry will have to map an incoming label to possibly multiple NHLFEs. If an LSR is an egress for a given IP prefix, LDP will program a POP entry in the forwarding engine. This too will result in an ILM entry being created in the forwarding plane but with no NHLFEs.
When unlabeled packets arrive at the ingress LER, the forwarding plane will consult the LTN entry and will use a hashing algorithm to map the packet to one of the NHLFEs (push label) and forward the packet to the corresponding next-hop peer. For labeled packets arriving at a transit or egress LSR, the forwarding plane will consult the ILM entry and either use a hashing algorithm to map it to one of the NHLFEs if they exist (swap label) or simply route the packet if there are no NHLFEs (pop label).

Static FEC swap will not be activated unless there is a matching route in system route table that also matches the user configured static FEC next-hop.
LDP over RSVP Tunnels

LDP over RSVP-TE provides end-to-end tunnels that have two important properties, fast reroute and traffic engineering which are not available in LDP. LDP over RSVP-TE is focused at large networks (over 100 nodes in the network). Simply using end-to-end RSVP-TE tunnels will not scale. While an LER may not have that many tunnels, any transit node will potentially have thousands of LSPs, and if each transit node also has to deal with detours or bypass tunnels, this number can make the LSR overly burdened.

LDP over RSVP-TE allows tunneling of user packets using an LDP LSP inside an RSVP LSP. The main application of this feature is for deployment of MPLS based services, for example, VPRN, VLL, and VPLS services, in large scale networks across multiple IGP areas without requiring full mesh of RSVP LSPs between PE routers.

![Figure 16: LDP over RSVP Application](image)

The network displayed in Figure 16 consists of two metro areas, Area 1 and 2 respectively, and a core area, Area 3. Each area makes use of TE LSPs to provide connectivity between the edge routers. In order to enable services between PE1 and PE2 across the three areas, LSP1, LSP2, and LSP3 are set up using RSVP-TE. There are in fact 6 LSPs required for bidirectional operation but we will refer to each bi-directional LSP with a single name, for example, LSP1. A targeted LDP (T-LDP) session is associated with each of these bidirectional LSP tunnels. That is, a T-LDP adjacency is created between PE1 and ABR1 and is associated with LSP1 at each end. The same is done for the LSP tunnel between ABR1 and ABR2, and finally between ABR2 and PE2. The loopback address of each of these routers is advertised using T-LDP. Similarly, backup bidirectional LDP over RSVP tunnels, LSP1a and LSP2a, are configured by way of ABR3.

This setup effectively creates an end-to-end LDP connectivity which can be used by all PEs to provision services. The RSVP LSPs are used as a transport vehicle to carry the LDP packets from
one area to another. Note that only the user packets are tunneled over the RSVP LSPs. The T-LDP control messages are still sent unlabeled using the IGP shortest path.

Note that in this application, the bi-directional RSVP LSP tunnels are not treated as IP interfaces and are not advertised back into the IGP. A PE must always rely on the IGP to look up the next hop for a service packet. LDP-over-RSVP introduces a new tunnel type, tunnel-in-tunnel, in addition to the existing LDP tunnel and RSVP tunnel types. If multiple tunnels types match the destination PE FEC lookup, LDP will prefer an LDP tunnel over an LDP-over-RSVP tunnel by default.

The design in Figure 16 allows a service provider to build and expand each area independently without requiring a full mesh of RSVP LSPs between PEs across the three areas.

In order to participate in a VPRN service, PE1 and PE2 perform the autobind to LDP. The LDP label which represents the target PE loopback address is used below the RSVP LSP label. Therefore a 3 label stack is required.

In order to provide a VLL service, PE1 and PE2 are still required to set up a targeted LDP session directly between them. Again a 3 label stack is required, the RSVP LSP label, followed by the LDP label for the loopback address of the destination PE, and finally the pseudowire label (VC label).

This implementation supports a variation of the application in Figure 16, in which area 1 is an LDP area. In that case, PE1 will push a two label stack while ABR1 will swap the LDP label and push the RSVP label as illustrated in Figure 17. LDP-over-RSVP tunnels can also be used as IGP shortcuts.

Figure 17: LDP over RSVP Application Variant
Signaling and Operation

- LDP Label Distribution and FEC Resolution on page 216
- Default FEC Resolution Procedure on page 217

LDP Label Distribution and FEC Resolution

The user creates a targeted LDP (T-LDP) session to an ABR or the destination PE. This results in LDP hellos being sent between the two routers. These messages are sent unlabeled over the IGP path. Next, the user enables LDP tunneling on this T-LDP session and optionally specifies a list of LSP names to associate with this T-LDP session. By default, all RSVP LSPs which terminate on the T-LDP peer are candidates for LDP-over-RSVP tunnels. At this point in time, the LDP FECs resolving to RSVP LSPs are added into the Tunnel Table Manager as tunnel-in-tunnel type.

Note that if LDP is running on regular interfaces also, then the prefixes LDP learns are going to be distributed over both the T-LDP session as well as regular IGP interfaces. The policy controls which prefixes go over the T-LDP session, for example, only /32 prefixes, or a particular prefix range.

LDP-over-RSVP works with both OSPF and ISIS. These protocols include the advertising router when adding an entry to the RTM. LDP-over-RSVP tunnels can be used as shortcuts for BGP next-hop resolution.
Default FEC Resolution Procedure

When LDP tries to resolve a prefix received over a T-LDP session, it performs a lookup in the Routing Table Manager (RTM). This lookup returns the next hop to the destination PE and the advertising router (ABR or destination PE itself). If the next-hop router advertised the same FEC over link-level LDP, LDP will prefer the LDP tunnel by default unless the user explicitly changed the default preference using the system wide prefer-tunnel-in-tunnel command. If the LDP tunnel becomes unavailable, LDP will select an LDP-over-RSVP tunnel if available.

When searching for an LDP-over-RSVP tunnel, LDP selects the advertising router(s) with best route. If the advertising router matches the T-LDP peer, LDP then performs a second lookup for the advertising router in the Tunnel Table Manager (TTM) which returns the user configured RSVP LSP with the best metric. If there are more than one configured LSP with the best metric, LDP selects the first available LSP.

If all user configured RSVP LSPs are down, no more action is taken. If the user did not configure any LSPs under the T-LDP session, the lookup in TTM will return the first available RSVP LSP which terminates on the advertising router with the lowest metric.

FEC Resolution Procedure When prefer-tunnel-in-tunnel is Enabled

When LDP tries to resolve a prefix received over a T-LDP session, it performs a lookup in the Routing Table Manager (RTM). This lookup returns the next hop to the destination PE and the advertising router (ABR or destination PE itself).

When searching for an LDP-over-RSVP tunnel, LDP selects the advertising router(s) with best route. If the advertising router matches the targeted LDP peer, LDP then performs a second lookup for the advertising router in the Tunnel Table Manager (TTM) which returns the user configured RSVP LSP with the best metric. If there are more than one configured LSP with the best metric, LDP selects the first available LSP.

If all user configured RSVP LSPs are down, then an LDP tunnel will be selected if available.

If the user did not configure any LSPs under the T-LDP session, a lookup in TTM will return the first available RSVP LSP which terminates on the advertising router. If none are available, then an LDP tunnel will be selected if available.
Rerouting Around Failures

Every failure in the network can be protected against, except for the ingress and egress PEs. All other constructs have protection available. These constructs are LDP-over-RSVP tunnel and ABR.

- LDP-over-RSVP Tunnel Protection on page 218
- ABR Protection on page 218

LDP-over-RSVP Tunnel Protection

An RSVP LSP can deal with a failure in two ways.

- If the LSP is a loosely routed LSP, then RSVP will find a new IGP path around the failure, and traffic will follow this new path. This may involve some churn in the network if the LSP comes down and then gets re-routed. The tunnel damping feature was implemented on the LSP so that all the dependent protocols and applications do not flap unnecessarily.
- If the LSP is a CSPF-computed LSP with the fast reroute option enabled, then RSVP will switch to the detour path very quickly. From that point, a new LSP will be attempted from the head-end (global revertive). When the new LSP is in place, the traffic switches over to the new LSP with make-before-break.

ABR Protection

If an ABR fails, then routing around the ABR requires that a new next-hop LDP-over-RSVP tunnel be found to a backup ABR. If an ABR fails, then the T-LDP adjacency fails. Eventually, the backup ABR becomes the new next hop (after SPF converges), and LDP learns of the new next-hop and can reprogram the new path.
LDP over RSVP Without Area Boundary

The LDP over RSVP capability set includes the ability to stitch LDP-over-RSVP tunnels at internal (non-ABR) OSPF and IS-IS routers.

![Figure 18: LDP over RSVP Without ABR Stitching Point](image)

In Figure 18, assume that the user wants to use LDP over RSVP between router A and destination “Dest”. The first thing that happens is that either OSPF or IS-IS will perform an SPF calculation resulting in an SPF tree. This tree specifies the lowest possible cost to the destination. In the example shown, the destination “Dest” is reachable at the lowest cost through router X. The SPF tree will have the following path: A>C>E>G>X.

Using this SPF tree, router A will search for the endpoint that is closest (farthest/highest cost from the origin) to “Dest” that is eligible. Assuming that all LSPs in the above diagram are eligible, LSP endpoint G will be selected as it terminates on router G while other LSPs only reach routers C and E, respectively.

IGP and LSP metrics associated with the various LSP are ignores; only tunnel endpoint matters to IGP. The endpoint that terminates closest to “Dest” (highest IGP path cost) will be selected for further selection of the LDP over RSVP tunnels to that endpoint. Note that the explicit path the tunnel takes may not match the IGP path the SPF computes.
If router A and G have an additional LSP terminating on router G, there would now be two tunnels both terminating on the same router closest to the final destination. For IGP, it does not make any difference on the numbers of LDPs to G, only that there is at least one LSP to G. In this case, the LSP metric will be considered by LDP when deciding which LSP to stitch for the LDP over RSVP connection.

The IGP only passes endpoint information to LDP. LDP looks up the tunnel table for all tunnels to that endpoint and picks up the one with the least tunnel metric. There may be many tunnels with the same least cost.

---

**LDP over RSVP and ECMP**

ECMP for LDP over RSVP is supported (also see ECMP Support for LDP on page 212). If ECMP applies, all LSP endpoints found over the ECMP IGP path will be installed in the routing table by the IGP for consideration by LDP. It is important to note that IGP costs to each endpoint may differ because IGP selects the farthest endpoint per ECMP path.

LDP will choose the endpoint that is highest cost in the route entry and will do further tunnel selection over those endpoints. If there are multiple endpoints with equal highest cost, then LDP will consider all of them.
LDP Fast-Reroute for IS-IS and OSPF Prefixes

LDP Fast Re-Route (FRR) is a feature which allows the user to provide local protection for an LDP FEC by pre-computing and downloading to IOM both a primary and a backup NHLFE for this FEC.

The primary NHLFE corresponds to the label of the FEC received from the primary next-hop as per standard LDP resolution of the FEC prefix in RTM. The backup NHLFE corresponds to the label received for the same FEC from a Loop-Free Alternate (LFA) next-hop.

The LFA next-hop pre-computation by IGP is described in RFC 5286 – “Basic Specification for IP Fast Reroute: Loop-Free Alternates”. LDP FRR relies on using the label-FEC binding received from the LFA next-hop to forward traffic for a given prefix as soon as the primary next-hop is not available. This means that a node resumes forwarding LDP packets to a destination prefix without waiting for the routing convergence. The label-FEC binding is received from the loop-free alternate next-hop ahead of time and is stored in the Label Information Base since LDP on the router operates in the liberal retention mode.

This feature requires that IGP performs the Shortest Path First (SPF) computation of an LFA next-hop, in addition to the primary next-hop, for all prefixes used by LDP to resolve FECs. IGP also populates both routes in the Routing Table Manager (RTM).

LDP FRR Configuration

The user enables Loop-Free Alternate (LFA) computation by SPF under the IS-IS or OSPF routing protocol level:

```
config>router>isis>loopfree-alternate
config>router>ospf>loopfree-alternate.
```

The above commands instruct the IGP SPF to attempt to pre-compute both a primary next-hop and an LFA next-hop for every learned prefix. When found, the LFA next-hop is populated into the RTM along with the primary next-hop for the prefix.

Next the user enables the use by LDP of the LFA next-hop by configuring the following option:

```
config>router>ldp>fast-reroute
```

When this command is enabled, LDP will use both the primary next-hop and LFA next-hop, when available, for resolving the next-hop of an LDP FEC against the corresponding prefix in the RTM. This will result in LDP programming a primary NHLFE and a backup NHLFE into the IOM for each next-hop of a FEC prefix for the purpose of forwarding packets over the LDP FEC.
Note that because LDP can detect the loss of a neighbor/next-hop independently, it is possible that it switches to the LFA next-hop while IGP is still using the primary next-hop. In order to avoid this situation, it is recommended to enable IGP-LDP synchronization on the LDP interface:

```
config>router>interface>ldp-sync-timer seconds
```

### Reducing the Scope of the LFA Calculation by SPF

The user can instruct IGP to not include all interfaces participating in a specific IS-IS level or OSPF area in the SPF LFA computation. This provides a way of reducing the LFA SPF calculation where it is not needed.

```
config>router>isis>level>loopfree-alternate-exclude
config>router>ospf>area>loopfree-alternate-exclude
```

Note that if IGP shortcut are also enabled in LFA SPF, as explained in Section 5.3.2, LSPs with destination address in that IS-IS level or OSPF area are also not included in the LFA SPF calculation.

The user can also exclude a specific IP interface from being included in the LFA SPF computation by IS-IS or OSPF:

```
config>router>isis>interface>loopfree-alternate-exclude
config>router>ospf>area>interface>loopfree-alternate-exclude
```

Note that when an interface is excluded from the LFA SPF in IS-IS, it is excluded in both level 1 and level 2. When the user excludes an interface from the LFA SPF in OSPF, it is excluded in all areas. However, the above OSPF command can only be executed under the area in which the specified interface is primary and once enabled, the interface is excluded in that area and in all other areas where the interface is secondary. If the user attempts to apply it to an area where the interface is secondary, the command will fail.

Finally, the user can apply the same above commands for an OSPF instance within a VPRN service:

```
config>service>vprn>ospf>area>loopfree-alternate-exclude
config>service>vprn>ospf>area>interface>loopfree-alternate-exclude
```

### LDP FRR Procedures

The LDP FEC resolution when LDP FRR is not enabled operates as follows. When LDP receives a *FEC, label* binding for a prefix, it will resolve it by checking if the exact prefix, or a longest match prefix when the *aggregate-prefix-match option* is enabled in LDP, exists in the routing table and is resolved against a next-hop which is an address belonging to the LDP peer which
advertized the binding, as identified by its LSR-id. When the next-hop is no longer available, LDP de-activates the FEC and de-programs the NHLFE in the data path. LDP will also immediately withdraw the labels it advertised for this FEC and deletes the ILM in the data path unless the user configured the **label-withdrawal-delay** option to delay this operation. Traffic that is received while the ILM is still in the data path is dropped. When routing computes and populates the routing table with a new next-hop for the prefix, LDP resolves again the FEC and programs the data path accordingly.

When LDP FRR is enabled and an LFA backup next-hop exists for the FEC prefix in RTM, or for the longest prefix the FEC prefix matches to when **aggregate-prefix-match** option is enabled in LDP, LDP will resolve the FEC as above but will program the data path with both a primary NHLFE and a backup NHLFE for each next-hop of the FEC.

In order perform a switchover to the backup NHLFE in the fast path, LDP follows the uniform FRR failover procedures which are also supported with RSVP FRR.

When any of the following events occurs, LDP instructs in the fast path the IOM to enable the backup NHLFE for each FEC next-hop impacted by this event. The IOM does that by simply flipping a single state bit associated with the failed interface or neighbor/next-hop:

1. An LDP interface goes operationally down, or is admin shutdown. In this case, LDP sends a neighbor/next-hop down message to the IOM for each LDP peer it has adjacency with over this interface.

2. An LDP session to a peer went down as the result of the Hello or Keep-Alive timer expiring over a specific interface. In this case, LDP sends a neighbor/next-hop down message to the IOM for this LDP peer only.

3. The TCP connection used by a link LDP session to a peer went down, due say to next-hop tracking of the LDP transport address in RTM, which brings down the LDP session. In this case, LDP sends a neighbor/next-hop down message to the IOM for this LDP peer only.

4. A BFD session, enabled on a T-LDP session to a peer, times-out and as a result the link LDP session to the same peer and which uses the same TCP connection as the T-LDP session goes also down. In this case, LDP sends a neighbor/next-hop down message to the IOM for this LDP peer only.

5. A BFD session enabled on the LDP interface to a directly connected peer, times-out and brings down the link LDP session to this peer. In this case, LDP sends a neighbor/next-hop down message to the IOM for this LDP peer only. BFD support on LDP interfaces is a new feature introduced for faster tracking of link LDP peers. See Section 1.2.1 for more details.

The tunnel-down-dump-time option or the label-withdrawal-delay option, when enabled, does not cause the corresponding timer to be activated for a FEC as long as a backup NHLFE is still available.
Link LDP Hello Adjacency Tracking with BFD

LDP can only track an LDP peer with which it established a link LDP session with using the Hello and Keep-Alive timers. If an IGP protocol registered with BFD on an IP interface to track a neighbor, and the BFD session times out, the next-hop for prefixes advertised by the neighbor are no longer resolved. This however does not bring down the link LDP session to the peer since the LDP peer is not directly tracked by BFD. More importantly the LSR-id of the LDP peer may not coincide with the neighbor’s router-id IGP is tracking by way of BFD.

In order to properly track the link LDP peer, LDP needs to track the Hello adjacency to its peer by registering with BFD. This way, the peer next-hop is tracked.

The user enables Hello adjacency tracking with BFD by enabling BFD on an LDP interface:

```
config>router>ldp>interface-parameters>interface>enable-bfd
```

The parameters used for the BFD session, i.e., transmit-interval, receive-interval, and multiplier, are those configured under the IP interface in existing implementation:

```
config>router>interface>bfd
```

When multiple links exist to the same LDP peer, a Hello adjacency is established over each link but only a single LDP session will exist to the peer and will use a TCP connection over one of the link interfaces. Also, a separate BFD session should be enabled on each LDP interface. If a BFD session times out on a specific link, LDP will immediately bring down the Hello adjacency on that link. In addition, if the there are FECs which have their primary NHLFE over this link, LDP triggers the LDP FRR procedures by sending to IOM the neighbor/next-hop down message. This will result in moving the traffic of the impacted FECs to an LFA next-hop on a different link to the same LDP peer or to an LFA backup next-hop on a different LDP peer depending on the lowest backup cost path selected by the IGP SPF.

As soon as the last Hello adjacency goes down due to BFD timing out, the LDP session goes down and the LDP FRR procedures will be triggered. This will result in moving the traffic to an LFA backup next-hop on a different LDP peer.

ECMP Considerations

Whenever the SPF computation determined there is more than one primary next-hop for a prefix, it will not program any LFA next-hop in RTM. Thus, the LDP FEC will resolve to the multiple primary next-hops in this case which provides the required protection.
Also note that when the system ECMP value is set to `ecmp=1` or to `no ecmp`, which translates to the same and is the default value, SPF will be able to use the overflow ECMP links as LFA next-hops in these two cases.
LDP FRR and LDP Shortcut

When LDP FRR is enabled in LDP and the ldp-shortcut option is enabled in the router level, in transit IPv4 packets and specific CPM generated IPv4 control plane packets with a prefix resolving to the LDP shortcut are protected by the backup LDP NHLFE.

LDP FRR and LDP-over-RSVP

When LDP-over-RSVP is enabled, the RSVP LSP is modeled as an endpoint, i.e., the destination node of the LSP, and not as a link in the IGP SPF. Thus, it is not possible for IGP to compute a primary or alternate next-hop for a prefix which FEC path is tunneled over the RSVP LSP. Only LDP is aware of the FEC tunneling but it cannot determine on its own a loop-free backup path when it resolves the FEC to an RSVP LSP.

As a result, LDP does not activate the LFA next-hop it learned from RTM for a FEC prefix when the FEC is resolved to an RSVP LSP. LDP will activate the LFA next-hop as soon as the FEC is resolved to direct primary next-hop.

LDP FEC tunneled over an RSVP LSP due to enabling the LDP-over-RSVP feature will thus not support the LDP FRR procedures and will follow the slow path procedure of prior implementation.

Note that when the user enables the lfa-only option for an RSVP LSP, as described in Loop-Free Alternate Calculation in the Presence of IGP shortcuts on page 230, such an LSP will not be used by LDP to tunnel an LDP FEC even when IGP shortcut is disabled but LDP-over-RSVP is enabled in IGP.

LDP FRR and RSVP Shortcut (IGP Shortcut)

When an RSVP LSP is used as a shortcut by IGP, it is included by SPF as a P2P link and can also be optionally advertised into the rest of the network by IGP. Thus the SPF is able of using a tunneled next-hop as the primary next-hop for a given prefix. LDP is also able of resolving a FEC to a tunneled next-hop when the IGP shortcut feature is enabled.

When both IGP shortcut and LFA are enabled in IS-IS or OSPF, and LDP FRR is also enabled, then the following additional LDP FRR capabilities are supported:

1. A FEC which is resolved to a direct primary next-hop can be backed up by a LFA tunneled next-hop.
2. A FEC which is resolved to a tunneled primary next-hop will not have an LFA next-hop. It will rely on RSVP FRR for protection.

The LFA SPF is extended to use IGP shortcuts as LFA next-hops as explained in Loop-Free Alternate Calculation in the Presence of IGP shortcuts on page 230.
IS-IS and OSPF Support for Loop-Free Alternate Calculation

SPF computation in IS-IS and OSPF is enhanced to compute LFA alternate routes for each learned prefix and populate it in RTM.

Figure 19 illustrates a simple network topology with point-to-point (P2P) interfaces and highlights three routes to reach router R5 from router R1.

The primary route is by way of R3. The LFA route by way of R2 has two equal cost paths to reach R5. The path by way of R3 protects against failure of link R1-R3. This route is computed by R1 by checking that the cost for R2 to reach R5 by way of R3 is lower than the cost by way of routes R1 and R3. This condition is referred to as the loop-free criterion. R2 must be loop-free with respect to source node R1.
The path by way of R2 and R4 can be used to protect against the failure of router R3. However, with the link R2-R3 metric set to 5, R2 sees the same cost to forward a packet to R5 by way of R3 and R4. Thus R1 cannot guarantee that enabling the LFA next-hop R2 will protect against R3 node failure. This means that the LFA next-hop R2 provides link-protection only for prefix R5. If the metric of link R2-R3 is changed to 8, then the LFA next-hop R2 provides node protection since a packet to R5 will always go over R4. In other words it is required that R2 becomes loop-free with respect to both the source node R1 and the protected node R3.

Consider the case where the primary next-hop uses a broadcast interface as illustrated in Figure 20.
The following are the detailed rules for this criterion as provided in RFC 5286:

- **Rule 1**: Link-protect LFA backup next-hop (primary next-hop R1-R3 is a P2P interface):
  \[
  \text{Distance}_{\text{opt}}(R2, R5) < \text{Distance}_{\text{opt}}(R2, R1) + \text{Distance}_{\text{opt}}(R1, R5)
  \]
  \[
  \text{and},
  \text{Distance}_{\text{opt}}(R2, R5) \geq \text{Distance}_{\text{opt}}(R2, R3) + \text{Distance}_{\text{opt}}(R3, R5)
  \]

- **Rule 2**: Node-protect LFA backup next-hop (primary next-hop R1-R3 is a P2P interface):
  \[
  \text{Distance}_{\text{opt}}(R2, R5) < \text{Distance}_{\text{opt}}(R2, R1) + \text{Distance}_{\text{opt}}(R1, R5)
  \]
  \[
  \text{and},
  \text{Distance}_{\text{opt}}(R2, R5) < \text{Distance}_{\text{opt}}(R2, R3) + \text{Distance}_{\text{opt}}(R3, R5)
  \]

- **Rule 3**: Link-protect LFA backup next-hop (primary next-hop R1-R3 is a broadcast interface):
  \[
  \text{Distance}_{\text{opt}}(R2, R5) < \text{Distance}_{\text{opt}}(R2, R1) + \text{Distance}_{\text{opt}}(R1, R5)
  \]
  \[
  \text{and},
  \text{Distance}_{\text{opt}}(R2, R5) < \text{Distance}_{\text{opt}}(R2, PN) + \text{Distance}_{\text{opt}}(PN, R5)
  \]
  where; PN stands for the R1-R3 link Pseudo-Node.

For the case of P2P interface, if SPF finds multiple LFA next-hops for a given primary next-hop, it follows the following selection algorithm:

A) It will pick the node-protect type in favor of the link-protect type.

B) If there is more than one LFA next-hop within the selected type, then it will pick one based on the least cost.

C) If more than one LFA next-hop with the same cost results from Step B, then SPF will select the first one. This is not a deterministic selection and will vary following each SPF calculation.

For the case of a broadcast interface, a node-protect LFA is not necessarily a link protect LFA if the path to the LFA next-hop goes over the same PN as the primary next-hop. Similarly, a link protect LFA may not guarantee link protection if it goes over the same PN as the primary next-hop.

The selection algorithm when SPF finds multiple LFA next-hops for a given primary next-hop is modified as follows:

A) The algorithm splits the LFA next-hops into two sets:
   - The first set consists of LFA next-hops which *do not* go over the PN used by primary next-hop.
   - The second set consists of LFA next-hops which *do* go over the PN used by the primary next-hop.

B) If there is more than one LFA next-hop in the first set, it will pick the node-protect type in favor of the link-protect type.
C) If there is more than one LFA next-hop within the selected type, then it will pick one based on the least cost.

D) If more than one LFA next-hop with equal cost results from Step C, SPF will select the first one from the remaining set. This is not a deterministic selection and will vary following each SPF calculation.

E) If no LFA next-hop results from Step D, SPF will rerun Steps B-D using the second set.

Note this algorithm is more flexible than strictly applying Rule 3 above; the link protect rule in the presence of a PN and specified in RFC 5286. A node-protect LFA which does not avoid the PN; does not guarantee link protection, can still be selected as a last resort. The same thing, a link-protect LFA which does not avoid the PN may still be selected as a last resort. Both the computed primary next-hop and LFA next-hop for a given prefix are programmed into RTM.

---

**Loop-Free Alternate Calculation in the Presence of IGP shortcuts**

In order to expand the coverage of the LFA backup protection in a network, RSVP LSP based IGP shortcuts can be placed selectively in parts of the network and be used as an LFA backup next-hop.

When IGP shortcut is enabled in IS-IS or OSPF on a given node, all RSVP LSP originating on this node and with a destination address matching the router-id of any other node in the network are included in the main SPF by default.

In order to limit the time it takes to compute the LFA SPF, the user must explicitly enable the use of an IGP shortcut as LFA backup next-hop using one of a couple of new optional argument for the existing LSP level IGP shortcut command:

```
config>router>mpls>lsp>igp-shortcut [lfa-protect | lfa-only]
```

The **lfa-protect** option allows an LSP to be included in both the main SPF and the LFA SPFs. For a given prefix, the LSP can be used either as a primary next-hop or as an LFA next-hop but not both. If the main SPF computation selected a tunneled primary next-hop for a prefix, the LFA SPF will not select an LFA next-hop for this prefix and the protection of this prefix will rely on the RSVP LSP FRR protection. If the main SPF computation selected a direct primary next-hop, then the LFA SPF will select a an LFA next-hop for this prefix but will prefer a direct LFA next-hop over a tunneled LFA next-hop.

The **lfa-only** option allows an LSP to be included in the LFA SPFs only such that the introduction of IGP shortcuts does not impact the main SPF decision. For a given prefix, the main SPF always selects a direct primary next-hop. The LFA SPF will select a an LFA next-hop for this prefix but will prefer a direct LFA next-hop over a tunneled LFA next-hop.

Thus the selection algorithm in Section 1.3 when SPF finds multiple LFA next-hops for a given primary next-hop is modified as follows:
A) The algorithm splits the LFA next-hops into two sets:
   → the first set consists of direct LFA next-hops
   → the second set consists of tunneled LFA next-hops. after excluding the LSPs which use the same outgoing interface as the primary next-hop.

B) The algorithm continues with first set if not empty, otherwise it continues with second set.

C) If the second set is used, the algorithm selects the tunneled LFA next-hop which endpoint corresponds to the node advertising the prefix.
   → If more than one tunneled next-hop exists, it selects the one with the lowest LSP metric.
   → If still more than one tunneled next-hop exists, it selects the one with the lowest tunnel-id.
   → If none is available, it continues with rest of the tunneled LFAs in second set.

D) Within the selected set, the algorithm splits the LFA next-hops into two sets:
   → The first set consists of LFA next-hops which do not go over the PN used by primary next-hop.
   → The second set consists of LFA next-hops which go over the PN used by the primary next-hop.

E) If there is more than one LFA next-hop in the selected set, it will pick the node-protect type in favor of the link-protect type.

F) If there is more than one LFA next-hop within the selected type, then it will pick one based on the least total cost for the prefix. For a tunneled next-hop, it means the LSP metric plus the cost of the LSP endpoint to the destination of the prefix.

G) If there is more than one LFA next-hop within the selected type (ecmp-case) in the first set, it will select the first direct next-hop from the remaining set. This is not a deterministic selection and will vary following each SPF calculation.

H) If there is more than one LFA next-hop within the selected type (ecmp-case) in the second set, it will pick the tunneled next-hop with the lowest cost from the endpoint of the LSP to the destination prefix. If there remains more than one, it will pick the tunneled next-hop with the lowest tunnel-id.

**Loop-Free Alternate Calculation for Inter-Area/inter-Level Prefixes**

When SPF resolves OSPF inter-area prefixes or IS-IS inter-level prefixes, it will compute an LFA backup next-hop to the same exit area/border router as used by the primary next-hop.
LDP FEC to BGP Label Route Stitching

The stitching of an LDP FEC to a BGP labeled route allows LDP capable PE devices to offer services to PE routers in other areas or domains without the need to support BGP labeled routes.

This feature is used in a large network to provide services across multiple areas or autonomous systems. Figure 21 shows a network with a core area and regional areas.

Specific /32 routes in a regional area are not redistributed into the core area. Therefore, only nodes within a regional area and the ABR nodes in the same area exchange LDP FECs. A PE router, for example, PE21, in a regional area learns the reachability of PE routers in other regional areas by way of RFC 3107 BGP labeled routes redistributed by the remote ABR nodes by way of the core area. The remote ABR then sets the next-hop self on the labeled routes before re-distributing them into the core area. The local ABR for PE2, for example, ABR3 may or may not set next-hop self when it re-distributes these labeled BGP routes from the core area to the local regional area.
When forwarding a service packet to the remote PE, PE21 inserts a VC label, the BGP route label to reach the remote PE, and an LDP label to reach either ABR3, if ABR3 sets next-hop self, or ABR1.

In the same network, an MPLS capable DSLAM also act as PE router for VLL services and will need to establish a PW to a PE in a different regional area by way of router PE21, acting now as an LSR. To achieve that, PE21 is required to perform the following operations:

- Translate the LDP FEC it learned from the DSLAM into a BGP labeled route and redistribute it by way of iBGP within its area. This is in addition to redistributing the FEC to its LDP neighbors in the same area.
- Translate the BGP labeled routes it learns through iBGP into an LDP FEC and redistribute it to its LDP neighbors in the same area. In the application in Figure 21, the DSLAM requests the LDP FEC of the remote PE router using LDP Downstream on Demand (DoD).
- When a packet is received from the DSLAM, PE21 swaps the LDP label into a BGP label and pushes the LDP label to reach ABR3 or ABR1. When a packet is received from ABR3, the top label is removed and the BGP label is swapped for the LDP label corresponding to the DSLAM FEC.

---

**Configuration**

The user enables the stitching of routes between LDP and BGP by configuring separately tunnel table route export policies in both protocols and enabling the advertising of RFC 3107 formatted labeled routes for prefixes learned from LDP FECs.

The route export policy in BGP instructs BGP to listen to LDP route entries in the CPM tunnel table. If a /32 LDP FEC prefix matches an entry in the export policy, BGP originates a BGP labeled route, stitches it to the LDP FEC, and re-distributes the BGP labeled route to its iBGP neighbors.

The user adds LDP FEC prefixes with the statement ‘from protocol ldp’ in the configuration of the existing BGP export policy at the global level, the peer-group level, or at the peer level using the commands:

- `configure>router>bgp>export policy-name`
- `configure>router>bgp>group>export policy-name`
- `configure>router>bgp>group>neighbour>export policy-name`

To indicate to BGP to evaluate the entries with the ‘from protocol ldp’ statement in the export policy when applied to a specific BGP neighbor, a new argument is added to the existing advertise-label command:
configure>router>bgp>group>neighbour>advertise-label ipv4 include-ldp-prefix

Without the new `include-ldp-prefix` argument, only core IPv4 routes learned from RTM are advertised as BGP labeled routes to this neighbor. And the stitching of LDP FEC to the BGP labeled route is not performed for this neighbor even if the same prefix was learned from LDP.

The tunnel table route export policy in LDP instructs LDP to listen to BGP route entries in the CPM Tunnel Table. If a /32 BGP labeled route matches a prefix entry in the export policy, LDP originates an LDP FEC for the prefix, stitches it to the BGP labeled route, and re-distributes the LDP FEC its iBGP neighbors.

The user adds BGP labeled route prefixes with the statement ‘from protocol bgp’ in the configuration of a new LDP tunnel table export policy using the command:

```configure>router>ldp>export-tunnel-table policy-name```

Note that the ‘from protocol’ statement has an effect only when the protocol value is ldp. Policy entries with protocol values of rsvp, bgp, or any value other than ldp are ignored at the time the policy is applied to LDP.

---

**Detailed LDP FEC Resolution**

When a 7x50 LSR receives a FEC-label binding from an LDP neighbor for a given specific FEC1 element, the following procedures are performed.

1. LDP installs the FEC if:
   
   → It was able to perform a successful exact match or a longest match, if aggregate-prefix-match option is enabled in LDP, of the FEC /32 prefix with a prefix entry in the routing table.
   
   → The advertising LDP neighbor is the next-hop to reach the FEC prefix.

2. When such a FEC-label binding has been installed in the LDP FIB, LDP will perform the following:
   
   → Program a push and a swap NHLFE entries in the egress data path to forward packets to FEC1.
   
   → Program the CPM tunnel table with a tunnel entry for the NHLFE.
   
   → Advertise a new FEC-label binding for FEC1 to all its LDP neighbors according to the global and per-peer LDP prefix export policies.
   
   → Install the ILM entry pointing to the swap NHLFE.
3. When BGP learns the LDP FEC by way of the CPM tunnel table and the FEC prefix exists in the BGP route export policy, it will perform the following:
   → Originate a labeled BGP route for the same prefix with this node as the next-hop and advertise it by way of iBGP to its BGP neighbors, for example, the local ABR/ASBR nodes, which have the advertise-label for LDP FEC prefixes is enabled.
   → Install the ILM entry pointing to the swap NHLFE programmed by LDP.

---

**Detailed BGP Labeled Route Resolution**

When a 7x50 LSR receives a BGP labeled route by way of iBGP for a given specific /32 prefix, the following procedures are performed.

1. BGP resolves and installs the route in BGP if:
   → There exists an LDP LSP to the BGP neighbor, for example, the ABR or ASBR, which advertised it and which is the next-hop of the BGP labeled route.

2. Once the BGP route is installed, BGP programs the following:
   → Push NHLFE in the egress data path to forward packets to this BGP labeled route.
   → The CPM tunnel table with a tunnel entry for the NHLFE.

3. When LDP learns the BGP labeled route by way of the CPM tunnel table and the prefix exists in the new LDP tunnel table route export policy, it performs the following:
   → Advertise a new LDP FEC-label binding for the same prefix to its LDP neighbors according the global and per-peer LDP export prefix policies. If LDP already advertised a FEC for the same /32 prefix after receiving it from an LDP neighbor then no action is required. For LDP neighbors that negotiated LDP Downstream on Demand (DoD), the FEC is advertised only when this node receives a Label Request message for this FEC from its neighbor.
   → Install the ILM entry pointing the BGP NHLFE if a new LDP FEC-label binding is advertised. If an ILM entry exists and points to an LDP NHLFE for the same prefix then no update to ILM entry is performed. The LDP route has always preference over the BGP labeled route.

---

**Data Plane Forwarding**

When a packet is received from an LDP neighbor, the 7x50 LSR swaps the LDP label into a BGP label and pushes the LDP label to reach the BGP neighbor, for example, ABR/ASBR, which advertised the BGP labeled route with itself as the next-hop.

When a packet is received from a BGP neighbor such as an ABR/ASBR, the top label is removed and the BGP label is swapped for the LDP label to reach the next-hop for the prefix.
Multicast P2MP LDP for GRT

P2MP LDP LSP setup is initiated by each leaf node of multicast tree. A leaf PE node learns to initiate a multicast tree setup from client application and sends a label map upstream towards the root node of the multicast tree. On propagation of label map, intermediate nodes that are common on path for multiple leaf nodes become branch nodes of the tree.

*Figure 22* illustrates wholesale video distribution over P2MP LDP LSP. Static IGMP entries on edge are bound to P2MP LDP LSP tunnel-interface for multicast video traffic distribution.
LDP P2MP Support

LDP P2MP Configuration
A node running LDP also supports P2MP LSP setup using LDP. By default, it would advertise the capability to a peer node using P2MP capability TLV in LDP initialization message.

This configuration option per interface is provided to restrict/allow the use of interface in LDP multicast traffic forwarding towards a downstream node. Interface configuration option does not restrict/allow exchange of P2MP FEC by way of established session to the peer on an interface, but it would only restrict/allow use of next-hops over the interface.

LDP P2MP Protocol
Only a single generic identifier range is defined for signaling multipoint tree for all client applications. Implementation on 7x50 SR reserves the range (1..8292) of generic LSP P2MP-ID on root node for static P2MP LSP.

Make Before Break (MBB)
When a transit or leaf node detects that the upstream node towards the root node of multicast tree has changed, it follows graceful procedure that allows make-before-break transition to the new upstream node. Make-before-break support is optional. If the new upstream node doe not support MBB procedures then the downstream node waits for the configured timer before switching over to the new upstream node.

ECMP Support
If multiple ECMP paths exist between two adjacent nodes then the upstream node of the multicast receiver programs all entries in forwarding plane. Only one entry is active based on ECMP hashing algorithm.
Multi-Area and Multi-Instance Extensions to LDP

In order to extend LDP across multiple areas of an IGP instance or across multiple IGP instances, the current standard LDP implementation based on RFC 3036 requires that all /32 prefixes of PEs be leaked between the areas or instances. This is because an exact match of the prefix in the routing table is required to install the prefix binding in the LDP Forwarding Information Base (FIB). Although a router will do this by default when configured as Area Border Router (ABR), this increases the convergence of IGP on routers when the number of PE nodes scales to thousands of nodes.

Multi-area and multi-instance extensions to LDP provide an optional behavior by which LDP installs a prefix binding in the LDP FIB by simply performing a longest prefix match with an aggregate prefix in the routing table (RIB). That way, the ABR will be configured to summarize the /32 prefixes of PE routers. This method is compliant to RFC 5283, LDP Extension for Inter-Area Label Switched Paths (LSPs).
LDP Shortcut for BGP Next-Hop Resolution

LDP shortcut for BGP next-hop resolution shortcuts allow for the deployment of a ‘route-less core’ infrastructure. Many service providers either have or intend to remove the IBGP mesh from their network core, retaining only the mesh between routers connected to areas of the network that require routing to external routes.

Shortcuts are implemented by utilizing Layer 2 tunnels (i.e., MPLS LSPs) as next hops for prefixes that are associated with the far end termination of the tunnel. By tunneling through the network core, the core routers forwarding the tunnel have no need to obtain external routing information and are immune to attack from external sources.

The tunnel table contains all available tunnels indexed by remote destination IP address. LSPs derived from received LDP /32 route FECs will automatically be installed in the table associated with the advertising router-ID when IGP shortcuts are enabled.

Evaluating tunnel preference is based on the following order in descending priority:

1. LDP /32 route FEC shortcut
2. Actual IGP next-hop

If a higher priority shortcut is not available or is not configured, a lower priority shortcut is evaluated. When no shortcuts are configured or available, the IGP next-hop is always used. Shortcut and next-hop determination is event driven based on dynamic changes in the tunneling mechanisms and routing states.

Refer to the 7710 SR OS Routing Protocols Guide for details on the use of LDP FEC and RSVP LSP for BGP Next-Hop Resolution.
LDP Shortcut for IGP Routes

The LDP shortcut for IGP route resolution feature allows forwarding of packets to IGP learned routes using an LDP LSP. When LDP shortcut is enabled globally, IP packets forwarded over a network IP interface will be labeled with the label received from the next-hop for the route and corresponding to the FEC-prefix matching the destination address of the IP packet. In such a case, the routing table will have the shortcut next-hop as the best route. If such a LDP FEC does not exist, then the routing table will have the regular IP next-hop and regular IP forwarding will be performed on the packet.

An egress LER advertises and maintains a FEC, label binding for each IGP learned route. This is performed by the existing LDP fec-originate capability.

LDP Shortcut Configuration

The user enables the use of LDP shortcut for resolving IGP routes by entering the global command

```
config>router>ldp-shortcut.
```

This command enables forwarding of user IP packets and specified control IP packets using LDP shortcuts over all network interfaces in the system which participate in the IS-IS and OSPF routing protocols. The default is to disable the LDP shortcut across all interfaces in the system.

IGP Route Resolution

When LDP shortcut is enabled, LDP populates the RTM with next-hop entries corresponding to all prefixes for which it activated an LDP FEC. For a given prefix, two route entries are populated in RTM. One corresponds to the LDP shortcut next-hop and has an owner of LDP. The other one is the regular IP next-hop. The LDP shortcut next-hop always has preference over the regular IP next-hop for forwarding user packets and specified control packets over a given outgoing interface to the route next-hop.

The prior activation of the FEC by LDP is done by performing an exact match with an IGP route prefix in RTM. It can also be done by performing a longest prefix-match with an IGP route in RTM if the aggregate-prefix-match option is enabled globally in LDP.

This feature is not restricted to /32 FEC prefixes. However only /32 FEC prefixes will be populated in the CPM Tunnel Table for use as a tunnel by services.

All user packets and specified control packets for which the longest prefix match in RTM yields the FEC prefix will be forwarded over the LDP LSP. Currently, the control packets that could be forwarded over the LDP LSP are ICMP ping and UDP-traceroute. The following is an example of the resolution process.
Assume the egress LER advertised a FEC for some /24 prefix using the fec-originate command. At the ingress LER, LDP resolves the FEC by checking in RTM that an exact match exists for this prefix. Once LDP activated the FEC, it programs the NHLFE in the egress data path and the LDP tunnel information in the ingress data path tunnel table.

Next, LDP provides the shortcut route to RTM which will associate it with the same /24 prefix. There will be two entries for this /24 prefix, the LDP shortcut next-hop and the regular IP next-hop. The latter was used by LDP to validate and activate the FEC. RTM then resolves all user prefixes which succeed a longest prefix match against the /24 route entry to use the LDP LSP.

Assume now the aggregate-prefix-match was enabled and that LDP found a /16 prefix in RTM to activate the FEC for the /24 FEC prefix. In this case, RTM adds a new more specific route entry of /24 and has the next-hop as the LDP LSP but it will still not have a specific /24 IP route entry. RTM then resolves all user prefixes which succeed a longest prefix match against the /24 route entry to use the LDP LSP while all other prefixes which succeed a longest prefix-match against the /16 route entry will use the IP next-hop.

**LDP Shortcut Forwarding Plane**

Once LDP activated a FEC for a given prefix and programmed RTM, it also programs the ingress Tunnel Table in forwarding engine with the LDP tunnel information.

When an IPv4 packet is received on an ingress network interface, a subscriber IES interface, or a regular IES interface, the lookup of the packet by the ingress forwarding engine will result in the packet being sent labeled with the label stack corresponding to the NHLFE of the LDP LSP when the preferred RTM entry corresponds to an LDP shortcut.

If the preferred RTM entry corresponds to an IP next-hop, the IPv4 packet is forwarded unlabeled.
ECMP Considerations

When ECMP is enabled and multiple equal-cost next-hops exit for the IGP route, the ingress forwarding engine sprays the packets for this route based on hashing routine currently supported for IPv4 packets.

When the preferred RTM entry corresponds to an LDP shortcut route, spraying will be performed across the multiple next-hops for the LDP FEC. The FEC next-hops can either be direct link LDP neighbors or T-LDP neighbors reachable over RSVP LSPs in the case of LDP-over-RSVP but not both. This is as per ECMP for LDP in existing implementation.

When the preferred RTM entry corresponds to a regular IP route, spraying will be performed across regular IP next-hops for the prefix.

Disabling TTL Propagation in an LSP Shortcut

This feature provides the option for disabling TTL propagation from a transit or a locally generated IP packet header into the LSP label stack when an LDP LSP is used as a shortcut for BGP next-hop resolution, a static-route next-hop resolution, or for an IGP route resolution.

A transit packet is a packet received from an IP interface and forwarded over the LSP shortcut at ingress LER.

A locally-generated IP packet is any control plane packet generated from the CPM and forwarded over the LSP shortcut at ingress LER.

TTL handling can be configured for all LDP LSP shortcuts originating on an ingress LER using the following global commands:

```
config>router>ldp>[no] shortcut-transit-ttl-propagate
config>router>ldp>[no] shortcut-local-ttl-propagate
```

These commands apply to all LDP LSPs which are used to resolve static routes, BGP routes, and IGP routes.

When the `no` form of the above command is enabled for local packets, TTL propagation is disabled on all locally generated IP packets, including ICMP Ping, traceroute, and OAM packets that are destined to a route that is resolved to the LSP shortcut. In this case, a TTL of 255 is programmed onto the pushed label stack. This is referred to as pipe mode.

Similarly, when the `no` form is enabled for transit packets, TTL propagation is disabled on all IP packets received on any IES interface and destined to a route that is resolved to the LSP shortcut. In this case, a TTL of 255 is programmed onto the pushed label stack.
**LDP Process Overview**

Figure 23 displays the process to provision basic LDP parameters.

![LDP Process Flowchart]

- **ENABLE**
- **CONFIGURE LDP INTERFACE PARAMETERS**
- **CONFIGURE TARGETED SESSION PARAMETERS**
- **CONFIGURE PATH PARAMETERS**
- **CONFIGURE PEER PARAMETERS**
- **ENABLE**
Figure 23: LDP Configuration and Implementation
Show Commands

admin-group

Syntax  admin-group group-name

Context  show>router>mpls

Description  This command displays MPLS administrative group information.

Parameters  group-name — Specify a group name up to 32 characters.

Output  MPLS Administrative Group Output Fields — The following table describes MPLS administrative group output fields.

<table>
<thead>
<tr>
<th>Label</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group Name</td>
<td>The name of the group. The name identifies the administrative group within a virtual router instance.</td>
</tr>
<tr>
<td>Group Value</td>
<td>The unique group value associated with the administrative group. If the value displays -1, then the group value for this entry has not been set.</td>
</tr>
<tr>
<td>No. of Groups</td>
<td>The total number of configured admin groups within the virtual router instance.</td>
</tr>
</tbody>
</table>

Sample Output

A:ALA-1# show router mpls admin-group
========================================
MPLS Administrative Groups
========================================
Group Name      | Group Value
----------------|-----------
green           | 15
red             | 25
yellow          | 20
========================================
No. of Groups: 3
========================================
A:ALA-1#
bypass-tunnel

**Syntax**
```
bypass-tunnel [to ip-address] [protected-lsp [lsp-name]] [dynamic | manual] [detail]
```

**Context**
```
show>router>mpls
```

**Description**
If fast reroute is enabled on an LSP and the facility method is selected, instead of creating a separate LSP for every LSP that is to be backed up, a single LSP is created which serves as a backup for a set of LSPs. Such an LSP tunnel is called a bypass tunnel.

**Parameters**
- `ip-address` — Specify the IP address of the egress router.
- `lsp-name` — Specify the name of the LSP protected by the bypass tunnel.
- `dynamic` — Displays dynamically assigned labels for bypass protection.
- `manual` — Displays manually assigned labels for bypass protection.
- `detail` — Displays detailed information.

**Output**

**MPLS Bypass Tunnel Output Fields** — The following table describes MPLS bypass tunnel output fields.

<table>
<thead>
<tr>
<th>Label</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>To</td>
<td>The system IP address of the egress router.</td>
</tr>
<tr>
<td>State</td>
<td>The LSP’s administrative state.</td>
</tr>
<tr>
<td>Out I/F</td>
<td>Specifies the name of the network IP interface.</td>
</tr>
<tr>
<td>Out Label</td>
<td>Specifies the incoming MPLS label on which to match.</td>
</tr>
<tr>
<td>Reserved BW (Kbps)</td>
<td>Specifies the amount of bandwidth in megabits per second (Mbps) reserved for the LSP.</td>
</tr>
</tbody>
</table>

**Sample Output**

*A:SRU4>show>router>mpls# bypass-tunnel

MPLS Bypass Tunnels
Legend : m - Manual   d - Dynamic   p - P2mp
To              State  Out I/F        Out Label     Reserved   Protected  Type
BW (Kbps)  LSP Count
-------------------------------------------------------------------------------
No Matching Entries Found
-------------------------------------------------------------------------------
*A:SRU4>show>router>mpls#

*A:Dut-B# show router mpls bypass-tunnel detail

MPLS Bypass Tunnels (Detail)
Legend : m - Manual   d - Dynamic   p - P2mp
bypass-link10.10.104.4
-------------------------------------------------------------------------------
To: 10.10.101.4
Out I/F: 1/1/2:1
Up Time: 0d 00:02:33
Reserved BW: 0 Kbps
Type: Dynamic
SetupPriority: 7
Class Type: 0
Actual Hops:
   10.10.101.2 -> 10.10.101.4

==============================================================================
*A:Dut-B#

*A:Dut-B# show router mpls bypass-tunnel detail
==============================================================================
MPLS Bypass Tunnels (Detail)
------------------------------------------------------------------------------
bypass-link10.10.104.4
------------------------------------------------------------------------------
To: 10.10.101.4
Out I/F: 1/1/2:1
Up Time: 0d 00:02:33
Reserved BW: 0 Kbps
Type: Dynamic
SetupPriority: 7
Class Type: 0
Actual Hops:
   10.10.101.2 -> 10.10.101.4

==============================================================================
*A:Dut-B#

interface

Syntax  interface [ip-int-name | ip-address] [label-map label]
interface [ip-int-name | ip-address] statistics

Context  show>router>mpls

Description  This command displays MPLS interface information.

Parameters  ip-int-name — The name of the network IP interface. An interface name cannot be in the form of an IP address. If the string contains special characters (#, $, spaces, etc.), the entire string must be enclosed within double quotes.

ip-address — The system or network interface IP address.

label-map label — The MPLS label on which to match.

Values  32 — 1048575

statistics — Displays IP address and the number of packets and octets sent and received on an interface-basis.
**Output**

**MPLS Interface Output Fields** — The following table describes MPLS interface output fields.

<table>
<thead>
<tr>
<th>Label</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface</td>
<td>The interface name.</td>
</tr>
<tr>
<td>Port-id</td>
<td>The port ID displayed in the <em>slot/mda/port</em> format.</td>
</tr>
<tr>
<td>Adm</td>
<td>Specifies the administrative state of the interface.</td>
</tr>
<tr>
<td>Opr</td>
<td>Specifies the operational state of the interface.</td>
</tr>
<tr>
<td>Te-metric</td>
<td>Specifies the traffic engineering metric used on the interface.</td>
</tr>
<tr>
<td>Srlg Groups</td>
<td>Specifies the shared risk loss group (SRLG) name(s).</td>
</tr>
<tr>
<td>Interfaces</td>
<td>The total number of interfaces.</td>
</tr>
<tr>
<td>Transmitted</td>
<td>Displays the number of packets and octets transmitted from the interface.</td>
</tr>
<tr>
<td>Received</td>
<td>Displays the number of packets and octets received.</td>
</tr>
<tr>
<td>In Label</td>
<td>Specifies the ingress label.</td>
</tr>
<tr>
<td>In I/F</td>
<td>Specifies the ingress interface.</td>
</tr>
<tr>
<td>Out Label</td>
<td>Specifies the egress label.</td>
</tr>
<tr>
<td>Out I/F</td>
<td>Specifies the egress interface.</td>
</tr>
<tr>
<td>Next Hop</td>
<td>Specifies the next hop IP address for the static LSP.</td>
</tr>
<tr>
<td>Type</td>
<td>Specifies whether the label value is statically or dynamically assigned.</td>
</tr>
</tbody>
</table>

**Sample Output**

*A:*SRU4>config>router>mpls# show router mpls interface

```
===============================================================================
MPLS Interfaces
===============================================================================
<table>
<thead>
<tr>
<th>Interface</th>
<th>Port-id</th>
<th>Adm</th>
<th>Opr</th>
<th>TE-metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>system</td>
<td>system</td>
<td>Up</td>
<td>Up</td>
<td>None</td>
</tr>
<tr>
<td>Admin Groups</td>
<td>None</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Srlg Groups</td>
<td>None</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>aps-1</em></td>
<td><em>aps-1</em></td>
<td>Up</td>
<td>Up</td>
<td>None</td>
</tr>
<tr>
<td>Admin Groups</td>
<td>None</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Srlg Groups</td>
<td>3410</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>aps-2</em></td>
<td><em>aps-2</em></td>
<td>Up</td>
<td>Up</td>
<td>None</td>
</tr>
<tr>
<td>Admin Groups</td>
<td>None</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Srlg Groups</td>
<td>3420</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>aps-3</em></td>
<td><em>aps-3</em></td>
<td>Up</td>
<td>Up</td>
<td>None</td>
</tr>
<tr>
<td>Admin Groups</td>
<td>None</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Srlg Groups</td>
<td>3430</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>sr4-1</td>
<td>1/1/4</td>
<td>Up</td>
<td>Up</td>
<td>None</td>
</tr>
<tr>
<td>Admin Groups</td>
<td>None</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Srlg Groups</td>
<td>3440</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ess-7-1</td>
<td>3/2/4</td>
<td>Up</td>
<td>Up</td>
<td>None</td>
</tr>
</tbody>
</table>
```
### MPLS and RSVP

**Admin Groups**: None  
**Srlg Groups**: 45100

<table>
<thead>
<tr>
<th>Interface</th>
<th>Port-id</th>
<th>Adm</th>
<th>Opr</th>
<th>TE-metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>ess-7-2</td>
<td>3/2/5</td>
<td>Up</td>
<td>Up</td>
<td>None</td>
</tr>
</tbody>
</table>

**Admin Groups**: None  
**Srlg Groups**: 45110

<table>
<thead>
<tr>
<th>Interface</th>
<th>Port-id</th>
<th>Adm</th>
<th>Opr</th>
<th>TE-metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>g7600</td>
<td>3/1/2</td>
<td>Up</td>
<td>Up</td>
<td>None</td>
</tr>
</tbody>
</table>

**Admin Groups**: None  
**Srlg Groups**: 41.80

<table>
<thead>
<tr>
<th>Interface</th>
<th>Port-id</th>
<th>Adm</th>
<th>Opr</th>
<th>TE-metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>m160</td>
<td>3/2/1</td>
<td>Up</td>
<td>Up</td>
<td>None</td>
</tr>
</tbody>
</table>

**Admin Groups**: None  
**Srlg Groups**: 420.40

---

### Interfaces: 35

---

*A:SRU4>config>router>mpls#

---

*A:SRU4>config>router>mpls# show router mpls interface "hubA"

---

**MPLS Interface**: hubA

---

**Interface**  
**Port-id**  
**Adm**  
**Opr**  
**TE-metric**

<table>
<thead>
<tr>
<th>hubA</th>
<th>3/2/8</th>
<th>Up</th>
<th>Up</th>
<th>None</th>
</tr>
</thead>
</table>

**Admin Groups**: None  
**Srlg Groups**: 44.200

---

**Interfaces**: 1

---

*A:SRU4>config>router>mpls#

---

*A:SRU4>config>router>mpls# show router mpls interface "hubA" label-map 203

---

**MPLS Interface**: hubA (Label-Map 203)

---

**In Label**  
**In I/F**  
**Out Label**  
**Out I/F**  
**Next Hop**  
**Type**  
**Adm**  
**Opr**

| 203 | 3/2/8 | 403 | 1/1/9 | 11.22.10.3 | Static | Up | Up |

**Interfaces**: 1

---

*A:SRU4>config>router>mpls#

---

*A:SRU4>config>router>mpls# show router mpls interface statistics

---

**MPLS Interface (statistics)**

---

**Interface**  
**Transmitted**  
**Received**

<table>
<thead>
<tr>
<th>Interface</th>
<th>Transmitted</th>
<th>Received</th>
</tr>
</thead>
<tbody>
<tr>
<td>aps-1</td>
<td>Pkts - 76554</td>
<td>Pkts - 17068</td>
</tr>
<tr>
<td></td>
<td>Octets - 7930285</td>
<td>Octets - 3626842</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Interface</th>
<th>Transmitted</th>
<th>Received</th>
</tr>
</thead>
<tbody>
<tr>
<td>aps-2</td>
<td>Pkts - 0</td>
<td>Pkts - 1311</td>
</tr>
<tr>
<td></td>
<td>Octets - 0</td>
<td>Octets - 219888</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Interface</th>
<th>Transmitted</th>
<th>Received</th>
</tr>
</thead>
<tbody>
<tr>
<td>aps-3</td>
<td>Pkts - 0</td>
<td>Pkts - 3</td>
</tr>
<tr>
<td></td>
<td>Octets - 0</td>
<td>Octets - 234</td>
</tr>
</tbody>
</table>
Interface : sr4-1
    Transmitted : Pkts - 0                     Octets - 0
    Received : Pkts - 0                     Octets - 0

Interface : ess-7-1
    Transmitted : Pkts - 113537                Octets - 15058332
    Received : Pkts - 13193                 Octets - 1091492

Interface : ess-7-2
    Transmitted : Pkts - 166133                Octets - 22762482
    Received : Pkts - 16672                 Octets - 1368464

Interface : ess-7-3
    Transmitted : Pkts - 122934                Octets - 11033246
    Received : Pkts - 12256                 Octets - 1026826

Interface : m160
    Transmitted : Pkts - 17188024              Octets - 2183076528
    Received : Pkts - 677745                Octets - 59367236

===============================================================================
*A:SRU4>config>router>mpls#

label

Syntax   label start-label [end-label | in-use | owner]
Context   show>router>mpls
Description Displays MPLS labels exchanged.
Parameters
start-label — The label value assigned at the ingress router.
end-label — The label value assigned for the egress router.
in-use — The number of in-use labels displayed.

Output   MPLS Label Output Fields — The following table describes MPLS label output fields.

<table>
<thead>
<tr>
<th>Label</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Label</td>
<td>Displays the value of the label being displayed.</td>
</tr>
<tr>
<td>Label Type</td>
<td>Specifies whether the label is statically or dynamically assigned.</td>
</tr>
<tr>
<td>Label Owner</td>
<td>The label owner.</td>
</tr>
<tr>
<td>In-use labels in entire range</td>
<td>The total number of labels being used by RSVP.</td>
</tr>
</tbody>
</table>

Sample Output

*A:SRU4>config>router>mpls#   show router mpls label 202
===============================================================================

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MPLS Label 202

<table>
<thead>
<tr>
<th>Label</th>
<th>Label Type</th>
<th>Label Owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>202</td>
<td>static-lsp</td>
<td>STATIC</td>
</tr>
</tbody>
</table>

In-use labels in entire range : 5057

*A:SRU4>config>router>mpls#

**label-range**

**Syntax**

label-range

**Context**

show>router>mpls

**Description**

This command displays the MPLS label range.

**Output**

**MPLS Label Range Output** — The following table describes the MPLS label range output fields.

<table>
<thead>
<tr>
<th>Label Type</th>
<th>Start Label</th>
<th>End Label</th>
<th>Aging</th>
<th>Total Available</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static-lsp</td>
<td>32</td>
<td>1023</td>
<td>-</td>
<td>736</td>
</tr>
<tr>
<td>Static-svc</td>
<td>2048</td>
<td>18431</td>
<td>-</td>
<td>16384</td>
</tr>
<tr>
<td>Dynamic</td>
<td>32768</td>
<td>131071</td>
<td>258</td>
<td>93232</td>
</tr>
</tbody>
</table>

**Label Description**

- **Label Type**
  Displays the information about static-lsp, static-svc, and dynamic label types.
- **Start Label**
  The label value assigned at the ingress router.
- **End Label**
  The label value assigned for the egress router.
- **Aging**
  The number of labels released from a service which are transitioning back to the label pool. Labels are aged 15 seconds.
- **Total Available**
  The number of label values available.

**Sample Output**

*A:SRU4>config>router>mpls# show router mpls label-range

Label Ranges

<table>
<thead>
<tr>
<th>Label Type</th>
<th>Start Label</th>
<th>End Label</th>
<th>Aging</th>
<th>Total Available</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static-lsp</td>
<td>32</td>
<td>1023</td>
<td>-</td>
<td>736</td>
</tr>
<tr>
<td>Static-svc</td>
<td>2048</td>
<td>18431</td>
<td>-</td>
<td>16384</td>
</tr>
<tr>
<td>Dynamic</td>
<td>32768</td>
<td>131071</td>
<td>258</td>
<td>93232</td>
</tr>
</tbody>
</table>

*A:SRU4>config>router>mpls#
Show Commands

**Isp**

**Syntax**

```
Isp lsp-name [status {up|down}] [from ip-address | to ip-address] [detail]
Isp {transit | terminate} [status {up | down}] [from ip-address | to ip-address | lsp-name name] [detail]
Isp count
Isp lsp-name activepath
Isp lsp-name path [path-name] [status {up | down}] [detail]
Isp [lsp-name] path [path-name] mbb
```

**Context**

`show>router>mpls`

**Description**

This command displays LSP details.

**Parameters**

- **Isp lsp-name** — The name of the LSP used in the path.
- **status up** — Displays an LSP that is operationally up.
- **status down** — Displays an LSP that is operationally down.
- **from ip-address** — Displays the IP address of the ingress router for the LSP.
- **to ip-address** — Displays the IP address of the egress router for the LSP.
- **transit** — Displays the number of static LSPs that transit through the router.
- **terminate** — Displays the number of static LSPs that terminate at the router.
- **Isp count** — Displays the total number of LSPs.
- **activepath** — Displays the present path being used to forward traffic.
- **mbb** — Displays make-before-break (MBB) information.
- **detail** — Displays detailed information.

**Output**

**MPLS LSP Output** — The following table describes MPLS LSP output fields.

<table>
<thead>
<tr>
<th>Label</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LSP Name</td>
<td>The name of the LSP used in the path.</td>
</tr>
<tr>
<td>To</td>
<td>The system IP address of the egress router for the LSP.</td>
</tr>
<tr>
<td>Adm State</td>
<td><strong>Down</strong> — The path is administratively disabled.</td>
</tr>
<tr>
<td></td>
<td><strong>Up</strong> — The path is administratively enabled.</td>
</tr>
<tr>
<td>Oper State</td>
<td><strong>Down</strong> — The path is operationally down.</td>
</tr>
<tr>
<td></td>
<td><strong>Up</strong> — The path is operationally up.</td>
</tr>
<tr>
<td>LSPs</td>
<td>The total number of LSPs configured.</td>
</tr>
<tr>
<td>From</td>
<td>The IP address of the ingress router for the LSP.</td>
</tr>
<tr>
<td>Label</td>
<td>Description</td>
</tr>
<tr>
<td>----------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>LSP Up Time</td>
<td>The length of time the LSP has been operational.</td>
</tr>
<tr>
<td>Transitions</td>
<td>The number of transitions that have occurred for the LSP.</td>
</tr>
<tr>
<td>Retry Limit</td>
<td>The number of attempts that the software should make to re-establish the LSP after it has failed.</td>
</tr>
<tr>
<td>Signaling</td>
<td>Specifies the signaling style.</td>
</tr>
<tr>
<td>Hop Limit</td>
<td>The maximum number of hops that an LSP can traverse, including the ingress and egress routers.</td>
</tr>
<tr>
<td>Fast Reroute/ FastFail Config</td>
<td>enabled — Fast reroute is enabled. In the event of a failure, traffic is immediately rerouted on the pre-computed detour LSP, thus minimizing packet loss.</td>
</tr>
<tr>
<td></td>
<td>disabled — There is no detour LSP from each node on the primary path.</td>
</tr>
<tr>
<td>ADSPEC</td>
<td>enabled — The LSP will include advertising data (ADSPEC) objects in RSVP messages.</td>
</tr>
<tr>
<td></td>
<td>disabled — The LSP will not include advertising data (ADSPEC) objects in RSVP messages.</td>
</tr>
<tr>
<td>Primary</td>
<td>The preferred path for the LSP.</td>
</tr>
<tr>
<td>Secondary</td>
<td>The alternate path that the LSP will use if the primary path is not available.</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>The amount of bandwidth in megabits per second (Mbps) reserved for the LSP path.</td>
</tr>
<tr>
<td>LSP Up Time</td>
<td>The total time in increments that the LSP path has been operational.</td>
</tr>
<tr>
<td>LSP Tunnel ID</td>
<td>The value which identifies the label switched path that is signaled for this entry.</td>
</tr>
<tr>
<td>To</td>
<td>The IP address of the egress router for the LSP.</td>
</tr>
<tr>
<td>LSP Down Time</td>
<td>The total time in increments that the LSP path has not been operational.</td>
</tr>
<tr>
<td>Path Changes</td>
<td>The number of path changes this LSP has had. For every path change (path down, path up, path change), a corresponding syslog/trap (if enabled) is generated.</td>
</tr>
<tr>
<td>Retry Timer</td>
<td>The time, in seconds, for LSP re-establishment attempts after an LSP failure.</td>
</tr>
<tr>
<td>Resv Style</td>
<td>se — Specifies a shared reservation environment with a limited reservation scope. This reservation style creates a single reservation over a link that is shared by an explicit list of senders.</td>
</tr>
</tbody>
</table>
### Sample Output

```
A:sim1>config>router>mpls>lsp$ show router mpls lsp path detail
```

<table>
<thead>
<tr>
<th>Label</th>
<th>Description (Continued)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ff</td>
<td>Specifies a shared reservation environment with an explicit reservation scope. Specifies an explicit list of senders and a distinct reservation for each of them.</td>
</tr>
<tr>
<td>Negotiated MTU</td>
<td>The size of the maximum transmission unit (MTU) that is negotiated during establishment of the LSP.</td>
</tr>
<tr>
<td>FR Hop Limit</td>
<td>The total number of hops a detour LSP can take before merging back onto the main LSP path.</td>
</tr>
<tr>
<td>LastResignalAttempt</td>
<td>Displays the system up time when the last attempt to resignal this LSP was made.</td>
</tr>
<tr>
<td>MBB Type</td>
<td>Displays an enumerated integer that specifies the type of make-before-break (MBB). If none displays then there is no MBB in progress or no last MBB.</td>
</tr>
<tr>
<td>MBB State</td>
<td>Displays the state of the most recent invocation of the make-before-break functionality.</td>
</tr>
<tr>
<td>End at</td>
<td>Displays the system up time when the last MBB ended.</td>
</tr>
<tr>
<td>Old Metric</td>
<td>Displays the cost of the traffic engineered path for the LSP path prior to MBB.</td>
</tr>
<tr>
<td>NextRetryIn</td>
<td>Displays the amount of time remaining, in seconds, before the next attempt is made to retry the in-progress MBB.</td>
</tr>
<tr>
<td>RetryAttempt</td>
<td>Displays the number attempts for the MBB is in progress.</td>
</tr>
<tr>
<td>Failure Code</td>
<td>Displays the reason code for in-progress MBB failure. A value of none indicates that no failure has occurred.</td>
</tr>
<tr>
<td>Failure Node</td>
<td>Displays the IP address of the node in the LSP path at which the in-progress MBB failed. When no failure has occurred, this value is none.</td>
</tr>
<tr>
<td>Path Name: 1</td>
<td>Path Type:</td>
</tr>
<tr>
<td>------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Primary</td>
<td></td>
</tr>
<tr>
<td>Path Admin: Up</td>
<td>Path Oper: Down</td>
</tr>
<tr>
<td>OutInterface: n/a</td>
<td>Out Label: n/a</td>
</tr>
<tr>
<td>Path Up Time: 0d 00:00:00</td>
<td>Path Dn Time: 0d 00:00:02</td>
</tr>
<tr>
<td>Retry Limit: 0</td>
<td>Retry Timer: 30 sec</td>
</tr>
<tr>
<td>RetryAttempt: 0</td>
<td>NextRetryIn: 7 sec (Fast)</td>
</tr>
<tr>
<td>SetupPriori*: 7</td>
<td>Hold Priori*: 0</td>
</tr>
<tr>
<td>Preference: n/a</td>
<td></td>
</tr>
<tr>
<td>Bandwidth: No Reservation</td>
<td>Oper Bw: 0 Mbps</td>
</tr>
<tr>
<td>Hop Limit: 255</td>
<td>Class Type: 0</td>
</tr>
<tr>
<td>Backup CT: None</td>
<td></td>
</tr>
<tr>
<td>MainCT Retry: n/a</td>
<td>MainCT Retry: 0</td>
</tr>
<tr>
<td>Rem:</td>
<td></td>
</tr>
<tr>
<td>Oper CT: None</td>
<td></td>
</tr>
<tr>
<td>Record Route: Record</td>
<td>Record Label: Record</td>
</tr>
<tr>
<td>Oper MTU: 0</td>
<td>Neg MTU: 0</td>
</tr>
<tr>
<td>Adaptive: Enabled</td>
<td>Oper Metric: 65535</td>
</tr>
<tr>
<td>Include Grps: None</td>
<td>Exclude Grps: None</td>
</tr>
<tr>
<td>Path Trans: 2</td>
<td>CSPF Queries: 0</td>
</tr>
<tr>
<td>Failure Code: noError</td>
<td>Failure Node: n/a</td>
</tr>
<tr>
<td>ExplicitHops:</td>
<td></td>
</tr>
<tr>
<td>No Hops Specified</td>
<td></td>
</tr>
<tr>
<td>ResigEligib*: False</td>
<td></td>
</tr>
<tr>
<td>LastResignal: n/a</td>
<td></td>
</tr>
<tr>
<td>========================================================================</td>
<td></td>
</tr>
<tr>
<td>*A:# show router mpls lsp path detail</td>
<td></td>
</tr>
<tr>
<td>========================================================================</td>
<td></td>
</tr>
</tbody>
</table>

**MPLS and RSVP**

---

**Legend:**
- @ - Detour Available
- # - Detour In Use
- b - Bandwidth Protected
- n - Node Protected
- s - Soft Preemption
- S - Strict
- L - Loose

---

**LSP to_C Path 1000_S**

<table>
<thead>
<tr>
<th>LSP Name: to_C</th>
<th>Path LSP ID: 17926</th>
</tr>
</thead>
<tbody>
<tr>
<td>From: 10.20.1.2</td>
<td>To: 10.20.1.3</td>
</tr>
<tr>
<td>Adm State: Up</td>
<td>Oper State: Up</td>
</tr>
<tr>
<td>Path Name: 1000_S</td>
<td>Path Type: Standby</td>
</tr>
<tr>
<td>Path Admin: Up</td>
<td>Path Oper: Up</td>
</tr>
<tr>
<td>OutInterface: 1/1/2</td>
<td>Out Label: 131068</td>
</tr>
<tr>
<td>Path Up Time: 0d 00:06:46</td>
<td>Path Dn Time: 0d 00:00:00</td>
</tr>
<tr>
<td>Retry Limit: 0</td>
<td>Retry Timer: 20 sec</td>
</tr>
<tr>
<td>RetryAttempt: 0</td>
<td>NextRetryIn: 0 sec</td>
</tr>
<tr>
<td>Adspec: Disabled</td>
<td>Oper Adspec: Disabled</td>
</tr>
<tr>
<td>CSPF: Enabled</td>
<td>Oper CSPF: Enabled</td>
</tr>
<tr>
<td>CSPF-FL: Enabled</td>
<td>Oper CSPF-FL: Enabled</td>
</tr>
<tr>
<td>Least Fill: Disabled</td>
<td>Oper LeastF*: Enabled</td>
</tr>
<tr>
<td>FRR NodePro*: Disabled</td>
<td>Oper FRR NP: Enabled</td>
</tr>
<tr>
<td>Prop Adm Grp: Disabled</td>
<td>Oper PropAG: Disabled</td>
</tr>
<tr>
<td>Neg MTU: 1496</td>
<td>Oper MTU: 1496</td>
</tr>
<tr>
<td>Bandwidth: No Reservation</td>
<td>Oper Bw: 0 Mbps</td>
</tr>
</tbody>
</table>
**Show Commands**

```
# A:Dut-C>config>router>mpls>lsp$ /show router mpls lsp path detail

------------------------------------------------------------------------
| LSP 2 Path 1 |
------------------------------------------------------------------------
| LSP Name     : 2 | Path LSP ID   : 54272 |
| From         : 10.20.1.3 | To      : 10.20.1.1 |
| Adm State    : Up | Oper State   : Down |
| Path Name    : 1 | Path Type    : Primary |
| Path Admin   : Up | Path Oper    : In Progress |
| Out Interface: n/a | Out Label  : n/a |
| Path Up Time : 0d 00:00:00 | Path Dn Time: 0d 00:00:13 |
| Retry Limit  : 0 | Retry Timer  : 30 sec |
| RetryAttempt : 1 | NextRetryIn  : 0 sec |
| Timeout In   : 19 sec |
```
Adspec      : Disabled                           Oper Adspec : N/A
CSPF        : Disabled                           Oper CSPF   : N/A
CSPF-FL     : Disabled                           Oper CSPF-FL: N/A
Least Fill  : Disabled                           Oper LeastF*: N/A
FRR         : Disabled                           Oper FRR    : N/A
FR Hop Limit: 16                                 Oper FRHopL*: N/A
Prop Adm Grp: Disabled                           Oper PropAG : N/A
Neg MTU     : 0                                  Oper MTU    : N/A
Bandwidth   : No Reservation                     Oper Bw     : N/A
Hop Limit   : 255                                Oper HopLim*: N/A
Record Route: Record                              Oper RecRou*: N/A
Record Label: Record                              Oper RecLab*: N/A
SetupPriori*: 7                                  Oper SetupP*: N/A
Hold Priori*: 0                                  Oper HoldPr*: N/A
Class Type  : 0                                  Oper CT     : N/A
Backup CT   : None                                MainCT Retry: Infinite
Rem :                                             Rem :
MainCT Retry: 0                                 MainCT Retry: 0
Limit :                                            Limit :
Include Grps:                                    Oper InclGr*: N/A
None                                           None
Exclude Grps:                                    Oper ExclGr*: N/A
None                                           None
Adaptive    : Enabled                            Oper Metric : 65535
Preference  : n/a
Path Trans  : 0                                  CSPF Queries: 0
Failure Code: noError                            Failure Node: n/a
ExplicitHops: 10.10.2.1(S)                        Failure Code: noError
Actual Hops : No Hops Specified                   Failure Node: n/a
ResigEligib*: False                              LastResignal: n/a
LastResignal: n/a                                CSPF Metric : 0
========================================================================
* indicates that the corresponding row element may have been truncated.

A:sim1(config-router>mpls)lsp$ show router mpls lsp path detail
========================================================================
LSP l1 Path 1
========================================================================
Legend :
@ - Detour Available               # - Detour In Use
b - Bandwidth Protected           n - Node Protected
s - Soft Preemption
S - Strict                        L - Loose
========================================================================
---LSP Name : l1 Path LSP ID : 30208
From : 10.20.1.1                      To : 10.20.1.3
Adm State : Up                     Oper State : Down
Path Name : 1                         Path Type : Primary
Path Admin : Up                     Path Oper : Down
OutInterface: n/a                   Out Label : n/a
Path Up Time: 0d 00:00:00            Path Dn Time: 0d 00:00:02
Show Commands

Retry Limit : 0
Retry Attempt: 0
SetupPriority*: 7
Preference : n/a
Bandwidth : No Reservation
Hop Limit : 255
Backup CT : None
MainCT Retry: 0
Rem :
Oper CT : None
Record Route: Record
Oper MTU : 0
Adaptive : Enabled
Include Grps: None
Path Trans : 2
Failure Code: noError
ExplicitHops:
10.20.1.2(S)
Actual Hops :
No Hops Specified
ResigEligib*: False
LastResignal: n/a
========================================================================

*M:SRU4> config> router> mpls# show router mpls lsp path

+------------------------------------------------------------------------+
| MPLS LSP Path (Detail)                                                 |
+------------------------------------------------------------------------+
| Legend :                                                               |
| @ - Detour Available              # - Detour In Use                     |
| b - Bandwidth Protected           n - Node Protected                   |
| s - Soft Preemption            S - Strict                               |
| L - loose                      |                             |
+------------------------------------------------------------------------+
| ExplicitHops:                                                             |
| 10.20.1.2(S) |
| Actual Hops :                                                            |
| 10.10.1.1(S) 10.20.1.1(S)       Record Label : N/A                    |
| -> 10.10.1.2(10.20.1.1)       Record Label : 131071                  |
| -> 10.10.5.3(10.20.1.3)       Record Label : 131071                  |
| -> 10.10.7.4(10.20.1.4)       Record Label : 131071                  |
| -> 10.10.8.5(10.20.1.5)       Record Label : 131071                  |
| ComputedHops:                                                            |
| 10.10.1.1(S) -> 10.10.1.2(S)   -> 10.10.5.3(S)                    |
| -> 10.20.1.4(L) -> 10.20.1.5(L) |
+------------------------------------------------------------------------+

*A:SRU4> config> router> mpls# show router mpls lsp

+------------------------------------------------------------------------+
| MPLS LS Ps (Originating)                                               |
+------------------------------------------------------------------------+
| LSP Name                  To                  Fastfail     Adm   Opr |
|-------------------------------|---------------------|-------------|--------|
| to_110_20_1_1_cspf          110.20.1.1  No  Up   Up   |
| to_110_20_1_2_cspf          110.20.1.2  No  Up   Dwn  |
| to_110_20_1_3_cspf          110.20.1.3  No  Up   Up   |
| to_110_20_1_4_cspf          110.20.1.4  No  Up   Dwn  |
| to_110_20_1_5_cspf          110.20.1.5  No  Up   Up   |
+------------------------------------------------------------------------+
<table>
<thead>
<tr>
<th>Label</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autobandwidth</td>
<td>Enabled – Auto-bandwidth adjustment is enabled on this LSP. Disabled – Auto-bandwidth adjustment is disabled on this LSP.</td>
</tr>
<tr>
<td>Auto BW Min</td>
<td>The minimum bandwidth of the LSP that auto-bandwidth can request</td>
</tr>
<tr>
<td>Auto BW Max</td>
<td>The maximum bandwidth of the LSP that auto-bandwidth can request</td>
</tr>
<tr>
<td>AB Up Thresh</td>
<td>The percent threshold for increasing LSP bandwidth followed by absolute threshold in ().</td>
</tr>
<tr>
<td>AB Down Thresh</td>
<td>The percent threshold for decreasing LSP bandwidth followed by absolute threshold in ().</td>
</tr>
<tr>
<td>AB Adj Time</td>
<td>The configured adjust-count times the collection-interval.</td>
</tr>
<tr>
<td>AB Sample Time</td>
<td>The configured sample-count times the collection-interval.</td>
</tr>
<tr>
<td>AB Last Adj</td>
<td>The system time of the last auto-bandwidth adjustment and the cause: (M) manual (T) normal expiry of adjust-timer (O) overflow (C) VLL CAC</td>
</tr>
<tr>
<td>AB Next Adj</td>
<td>The system time when the adjust-timer will expire next [or the remaining adjust-count, if this is not possible].</td>
</tr>
<tr>
<td>AB Max AvgR*</td>
<td>The maximum average data rate in any sample interval of the current adjust interval</td>
</tr>
</tbody>
</table>
Show Commands

*A:*SRU4>config>router>mpls# show router mpls lsp detail

-----------------------------------------------------------------------------------------------
MPLS LSPs (Originating) (Detail)
-----------------------------------------------------------------------------------------------
Type : Originating
-----------------------------------------------------------------------------------------------
LSP Name : to_110_20_1_1_cspf
LSP Type : RegularLsp
From : 110.20.1.4
Adm State : Up
LSP Up Time : 0d 01:47:49
Transitions : 11
Signaling : RSVP
Hop Limit : 255
Adaptive : Enabled
FastReroute : Disabled
CSPF : Enabled
Metric : 0
Include Grps: None
Least Fill : Disabled
LdpOverRsvp : Enabled
IGP Shortcut: Enabled
Oper Metric : 1001
Primary(a) : to_110_20_1_1
Bandwidth : 0 Mbps
-----------------------------------------------------------------------------------------------

Type : Originating
-----------------------------------------------------------------------------------------------
LSP Name : to_10_100_1_1_cspf_20
LSP Type : RegularLsp
From : 110.20.1.4
Adm State : Up
LSP Up Time : 0d 00:00:00
Transitions : 0
Retry Limit : 0
Signaling : RSVP
Hop Limit : 255
Adaptive : Enabled
-----------------------------------------------------------------------------------------------

*Label* | *Description (Continued)*
--------|----------------------------------
AB Lst AvgR* | The average data rate measured in the sample interval that ended most recently
AB Oflow Lmt | The configured value of the auto-bandwidth overflow-limit
AB Oflow Count | The number of overflow samples since the last reset
Init BW | The configured bandwidth of the primary path (and used at original establishment of the LSP)
Current BW | The current bandwidth reserved along the primary path

The average data rate measured in the sample interval that ended most recently
The configured value of the auto-bandwidth overflow-limit
The number of overflow samples since the last reset
The configured bandwidth of the primary path (and used at original establishment of the LSP)
The current bandwidth reserved along the primary path
FastReroute : Disabled                         Oper FR        : Disabled
CSPF       : Enabled                          ADSPEC         : Disabled
Metric     : 0                                Use TE metric  : Disabled
Include Grps:                                  Exclude Grps   :
None                                           None
Least Fill : Disabled                          VprnAutoBind   : Enabled
LdpOverRsvp : Enabled                          IGP Shortcut: Enabled
Oper Metric : 65535                            IGPMetric      : 65535
Primary     : to_10_100_1_1                    Down Time      : 0d 13:30:49
Bandwidth   : 0 Mbps                          No Reservation
===============================================================================
*A:SRU4>config>router>mpls#

*A:SRU4>config>router>mpls# show router mpls lsp path detail
===============================================================================
MPLS LSP  Path  (Detail)
===============================================================================
Legend :
@ - Detour Available              # - Detour In Use
b - Bandwidth Protected           n - Node Protected
s - Soft Preemption
===============================================================================
-------------------------------------------------------------------------------
LSP to_110_20_1_1_cspf Path to_110_20_1_1
-------------------------------------------------------------------------------
LSP Name    : to_110_20_1_1_cspf                 Path LSP ID : 12856
From        : 110.20.1.4                         To          : 110.20.1.1
Adm State   : Up                                 Oper State  : Up
Path Name   : to_110_20_1_1                      Path Type   : Primary
Path Admin  : Up                                 Path Oper   : Up
OutInterface: 3/2/1                              Out Label   : 336302
Path Up Time: 0d 01:43:19                        Path Dn Time: 0d 00:00:00
Retry Limit : 0                                  Retry Timer : 30 sec
RetryAttempt: 0                                  NextRetryIn : 0 sec
SetupPriori*: 7                                  Hold Priori*: 0
Preference  : n/a                                Bandwidth   : No Reservation
Bandwidth   : No Reservation                     Oper Bw     : 0 Mbps
Hop Limit   : 255                                Class Type  : 0
Backup CT   : None                               MainCT Retry: n/a
MainCT Retry: n/a                                Limit       : 0
Rem         :                                        Oper CT     : 0
Record Route: Record                             Record Label: Record
Oper MTU    : 1500                                Neg MTU     : 1500
Adaptive    : Enabled                            Oper Metric : 1001
Include Grps:                                    Exclude Grps: None
None                                                   None
Path Trans  : 13                                  CSPF Queries: 56
Path Trans  : 13                                  Failure Node: n/a
ResigEligib*: False
Actual Hops :
  10.100.30.4(110.20.1.1) Record Label : N/A
  -> 10.100.30.20(10.20.1.20) Record Label : 336302
  -> 10.100.14.1(110.20.1.1) Record Label : 126325
ComputedHops:
  10.100.30.4 -> 10.100.30.20 -> 10.100.14.1
ResigEligib*: False
### LSP to_10_100_1_1_cspf_20 Path to_10_100_1_1

<table>
<thead>
<tr>
<th>LSP Name</th>
<th>Path LSP ID</th>
<th>From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>to_10_100_1_1_cspf_20</td>
<td>40960</td>
<td>110.20.1.4</td>
<td>10.100.1.1</td>
</tr>
</tbody>
</table>

- **Adm State**: Up
- **Oper State**: Down
- **Path Name**: to_10_100_1_1_cspf_20
- **Path Type**: Primary
- **Path Admin**: Up
- **Path Oper**: Down
- **OutInterface**: n/a
- **Out Label**: n/a
- **Path Up Time**: 0d 00:00:00
- **Path Dn Time**: 0d 13:26:06
- **Retry Limit**: 0
- **Retry Attempt**: 1612
- **Setup Priori**: 7
- **Hold Priori**: 0
- **Bandwidth**: No Reservation
- **Oper Bw**: 0 Mbps
- **Hop Limit**: 255
- **Class Type**: 0
- **Backup CT**: None
- **Main CT Retry**: Infinite
- **Rem**: Limit
- **Oper CT**: None
- **Record Route**: Record
- **Record Label**: Record
- **Oper MTU**: 0
- **Neg MTU**: 0
- **Adaptive**: Enabled
- **Oper Metric**: 65535
- **Include Grps**: None
- **Exclude Grps**: None
- **Path Trans**: 0
- **CSPF Queries**: 0
- **Explicit Hops**: No Hops Specified
- **Actual Hops**: No Hops Specified
- **Computed Hops**: No Hops Specified
- **Resig Eligib**: False
- **Last Resignal**: n/a

---

* indicates that the corresponding row element may have been truncated.

*A:SRU4>config>router>mpls#

*A:SRU4>config>router>mpls# show router mpls lsp "to_110_20_1_1_cspf"

### MPLS LSPs (Originating)

<table>
<thead>
<tr>
<th>LSP Name</th>
<th>To</th>
<th>Fastfail</th>
<th>Adm</th>
<th>Opr</th>
</tr>
</thead>
<tbody>
<tr>
<td>to_110_20_1_1_cspf</td>
<td>110.20.1.1</td>
<td>No</td>
<td>Up</td>
<td>Up</td>
</tr>
</tbody>
</table>

LSPs : 1

*A:SRU4>config>router>mpls#

*A:SRU4>config>router>mpls# show router mpls lsp "to_110_20_1_1_cspf" detail
### MPLS LSPs (Originating) (Detail)

<table>
<thead>
<tr>
<th>Type</th>
<th>Originating</th>
</tr>
</thead>
<tbody>
<tr>
<td>LSP Name</td>
<td>to_110_20_1_1_cspf</td>
</tr>
<tr>
<td>LSP Type</td>
<td>RegularLsp</td>
</tr>
<tr>
<td>LSP Tunnel ID</td>
<td>1</td>
</tr>
<tr>
<td>From</td>
<td>110.20.1.4</td>
</tr>
<tr>
<td>Adm State</td>
<td>Up</td>
</tr>
<tr>
<td>LSP Up Time</td>
<td>0d 01:47:02</td>
</tr>
<tr>
<td>Transitions</td>
<td>11</td>
</tr>
<tr>
<td>Retry Limit</td>
<td>0</td>
</tr>
<tr>
<td>Signaling</td>
<td>RSVP</td>
</tr>
<tr>
<td>Hop Limit</td>
<td>255</td>
</tr>
<tr>
<td>Adaptive</td>
<td>Enabled</td>
</tr>
<tr>
<td>Metric</td>
<td>0</td>
</tr>
<tr>
<td>Include Grps</td>
<td>None</td>
</tr>
<tr>
<td>Primary(a)</td>
<td>to_110_20_1_1</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>0 Mbps</td>
</tr>
</tbody>
</table>

```
*A:*SRU4>config>router>mpls# show router mpls lsp detail to 110.20.1.2
```

<table>
<thead>
<tr>
<th>Type</th>
<th>Originating</th>
</tr>
</thead>
<tbody>
<tr>
<td>LSP Name</td>
<td>to_110_20_1_1_cspf</td>
</tr>
<tr>
<td>LSP Type</td>
<td>RegularLsp</td>
</tr>
<tr>
<td>LSP Tunnel ID</td>
<td>2</td>
</tr>
<tr>
<td>From</td>
<td>110.20.1.4</td>
</tr>
<tr>
<td>Adm State</td>
<td>Up</td>
</tr>
<tr>
<td>LSP Up Time</td>
<td>0d 00:01:26</td>
</tr>
<tr>
<td>Transitions</td>
<td>529</td>
</tr>
<tr>
<td>Retry Limit</td>
<td>0</td>
</tr>
<tr>
<td>Signaling</td>
<td>RSVP</td>
</tr>
<tr>
<td>Hop Limit</td>
<td>255</td>
</tr>
<tr>
<td>Adaptive</td>
<td>Enabled</td>
</tr>
<tr>
<td>Metric</td>
<td>0</td>
</tr>
<tr>
<td>Include Grps</td>
<td>None</td>
</tr>
<tr>
<td>Primary(a)</td>
<td>to_110_20_1_2</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>0 Mbps</td>
</tr>
</tbody>
</table>
Show Commands

...  

Type : Originating

LSP Name    : to_110_20_1_2_cspf_20  
LSP Type    : RegularLsp  
From        : 110.20.1.4  
Adm State   : Up  
LSP Up Time : 0d 00:41:15  
Transitions : 431  
Retry Limit : 0  
Signaling   : RSVP  
Hop Limit   : 255  
Adaptive    : Enabled  
FastReroute : Disabled  
Metric      : 0  
Include Grps:  
Least Fill  : Disabled  
LdpOverRsvp : Enabled  
IGP Shortcut: Enabled  
Oper Metric : 66536  

Primary(a)  : to_110_20_1_2  
Bandwidth   : 0 Mbps

MPLS LSP Count

<table>
<thead>
<tr>
<th>LSP Type</th>
<th>Originated</th>
<th>Transit</th>
<th>Terminated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static LSPs</td>
<td>0</td>
<td>136</td>
<td>0</td>
</tr>
<tr>
<td>Dynamic LSPs</td>
<td>140</td>
<td>421</td>
<td>1620</td>
</tr>
<tr>
<td>Detour LSPs</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>P2MP S2Ls</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

MPLS LSP Paths

LSP to 110_20_1_1_cspf Path to 110_20_1_1

LastResignal: n/a  
CSPF Metric : 1001
Last MBB :  
MBB Type : TimerBasedResignal  
MBB State : Fail  
Ended At : 03/04/2010 09:23:58  
Old Metric : 0

LSP to 110_20_1_2_cspf Path to 110_20_1_2

LastResignal: 03/04/2010 09:23:58  
CSPF Metric : 65535

LSP to 110_20_1_3_cspf Path to 110_20_1_3

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MPLS and RSVP

LastResignal: n/a                                CSPF Metric : 1001
Last MBB :                                       MBB State : Fail
MBB Type : TimerBasedResignal                    Ended At : 03/04/2010 09:23:58
MBB State : Fail                                Old Metric : 0
Ended At : 03/04/2010 09:23:58

LSP to_110_20_1_4_cspf Path to_110_20_1_4

LastResignal: n/a                                CSPF Metric : 0

LSP to_110_20_1_5_cspf Path to_110_20_1_5

LSP to_10_100_1_1_cspf_19 Path to_10_100_1_1

LSP to_10_100_1_1_cspf_20 Path to_10_100_1_1

Legend :
  @ - Detour Available              # - Detour In Use
  b - Bandwidth Protected           n - Node Protected
  s - Soft Preemption

LSP tof1 Path 1

LSP Name    : tof1                             Path LSP ID : 4706
From        : 10.20.1.2                        To          : 10.20.1.4
Adm State   : Up                               Oper State : Up
Path Name   : 1                                Path Type : Primary
Path Admin  : Up                               Path Oper : Up
OutInterface: 1/1/2:5                         Out Label : 124809
Path Up Time: 0d 00:01:16                      Path Dn Time: 0d 00:00:00
Retry Limit : 0                               Retry Timer : 20 sec
Retry Attempt: 0                              NextRetryIn : 0 sec
SetupPriority: 4                              Hold Priority: 4
Bandwidth   : 1 Mbps                          Oper Bw : 1 Mbps
Hop Limit   : 255                              Class Type : 5
Record Route: Record                          Record Label: Record
Oper MTU    : 1492                             Neg MTU : 1492
Adaptive    : Enabled                         Oper Metric : 1000
Include Grps:                                Exclude Grps:
None                                                None
Path Trans  : 2                              CSPF Queries: 1
Failure Code: noError                          Failure Node: n/a
ExplicitHops:                                  None
  10.20.1.4
Actual Hops :
Show Commands

```
10.10.105.2(10.20.1.2) @ s                   Record Label    : N/A
-> 10.10.105.4(10.20.1.4)                       Record Label    : 124809
ComputedHops:
    10.10.105.2     -> 10.10.105.4
ResigEligib*: False
LastResignal: n/a                                CSPF Metric : 1000
In Prog MBB :
    MBB Type   : SoftPreemption                     NextRetryIn : 19 sec
    Started At : 12/08/2008 22:21:11                RetryAttempt: 0
    FailureCode: noError                            Failure Node: n/a
*A:Dut-B#
```

```
*A:SRU4>config>router>mpls# show router mpls lsp transit
```

```
Table: MPLS LSPs (Transit)

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
<th>In I/F</th>
<th>Out I/F</th>
<th>State</th>
<th>LSP Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>110.20.1.5</td>
<td>10.20.1.22</td>
<td>3/2/1</td>
<td>3/2/7</td>
<td>Up</td>
<td>to_10_20_1_22_cspf::to*</td>
</tr>
<tr>
<td>110.20.1.5</td>
<td>10.20.1.20</td>
<td>3/2/7</td>
<td>3/2/1</td>
<td>Up</td>
<td>to_10_20_1_20_cspf_3::*</td>
</tr>
<tr>
<td>110.20.1.5</td>
<td>10.20.1.20</td>
<td>3/2/7</td>
<td>3/2/1</td>
<td>Up</td>
<td>to_10_20_1_20_cspf_4::*</td>
</tr>
<tr>
<td>110.20.1.5</td>
<td>10.20.1.20</td>
<td>3/2/7</td>
<td>3/2/1</td>
<td>Up</td>
<td>to_10_20_1_20_cspf_2::*</td>
</tr>
<tr>
<td>110.20.1.5</td>
<td>10.20.1.20</td>
<td>3/2/7</td>
<td>3/2/1</td>
<td>Up</td>
<td>to_10_20_1_20_cspf_20:*</td>
</tr>
<tr>
<td>110.20.1.5</td>
<td>10.20.1.20</td>
<td>3/2/7</td>
<td>3/2/1</td>
<td>Up</td>
<td>to_10_20_1_20_cspf_18:*</td>
</tr>
<tr>
<td>110.20.1.5</td>
<td>10.20.1.20</td>
<td>3/2/7</td>
<td>3/2/1</td>
<td>Up</td>
<td>to_10_20_1_20_cspf_19:*</td>
</tr>
<tr>
<td>110.20.1.5</td>
<td>10.20.1.20</td>
<td>3/2/7</td>
<td>3/2/1</td>
<td>Up</td>
<td>to_10_20_1_20_cspf_17:*</td>
</tr>
<tr>
<td>110.20.1.5</td>
<td>10.20.1.20</td>
<td>3/2/7</td>
<td>3/2/1</td>
<td>Up</td>
<td>to_10_20_1_20_cspf_16:*</td>
</tr>
<tr>
<td>110.20.1.5</td>
<td>10.20.1.20</td>
<td>3/2/7</td>
<td>3/2/1</td>
<td>Up</td>
<td>to_10_20_1_20_cspf_15:*</td>
</tr>
<tr>
<td>110.20.1.5</td>
<td>10.20.1.20</td>
<td>3/2/7</td>
<td>3/2/1</td>
<td>Up</td>
<td>to_10_20_1_20_cspf_13:*</td>
</tr>
<tr>
<td>110.20.1.5</td>
<td>10.20.1.20</td>
<td>3/2/7</td>
<td>3/2/1</td>
<td>Up</td>
<td>to_10_20_1_20_cspf_14:*</td>
</tr>
<tr>
<td>110.20.1.5</td>
<td>10.20.1.20</td>
<td>3/2/7</td>
<td>3/2/1</td>
<td>Up</td>
<td>to_10_20_1_20_cspf_12:*</td>
</tr>
<tr>
<td>110.20.1.5</td>
<td>10.20.1.20</td>
<td>3/2/7</td>
<td>3/2/1</td>
<td>Up</td>
<td>to_10_20_1_20_cspf_10:*</td>
</tr>
<tr>
<td>110.20.1.3</td>
<td>10.20.1.22</td>
<td>aps-1</td>
<td>3/2/7</td>
<td>Up</td>
<td>to_10_20_1_22_cspf_6::*</td>
</tr>
<tr>
<td>110.20.1.3</td>
<td>10.20.1.22</td>
<td>aps-1</td>
<td>3/2/7</td>
<td>Up</td>
<td>to_10_20_1_22_cspf::to*</td>
</tr>
<tr>
<td>110.20.1.3</td>
<td>10.20.1.22</td>
<td>aps-1</td>
<td>3/2/7</td>
<td>Up</td>
<td>to_10_20_1_22_cspf_9::*</td>
</tr>
</tbody>
</table>
```

```
LSPs : 520

*A:SRU4>config>router>mpls# show router mpls lsp terminate
```

```
Table: MPLS LSPs (Terminate)

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
<th>In I/F</th>
<th>Out I/F</th>
<th>State</th>
<th>LSP Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>110.20.1.5</td>
<td>110.20.1.4</td>
<td>3/2/1</td>
<td>n/a</td>
<td>Up</td>
<td>b4-1::b4-1</td>
</tr>
<tr>
<td>110.20.1.5</td>
<td>110.20.1.4</td>
<td>3/2/7</td>
<td>n/a</td>
<td>Up</td>
<td>gsr::gsr</td>
</tr>
<tr>
<td>10.20.1.22</td>
<td>110.20.1.4</td>
<td>3/2/7</td>
<td>n/a</td>
<td>Up</td>
<td>gsr2_t10</td>
</tr>
<tr>
<td>110.20.1.6</td>
<td>110.20.1.4</td>
<td>3/2/3:10</td>
<td>n/a</td>
<td>Up</td>
<td>1::2</td>
</tr>
<tr>
<td>110.20.1.6</td>
<td>110.20.1.4</td>
<td>3/2/3:3</td>
<td>n/a</td>
<td>Up</td>
<td>1::stby</td>
</tr>
<tr>
<td>110.20.1.6</td>
<td>110.20.1.4</td>
<td>3/2/3:10</td>
<td>n/a</td>
<td>Up</td>
<td>2::2</td>
</tr>
<tr>
<td>110.20.1.6</td>
<td>110.20.1.4</td>
<td>3/2/3:6</td>
<td>n/a</td>
<td>Up</td>
<td>2::stby</td>
</tr>
</tbody>
</table>
```
LSPs : 1603

* indicates that the corresponding row element may have been truncated.

*A:SRU4>config>router>mpls#

*A:SRU4>config>router>mpls# show router mpls lsp terminate detail

MPLS LSPs (Terminate) (Detail)

-------------------------------------------------------------------------------
LSP b4-1::b4-1
-------------------------------------------------------------------------------
From                 : 110.20.1.5            To            : 110.20.1.4
State                : Up
SetupPriority        : 7                     Hold Priority : 0
Class Type           : 0
In Interface         : 3/2/1                 In Label      : 131071
Previous Hop         : 10.100.30.20

-------------------------------------------------------------------------------
LSP gsr::gsr
-------------------------------------------------------------------------------
From                 : 110.20.1.5            To            : 110.20.1.4
State                : Up
SetupPriority        : 7                     Hold Priority : 0
Class Type           : 0
In Interface         : 3/2/7                 In Label      : 128547
Previous Hop         : 160.60.60.2

-------------------------------------------------------------------------------

Legend :
@ - Detour Available                          # - Detour In Use
b - Bandwidth Protected                       n - Node Protected
S - Strict                                    L - Loose
s - Soft Preemption

========================================================================
### MPLS LSP Configuration

**LSP Name**: 1  
**S2L LSP ID**: 26624  
**P2MP ID**: 0  
**S2L Grp Id**: 0  
**Adm State**: Up  
**Oper State**: Down  
**S2L State**: Inactive  
**S2L Name**: 1  
**To**: 10.20.1.3  
**S2L Admin**: Up  
**Oper**: Down  
**OutInterface**: n/a  
**Out Label**: n/a  
**S2L Uptime**: 0d 00:00:00  
**S2L Downtime**: 0d 00:00:01  
**Retry Attempt**: 0  
**Next Retry**: 9 sec (Fast)  
**S2L Trans**: 8  
**CSPF Queries**: 4  
**Failure Code**: noError  
**Failure Node**: n/a  
**Explicit Hops**:  
10.20.1.2(S)  
**Actual Hops**:  
No Hops Specified  
**Computed Hops**:  
No Hops Specified  
**Last Resignal**: n/a

### MP2LSP Configuration

**LSP Name**: 2  
**S2L LSP ID**: 52230  
**P2MP ID**: 0  
**S2L Grp Id**: 2  
**Adm State**: Up  
**Oper State**: Up  
**S2L State**: Active  
**S2L Name**: 2  
**To**: 10.20.1.3  
**S2L Admin**: Up  
**Oper**: Up  
**Out Interface**: 1/1/1  
**Out Label**: 131071  
**S2L Uptime**: 0d 04:43  
**S2L Downtime**: 0d 00:00  
**Retry Attempt**: 0  
**Next Retry**: 0 sec  
**S2L Trans**: 5  
**CSPF Queries**: 21  
**Failure Code**: tunnelLocallyRepaired  
**Failure Node**: 10.20.1.2  
**Explicit Hops**:  
10.20.1.2(S)  
**Actual Hops**:  
10.10.1.1(10.20.1.1)  
Record Label: N/A  
-> 10.10.1.2(10.20.1.2) @ #  
Record Label: 131071  
-> 10.10.6.3(10.20.1.3)  
Record Label: 131068  
**Computed Hops**:  
10.10.1.1(S) -> 10.10.1.2(S) -> 10.10.5.3(S)  
**Last Resignal**: n/a  
**In Prog MBB**:  
MBB Type: GlobalRevert  
**Timeout In**: 23 sec  
**Started At**: 06/29/2011 11:06:09  
**Retry Attempt**: 7  
**Failure Code**: noError  
**Failure Node**: n/a

* *A:Dut-C>config>router>mpls>lsp$ /show router mpls lsp path detail

---

**Legend**:  
# - Detour Available  
@ - Detour In Use
**MPLS and RSVP**

- **b** - Bandwidth Protected
- **n** - Node Protected
- **s** - Soft Preemption
- **S** - Strict
- **L** - Loose

------------------------------------------------------------------------

<table>
<thead>
<tr>
<th>LSP 1 Path 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>LSP Name     : 1</td>
</tr>
<tr>
<td>From         : 10.20.1.3</td>
</tr>
<tr>
<td>Adm State     : Up</td>
</tr>
<tr>
<td>Path Name     : 1</td>
</tr>
<tr>
<td>Path Admin    : Up</td>
</tr>
<tr>
<td>OutInterface  : 1/1/1</td>
</tr>
<tr>
<td>Path Up Time  : 0d 00:03:09</td>
</tr>
<tr>
<td>Retry Limit   : 0</td>
</tr>
<tr>
<td>RetryAttempt  : 0</td>
</tr>
<tr>
<td>SetupPriori*  : 7</td>
</tr>
<tr>
<td>Preference    : n/a</td>
</tr>
<tr>
<td>Bandwidth     : No Reservation</td>
</tr>
<tr>
<td>Hop Limit     : 255</td>
</tr>
<tr>
<td>Backup CT     : None</td>
</tr>
<tr>
<td>MainCT Retry  : n/a</td>
</tr>
<tr>
<td>Rem           :</td>
</tr>
<tr>
<td>Oper CT       : 0</td>
</tr>
<tr>
<td>Record Route  : Record</td>
</tr>
<tr>
<td>Oper MTU      : 1496</td>
</tr>
<tr>
<td>Adaptive      : Enabled</td>
</tr>
<tr>
<td>Include Grps  : Exclude Grps :</td>
</tr>
<tr>
<td>None</td>
</tr>
<tr>
<td>Path Trans    : 1</td>
</tr>
<tr>
<td>Failure Code  : badNode</td>
</tr>
<tr>
<td>Oper Values   :</td>
</tr>
<tr>
<td>Setup Prior*  : 7</td>
</tr>
<tr>
<td>Record Route  : Record</td>
</tr>
<tr>
<td>Hop Limit     : 255</td>
</tr>
<tr>
<td>Adspec        : Disabled</td>
</tr>
<tr>
<td>CSPF          : Enabled</td>
</tr>
<tr>
<td>Least Fill    : Disabled</td>
</tr>
<tr>
<td>Prop Adm Grp  : Disabled</td>
</tr>
<tr>
<td>None</td>
</tr>
<tr>
<td>ExplicitHops  : No Hops Specified</td>
</tr>
<tr>
<td>Actual Hops   : 10.10.2.3(10.20.1.3) @ #</td>
</tr>
<tr>
<td>: 10.10.1.1(10.20.1.1)</td>
</tr>
<tr>
<td>ComputedHops  :</td>
</tr>
<tr>
<td>: 10.10.2.3(S)</td>
</tr>
<tr>
<td>ResigEligib*  : False</td>
</tr>
<tr>
<td>LastResignal  : n/a</td>
</tr>
<tr>
<td>In Prog MBB   :</td>
</tr>
<tr>
<td>MBB Type      : GlobalRevert</td>
</tr>
<tr>
<td>Timeout In    : 22 sec</td>
</tr>
<tr>
<td>FailureCode   : noError</td>
</tr>
<tr>
<td>Signaled BW   : 0 Mbps</td>
</tr>
</tbody>
</table>
------------------------------------------------------------------------

* indicates that the corresponding row element may have been truncated.
show router mpls p2mp-lsp p2mp-instance s2l detail
------------------------------------------------------------------------
| LSP 2  S2L 2 |
------------------------------------------------------------------------
| LSP Name   : 2 | S2L LSP ID  : 52230 |
| P2MP ID    : 0 | S2L Grp Id  : 4 |
| Adm State  : Up | Oper State  : Down |
| S2L State  : Inactive |
| S2L Name   : 2 | To          : 10.20.1.3 |
| S2L Admin  : Up | S2L Oper    : In Progress |
| OutInterface: n/a | Out Label   : n/a |
| S2L Up Time : 0d 00:00:00 | S2L Dn Time : 0d 00:00:20 |
| RetryAttempt: 1 | NextRetryIn : n/a |
| Timeout In : 21 sec |
| S2L Trans  : 6 |
| Failure Code: noError |
| ExplicitHops: |
|          10.20.1.2(S) |
| Actual Hops : |
| No Hops Specified |
| LastResignal: n/a |

srlg-database

**Syntax**

srlg-database [router-id ip-address] [interface ip-address]

**Context**

show>router>mpls

**Description**

This command displays MPLS SRLG database information.

**Parameters**

- **router-id ip-address** — Specifies a 32-bit integer uniquely identifying the router in the Autonomous System. By convention to ensure uniqueness, this may default to the value of one of the router's IPv4 host addresses, represented as a 32-bit unsigned integer, if IPv4 is configured on the router. The router-id can be either the local one or some remote router.

- **interface ip-address** — Specifies the IP address of the interface.
**path**

**Syntax**

`path [path-name] [lsp-binding]`

**Context**

`show>router>mpls`

**Description**

This command displays MPLS paths.

**Parameters**

- `path-name` — The unique name label for the LSP path.
- `lsp-binding` — Keyword to display binding information.

**Output**

**MPLS Path Output** — The following table describes MPLS Path output fields.

<table>
<thead>
<tr>
<th>Label</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Path Name</td>
<td>The unique name label for the LSP path.</td>
</tr>
<tr>
<td>Adm</td>
<td><strong>Down</strong> — The path is administratively disabled.</td>
</tr>
<tr>
<td></td>
<td><strong>Up</strong> — The path is administratively enabled.</td>
</tr>
<tr>
<td>Hop Index</td>
<td>The value used to order the hops in a path.</td>
</tr>
<tr>
<td>IP Address</td>
<td>The IP address of the hop that the LSP should traverse on the way to the egress router.</td>
</tr>
<tr>
<td>Strict/Loose</td>
<td><strong>Strict</strong> — The LSP must take a direct path from the previous hop router to the next router.</td>
</tr>
<tr>
<td></td>
<td><strong>Loose</strong> — The route taken by the LSP from the previous hop to the next hop can traverse through other routers.</td>
</tr>
<tr>
<td>LSP Name</td>
<td>The name of the LSP used in the path.</td>
</tr>
<tr>
<td>Binding</td>
<td><strong>Primary</strong> — The preferred path for the LSP.</td>
</tr>
<tr>
<td></td>
<td><strong>Secondary</strong> — The standby path for the LSP.</td>
</tr>
<tr>
<td>Paths</td>
<td>Total number of paths configured.</td>
</tr>
</tbody>
</table>

**Sample Output**

```
*A:SRU4>config>router>mpls# show router mpls path
===============================================================================
MPLS Path:                                                                                                                                                                                                                                                                                                                                                     
===============================================================================
Path Name  Adm  Hop Index   IP Address       Strict/Loose
-------------------------------------------------------------------------------
to_110_20_1_1                    Up   no hops     n/a              n/a
to_110_20_1_2                    Up   no hops     n/a              n/a
to_110_20_1_3                    Up   no hops     n/a              n/a
to_110_20_1_4                    Up   no hops     n/a              n/a
to_110_20_1_5                    Up   no hops     n/a              n/a
```

MPLS and RSVP
Show Commands

to_110_20_1_6                    Up   no hops     n/a              n/a

to_110_20_1_110                  Up   no hops     n/a              n/a

to_10_8_100_15                   Up   no hops     n/a              n/a

to_10_20_1_20                    Up   no hops     n/a              n/a

to_10_20_1_22                    Up   no hops     n/a              n/a

to_10_100_1_1                    Up   no hops     n/a              n/a

Paths : 11

*A:SRU4>config>router>mpls#

*A:SRU4>config>router>mpls# show router mpls path lsp-binding

MPLS Path:

<table>
<thead>
<tr>
<th>Path Name</th>
<th>Opr</th>
<th>LSP Name</th>
<th>Binding</th>
</tr>
</thead>
<tbody>
<tr>
<td>to_110_20_1_1</td>
<td>Up</td>
<td>to_110_20_1_1_cspf</td>
<td>Primary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>to_110_20_1_1_cspf_2</td>
<td>Primary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>to_110_20_1_1_cspf_3</td>
<td>Primary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>to_110_20_1_1_cspf_16</td>
<td>Primary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>to_110_20_1_1_cspf_17</td>
<td>Primary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>to_110_20_1_1_cspf_18</td>
<td>Primary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>to_110_20_1_1_cspf_19</td>
<td>Primary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>to_110_20_1_1_cspf_20</td>
<td>Primary</td>
</tr>
<tr>
<td>to_110_20_1_2</td>
<td>Up</td>
<td>to_110_20_1_2_cspf</td>
<td>Primary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>to_110_20_1_2_cspf_2</td>
<td>Primary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>to_110_20_1_2_cspf_3</td>
<td>Primary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>to_110_20_1_2_cspf_4</td>
<td>Primary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>to_110_20_1_2_cspf_5</td>
<td>Primary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>to_110_20_1_2_cspf_6</td>
<td>Primary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>to_110_20_1_2_cspf_13</td>
<td>Primary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>to_110_20_1_2_cspf_14</td>
<td>Primary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>to_110_20_1_2_cspf_15</td>
<td>Primary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>to_110_20_1_2_cspf_16</td>
<td>Primary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>to_110_20_1_2_cspf_17</td>
<td>Primary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>to_110_20_1_2_cspf_18</td>
<td>Primary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>to_110_20_1_2_cspf_19</td>
<td>Primary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>to_110_20_1_2_cspf_20</td>
<td>Primary</td>
</tr>
</tbody>
</table>

Paths : 11

*A:SRU4>config>router>mpls#
**srlg-group**

**Syntax**
```
srlg-group [group-name]
```

**Context**
```
show>router>mpls
```

**Description**
This command displays MPLS SRLG groups

**Parameters**
`group-name` — Specifies the name of the SRLG group within a virtual router instance.

**Output**
**MPLS SRLG Group Output** — The following table describes MPLS SRLG group output fields

<table>
<thead>
<tr>
<th>Label</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group Name</td>
<td>Displays the name of the SRLG group within a virtual router instance.</td>
</tr>
<tr>
<td>Group Value</td>
<td>Displays the group value associated with this SRLG group.</td>
</tr>
<tr>
<td>Interface</td>
<td>Displays the interface where the SRLG groups is associated.</td>
</tr>
<tr>
<td>No. of Groups</td>
<td>Displays the total number of SRLG groups associated with the output.</td>
</tr>
</tbody>
</table>

**Sample Output**

```
*A:SRU4>config>router>mpls# show router mpls srlg-group
Episode: 0x9e1e8
------------------------------------------
MPLS Srlg Groups
Episode: 0x9e1e8
------------------------------------------
Group Name Group Value Interfaces
1432 1432 srl-1
1433 1433 srl-3
1434 1434 aps-8
1435 1435 aps-9
2410 2410 srr-1
2411 2411 srr-2
2412 2412 srr-3
3410 3410 aps-1
3420 3420 aps-2
3430 3430 aps-3
3440 3440 sr4-1
41.80 4180 g7600
41104 41104 germ-1
415.70 41570 gsr1
420.40 42040 m160
422.60 42260 gsr2
44.200 44200 hubA
45100 45100 ess-7-1
45110 45110 ess-7-2
45120 45120 ess-7-3
4651 4651 src-1.1
4652 4652 src-1.2
4653 4653 src-1.3
4654 4654 src-1.4
4655 4655 src-1.5
4656 4656 src-1.6
4657 4657 src-1.7
4658 4658 src-1.8
```
Show Commands

4659 4659  src-1.9
4660 4660  src-1.10

No. of Groups: 30
===============================================================================
*A:SRU4>config>router>mpls#

*A:SRU4>config>router>mpls# show router mpls srlg-group "1432"
===============================================================================
MPLS Srlg Groups
===============================================================================
Group Name   Group Value   Interfaces
-----------------------------------------------------------------------------
1432          1432          srl-1
-----------------------------------------------------------------------------
No. of Groups: 1
===============================================================================
*A:SRU4>config>router>mpls#

static-lsp

Syntax  static-lsp [lsp-name]
static-lsp {transit | terminate}
static-lsp count

Context  show>router>mpls

Description  This command displays MPLS static LSP information.

Output  **MPLS Static LSP Output** — The following table describes MPLS static LSP output fields.

<table>
<thead>
<tr>
<th>Label</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lsp Name</td>
<td>The name of the LSP used in the path.</td>
</tr>
<tr>
<td>To</td>
<td>The system IP address of the egress router for the LSP.</td>
</tr>
<tr>
<td>Next Hop</td>
<td>The system IP address of the next hop in the LSP path.</td>
</tr>
<tr>
<td>In I/F</td>
<td>The ingress interface.</td>
</tr>
<tr>
<td>Out Label</td>
<td>The egress interface.</td>
</tr>
<tr>
<td>Out I/F</td>
<td>The egress interface.</td>
</tr>
<tr>
<td>Adm</td>
<td>Down — The path is administratively disabled.</td>
</tr>
<tr>
<td></td>
<td>Up — The path is administratively enabled.</td>
</tr>
<tr>
<td>Opr</td>
<td>Down — The path is operationally down.</td>
</tr>
<tr>
<td></td>
<td>Up — The path is operationally up.</td>
</tr>
<tr>
<td>LSPs</td>
<td>The total number of static LSPs.</td>
</tr>
</tbody>
</table>
**Sample Output**

```
A:ALA-12# show router mpls static-lsp
===============================================================================
MPLS Static LSPs (Originating)
===============================================================================
Lsp Name          To              Next Hop        Out Label Out I/F   Adm  Opr
-------------------------------------------------------------------------------
NYC_SJC_customer2 100.20.1.10     10.10.1.4       1020      1/1/1     Up   Up
-------------------------------------------------------------------------------
LSPs : 1
===============================================================================
A:ALA-12#
```

```
*A:SRU4>config>router>mpls# show router mpls static-lsp transit
===============================================================================
MPLS Static LSPs (Transit)
===============================================================================
In Label    In Port     Out Label   Out Port    Next Hop            Adm   Opr
-------------------------------------------------------------------------------
240         aps-1       440         1/1/10      11.22.11.3          Up    Up
241         aps-1       441         1/1/10      11.22.11.3          Up    Up
242         aps-1       442         1/1/10      11.22.11.3          Up    Up
243         aps-1       443         1/1/10      11.22.11.3          Up    Up
244         aps-1       444         1/1/10      11.22.11.3          Up    Up
245         aps-1       445         1/1/10      11.22.11.3          Up    Up
246         aps-1       446         1/1/10      11.22.11.3          Up    Up
247         aps-1       447         1/1/10      11.22.11.3          Up    Up
248         aps-1       448         1/1/10      11.22.11.3          Up    Up
249         aps-1       449         1/1/10      11.22.11.3          Up    Up
250         aps-1       450         1/1/10      11.22.11.3          Up    Up
251         aps-1       451         1/1/10      11.22.11.3          Up    Up
252         aps-1       452         1/1/10      11.22.11.3          Up    Up
253         aps-1       453         1/1/10      11.22.11.3          Up    Up
...  
207         3/2/8       407         1/1/9       11.22.10.3          Up    Up
208         3/2/8       408         1/1/9       11.22.10.3          Up    Up
209         3/2/8       409         1/1/9       11.22.10.3          Up    Up
-------------------------------------------------------------------------------
LSPs : 256
===============================================================================
*A:SRU4>config>router>mpls#
```

```
A:ALA-12# show router mpls static-lsp terminate
===============================================================================
MPLS Static LSPs (Terminate)
===============================================================================
In Label    In I/F      Out Label   Out I/F     Next Hop            Adm   Opr
-------------------------------------------------------------------------------
1021        1/1/1       n/a         n/a         n/a                 Up    Up
-------------------------------------------------------------------------------
LSPs : 1
===============================================================================
A:ALA-12#
```
statistics-summary

Syntax  statistics-summary

Context  show>router>mpls>statistics-summary

Description  This command displays the number of LSP statistics configured.

Sample Output

*A:SRU4>config>router>mpls# show router mpls statistics-summary
===============================================================================
Statistics Summary
===============================================================================
LSP egress statistics : 0
LSP ingress statistics : 0
===============================================================================
*A:SRU4>config>router>mpls#
status

Syntax

status

Context

show>router>mpls

Description

This command displays MPLS operation information.

Output

MPLS Status Output — The following table describes MPLS status output fields.

<table>
<thead>
<tr>
<th>Label</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admin Status</td>
<td>Down — MPLS is administratively disabled.</td>
</tr>
<tr>
<td></td>
<td>Up — MPLS is administratively enabled.</td>
</tr>
<tr>
<td>Oper Status</td>
<td>Down — MPLS is operationally down.</td>
</tr>
<tr>
<td></td>
<td>Up — MPLS is operationally up.</td>
</tr>
<tr>
<td>LSP Counts</td>
<td>Static LSPs — Displays the count of static LSPs that originate, transit, and terminate on or through the router.</td>
</tr>
<tr>
<td></td>
<td>Dynamic LSPs — Displays the count of dynamic LSPs that originate, transit, and terminate on or through the router.</td>
</tr>
<tr>
<td></td>
<td>Detour LSPs — Displays the count of detour LSPs that originate, transit, and terminate on or through the router.</td>
</tr>
<tr>
<td>FR Object</td>
<td>Enabled — Specifies that Fast reroute object is signaled for the LSP.</td>
</tr>
<tr>
<td></td>
<td>Disabled — Specifies that Fast reroute object is not signaled for the LSP.</td>
</tr>
<tr>
<td>Resignal Timer</td>
<td>Enabled — Specifies that the resignal timer is enabled for the LSP.</td>
</tr>
<tr>
<td></td>
<td>Disabled — Specifies that the resignal timer is disabled for the LSP.</td>
</tr>
<tr>
<td>Hold Timer</td>
<td>Displays the amount of time that the ingress node holds before programming its data plane and declaring the LSP up to the service module.</td>
</tr>
</tbody>
</table>

Sample Output

*A:Dut-C# show router mpls status

+----------------+-----------------+-----------------+-----------------+
<table>
<thead>
<tr>
<th>MPLS Status</th>
<th>Admin Status</th>
<th>Oper Status</th>
<th>Oper Down Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Down</td>
<td>Down</td>
<td>adminDown</td>
</tr>
<tr>
<td>FR Object</td>
<td>Enabled</td>
<td>Resignal Timer</td>
<td>Disabled</td>
</tr>
<tr>
<td>Hold Timer</td>
<td>1 seconds</td>
<td>Next Resignal</td>
<td>N/A</td>
</tr>
<tr>
<td>Srlg Frr</td>
<td>Disabled</td>
<td>Srlg Frr Strict</td>
<td>Disabled</td>
</tr>
<tr>
<td>Dynamic Bypass</td>
<td>Enabled</td>
<td>User Srlg Database</td>
<td>Disabled</td>
</tr>
</tbody>
</table>

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Show Commands

Least Fill Min Thd.: 5 percent          LeastFill ReoptiThd: 10 percent
Short. TTL Prop Lo*: Enabled            Short. TTL Prop Tr*: Enabled
AB Sample Multipli*: 1                  AB Adjust Multipli*: 288
Exp Backoff Retry : Disabled            CSPF On Loose Hop : Disabled
P2mp Resignal Timer: Disabled           P2mp Next Resignal : N/A
Sec FastRetryTimer : Disabled           Static LSP FR Timer: 30 seconds
P2P Max Bypass Ass*: 1000               P2P S2L Fast Retr*: 10
P2P Active Path Fa*: 10                 P2MP S2L Fast Retr*: 10
ActiveFastRetryTime: Disabled
LSP Counts

<table>
<thead>
<tr>
<th></th>
<th>Originate</th>
<th>Transit</th>
<th>Terminate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static LSPs</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Dynamic LSPs</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Detour LSPs</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>P2MP S2L</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

* indicates that the corresponding row element may have been truncated.

*A:Dut-C# /show router mpls status

MPLS Status

Admin Status       : Up                 Oper Status        : Up
Oper Down Reason   : n/a
FR Object          : Enabled            Resignal Timer     : Disabled
Hold Timer         : 1 seconds          Next Resignal      : N/A
Srlg Frr           : Disabled           Srlg Frr Strict    : Disabled
Dynamic Bypass     : Disabled           User Srlg Database : Disabled
Least Fill Min Thd.: 5 percent          LeastFill ReoptiThd: 10 percent
Short. TTL Prop Lo*: Enabled            Short. TTL Prop Tr*: Enabled
AB Sample Multipli*: 1                  AB Adjust Multipli*: 288
Exp Backoff Retry : Disabled            CSPF On Loose Hop : Disabled
Lsp Init RetryTime*: 30 seconds
P2mp Resignal Timer: Disabled           P2mp Next Resignal : N/A
Sec FastRetryTimer : Disabled           Static LSP FR Timer: 30 seconds
P2P Max Bypass Ass*: 1000               P2P S2L Fast Retr*: 10
P2P Active Path Fa*: 10                 P2MP S2L Fast Retr*: 10
ActiveFastRetryTime: Disabled
LSP Counts

<table>
<thead>
<tr>
<th></th>
<th>Originate</th>
<th>Transit</th>
<th>Terminate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static LSPs</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Dynamic LSPs</td>
<td>3</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Detour LSPs</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>P2MP S2L</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

* indicates that the corresponding row element may have been truncated.

show router mpls status

MPLS Status

Admin Status       : Down               Oper Status        : Down
Oper Down Reason   : adminDown         Resignal Timer     : Disabled
FR Object          : Enabled            Next Resignal      : N/A
Hold Timer         : 1 seconds          Srlg Frr Strict    : Disabled
Srlg Frr           : Disabled           User Srlg Database : Disabled
Dynamic Bypass     : Enabled            Srlg Frr Strict    : Disabled
Least Fill Min Thd.: 5 percent          LeastFill ReoptiThd: 10 percent
Short. TTL Prop Lo*: Enabled            Short. TTL Prop Tr*: Enabled
AB Sample Multipli*: 1                  AB Adjust Multipli*: 288
Exp Backoff Retry : Disabled            CSPF On Loose Hop : Disabled
Lsp Init RetryTime*: 30 seconds
P2mp Resignal Timer: Disabled           P2mp Next Resignal : N/A
Sec FastRetryTimer : Disabled           Static LSP FR Timer: 30 seconds
P2P Max Bypass Ass*: 1000               P2P S2L Fast Retr*: 10
P2P Active Path Fa*: 10                 P2MP S2L Fast Retr*: 10
ActiveFastRetryTime: Disabled
LSP Counts

<table>
<thead>
<tr>
<th></th>
<th>Originate</th>
<th>Transit</th>
<th>Terminate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static LSPs</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Dynamic LSPs</td>
<td>3</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Detour LSPs</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>P2MP S2L</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

* indicates that the corresponding row element may have been truncated.
<table>
<thead>
<tr>
<th>Feature</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Least Fill Min Thd.:</td>
<td>5 percent</td>
</tr>
<tr>
<td>LeastFill ReoptiThd:</td>
<td>10 percent</td>
</tr>
<tr>
<td>Short. TTL Prop Lo*:</td>
<td>Enabled</td>
</tr>
<tr>
<td>Short. TTL Prop Tr*:</td>
<td>Enabled</td>
</tr>
<tr>
<td>AB Sample Multipli*:</td>
<td>1</td>
</tr>
<tr>
<td>AB Adjust Multipli*:</td>
<td>288</td>
</tr>
<tr>
<td>Exp Backoff Retry :</td>
<td>Disabled</td>
</tr>
<tr>
<td>CSPF On Loose Hop :</td>
<td>Disabled</td>
</tr>
<tr>
<td>P2mp Resignal Timer:</td>
<td>Disabled</td>
</tr>
<tr>
<td>P2mp Next Resignal :</td>
<td>N/A</td>
</tr>
<tr>
<td>Sec FastRetryTimer :</td>
<td>Disabled</td>
</tr>
<tr>
<td>Static LSP FR Timer:</td>
<td>30 seconds</td>
</tr>
<tr>
<td>P2mp Max Bypass Ass*:</td>
<td>1000</td>
</tr>
<tr>
<td>P2MP S2l Fast Retr*:</td>
<td>10</td>
</tr>
<tr>
<td>P2P Active Path Fa*:</td>
<td>10</td>
</tr>
<tr>
<td>P2MP S2l Fast Retr*:</td>
<td>10</td>
</tr>
<tr>
<td>ActiveFastRetryTime:</td>
<td>Disabled</td>
</tr>
<tr>
<td>CSPF On Loose Hop :</td>
<td>Disabled</td>
</tr>
<tr>
<td>P2P Max Bypass Ass*:</td>
<td>1000</td>
</tr>
<tr>
<td>P2MP Next Resignal :</td>
<td>N/A</td>
</tr>
<tr>
<td>Sec FastRetryTimer :</td>
<td>Disabled</td>
</tr>
<tr>
<td>Static LSP FR Timer:</td>
<td>30 seconds</td>
</tr>
</tbody>
</table>

### LSP Counts

<table>
<thead>
<tr>
<th>LSP Type</th>
<th>Originate</th>
<th>Transit</th>
<th>Terminate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static LSPs</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Dynamic LSPs</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Detour LSPs</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>P2MP S2Ls</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

* indicates that the corresponding row element may have been truncated.

*A:SRU4>config>router>mpls# show router mpls status

MPLS Status

- **Admin Status**: Up
- **Oper Status**: Up
- **Oper Down Reason**: n/a
- **FR Object**: Enabled
- **Hold Timer**: 1 seconds
- **Srlg Frr**: Enabled
- **Dynamic Bypass**: Enabled
- **User Srlg Database**: Disabled
- **Least Fill Min Thd.**: 5 percent
- **LeastFill ReoptiThd**: 10 percent
- **Short. TTL Prop Lo**: Enabled
- **Short. TTL Prop Tr**: Enabled
- **P2mp Resignal Timer**: Disabled
- **P2mp Next Resignal**: N/A
- **P2MP S2l Fast Retr**: 10
- **ActiveFastRetryTime**: Disabled

### LSP Counts

<table>
<thead>
<tr>
<th>LSP Type</th>
<th>Originate</th>
<th>Transit</th>
<th>Terminate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static LSPs</td>
<td>0</td>
<td>136</td>
<td>0</td>
</tr>
<tr>
<td>Dynamic LSPs</td>
<td>140</td>
<td>499</td>
<td>1626</td>
</tr>
<tr>
<td>Detour LSPs</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>P2MP S2Ls</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

* indicates that the corresponding row element may have been truncated.

*A:SRU4>config>router>mpls#
Show RSVP Commands

interface

Syntax  interface [ip-int-name | ip-address] statistics[detail]

Context  show>router>rsvp

Description  This command shows RSVP interfaces.

  ip-int-name — The name of the network IP interface. An interface name cannot be in the form of an IP address. If the string contains special characters (#, $, spaces, etc.), the entire string must be enclosed within double quotes.

  ip-address — The system or network interface IP address.

  statistics — Displays IP address and the number of packets sent and received on an interface-basis.

  detail — Displays detailed information.

Output  RSVP Interface Output — The following table describes RSVP interface output fields.

<table>
<thead>
<tr>
<th>Label</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface</td>
<td>The name of the IP interface.</td>
</tr>
<tr>
<td>Total Sessions</td>
<td>The total number of RSVP sessions on this interface. This count includes sessions that are active as well as sessions that have been signaled but a response has not yet been received.</td>
</tr>
<tr>
<td>Active Sessions</td>
<td>The total number of active RSVP sessions on this interface.</td>
</tr>
<tr>
<td>Total BW (Mbps)</td>
<td>The amount of bandwidth in megabits per second (Mbps) available to be reserved for the RSVP protocol on the interface.</td>
</tr>
<tr>
<td>Resv BW (Mbps)</td>
<td>The amount of bandwidth in mega-bits per seconds (Mbps) reserved on this interface. A value of zero (0) indicates that no bandwidth is reserved.</td>
</tr>
<tr>
<td>Adm Down</td>
<td>The RSVP interface is administratively disabled.</td>
</tr>
<tr>
<td>Adm Up</td>
<td>The RSVP interface is administratively enabled.</td>
</tr>
<tr>
<td>Bfd Yes</td>
<td>BFD is enabled on the RSVP interface.</td>
</tr>
<tr>
<td>Bfd No</td>
<td>BFD is disabled on the RSVP interface.</td>
</tr>
<tr>
<td>Opr Down</td>
<td>The RSVP interface is operationally down.</td>
</tr>
<tr>
<td>Opr Up</td>
<td>The RSVP interface is operationally up.</td>
</tr>
<tr>
<td>Port ID</td>
<td>Specifies the physical port bound to the interface.</td>
</tr>
<tr>
<td>Label</td>
<td>Description</td>
</tr>
<tr>
<td>-----------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Active Resvs</td>
<td>The total number of active RSVP sessions that have reserved bandwidth.</td>
</tr>
<tr>
<td>Subscription</td>
<td>Specifies the percentage of the link bandwidth that RSVP can use for reservation. When the value is zero (0), no new sessions are permitted on this interface.</td>
</tr>
<tr>
<td>Port Speed</td>
<td>Specifies the speed for the interface.</td>
</tr>
<tr>
<td>Unreserved BW</td>
<td>Specifies the amount of unreserved bandwidth.</td>
</tr>
<tr>
<td>Reserved BW</td>
<td>Specifies the amount of bandwidth in megabits per second (Mbps) reserved by the RSVP session on this interface. A value of zero (0) indicates that no bandwidth is reserved.</td>
</tr>
<tr>
<td>Total BW</td>
<td>Specifies the amount of bandwidth in megabits per second (Mbps) available to be reserved for the RSVP protocol on this interface.</td>
</tr>
<tr>
<td>Aggregate</td>
<td>Aggregate messages are used to pack multiple RSVP messages into a single packet to reduce the network overhead. When the value is true, RSVP negotiates with each neighbor and gets consensus before sending aggregate messages.</td>
</tr>
<tr>
<td>Hello Interval</td>
<td>Specifies the length of time, in seconds, between the hello packets that the router sends on the interface. This value must be the same for all routers attached to a common network. When the value is zero (0), the sending of hello messages is disabled.</td>
</tr>
<tr>
<td>Refresh Time</td>
<td>Specifies the interval between the successive Path and Resv refresh messages. RSVP declares the session down after it misses ((keep-multipier + 0.5) * 1.5 * refresh-time)) consecutive refresh messages.</td>
</tr>
<tr>
<td>Hello Timeouts</td>
<td>The total number of hello messages that timed out on this RSVP interface.</td>
</tr>
<tr>
<td>Neighbors</td>
<td>The IP address of the RSVP neighbor.</td>
</tr>
<tr>
<td>Sent</td>
<td>The total number of error free RSVP packets that have been transmitted on the RSVP interface.</td>
</tr>
<tr>
<td>Recd</td>
<td>The total number of error free RSVP packets received on the RSVP interface.</td>
</tr>
<tr>
<td>Total Packets</td>
<td>The total number of RSVP packets, including errors, received on the RSVP interface.</td>
</tr>
<tr>
<td>Bad Packets</td>
<td>The total number of RSVP packets with errors transmitted on the RSVP interface.</td>
</tr>
<tr>
<td>Paths</td>
<td>The total number of RSVP PATH messages received on the RSVP interface.</td>
</tr>
<tr>
<td>Path Errors</td>
<td>The total number of RSVP PATH ERROR messages transmitted on the RSVP interface.</td>
</tr>
</tbody>
</table>
**Show RSVP Commands**

### Sample Output

```
*A:SRU4>show>router>rsvp# interface
-------------------------------------------------------------------------------
RSVP Interfaces
-------------------------------------------------------------------------------
<table>
<thead>
<tr>
<th>Interface</th>
<th>Total Sessions</th>
<th>Active Sessions</th>
<th>Total BW (Mbps)</th>
<th>Resv BW (Mbps)</th>
<th>Adm Opr</th>
</tr>
</thead>
<tbody>
<tr>
<td>system</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Up</td>
</tr>
<tr>
<td>aps-1</td>
<td>0</td>
<td>0</td>
<td>6012</td>
<td>0</td>
<td>Up</td>
</tr>
<tr>
<td>aps-2</td>
<td>0</td>
<td>0</td>
<td>6100</td>
<td>0</td>
<td>Up</td>
</tr>
<tr>
<td>aps-3</td>
<td>0</td>
<td>0</td>
<td>6010</td>
<td>0</td>
<td>Up</td>
</tr>
<tr>
<td>sr4-1</td>
<td>0</td>
<td>0</td>
<td>6100</td>
<td>0</td>
<td>Up</td>
</tr>
<tr>
<td>ess-7-1</td>
<td>9</td>
<td>9</td>
<td>100</td>
<td>0</td>
<td>Up</td>
</tr>
<tr>
<td>ess-7-2</td>
<td>7</td>
<td>7</td>
<td>100</td>
<td>0</td>
<td>Up</td>
</tr>
<tr>
<td>ess-7-3</td>
<td>4</td>
<td>4</td>
<td>100</td>
<td>0</td>
<td>Up</td>
</tr>
<tr>
<td>ess-7-4</td>
<td>0</td>
<td>0</td>
<td>800</td>
<td>0</td>
<td>Up</td>
</tr>
<tr>
<td>ess-7-5</td>
<td>0</td>
<td>0</td>
<td>800</td>
<td>0</td>
<td>Up</td>
</tr>
<tr>
<td>ess-7-6</td>
<td>0</td>
<td>0</td>
<td>800</td>
<td>0</td>
<td>Up</td>
</tr>
<tr>
<td>hubA</td>
<td>0</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>Up</td>
</tr>
<tr>
<td>germ-1</td>
<td>0</td>
<td>0</td>
<td>1000</td>
<td>0</td>
<td>Up</td>
</tr>
<tr>
<td>src-1.1</td>
<td>3</td>
<td>2</td>
<td>100</td>
<td>0</td>
<td>Up</td>
</tr>
<tr>
<td>src-1.2</td>
<td>2</td>
<td>2</td>
<td>100</td>
<td>0</td>
<td>Up</td>
</tr>
<tr>
<td>src-1.3</td>
<td>1</td>
<td>1</td>
<td>100</td>
<td>0</td>
<td>Up</td>
</tr>
<tr>
<td>src-1.4</td>
<td>4</td>
<td>5</td>
<td>100</td>
<td>0</td>
<td>Up</td>
</tr>
<tr>
<td>g7600</td>
<td>0</td>
<td>0</td>
<td>1000</td>
<td>0</td>
<td>Up</td>
</tr>
<tr>
<td>m160</td>
<td>481</td>
<td>481</td>
<td>1000</td>
<td>82</td>
<td>Up</td>
</tr>
</tbody>
</table>
-------------------------------------------------------------------------------
Interfaces : 35
```

**Path Tears**
The total number of RSVP PATH TEAR messages received on the RSVP interface.

**Resvs**
The total number of RSVP RESV messages received on the RSVP interface.

**Resv Confirms**
The total number of RSVP RESV CONFIRM messages received on the RSVP interface.

**Resv Errors**
Total RSVP RESV ERROR messages received on RSVP interface.

**Resv Tears**
Total RSVP RESV TEAR messages received on RSVP interface.

**Refresh Summaries**
Total RSVP RESV summary refresh messages received on interface.

**Refresh Acks**
Total RSVP RESV acknowledgement messages received when refresh reduction is enabled on the RSVP interface.

**Bundle Packets**
Total RSVP RESV bundled packets received on the RSVP interface.

**Hellos**
Total RSVP RESV HELLO REQ messages received on the interface.
### RSVP Interface (statistics)

<table>
<thead>
<tr>
<th>Interface</th>
<th>Up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Packets</td>
<td>Sent: 0</td>
</tr>
<tr>
<td>Bad Packets</td>
<td>Sent: 0</td>
</tr>
<tr>
<td>Paths</td>
<td>Sent: 0</td>
</tr>
<tr>
<td>Path Errors</td>
<td>Sent: 0</td>
</tr>
<tr>
<td>Path Tears</td>
<td>Sent: 0</td>
</tr>
<tr>
<td>Resvs</td>
<td>Sent: 0</td>
</tr>
<tr>
<td>Resv Confirms</td>
<td>Sent: 0</td>
</tr>
<tr>
<td>Resv Errors</td>
<td>Sent: 0</td>
</tr>
<tr>
<td>Resv Tears</td>
<td>Sent: 0</td>
</tr>
<tr>
<td>Refresh Summaries</td>
<td>Sent: 0</td>
</tr>
<tr>
<td>Refresh Acknowledges</td>
<td>Sent: 0</td>
</tr>
<tr>
<td>Bundle Packets</td>
<td>Sent: 0</td>
</tr>
<tr>
<td>Hellos</td>
<td>Sent: 0</td>
</tr>
<tr>
<td>Auth Errors</td>
<td>Sent: 0</td>
</tr>
</tbody>
</table>

### Interface m160

<table>
<thead>
<tr>
<th>Interface</th>
<th>Up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Packets</td>
<td>Sent: 883643</td>
</tr>
<tr>
<td>Bad Packets</td>
<td>Sent: 0</td>
</tr>
<tr>
<td>Paths</td>
<td>Sent: 592153</td>
</tr>
<tr>
<td>Path Errors</td>
<td>Sent: 464</td>
</tr>
<tr>
<td>Path Tears</td>
<td>Sent: 29563</td>
</tr>
<tr>
<td>Resvs</td>
<td>Sent: 93970</td>
</tr>
<tr>
<td>Resv Confirms</td>
<td>Sent: 0</td>
</tr>
<tr>
<td>Resv Errors</td>
<td>Sent: 136815</td>
</tr>
<tr>
<td>Resv Tears</td>
<td>Sent: 13338</td>
</tr>
<tr>
<td>Refresh Summaries</td>
<td>Sent: 0</td>
</tr>
<tr>
<td>Refresh Acknowledges</td>
<td>Sent: 0</td>
</tr>
<tr>
<td>Bundle Packets</td>
<td>Sent: 0</td>
</tr>
<tr>
<td>Hellos</td>
<td>Sent: 17340</td>
</tr>
<tr>
<td>Auth Errors</td>
<td>Sent: 0</td>
</tr>
</tbody>
</table>

### Interface sr4-1

<table>
<thead>
<tr>
<th>Interface</th>
<th>Up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Packets</td>
<td>Sent: 33100</td>
</tr>
<tr>
<td>Bad Packets</td>
<td>Sent: 0</td>
</tr>
<tr>
<td>Paths</td>
<td>Sent: 0</td>
</tr>
<tr>
<td>Path Errors</td>
<td>Sent: 1783</td>
</tr>
<tr>
<td>Path Tears</td>
<td>Sent: 0</td>
</tr>
<tr>
<td>Resvs</td>
<td>Sent: 76</td>
</tr>
<tr>
<td>Resv Confirms</td>
<td>Sent: 0</td>
</tr>
</tbody>
</table>
### RSVP Errors

<table>
<thead>
<tr>
<th>Type</th>
<th>Sent</th>
<th>Recd.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resv Errors</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Resv Tears</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Refresh Summaries</td>
<td>4</td>
<td>33</td>
</tr>
<tr>
<td>Refresh Acks</td>
<td>1520</td>
<td>4</td>
</tr>
<tr>
<td>Bundle Packets</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Auth Errors</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### Statistics

- Resv Errors: Sent 0, Recd. 0
- Resv Tears: Sent 1, Recd. 0
- Refresh Summaries: Sent 4, Recd. 33
- Refresh Acks: Sent 1520, Recd. 4
- Bundle Packets: Sent 0, Recd. 0
- Auth Errors: Sent 0, Recd. 0

---

*a:* SRU4>show>router>rsvp#

*a:* SRU4>show>router>rsvp#  interface detail

---

**RSVP Interfaces (Detailed)**

---

**Interface:** system

---

**System Interface**

<table>
<thead>
<tr>
<th>Option</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port ID</td>
<td>system</td>
</tr>
<tr>
<td>Admin State</td>
<td>Up</td>
</tr>
<tr>
<td>Oper State</td>
<td>Up</td>
</tr>
<tr>
<td>Active Sessions</td>
<td>0</td>
</tr>
<tr>
<td>Active Resvs</td>
<td>0</td>
</tr>
<tr>
<td>Total Sessions</td>
<td>0</td>
</tr>
<tr>
<td>Subscription</td>
<td>100 %</td>
</tr>
<tr>
<td>Total BW</td>
<td>0 Mbps</td>
</tr>
<tr>
<td>Hello Interval</td>
<td>3000 ms</td>
</tr>
<tr>
<td>Authentication</td>
<td>Disabled</td>
</tr>
<tr>
<td>Auth Rx Seq Num</td>
<td>n/a</td>
</tr>
<tr>
<td>Auth Tx Seq Num</td>
<td>n/a</td>
</tr>
<tr>
<td>Refresh Reduc.</td>
<td>Enabled</td>
</tr>
<tr>
<td>Reliable Deli.</td>
<td>Disabled</td>
</tr>
<tr>
<td>Bfd Enabled</td>
<td>No</td>
</tr>
<tr>
<td>Graceful Shut.</td>
<td>Disabled</td>
</tr>
<tr>
<td>ImplicitNullLabel</td>
<td>Disabled</td>
</tr>
</tbody>
</table>

---

**Percent Link Bandwidth for Class Types**

- Link Bw CT0: 100
- Link Bw CT1: 0
- Link Bw CT2: 0
- Link Bw CT3: 0

---

**Bandwidth Constraints for Class Types (Kbps)**

- BC0: 0
- BC1: 0
- BC2: 0
- BC3: 0
- BC4: 0
- BC5: 0
- BC6: 0
- BC7: 0

---

**Bandwidth for TE Class Types (Kbps)**

- TE0-> Resv. Bw: 0
- TE1-> Resv. Bw: 0
- TE2-> Resv. Bw: 0
- TE3-> Resv. Bw: 0
- TE4-> Resv. Bw: 0
- TE5-> Resv. Bw: 0
- TE6-> Resv. Bw: 0
- TE7-> Resv. Bw: 0

---

**IGP Update**

- Up Thresholds(%) : 0 15 30 45 60 75 80 85 90 95 96 97 98 99 100  *
- Down Thresholds(%) : 100 99 98 97 96 95 90 85 80 75 60 45 30 15 0  *

---

**IGP Update Pending:** No

---

**No Neighbors.**
Interface : m160

-----------------------------------------------
Interface : m160
Port ID : 3/2/1
Admin State : Up  Oper State : Up
Active Sessions : 218  Active Resvs : 0
Total Sessions : 517
Subscription : 1000 %  Port Speed : 100 Mbps
Total BW : 1000 Mbps  Aggregate : Dsabl
Hello Interval : 3000 ms  Hello Timeouts : 0
Authentication : Disabled
Auth Rx Seq Num : n/a  Auth Key Id : n/a
Auth Tx Seq Num : n/a  Auth Win Size : n/a
Refresh Reduc. : Enabled  Reliable Deli. : Disabled
Bfd Enabled : No  Graceful Shut. : Disabled
ImplicitNullLabel : Disabled*

Percent Link Bandwidth for Class Types*
Link Bw CT0 : 100  Link Bw CT4 : 0
Link Bw CT1 : 0  Link Bw CT5 : 0
Link Bw CT2 : 0  Link Bw CT6 : 0
Link Bw CT3 : 0  Link Bw CT7 : 0

Bandwidth Constraints for Class Types (Kbps)
BC0 : 1000000  BC4 : 0
BC1 : 0  BC5 : 0
BC2 : 0  BC6 : 0
BC3 : 0  BC7 : 0

Bandwidth for TE Class Types (Kbps)
TE0-> Resv. Bw : 0  Unresv. Bw : 1000000
TE1-> Resv. Bw : 0  Unresv. Bw : 1000000
TE2-> Resv. Bw : 0  Unresv. Bw : 1000000
TE3-> Resv. Bw : 0  Unresv. Bw : 1000000
TE4-> Resv. Bw : 0  Unresv. Bw : 1000000
TE5-> Resv. Bw : 0  Unresv. Bw : 1000000
TE6-> Resv. Bw : 0  Unresv. Bw : 1000000
TE7-> Resv. Bw : 0  Unresv. Bw : 1000000

IGP Update
Up Thresholds(%) : 0 15 30 45 60 75 80 85 90 95 96 97 98 99 100  *
Down Thresholds(%) : 100 99 98 97 96 95 90 85 80 75 60 45 30 15 0  *
IGP Update Pending : No
Next Update : N/A
Neighbors : 10.100.30.20
* indicates inherited values
===============================================================================
*A:SRU4>show>router>rsvp#
Parameters

ip-address — Displays RSVP information about the specified IP address.
detail — Displays detailed information.

Sample Output

*A:SR1# show router rsvp neighbor detail
RSVP Neighbors (Detailed)
Legend :
LR - Local Refresh Reduction
LD - Local Reliable Delivery
LG - Local Graceful Restart
RR - Remote Refresh Reduction
RM - Remote Node supports Message ID
RG - Remote Graceful Restart
===============================================================================
Neighbor : 30.30.30.2
===============================================================================
Interface : int_SR1_SR3 Hello State : Up
Last Oper Change : 0d 00:01:02 Flags :
Source Instance : 0x6c8b7 Dst. Instance : 0x530f8e0
Hello Refresh Time : 2 secs Hello Timeout Time : 8 secs
Hello Timeout Cnt : 0 Inst. Mismatch Cnt : 0
Srefresh Time Rem. : 0 secs Epoch Num Rx : 0
Max Msg Id Rx : 0 Out of order Msgs : 0
Retransmitted Msgs : 0 GR Helper : Disabled
GR Proc Invoked Cnt : 0 GR Helper State : None
GR Helper Time Rem : N/A GR Nbr Restart Cap : N/A
GR Nbr Restart Time : N/A GR Nbr Recvry Time : N/A
==============================================================================

*B:edge13# show router rsvp neighbor
RSVP Neighbors
Legend :
LR - Local Refresh Reduction
LD - Local Reliable Delivery
LG - Local Graceful Restart
RR - Remote Refresh Reduction
RM - Remote Node supports Message ID
RG - Remote Graceful Restart
========================================================================
Neighbor Interface Hello Last Oper Flags Change
========================================================================
10.11.101.2 e13c2_1 Up 1d 00:52:56 LR RR LD RM
LG
10.11.102.2 e13c2_2 Up 1d 00:52:56 LR RR LD RM
10.11.103.3 e13s1_1 Up 1d 00:52:54 LR RR LD RM
LG
10.11.104.3 e13s1_2 Up 1d 00:52:56
10.11.105.4 e13s2_1 Up 1d 00:52:56
10.11.106.4 e13s2_2 Up 1d 00:52:56
========================================================================
Neighbors : 6
session

Syntax

```
session session-type [from ip-address | to ip-address] lsp-name name] [status (up | down)] [detail]
```

Context

```
show>router>rsvp
```

Description

This command shows RSVP session information.

Parameters

**session session-type** — Specifies the session type.

**Values**

- originate, transit, terminate, detour, detour-transit, detour-terminate, bypass-tunnel

**from ip-address** — Specifies the IP address of the originating router.

**to ip-address** — Specifies the IP address of the egress router.

**lsp-name name** — Specifies the name of the LSP used in the path.

**status up** — Specifies to display a session that is operationally up.

**status down** — Specifies to display a session that is operationally down.

**detail** — Displays detailed information.

Output

**RSVP Session Output** — The following table describers RSVP session output fields.

<table>
<thead>
<tr>
<th>Label</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>From</td>
<td>The IP address of the originating router.</td>
</tr>
<tr>
<td>To</td>
<td>The IP address of the egress router.</td>
</tr>
<tr>
<td>Tunnel ID</td>
<td>The IP address of the tunnel’s ingress node supporting this RSVP session.</td>
</tr>
<tr>
<td>LSP ID</td>
<td>The ID assigned by the agent to this RSVP session.</td>
</tr>
<tr>
<td>Name</td>
<td>The administrative name assigned to the RSVP session by the agent.</td>
</tr>
<tr>
<td>State</td>
<td>Down — The operational state of this RSVP session is down. Up — The operational state of this RSVP session is up.</td>
</tr>
</tbody>
</table>

Sample Output

```
*A:SRU4>show>router>rsvp#  session
RSVP Sessions
+-----------------+-----------------+-----------------+-----------------+-----------------+--------+
| From | To | Tunnel | LSP | Name | State |
| ID   | ID | ID    | ID  |      |       |
| 110.20.1.5 | 110.20.1.4 | 18 | 27648 b4-1::b4-1 | Up    |
| 110.20.1.5 | 110.20.1.4 | 1 | 37902 gsr::gsr | Up    |
| 110.20.1.5 | 10.20.1.22 | 11 | 53760 to_10_20_1_22_cspf::to_10_2 | Up    |
| 110.20.1.4 | 10.20.1.20 | 146 | 17920 to_10_20_1_20_cspf::to_10_2* | Up    |
| 110.20.1.4 | 10.20.1.20 | 145 | 34816 to_10_20_1_20_cspf_2::to_10_2* | Up    |
| 110.20.1.4 | 10.20.1.20 | 147 | 45056 to_10_20_1_20_cspf_4::to_10_2* | Up    |
```
Show RSVP Commands

110.20.1.4      10.20.1.20      148    6656  to_10_20_1_20_cspf_5::to_10* Up
110.20.1.4      10.20.1.20      149    58880 to_10_20_1_20_cspf_6::to_10* Up
110.20.1.4      10.20.1.20      150    13312 to_10_20_1_20_cspf_7::to_10* Up
110.20.1.4      10.20.1.20      152    40448 to_10_20_1_20_cspf_9::to_10* Up
110.20.1.4      10.20.1.20      154    27648 to_10_20_1_20_cspf_11::to_1* Up
110.20.1.4      10.20.1.20      155    12288 to_10_20_1_20_cspf_12::to_1* Up
110.20.1.4      10.20.1.20      151    46080 to_10_20_1_20_cspf_8::to_10* Up
110.20.1.4      10.20.1.20      153    512 to_10_20_1_20_cspf_10::to_1* Up
110.20.1.4      10.20.1.20      152    40448 to_10_20_1_20_cspf_9::to_1* Up
110.20.1.4      10.20.1.20      154    27648 to_10_20_1_20_cspf_11::to_1* Up
110.20.1.4      10.20.1.22      164    62464 to_10_20_1_22_cspf_2::to_10* Up
110.20.1.4      10.20.1.20      156    37888 to_10_20_1_20_cspf_13::to_1* Up
110.20.1.4      10.20.1.20      157    24064 to_10_20_1_20_cspf_14::to_1* Up
110.20.1.4      10.20.1.20      158    19968 to_10_20_1_20_cspf_15::to_1* Up
110.20.1.4      10.20.1.20      161    59904 to_10_20_1_20_cspf_18::to_1* Up

A:ALA-12# show router rsvp session lsp-name A_C_2::A_C_2 status up
RSVP Sessions
From            To              Tunnel LSP   Name                         State
ID     ID
-------------------------------------------------------------------------------
10.20.1.1       10.20.1.3       2      40    A_C_2::A_C_2                 Up
-------------------------------------------------------------------------------
Sessions : 1
A:ALA-12#

A:SRU4>show>router>rsvp#   session detail
RSVP Sessions (Detailed)
-------------------------------------------------------------------------------
LSP : b4-1::b4-1
-------------------------------------------------------------------------------
From           : 110.20.1.5             To             : 110.20.1.4
Tunnel ID      : 18                     LSP ID         : 27648
Style          : FF                     State          : Up
Session Type   : Terminate
In Interface   : 3/2/1                  Out Interface  : n/a
In Label       : 131071                 Out Label      : n/a
Previous Hop   : 10.100.30.20          Next Hop       : n/a
SetupPriority  : 7                      Hold Priority  : 0
Class Type     : 0
SubGrpOrig ID  : 0                      SubGrpOrig Addr: 0.0.0.0
P2MP ID        : 0
Path Recd      : 7497                   Path Sent      : 0
Resv Recd      : 0                      Resv Sent      : 1757
Summary messages:
SPath Recd      : 0                      SPath Sent     : 0
SResv Recd      : 0                      SResv Sent     : 0
LSP : gsr::gsr

<table>
<thead>
<tr>
<th>From</th>
<th>110.20.1.5</th>
<th>To</th>
<th>110.20.1.4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tunnel ID</td>
<td>1</td>
<td>LSP ID</td>
<td>37902</td>
</tr>
<tr>
<td>Style</td>
<td>FF</td>
<td>State</td>
<td>Up</td>
</tr>
<tr>
<td>Session Type</td>
<td>Terminate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>In Interface</td>
<td>3/2/7</td>
<td>Out Interface</td>
<td>n/a</td>
</tr>
<tr>
<td>In Label</td>
<td>128547</td>
<td>Out Label</td>
<td>n/a</td>
</tr>
<tr>
<td>Previous Hop</td>
<td>160.60.60.2</td>
<td>Next Hop</td>
<td>n/a</td>
</tr>
<tr>
<td>SetupPriority</td>
<td>7</td>
<td>Hold Priority</td>
<td>0</td>
</tr>
<tr>
<td>Class Type</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SubGrpOrig ID</td>
<td>0</td>
<td>SubGrpOrig Addr</td>
<td>0.0.0.0</td>
</tr>
<tr>
<td>P2MP ID</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Path Recd</td>
<td>5225</td>
<td>Path Sent</td>
<td>0</td>
</tr>
<tr>
<td>Resv Recd</td>
<td>0</td>
<td>Resv Sent</td>
<td>1741</td>
</tr>
<tr>
<td>Summary messages:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPath Recd</td>
<td>0</td>
<td>SPath Sent</td>
<td>0</td>
</tr>
<tr>
<td>SResv Recd</td>
<td>0</td>
<td>SResv Sent</td>
<td>0</td>
</tr>
</tbody>
</table>

From           : 110.20.1.3             | To             : 110.20.1.4
Tunnel ID      : 54                      | LSP ID         : 23088
Style          : SE                     | State          : Up
Session Type   : Terminate              |                |             |
In Interface   : aps-1                  | Out Interface  | n/a         |
In Label       : 130409                 | Out Label      | n/a         |
Previous Hop   : 104.104.0.3            | Next Hop       | n/a         |
SetupPriority  : 7                      | Hold Priority  | 0           |
Class Type     : 0                      |                |             |
SubGrpOrig ID  : 0                      | SubGrpOrig Addr| 0.0.0.0     |
P2MP ID        : 0                      |                |             |
Path Recd      : 1                      | Path Sent      | 0           |
Resv Recd      : 0                      | Resv Sent      | 1           |
Summary messages: |                     |                |             |
SPath Recd     : 840                    | SPath Sent     | 0           |
SResv Recd     : 0                      | SResv Sent     | 850         |

*A:SRU4>show>router

*A:Dut-B# show router rsvp session detour detail

RSVP Sessions (Detailed)

LSP : tof919::1_detour

<table>
<thead>
<tr>
<th>From</th>
<th>10.20.1.2</th>
<th>To</th>
<th>10.20.1.4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tunnel ID</td>
<td>919</td>
<td>LSP ID</td>
<td>15441</td>
</tr>
<tr>
<td>Style</td>
<td>SE</td>
<td>State</td>
<td>Up</td>
</tr>
<tr>
<td>Session Type</td>
<td>Originate (Detour)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>In Interface</td>
<td>n/a</td>
<td>Out Interface</td>
<td>1/1/2:1</td>
</tr>
<tr>
<td>In Label</td>
<td>n/a</td>
<td>Out Label</td>
<td>129865</td>
</tr>
<tr>
<td>Previous Hop</td>
<td>n/a</td>
<td>Next Hop</td>
<td>10.10.101.4</td>
</tr>
<tr>
<td>SetupPriority</td>
<td>4</td>
<td>Hold Priority</td>
<td>4</td>
</tr>
<tr>
<td>Class Type</td>
<td>5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Show RSVP Commands

SugGrpOrig ID : 0                  SubGrpOrig Addr: 0.0.0.0
P2MP ID      : 0

Path Recd : 0                      Path Sent : 106
Resv Recd : 113                    Resv Sent : 0

Summary messages:
SPath Recd : 0                      SPath Sent : 0
SResv Recd : 0                      SResv Sent : 0

*A:Dut-B#

*A:Dut-C# show router mpls lsp transit detail
MPLS LSPs (Transit) (Detail)
------------------------------------------------------------------------------
LSP tof1::sec2
------------------------------------------------------------------------------
From                 : 10.20.1.2             To            : 10.20.1.4
State                : Up
SetupPriority        : 5                     Hold Priority : 5
Class Type           : 5
In Interface         : lag-1:0               In Label      : 131068
Out Interface        : 2/1/2                 Out Label     : 131068
Previous Hop         : 10.10.12.2            Next Hop      : 10.10.11.4
Reserved BW          : 1000 Kbps
==============================================================================

*A:Dut-C#

*A:Dut-B# show router rsvp session detour-terminate detail
RSVP Sessions (Detailed)
==============================================================================
LSP : tof878::1_detour
------------------------------------------------------------------------------
From           : 10.20.1.2              To             : 10.20.1.4
Tunnel ID      : 878                    LSP ID         : 14929
Style          : SE                     State          : Up
Session Type   : Terminate (Detour)
In Interface   : lag-1:0                Out Interface  : 1/1/2:8
In Label       : 131069                 Out Label      : 127951
Previous Hop   : 10.10.12.3             Next Hop       : 10.10.108.4
SetupPriority  : 4                      Hold Priority  : 4
Class Type     : 5
SugGrpOrig ID  : 0                      SubGrpOrig Addr: 0.0.0.0
P2MP ID        : 0
Path Recd      : 128                    Path Sent      : 0
Resv Recd      : 125                    Resv Sent      : 124
Summary messages:
SPath Recd     : 0                      SPath Sent     : 0
SResv Recd     : 0                      SResv Sent     : 0
==============================================================================

*A:Dut-B#

*A:Dut-B# show router rsvp session bypass-tunnel detail
RSVP Sessions (Detailed)
==============================================================================
<table>
<thead>
<tr>
<th>LSP</th>
<th>bypass-link10.10.108.4</th>
</tr>
</thead>
<tbody>
<tr>
<td>From</td>
<td>10.20.1.2</td>
</tr>
<tr>
<td>To</td>
<td>10.10.109.4</td>
</tr>
<tr>
<td>Tunnel ID</td>
<td>4003</td>
</tr>
<tr>
<td>LSP ID</td>
<td>6</td>
</tr>
<tr>
<td>Style</td>
<td>FF</td>
</tr>
<tr>
<td>State</td>
<td>Up</td>
</tr>
<tr>
<td>Session Type</td>
<td>Bypass Tunnel</td>
</tr>
<tr>
<td>In Interface</td>
<td>n/a</td>
</tr>
<tr>
<td>Out Interface</td>
<td>1/1/2:9</td>
</tr>
<tr>
<td>In Label</td>
<td>n/a</td>
</tr>
<tr>
<td>Out Label</td>
<td>124069</td>
</tr>
<tr>
<td>Previous Hop</td>
<td>n/a</td>
</tr>
<tr>
<td>Next Hop</td>
<td>10.10.109.4</td>
</tr>
<tr>
<td>SetupPriority</td>
<td>7</td>
</tr>
<tr>
<td>Hold Priority</td>
<td>0</td>
</tr>
<tr>
<td>Class Type</td>
<td>0</td>
</tr>
<tr>
<td>SugGrpOrig ID</td>
<td>0</td>
</tr>
<tr>
<td>SubGrpOrig Addr</td>
<td>0.0.0.0</td>
</tr>
<tr>
<td>P2MP ID</td>
<td>0</td>
</tr>
<tr>
<td>Path Recd</td>
<td>0</td>
</tr>
<tr>
<td>Path Sent</td>
<td>3</td>
</tr>
<tr>
<td>Resv Recd</td>
<td>4</td>
</tr>
<tr>
<td>Resv Sent</td>
<td>0</td>
</tr>
</tbody>
</table>

Summary messages:
SPath Recd : 0
SPath Sent : 0
SResv Recd : 0
SResv Sent : 0

<table>
<thead>
<tr>
<th>LSP</th>
<th>tof919::1_detour</th>
</tr>
</thead>
<tbody>
<tr>
<td>From</td>
<td>10.20.1.2</td>
</tr>
<tr>
<td>To</td>
<td>10.20.1.4</td>
</tr>
<tr>
<td>Tunnel ID</td>
<td>919</td>
</tr>
<tr>
<td>LSP ID</td>
<td>15441</td>
</tr>
<tr>
<td>Style</td>
<td>SE</td>
</tr>
<tr>
<td>State</td>
<td>Up</td>
</tr>
<tr>
<td>Session Type</td>
<td>Originate (Detour)</td>
</tr>
<tr>
<td>In Interface</td>
<td>n/a</td>
</tr>
<tr>
<td>Out Interface</td>
<td>1/1/2:1</td>
</tr>
<tr>
<td>In Label</td>
<td>n/a</td>
</tr>
<tr>
<td>Out Label</td>
<td>129865</td>
</tr>
<tr>
<td>Previous Hop</td>
<td>n/a</td>
</tr>
<tr>
<td>Next Hop</td>
<td>10.10.101.4</td>
</tr>
<tr>
<td>SetupPriority</td>
<td>4</td>
</tr>
<tr>
<td>Hold Priority</td>
<td>4</td>
</tr>
<tr>
<td>Class Type</td>
<td>5</td>
</tr>
<tr>
<td>SugGrpOrig ID</td>
<td>0</td>
</tr>
<tr>
<td>SubGrpOrig Addr</td>
<td>0.0.0.0</td>
</tr>
<tr>
<td>P2MP ID</td>
<td>0</td>
</tr>
<tr>
<td>Path Recd</td>
<td>0</td>
</tr>
<tr>
<td>Path Sent</td>
<td>106</td>
</tr>
<tr>
<td>Resv Recd</td>
<td>113</td>
</tr>
<tr>
<td>Resv Sent</td>
<td>0</td>
</tr>
</tbody>
</table>

Summary messages:
SPath Recd : 0
SPath Sent : 0
SResv Recd : 0
SResv Sent : 0

<table>
<thead>
<tr>
<th>LSP</th>
<th>tof919::1_detour</th>
</tr>
</thead>
<tbody>
<tr>
<td>From</td>
<td>10.20.1.2</td>
</tr>
<tr>
<td>To</td>
<td>10.20.1.4</td>
</tr>
<tr>
<td>Tunnel ID</td>
<td>919</td>
</tr>
<tr>
<td>LSP ID</td>
<td>15441</td>
</tr>
</tbody>
</table>
Show RSVP Commands

Style : SE                     State : Up
Session Type : Transit (Detour)
In Interface : lag-1:0                Out Interface : 1/1/2:6
In Label : 131071                 Out Label : 127952
Previous Hop : 10.10.12.3     Next Hop : 10.10.106.4
SetupPriority : 4                      Hold Priority : 4
Class Type : 5
SugGrpOrig ID : 0                      SubGrpOrig Addr: 0.0.0.0
P2MP ID : 0

Path Recd : 119                    Path Sent : 123
Resv Recd : 121                    Resv Sent : 120

Summary messages:
SPath Recd : 0                      SPath Sent : 0
SResv Recd : 0                      SResv Sent : 0

==============================================================================
*A:Dut-B#
*A:Dut-B# show router rsvp session detour-terminate detail
==============================================================================
RSVP Sessions (Detailed)
------------------------------------------------------------------------------
LSP : tof878::1_detour
------------------------------------------------------------------------------
From           : 10.20.1.2              To             : 10.20.1.4
Tunnel ID      : 878                    LSP ID         : 14929
Style          : SE                     State          : Up
Session Type   : Terminate (Detour)
In Interface   : lag-1:0                Out Interface  : 1/1/2:8
In Label       : 131069                 Out Label      : 127951
Previous Hop   : 10.10.12.3             Next Hop       : 10.10.108.4
SetupPriority  : 4                      Hold Priority  : 4
Class Type     : 5
SugGrpOrig ID  : 0                      SubGrpOrig Addr: 0.0.0.0
P2MP ID        : 0
Path Recd      : 128                    Path Sent      : 0
Resv Recd      : 125                    Resv Sent      : 124
Summary messages:
SPath Recd     : 0                      SPath Sent     : 0
SResv Recd     : 0                      SResv Sent     : 0

==============================================================================
*A:Dut-B#
*A:Dut-B# show router rsvp session bypass-tunnel detail
==============================================================================
RSVP Sessions (Detailed)
------------------------------------------------------------------------------
LSP : bypass-link10.10.108.4
------------------------------------------------------------------------------
From           : 10.20.1.2              To             : 10.10.109.4
Tunnel ID      : 4003                   LSP ID         : 6
Style          : FF                     State          : Up
Session Type   : Bypass Tunnel
In Interface   : n/a                    Out Interface  : 1/1/2:9
In Label       : n/a                    Out Label      : 124069
Previous Hop   : n/a                    Next Hop       : 10.10.109.4

Summary messages:
SPath Recd     : 0                      SPath Sent     : 0
SResv Recd     : 0                      SResv Sent     : 0

==============================================================================
*A:Dut-B#
MPLS and RSVP

7710 SR OS MPLS Configuration Guide
Show RSVP Commands

status

Syntax  rsvp status
Context  show>router>rsvp
Description  This command displays RSVP status.

Output  RSVP Status — The following table describes RSVP status output fields.

<table>
<thead>
<tr>
<th>Label</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admin Status</td>
<td>Down — RSVP is administratively disabled.</td>
</tr>
<tr>
<td></td>
<td>Up — RSVP is administratively enabled.</td>
</tr>
<tr>
<td>Oper Status</td>
<td>Down — RSVP is operationally down.</td>
</tr>
<tr>
<td></td>
<td>Up — RSVP is operationally up.</td>
</tr>
<tr>
<td>Keep Multiplier</td>
<td>Displays the keep-multiplier number used by RSVP to declare that a reservation is down or the neighbor is down.</td>
</tr>
<tr>
<td>Refresh Time</td>
<td>Displays the refresh-time interval, in seconds, between the successive Path and Resv refresh messages.</td>
</tr>
<tr>
<td>Message Pacing</td>
<td>Enabled — RSVP messages, specified in the max-burst command, are sent in a configured interval, specified in the period command.</td>
</tr>
<tr>
<td></td>
<td>Disabled — Message pacing is disabled. RSVP message transmission is not regulated.</td>
</tr>
<tr>
<td>Pacing Period</td>
<td>Displays the time interval, in milliseconds, when the router can send the specified number of RSVP messages specified in the rsvp max-burst command.</td>
</tr>
<tr>
<td>Max Packet Burst</td>
<td>Displays the maximum number of RSVP messages that are sent in the specified period under normal operating conditions.</td>
</tr>
<tr>
<td>Soft Preemption</td>
<td>Displays the time, in seconds, a node holds on to a reservation for which it has triggered the soft preemption procedure.</td>
</tr>
<tr>
<td>Timer</td>
<td></td>
</tr>
<tr>
<td>Rapid Retransmit</td>
<td>Displays the value of the rapid retransmission interval.</td>
</tr>
<tr>
<td>Rapid Retry Limit</td>
<td>Displays the rapid retry limit.</td>
</tr>
<tr>
<td>Graceful Shutdown</td>
<td>Specifies whether graceful shutdown of the RSVP node is enabled.</td>
</tr>
</tbody>
</table>

Sample Output

B:# show router rsvp status
========================================================================
RSVP Status
========================================================================
Admin Status : Down               Oper Status : Down
Keep Multiplier : 3                 Refresh Time : 30 sec
Message Pacing : Disabled          Pacing Period : 100 msec
Max Packet Burst : 650 msgs
Rapid Retransmit : 5 hmsec
Graceful Shutdown : Disabled
Implicit Null Label: Disabled
P2P Merge Point Ab*: 10
DiffServTE AdmModel: Basic
Percent Link Bw CT0: 100
Percent Link Bw CT1: 0
Percent Link Bw CT2: 0
Percent Link Bw CT3: 0
TE0 -> Class Type : 0
TE1 -> Class Type : 0
TE2 -> Class Type : 0
TE3 -> Class Type : 0
TE4 -> Class Type : 0
TE5 -> Class Type : 0
TE6 -> Class Type : 0
TE7 -> Class Type : 0
IgpThresholdUpdate : Disabled
Up Thresholds(%) : 0 15 30 45 60 75 80 85 90 95 96 97 98 99 100
Down Thresholds(%) : 100 99 98 97 96 95 90 85 80 75 60 45 30 15 0

---

RSVP Status

<table>
<thead>
<tr>
<th>Admin Status</th>
<th>Oper Status</th>
<th>Keep Multiplier</th>
<th>Message Pacing</th>
<th>Max Packet Burst</th>
<th>Rapid Retransmit</th>
<th>Graceful Shutdown</th>
<th>Implicit Null Label</th>
<th>P2P Merge Point Ab*</th>
<th>DiffServTE AdmModel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Down</td>
<td>Down</td>
<td>3</td>
<td>Disabled</td>
<td>650 msgs</td>
<td>5 hmsec</td>
<td>Disabled</td>
<td>Disabled</td>
<td>Disabled</td>
<td>Basic</td>
</tr>
<tr>
<td>Percent Link Bw CT0: 100</td>
<td>Percent Link Bw CT1: 0</td>
<td>Percent Link Bw CT2: 0</td>
<td>Percent Link Bw CT3: 0</td>
<td>TE0 -&gt; Class Type : 0</td>
<td>TE1 -&gt; Class Type : 0</td>
<td>TE2 -&gt; Class Type : 0</td>
<td>TE3 -&gt; Class Type : 0</td>
<td>TE4 -&gt; Class Type : 0</td>
<td>TE5 -&gt; Class Type : 0</td>
</tr>
<tr>
<td>IgpThresholdUpdate : Disabled</td>
<td>Up Thresholds(%) : 0 15 30 45 60 75 80 85 90 95 96 97 98 99 100</td>
<td>Down Thresholds(%) : 100 99 98 97 96 95 90 85 80 75 60 45 30 15 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

* indicates that the corresponding row element may have been truncated.

show router rsvp status

* indicates that the corresponding row element may have been truncated.
Show RSVP Commands

RSVP Status

Admin Status : Down  Oper Status : Down
Keep Multiplier : 3  Refresh Time : 30 sec
Message Pacing : Disabled  Refresh Period : 100 msec
Max Packet Burst : 650 msgs  Refresh Bypass : Disabled
Rapid Retransmit : 5 hmsec  Rapid Retry Limit : 3
Graceful Shutdown : Disabled  SoftPreemptionTimer : 300 sec
Implicit Null Label : Disabled  Node-id in RRO : Exclude
P2P Merge Point Ab* : 10  P2MP Merge Point A* : 10
DiffServTE AdmModel : Basic
Percent Link Bw CT0 : 100  Percent Link Bw CT4 : 0
Percent Link Bw CT2 : 0  Percent Link Bw CT6 : 0
Percent Link Bw CT3 : 0  Percent Link Bw CT7 : 0
TE0 -> Class Type : 0  Priority : 0
TE1 -> Class Type : 0  Priority : 1
TE2 -> Class Type : 0  Priority : 2
TE3 -> Class Type : 0  Priority : 3
TE4 -> Class Type : 0  Priority : 4
TE5 -> Class Type : 0  Priority : 5
TE6 -> Class Type : 0  Priority : 6
TE7 -> Class Type : 0  Priority : 7
IgpThresholdUpdate : Disabled
Up Thresholds(%) : 0 15 30 45 60 75 80 85 90 95 96 97 98 99 100
Down Thresholds(%) : 100 99 98 97 96 95 90 85 80 75 60 45 30 15 0
Update Timer : N/A
Update on CAC Fail : Disabled

RSVP Status

Admin Status : Up  Oper Status : Up
Keep Multiplier : 3  Refresh Time : 30 sec
Message Pacing : Disabled  Refresh Period : 100 msec
Max Packet Burst : 650 msgs  Refresh Bypass : Disabled
Rapid Retransmit : 100 hmsec  Rapid Retry Limit : 3
Graceful Shutdown : Disabled  SoftPreemptionTimer : 300 sec
Implicit Null Label : Disabled
DiffServTE AdmModel : Basic
Percent Link Bw CT0 : 100  Percent Link Bw CT4 : 0
Percent Link Bw CT2 : 0  Percent Link Bw CT6 : 0
Percent Link Bw CT3 : 0  Percent Link Bw CT7 : 0
TE0 -> Class Type : 0  Priority : 0
TE1 -> Class Type : 0  Priority : 1
TE2 -> Class Type : 0  Priority : 2
TE3 -> Class Type : 0  Priority : 3
TE4 -> Class Type : 0  Priority : 4
TE5 -> Class Type : 0  Priority : 5
TE6 -> Class Type : 0  Priority : 6
TE7 -> Class Type : 0  Priority : 7
IgpThresholdUpdate : Disabled
Up Thresholds(%) : 0 15 30 45 60 75 80 85 90 95 96 97 98 99 100
Down Thresholds(%) : 100 99 98 97 96 95 90 85 80 75 60 45 30 15 0
Update Timer : N/A
Update on CAC Fail : Disabled

* indicates that the corresponding row element may have been truncated.

*A:SRU4>show>router>rsvp# status

*A:SRU4>show>router>rsvp#
## Tools Commands

### lspinfo

**Syntax**  
```bash
lspinfo
```

**Context**  
```bash
tools>dump>router>mpls
```

**Description**  
This command dumps LSP information for MPLS.

**Sample Output**

```
A:PC6-192.168.2.104># /tools dump router mpls lspinfo
LSP "1"  LspIdx 1  LspType Dynamic  State LSPS_ON_PRIMARY  Flags 0x2000
NumPaths 2  NumSdps 0  NumCBFSdps 0
HoldTimeRemaining 0sec  ClassType 0  Metric 0  OperMetric 65535
LDPoRsvp Include  VprnAutoBind Include IgpShortCut Include BgpShortCut Include
BgpTransTunnel Include IpShCutTtlPropLocal TRUE IpShCutTtlPropTans TRUE
Path "1"  LspId 54322  PathType Primary  ActivePath Yes
  Hop No: 1  IngIp 10.254.1.3  EgrIp 0.0.0.0  rtrId 0.0.0.0  HopType 1  Flag 0x0
  Hop No: 2  IngIp 10.254.1.1  EgrIp 0.0.0.0  rtrId 0.0.0.0  HopType 1  Flag 0x1
LspPath FsmState LSP_PATHS_UP  Flags 0x0
RetryAttempts 0  RetryRemaining -1  RetryInterval 30  NextRetryIn 0secs
Oper Values:
  Class Type 0  SetupPri 7  HoldPri 0  Pref 0  HopLimit 20  TotIgpCost 0  Metric 65535
  record route no record label Metric 65535 [TE] include 0x25  exclude 0x80
Last MBB -
  Type Config Change  State Successful  CspfFailures 0
  Started 2011/03/30 12:21:23.25 UTC
  Ended 2011/03/30 12:21:24.13 UTC
  Pre-MBB IGP Cost 0
```

### ftn

**Syntax**  
```bash
ftn
```

**Context**  
```bash
tools>dump>router>mpls
```

**Description**  
This command dumps FTN information for MPLS.

### ilm

**Syntax**  
```bash
ilm
```

**Context**  
```bash
tools>dump>router>mpls
```

**Description**  
This command dumps ILM information for MPLS.
Tools Commands

memory-usage

Syntax   memory-usage
Context   tools>dump>router>mpls
Description  This command dumps memory usage information for MPLS.

force-switch-path

Syntax   force-switch-path [lsp lsp-name] [path path-name]
Context   tools>perform>router>mpls
Description  Use this command to move from a standby path to any other standby path regardless of priority.
The no form of the command reverts to priority path.
Parameters   lsp-name — Specifies an existing LSP name to move.
               path-name — Specifies the path name to which to move the specified LSP.

plr

Syntax   plr
Context   tools>dump>router>mpls>bypass-tunnel
Description

Sample Output

tools dump router mpls bypass-tunnel plr
========================================================================
MPLS Bypass Tunnels
========================================================================
Legend :  m - Manual      d - Dynamic      p - P2mp
========================================================================
To              State  Out I/F        Out Label     Reserved   Protected  Type
BW (Kbps)  LSP Count
------------------------------------------------------------------------
10.10.12.1      Up     1/1/4          124181        0          369        d
To              : 10.10.12.1         State               : Up
Out I/F         : 1/1/4              Out Label           : 124181
Up Time         : 0d 19:24:13        Active Time         : n/a
Reserved BW     : 0 Kbps             Protected LSP Count : 369
Type            : Dynamic
SetupPriority   : 7                  Hold Priority       : 0
Class Type      : 0                  Tunnel Id : 63697
Actual Hops     :
10.10.12.2(S)    -> 10.10.12.1(S)
Plr List: (Last PlrIdx 2)
--------
PLR List Index = 1
PLR current State = PLRS_CONNECTED
NextNodeSysId = 8.8.8.8
AvoidNodeId = 2.2.2.2
NodeProtect = 2 (Node Protect)
LSP Count = 197
PLR List Index = 2
PLR current State = PLRS_BackupInUse
NextNodeSysId = 8.8.8.8
AvoidNodeId = 2.2.2.2
NodeProtect = 2 (Node Protect)
LSP Count = 203

**cspf**

**Syntax**

cspf to ip-addr [from ip-addr] [bandwidth bandwidth] [include-bitmap bitmap] [exclude-bitmap bitmap] [hop-limit limit] [exclude-address excl-addr [excl-addr...(up to 8 max)]] [use-te-metric] [strict-srlg] [srlg-group grp-id...(up to 8 max)] [exclude-node excl-node-id [excl-node-id...(up to 8 max)]] [skip-interface interface-name] [ds-class-type class-type] [cspf-reqtype req-type] [least-fill-min-thd thd] [setup-priority val] [hold-priority val]

**Context**
tools>perform>router>mpls

**Description**
This command computes a CSPF path with specified user constraints.

**Default**
none

**Parameters**
to ip-addr — Specify the destination IP address.
from ip-addr — Specify the originating IP address.
bandwidth bandwidth — Specifies the amount of bandwidth in mega-bits per second (Mbps) to be reserved.
include-bitmap bitmap — Specifies to include a bit-map that specifies a list of admin groups that should be included during setup.
exclude-bitmap bitmap — Specifies to exclude a bit-map that specifies a list of admin groups that should be included during setup.
hop-limit limit — Specifies the total number of hops a detour LSP can take before merging back onto the main LSP path.
exclude-address ip-addr — Specifies IP addresses, up to 8, that should be included during setup.
use-te-metric — Specifies the use of the traffic engineering metric used on the interface.
strict-srlg — Specifies whether to associate the LSP with a bypass or signal a detour if a bypass or detour satisfies all other constraints except the SRLG constraints.
srlg-group grp-id — Specifies up to 8 Shared Risk Loss Groups (SRLGs). An SRLG group represents a set of interfaces which could be subject to the same failures or defects and thus share the same risk of failing.

**Values**

0 — 4294967295
Tools Commands

**exclude-node excl-node-id** — specifies a list of address that should be excluded when this LSP is setup.

**skip-interface interface-name** — Specifies an interface name that should be skipped during setup.

**ds-class-type class-type** — Specifies the class type (CT) associated with this LSP.

**Values**

0 — 7

**cspf-reqtype req-type** — Specifies the req. type.

**Values**

all, random, least-fill

**least-fill-min-thd thd** — Specifies whether the use of the least-fill path selection method for the computation of the path of this LSP is enabled.

**Values**

1 — 100

**setup-priority val** — Specifies the setup priority to use when insufficient bandwidth is available to setup an LSP.

**Values**

0 — 7

**hold-priority val** — Specifies the hold priority value to use when insufficient bandwidth is available to setup an LSP.

**Values**

0 — 7

resignal

**Syntax**

resignal {lsp lsp-name path path-name | delay minutes}

**Context**

tools>perform>router>mpls

**Description**

This command resignals a specific LSP path. The minutes parameter configures the global timer or all LSPs for resignal. If only lsp-name and path-name are provided, the LSP will be resignedaled immediately.

**Parameters**

- **lsp-name** — Specifies an existing LSP name to resignal.
- **path-name** — Specifies an existing path name to resignal.
- **delay minutes** — Configures the global timer or all LSPs to resignal.

switch-path

**Syntax**

switch-path [lsp lsp-name] [path path-name]

**Context**

tools>perform>router>mpls

Use this command to move from a standby (or an active secondary) to another standby of the same priority. If a new standby path with a higher priority or a primary path comes up after the tools perform command is executed, the path re-evaluation command runs and the path is moved to the path specified by the outcome of the re-evaluation.
Parameters

- `lsp-name` — Specifies an existing LSP name to move.
- `path-name` — Specifies the path name to which to move the specified LSP.

### trap-suppress

**Syntax**

```
trap-suppress number-of-traps time-interval
```

**Context**

`tools>perform>router>mpls`

**Description**

This command modifies thresholds for trap suppression. The `time-interval` parameter is used to suppress traps after a certain number of traps have been raised within a period. By executing this command, there will be no more than `number-of-traps` within `time-interval`.

**Parameters**

- `number-of-traps` — Specifies to suppress the number of traps raised within a period.
  - **Values**
    - `100 — 1000`, in multiples of 100
- `time-interval` — Specifies to suppress a certain number of traps raised within a period.
  - **Values**
    - `1 — 300`

### update-path

**Syntax**

```
update-path {lsp lsp-name path current-path-name new-path new-path-name}
```

**Context**

`tools>perform>router>mpls`

**Description**

This command enables you to instruct MPLS to replace the path of a primary or secondary LSP. The primary or secondary LSP path is indirectly identified via the `current-path-name` value. The same path name cannot be used more than once in a given LSP name.

This command applies to both CSPF LSP and to a non-CSPF LSP. This command will only work when the specified `current-path-name` has the adaptive option enabled. The adaptive option can be enabled at the LSP level or the path level.

The new path must have been configured in the CLI or provided via SNMP. The CLI command for entering the path is

```
configure router mpls path path-name
```

The command fails if any of the following conditions exist:

- The specified `current-path-name` of this LSP does not have the adaptive option enabled.
- The specified `new-path-name` value does not correspond to a previously defined path.
- The specified `new-path-name` value exists but is being used by any path of the same LSP, including this one.

When you execute this command, MPLS performs the following procedures:

- MPLS performs a single MBB attempt to move the LSP path to the new path.
- If the MBB is successful, MPLS updates the new path.
Tools Commands

- MPLS writes the corresponding NHLFE in the data path if this path is the current backup path for the primary.
- If the current path is the active LSP path, it will update the path, write the new NHLFE in the data path that will cause traffic to switch to the new path.
  - If the MBB is not successful, the path retains its current value.
  - The update-path MBB has the same priority as the manual re-signal MBB.
Clear Commands

interface

Syntax  interface ip-int-name [statistics]
Context  clear>router>mpls
Description  This command resets or clears statistics for MPLS interfaces.
Parameters  ip-int-name — The name of an existing IP interface. If the string contains special characters (#, $, spaces, etc.), the entire string must be enclosed within double quotes.
          statistics — This parameter clears only statistics.

lsp

Syntax  lsp lsp-name
Context  clear>router>mpls
Description  This command resets and restarts an LSP.
Parameters  lsp-name — The name of the LSP to clear up to 64 characters in length.

interface

Syntax  interface ip-int-name statistics
Context  clear>router>rsvp
Description  This command resets or clears statistics for an RSVP interface.
Parameters  ip-int-name — The name of the IP interface to clear. If the string contains special characters (#, $, spaces, etc.), the entire string must be enclosed within double quotes.
          statistics — This parameter clears only statistics.

statistics

Syntax  statistics
Context  clear>router>rsvp
Description  This command clears global statistics for the RSVP instance, for example, clears path and resv timeout counters.
Debug Commands

mpls

Syntax
```
mpls [lsp lsp-name] [sender source-address] [endpoint endpoint-address] [tunnel-id tunnel-id] [lsp-id lsp-id] [interface ip-int-name]
```

Context debug>router

Description This command enables and configures debugging for MPLS.

Parameters
- **lsp lsp-name** — Name that identifies the LSP. The LSP name can be up to 32 characters long and must be unique.
- **sender source-address** — The system IP address of the sender.
- **endpoint endpoint-address** — The far-end system IP address.
- **tunnel-id tunnel-id** — The MPLS SDP ID.
  
  **Values**
  - 0 — 4294967295

- **lsp-id lsp-id** — The LSP ID.
  
  **Values**
  - 1 — 65535

- **interface ip-int-name** — Name that identifies the interface. The interface name can be up to 32 characters long and must be unique. If the string contains special characters (#, $, spaces, etc.), the entire string must be enclosed within double quotes.

event

Syntax
```
[no] event
```

Context debug>router>mpls
debu**

Description This command enables debugging for specific events.

The **no** form of the command disables the debugging.
all

**Syntax**: all [detail]

**Context**: debug>router>mpls>event
d debug>router>rsvp>event

**Description**: This command debugs all events.
The **no** form of the command disables the debugging.

**Parameters**: detail — Displays detailed information about all events.

frr

**Syntax**: frr [detail]

**Context**: debug>router>mpls>event

**Description**: This command debugs fast re-route events.
The **no** form of the command disables the debugging.

**Parameters**: detail — Displays detailed information about re-route events.

iom

**Syntax**: iom [detail]

**Context**: debug>router>mpls>event

**Description**: This command reports MPLS debug events originating from the XMA.
The **no** form of the command disables the debugging.

**Parameters**: detail — Displays detailed information about MPLS events originating from the XMA.

lsp-setup

**Syntax**: lsp-setup [detail]

**Context**: debug>router>mpls>event

**Description**: This command debugs LSP setup events.
The **no** form of the command disables the debugging.

**Parameters**: detail — Displays detailed information about LSP setup events.
Debug Commands

**mbb**

**Syntax**

```
mbb [detail]
no mbb
```

**Context**

debug>router>mpls>event

**Description**

This command debugs the state of the most recent invocation of the make-before-break (MBB) functionality.

The `no` form of the command disables the debugging.

**Parameters**

detail — Displays detailed information about MBB events.

**misc**

**Syntax**

```
misc [detail]
no misc
```

**Context**

debug>router>mpls>event
debug>router>rsvp>event

**Description**

This command debugs miscellaneous events.

The `no` form of the command disables the debugging.

**Parameters**

detail — Displays detailed information about miscellaneous events.

**xc**

**Syntax**

```
xc [detail]
no xc
```

**Context**

debug>router>mpls>event

**Description**

This command debugs cross connect events.

The `no` form of the command disables the debugging.

**Parameters**

detail — Displays detailed information about cross connect events.

**rsvp**

**Syntax**

```
[lsp lsp-name] [sender source-address] [endpoint endpoint-address] [tunnel-id tunnel-id]
[lsp-id lsp-id] [interface ip-int-name]
no rsvp
```

**Context**

debug>router

**Description**

This command enables and configures debugging for RSVP.
Parameters  

- **lsp lsp-name** — Name that identifies the LSP. The LSP name can be up to 32 characters long and must be unique.

- **sender source-address** — The system IP address of the sender.

- **endpoint endpoint-address** — The far-end system IP address.

- **tunnel-id tunnel-id** — The RSVP tunnel ID.
  - Values
    - 0 — 4294967295

- **lsp-id lsp-id** — The LSP ID.
  - Values
    - 1 — 65535

- **interface ip-int-name** — The interface name. The interface name can be up to 32 characters long and must be unique. If the string contains special characters (#, $, spaces, etc.), the entire string must be enclosed within double quotes.

**nbr**

**Syntax**

- `nbr [detail]`
- `no nbr`

**Context**

debug>router>rsvp>event

**Description**

This command debugs neighbor events.

The **no** form of the command disables the debugging.

**Parameters**

- **detail** — Displays detailed information about neighbor events.

**path**

**Syntax**

- `path [detail]`
- `no path`

**Context**

debug>router>rsvp>event

**Description**

This command debugs path-related events.

The **no** form of the command disables the debugging.

**Parameters**

- **detail** — Displays detailed information about path-related events.

**resv**

**Syntax**

- `resv [detail]`
- `no resv`

**Context**

debug>router>rsvp>event

**Description**

This command debugs RSVP reservation events.
Debug Commands

The **no** form of the command disables the debugging.

**Parameters**
- **detail** — Displays detailed information about RSVP reservation events.

### te-threshold-update

**Syntax**
- `te-threshold-update`
- `no te-threshold-update`

**Context**
- `debug>router>rsvp>event`
- `debug>router>rsvp>ip-int-name>event`

**Description**
This command debugs the te-threshold-update events.

The **no** form of this command disables the debugging.

### packet

**Syntax**
- `[no] packet`

**Context**
- `debug>router>rsvp>`

**Description**
This command enters the syntax to debug packets.

### all

**Syntax**
- `all [detail]`
- `no all`

**Context**
- `debug>router>rsvp>packet`

**Description**
This command debugs all packets.

The **no** form of the command disables the debugging.

**Parameters**
- **detail** — Displays detailed information about all RSVP packets.

### hello

**Syntax**
- `hello [detail]`
- `no hello`

**Context**
- `debug>router>rsvp>packet`

**Description**
This command debugs hello packets.

The **no** form of the command disables the debugging.

**Parameters**
- **detail** — Displays detailed information about hello packets.
path

Syntax  path [detail]
        no path

Context  debug>router>rsvp>packet

Description  This command enables debugging for RSVP path packets.
The no form of the command disables the debugging.

Parameters  detail — Displays detailed information about path-related events.

patherr

Syntax  patherr [detail]
        no patherr

Context  debug>router>rsvp>packet

Description  This command debugs path error packets.
The no form of the command disables the debugging.

Parameters  detail — Displays detailed information about path error packets.

path tear

Syntax  path tear [detail]
        no path tear

Context  debug>router>rsvp>packet

Description  This command debugs path tear packets.
The no form of the command disables the debugging.

Parameters  detail — Displays detailed information about path tear packets.

resv

Syntax  resv [detail]
        no resv

Context  debug>router>rsvp>packet

Description  This command enables debugging for RSVP resv packets.
The no form of the command disables the debugging.

Parameters  detail — Displays detailed information about RSVP Resv events.
Debug Commands

resverr

Syntax: resverr [detail]
no resverr

Context: debug>router>rsvp>packet

Description: This command debugs ResvErr packets.
The no form of the command disables the debugging.

Parameters: detail — Displays detailed information about ResvErr packets.

resvtear

Syntax: resvtear [detail]
no resvtear

Context: debug>router>rsvp>packet

Description: This command debugs ResvTear packets.
The no form of the command disables the debugging.

Parameters: detail — Displays detailed information about ResvTear packets.
Configuring LDP with CLI

This section provides information to configure LDP using the command line interface.

Topics in this section include:

- LDP Configuration Overview on page 312
- Basic LDP Configuration on page 313
- Common Configuration Tasks on page 314
- LDP Configuration Management Tasks on page 324
LDP Configuration Overview

When the implementation of LDP is instantiated, the protocol is in the `no shutdown` state. In addition, targeted sessions are then enabled. The default parameters for LDP are set to the documented values for targeted sessions in `draft-ietf-mpls-ldp-mib-09.txt`.

LDP must be enabled in order for signaling to be used to obtain the ingress and egress labels in frames transmitted and received on the service distribution path (SDP). When signaling is `off`, labels must be manually configured when the SDP is bound to a service.
Basic LDP Configuration

This chapter provides information to configure LDP and remove configuration examples of common configuration tasks.

The LDP protocol instance is created in the `no shutdown` (enabled) state.

The following displays the default LDP configuration.

```
A:ALA-1>config>router>ldp# info
----------------------------------------------
| interface-parameters | exit          |
| exit                | targeted-session | exit |
----------------------------------------------
A:ALA-1>config>router>ldp#
```
Common Configuration Tasks

This section provides information to configure:

- Enabling LDP on page 314
- Configuring FEC Originate Parameters on page 315
- Configuring Graceful-Restart Helper Parameters on page 316
- Applying Export and Import Policies on page 317
- Targeted Session Parameters on page 318
- Interface Parameters on page 319
- Peer Parameters on page 320
- Interface Parameters on page 319

Enabling LDP

LDP must be enabled in order for the protocol to be active. MPLS must also be enabled. MPLS is enabled in the `config>router>mpls` context.

Use the following syntax to enable LDP on a router:

**CLI Syntax:** ldp

**Example:** config>router# ldp

The following displays the enabled LDP configuration.

```
A:ALA-1>config>router# info
----------------------------------------------
...                                        ...
#------------------------------------------
echo "LDP Configuration"
#------------------------------------------
  ldp
    interface-parameters
    exit
    targeted-session
    exit
    exit
----------------------------------------------
...                                        ...
A:ALA-1>config>router#
```
Configuring FEC Originate Parameters

A FEC can be added to the LDP IP prefix database with a specific label operation on the node. Permitted operations are pop or swap. For a swap operation, an incoming label can be swapped with a label in the range of 16 to 1048575. If a swap-label is not configured then the default value is 3.

A route table entry is required for a FEC with a pop operation to be advertised. For a FEC with a swap operation, a route-table entry must exist and user configured next-hop for swap operation must match one of the next-hops in route-table entry.

Use the following syntax to configure FEC originate parameters:

**CLI Syntax:**
```
config>router>ldp
   fec-originate ip-prefix/mask [advertised-label in-label]
   next-hop ip-address [swap-label out-label]
   fec-originate ip-prefix/mask [advertised-label in-label] pop
```

The following displays a FEC originate configuration example.

A:ALA-5>config>router# info
----------------------------------------------
fec-originate 100.1.1.1/32 pop
fec-originate 100.2.1.1/32 advertised-label 1000 next-hop 10.10.1.2
fec-originate 100.3.1.1/32 advertised-label 1001 next-hop 10.10.2.3
   swap-label 131071
interface-parameters
exit
targeted-session
exit
exit
----------------------------------------------
A:ALA-5>config>router>ldp#
Configuring Graceful-Restart Helper Parameters

Graceful-restart helper advertises to its LDP neighbors by carrying the fault tolerant (FT) session TLV in the LDP initialization message, assisting the LDP in preserving its IP forwarding state across the restart. Alcatel-Lucent’s recovery is self-contained and relies on information stored internally to self-heal. This feature is only used to help third-party routers without a self-healing capability to recover.

Maximum recovery time is the time (in seconds) the sender of the TLV would like the receiver to wait, after detecting the failure of LDP communication with the sender.

Neighbor liveness time is the time (in seconds) the LSR is willing to retain its MPLS forwarding state. The time should be long enough to allow the neighboring LSRs to re-sync all the LSPs in a graceful manner, without creating congestion in the LDP control plane.

Use the following syntax to configure graceful-restart parameters:

CLI Syntax: config>router>ldp

[no] graceful-restart
Applying Export and Import Policies

Both inbound and outbound label binding filtering are supported. Inbound filtering allows a route policy to control the label bindings an LSR accepts from its peers. An import policy can accept or reject label bindings received from LDP peers.

Label bindings can be filtered based on:

• Neighbor — Match on bindings received from the specified peer.
• Interface — Match on bindings received from a neighbor or neighbors adjacent over the specified interface.
• Prefix-list — Match on bindings with the specified prefix/prefixes.

Outbound filtering allows a route policy to control the set of LDP label bindings advertised by the LSR. An export policy can control the set of LDP label bindings advertised by the router. By default, label bindings for only the system address are advertised and propagate all FECs that are received. All other local interface FECs can be advertised using policies. Beware that the system IP address AND static FECs cannot be blocked using an export policy.

Matches can be based on:

• Loopback — loopback interfaces.
• All — all local subnets.
• Match — match on bindings with the specified prefix/prefixes.

Use the following syntax to apply import and export policies:

**CLI Syntax:**
```
config>router>ldp
export policy-name [policy-name...(upto 32 max)]
import policy-name [policy-name...(upto 32 max)]
```

The following displays export and import policy configuration examples.

```text
A:ALA-1>config-router# info
----------------------------------------------
export "LDP-export"
 fec-originate 100.1.1.1/32 pop
 fec-originate 100.2.1.1/32 advertised-label 1000 next-hop 10.10.1.2
 import "LDP-import"
 interface-parameters
 exit
 targeted-session
 exit
----------------------------------------------
A:ALA-1>config-router#
```
Targeted Session Parameters

Use the following syntax to specify targeted-session parameters:

**CLI Syntax:**
```
config>router# ldp
targeted-session
  disable-targeted-session
  export-prefixes policy-name [policy-name...(up to 5 max)]
  hello timeout factor
  import-prefixes policy-name [policy-name...(up to 5 max)]
  keepalive timeout factor
  peer ip-address
    hello timeout factor
    keepalive timeout factor
  no shutdown
  tunneling
    lsp lsp-name
```

The following example displays an LDP configuration example:

```
A:ALA-1>config>router>ldp# info
----------------------------------------------
... targeted-session
  hello 5000 255
  keepalive 5000 255
  peer 10.10.10.104
    hello 2500 104
    keepalive 15 3
  exit
  exit
----------------------------------------------
A:ALA-1>config>router>ldp#
```
Interface Parameters

Use the following syntax to configure interface parameters:

**CLI Syntax:**
```
cfg-router# ldp
  interface-parameters
    hello timeout factor
    keepalive timeout factor
    transport-address {system|interface}
    interface ip-int-name
      hello timeout factor
      keepalive timeout factor
      transport-address {system|interface}
    no shutdown
```

The following example displays an interface parameter configuration example:

```
A:ALA-1>config>router>ldp# info
----------------------------------------------
... targeted-session
  no disable-targeted-session
  hello 5000 255
  keepalive 5000 255
  peer 10.10.10.104
    hello 2500 104
    keepalive 15 3
    no shutdown
  exit
  exit
  no shutdown
----------------------------------------------
A:ALA-1>config>router>ldp#
```
Peer Parameters

Use the following syntax to specify interface parameters:

**CLI Syntax:**
```
config>router# ldp
    peer-parameters
    peer ip-address
    auth-keychain name
    authentication-key [authentication-key|hash-key]
        [hash|hash2]
    ttl-security min-ttl-value [log log-id]
```

The following example displays an LDP configuration example:

```
A:ALA-1>config>router>ldp# info
----------------------------------------------
export "LDP-export"
import "LDP-import"
peer-parameters
    peer 10.10.10.104
        authentication-key "3WBzEDozxyQ" hash
    exit
exit
interface-parameters
    interface "test"
    exit
    interface "to-104"
        hello 15 3
    exit
exit
targeted-session
    hello 5000 255
    keepalive 5000 255
    peer 10.10.10.104
        hello 2500 100
        keepalive 15 3
    exit
exit
----------------------------------------------
A:ALA-1>config>router>ldp#
```
LDP Signaling and Services

When LDP is enabled, targeted sessions can be established to create remote adjacencies with nodes that are not directly connected. When service distribution paths (SDPs) are configured, extended discovery mechanisms enable LDP to send periodic targeted hello messages to the SDP’s far-end point. The exchange of LDP hellos trigger session establishment. The SDP’s signaling default enables \texttt{tldp}. The service SDP uses the targeted-session parameters configured in the \texttt{config(router)ldp>targeted-session} context.

The SDP’s LDP and LSP commands are mutually exclusive; either one LSP can be specified or LDP can be enabled. If LDP is already enabled on an MPLS SDP, then an LSP cannot be specified on the SDP. If an LSP is specified on an MPLS SDP, then LDP cannot be enabled on the SDP.

To enable LDP on the SDP when an LSP is already specified, the LSP must be removed from the configuration using the \texttt{no lsp \texttt{lsp-name}} command. For further information about configuring SDPs, refer to the 7710 SR OS Services Guide.

The following example displays the command syntax usage to configure enable LDP on an MPLS SDP:

**CLI Syntax:**

```
config>service>sdp#
  ldp
    signaling {off|tldp}
```

The following displays an example of an SDP configuration showing the signaling default \texttt{tldp} enabled.

```
A:ALA-1#config>service>sdp# info detail
----------------------------------------------
| description "MPLS: to-99"
| far-end 10.10.10.99
| ldp
| signaling tldp
| path-mtu 4462
| keep-alive
|   hello-time 10
|   hold-down-time 10
|   max-drop-count 3
|   timeout 5
|   no message-length
|   no shutdown
| exit
| no shutdown
----------------------------------------------
A:ALA-1#config>service>sdp#
```
The following shows a working configuration of LDP over RSVP-TE (1) where tunnels look like the second example (2):

1. *A:ALA-1>config>router>ldp# info
   ----------------------------------------------
   prefer-tunnel-in-tunnel
   interface-parameters
   interface "port-1/1/3"
   exit
   interface "port-lag-1"
   exit
   exit
   targeted-session
   peer 10.51.0.1
   shutdown
tunneling
   lsp "to_P_1"
   exit
   exit
   peer 10.51.0.17
   shutdown
tunneling
   lsp "to_P_6"
   exit
   exit
   exit
   ----------------------------------------------
   *A:ALA-1>config>router>ldp#

2. *A:ALA-1>config>router>mpls# info
   ----------------------------------------------
   resignal-timer 30
   admin-group "lower" 2
   admin-group "upper" 1
   interface "system"
   exit
   interface "port-1/1/3"
   exit
   interface "port-lag-1"
   exit
   path "dyn"
   no shutdown
   exit
   lsp "to_P_1"
   to 10.51.0.1
   cspf
   fast-reroute facility
   exit
   primary "dyn"
   exit
   no shutdown
   exit
   lsp "to_P_6"
   to 10.51.0.17
   cspf
   fast-reroute facility
   exit
exit
primary "dyn"
exit
no shutdown
exit
no shutdown

*A:ALA-1>config>router>mpls#
LDP Configuration Management Tasks

This section discusses the following LDP configuration management tasks:

- Disabling LDP on page 324
- Modifying Targeted Session Parameters on page 325
- Modifying Interface Parameters on page 326
- Modifying Interface Parameters on page 326

Disabling LDP

The `no ldp` command disables the LDP protocol on the router. All parameters revert to the default settings. LDP must be shut down before it can be disabled.

Use the following command syntax to disable LDP:

**CLI Syntax:**

```
no ldp
    shutdown
```
**Modifying Targeted Session Parameters**

The modification of LDP targeted session parameters does not take effect until the next time the session goes down and is re-establishes. Individual parameters cannot be deleted. The `no` form of a `targeted-session` parameter command reverts modified values back to the default.

The following example displays the command syntax usage to revert targeted session parameters back to the default values:

**Example:**
```
cfg>router# ldp
cfg>router>ldp# targeted-session
cfg>router>ldp>targeted# no authentication-key
cfg>router>ldp>targeted# no disable-targeted-session
cfg>router>ldp>targeted# no hello
```
```
cfg>router>ldp>targeted# no keepalive
```
```
cfg>router>ldp>targeted# no peer 10.10.10.99
```

The following output displays the default values:

```
A:ALA-1>config>router# ldp
----------------------------------------------------------
no disable-targeted-session
hello 45 3
keepalive 40 4
----------------------------------------------------------
A:ALA-1>config>router# ldp
```
Modifying Interface Parameters

Individual parameters cannot be deleted. The no form of a interface-parameter command reverts modified values back to the defaults.

The following output displays the default values:

```
A:ALA-1>config>router>ldp-targeted# info detail
----------------------------------------------
    hello 15 3
    keepalive 30 3
    no transport-address
----------------------------------------------
A:ALA-1>config>router>ldp-targeted#
```
LDP Command Reference

Command Hierarchies

- LDP Commands on page 327
- Show Commands on page 330
- Clear Commands on page 331
- Debug Commands on page 331
- Tools Commands on page 331

LDP Commands

```
config
    — router
    — [no] ldp
        — [no] adv-adj-addr-only
        — [no] aggregate-prefix-match
            — prefix-exclude policy-name [policy-name...(up to 5 max)]
            — no prefix-exclude
            — [no] shutdown
        — egress-statistics
            — [no] fec-prefix ip-prefix[/mask]
                — accounting-policy policy-id
                — no accounting-policy
                — [no] collect-stats
                — [no] shutdown
        — export policy-name [policy-name...(up to 5 max)]
        — no export
        — [no] fast-reroute
        — [no] export-tunnel-table policy-name
        — fec-originate ip-prefix/mask [advertised-label in-label] next-hop ip-address
            [swap-label out-label]
        — fec-originate ip-prefix/mask [advertised-label in-label] pop
        — no fec-originate ip-prefix/mask next-hop ip-address
        — no fec-originate ip-prefix/mask pop
        — [no] graceful-restart
            — maximum-recovery-time interval
            — no maximum-recovery-time
            — neighbor-liveness-time interval
            — no neighbor-liveness-time
        — [no] implicit-null-label
        — interface-parameters
            — bfd
            — hello timeout factor
            — no hello
            — [no] interface ip-int-name
                — [no] bfd-enable
                — hello timeout factor
```
— no hello
— keepalive timeout factor
— no keepalive
— multicast-traffic {enable|disable}
— local-lsr-id {system | interface}
— no local-lsr-id
— [no] shutdown
— transport-address {system | interface}
— no transport-address
— keepalive timeout factor
— no keepalive
— transport-address {system | interface}
— no transport-address
— label-withdrawal-delay seconds
— ldp-frrpeer-parameters
  — peer ip-address
  — no peer [ip-address]
    — auth-keychain name
    — authentication-key [authentication-key | hash-key] [hash | hash2]
    — no authentication-key
    — [no] dod-label-distribution
    — [no] export-prefixes policy-name
    — [no] fec129-cisco-interop
    — [no] import-prefixes policy-name
    — [no] path-mtu-discovery
    — ttl-security min-ttl-value
    — [no] ttl-security
  — [no] mp-mbb-time
  — [no] prefer-tunnel-in-tunnel
  — [no] shortcut-transit-ttl-propagate
  — [no] shortcut-local-ttl-propagate
  — [no] shutdown
— targeted-session
  — [no] disable-targeted-session
  — export-prefixes policy-name [policy-name...(up to 5 max)]
  — no export-prefixes
  — hello timeout factor
  — no hello
  — import-prefixes policy-name [policy-name...(up to 5 max)]
  — no import-prefixes
  — keepalive timeout factor
  — no keepalive
  — local-lsr-id interface-name
  — no local-lsr-id
  — peer ip-address
  — no peer ip-address
    — [no] bfd-enable
    — hello timeout factor
    — no hello
    — keepalive timeout factor
    — no keepalive
    — local-lsr-id interface-name
    — no local-lsr-id
    — [no] shutdown
— [no] tunneling
— [no] lsp
— tunnel-down-damp-time seconds
— no tunnel-down-damp-time
— [no] ldp-shortcut
Show Commands

```plaintext
show
  — router
    — ldp
      — adv-adj-addr-only
      — auth-keychain [keychain]
      — bindings active [prefix ip-prefix/mask] [summary | egress-nh ip-prefix/mask | egress-if port-id | egress-lsp tunnel-id]
      — bindings active [fec-type prefixes] [prefix <ip-prefix/mask>] [egress-nh <ip-prefix/mask> | egress-if <port-id> | egress-lsp <tunnel-id>] [summary]
      — bindings active [fec-type p2mp] [p2mp-id <identifier> root <ip-address>]
        [egress-nh <ip-prefix/mask> | egress-if <port-id> | egress-lsp <tunnel-id>] [summary]
      — bindings [fec-type fec-type [detail]] [session ip-addr[:label-space]]
      — bindings [label-type] [start-label [end-label]
      — bindings [prefix ip-prefix/mask [detail]] [session ip-addr[:label-space]]
      — bindings active [prefix ip-prefix/mask] [summary | egress-nh ip-prefix/mask | egress-if port-id | egress-lsp tunnel-id]
      — bindings service-id service-id [detail]
      — bindings vc-type vc-type [[vc-id vc-id] [agi agi]] [session ip-addr[:label-space]]
      — discovery [[peer [ip-address]] | [interface [ip-int-name]]] [state state] [detail]
        [adjacency-type type]
      — fec-egress-stats [ip-prefix/mask]
      — fec-egress-stats active
      — fec-egress-stats active
      — interface [ip-int-name | ip-address] [detail]
      — parameters
      — peer [ip-address] [detail]
      — peer-parameters peer-ip-address
      — session [ip-addr[:label-space]] [detail | statistics [packet-type]] [session-type]
      — status
      — statistics-summary
```

Note: See 7710 SR OS OAM and Diagnostics Guide for tools command descriptions, syntax, and usage information.
Clear Commands

clear router ldp
  fec-egress-statistics [ip-prefix/mask]
  instance
  interface [ip-int-name]
  peer [ip-address] [statistics]
  session [ip-addr[:label-space]] [statistics]
  statistics

Debug Commands

[no] debug router ldp
  interface interface-name
    event
      messages
      packet [detail]
      hello [detail]
      no hello
  peer ip-address
    event
      bindings
      messages
      packet
        hello [detail]
        no hello
        init [detail]
        no init
        keepalive
        label [detail]
        no label

Tools Commands

See 7710 SR OS OAM and Diagnostics Guide for CLI description and syntax.

tools dump ldp-treetrace [prefix ip-prefix/mask] manual-prefix ip-prefix/mask] [path-destination ip-address] [trace-tree]
## LDP Configuration Commands

### Generic Commands

#### ldp

<table>
<thead>
<tr>
<th>Syntax</th>
<th>[no] ldp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Context</td>
<td>config&gt;router</td>
</tr>
</tbody>
</table>

**Default**

This command creates the context to configure an LDP parameters. LDP is not enabled by default and must be explicitly enabled (**no shutdown**).

To suspend the LDP protocol, use the **shutdown** command. Configuration parameters are not affected.

The **no** form of the command deletes the LDP protocol instance, removing all associated configuration parameters. The LDP instance must first be disabled with the **shutdown** command before being deleted.

**Default**

none (LDP must be explicitly enabled)

#### ldp-shortcut

<table>
<thead>
<tr>
<th>Syntax</th>
<th>[no] ldp-shortcut</th>
</tr>
</thead>
<tbody>
<tr>
<td>Context</td>
<td>config&gt;router</td>
</tr>
</tbody>
</table>

**Description**

This command enables the resolution of IGP routes using LDP LSP across all network interfaces participating in the IS-IS and OSPF routing protocol in the system.

When LDP shortcut is enabled, LDP populates the routing table with next-hop entries corresponding to all prefixes for which it activated an LDP FEC. For a given prefix, two route entries are populated in the system routing table. One corresponds to the LDP shortcut next-hop and has an owner of LDP. The other one is the regular IP next-hop. The LDP shortcut next-hop always has preference over the regular IP next-hop for forwarding user packets and specified control packets over a given outgoing interface to the route next-hop.

All user and specified control packets for which the longest prefix match in RTM yields the FEC prefix will be forwarded over the LDP LSP.

When an IPv4 packet is received on an ingress network interface, a subscriber IES interface, or a regular IES interface, the lookup of the packet by the ingress forwarding engine will result in the packet being sent labeled with the label stack corresponding to the NHLFE of the LDP LSP when the preferred RTM entry corresponds to an LDP shortcut.

If the preferred RTM entry corresponds to an IP next-hop, the IPv4 packet is forwarded unlabelled.

When ECMP is enabled and multiple equal-cost next-hops exit for the IGP route, the ingress forwarding engine will spray the packets for this route based on hashing routine currently supported
for IPv4 packets. When the preferred RTM entry corresponds to an LDP shortcut route, spraying will be performed across the multiple next-hops for the LDP FEC. The FEC next-hops can either be direct link LDP neighbors or T-LDP neighbors reachable over RSVP LSPs in the case of LDP-over-RSVP but not both.

When the preferred RTM entry corresponds to a regular IP route, spraying will be performed across regular IP next-hops for the prefix.

The no form of this command disables the resolution of IGP routes using LDP shortcuts.

**Default** no ldp-shortcut

### shutdown

**Syntax**

[n] shutdown

**Context**

config>router>ldp
config>router>ldp>if-params>if
config>router>ldp>targ-session>peer
config>router>ldp>egr-stats>fec-prefix
config>router>ldp>aggregate-prefix-match

**Description**

This command administratively disables an entity. When disabled, an entity does not change, reset, or remove any configuration settings or statistics.

The operational state of the entity is disabled as well as the operational state of any entities contained within. Many objects must be shut down before they may be deleted.

The no form of this command administratively enables an entity.

Unlike other commands and parameters where the default state is not indicated in the configuration file, the shutdown and no shutdown states are always indicated in system generated configuration files.

The no form of the command places an entity in an administratively enabled state.

**Default** no shutdown

### adv-adj-addr-only

**Syntax**

[n] adv-adj-addr-only

**Context**

config>router>ldp

**Description**

This command provides a means for an LDP router to advertise only the local interfaces it uses to establish hello adjacencies with an LDP peer. By default, when a router establishes an LDP session with a peer, it advertises in an LDP Address message the addresses of all local interfaces to allow the peer to resolve LDP FECs distributed by this router. Similarly, a router sends a Withdraw Address message to all its peers to withdraw a local address if the corresponding interface went down or was deleted.
This new option reduces CPU processing when a large number of LDP neighbors come up or go down. The new CLI option is strongly recommended in mobile backhaul networks where the number of LDP peers can be very large.

The `no` version of this command reverts LDP to the default behaviour of advertising all local interfaces.

**aggregate-prefix-match**

**Syntax**  
`[no] aggregate-prefix-match`

**Context**  
`config>router>ldp`

**Description**  
The command enables the use by LDP of the aggregate prefix match procedures.

When this option is enabled, LDP performs the following procedures for all prefixes. When an LSR receives a FEC-label binding from an LDP neighbor for a given specific FEC1 element, it will install the binding in the LDP FIB if:

- It is able to perform a successful longest IP match of the FEC prefix with an entry in the routing table, and
- The advertising LDP neighbor is the next-hop to reach the FEC prefix.

When such a FEC-label binding has been installed in the LDP FIB, then LDP programs an NHLFE entry in the egress data path to forward packets to FEC1. It also advertises a new FEC-label binding for FEC1 to all its LDP neighbors.

When a new prefix appears in the routing table, LDP inspects the LDP FIB to determine if this prefix is a better match (a more specific match) for any of the installed FEC elements. For any FEC for which this is true, LDP may have to update the NHLFE entry for this FEC.

When a prefix is removed from the routing table, LDP inspects the LDP FIB for all FEC elements which matched this prefix to determine if another match exists in the routing table. If so, it updates the NHLFE entry accordingly. If not, it sends a label withdraw message to its LDP neighbors to remove the binding.

When the next hop for a routing prefix changes, LDP updates the LDP FIB entry for the FEC elements which matched this prefix. It also updates the NHLFE entry for these FEC elements accordingly.

The `no` form of this command disables the use by LDP of the aggregate prefix procedures and deletes the configuration. LDP resumes performing exact prefix match for FEC elements.

**Default**  
`no aggregate-prefix-match`
prefix-exclude

**Syntax**

```
prefix-exclude policy-name [policy-name...(up to 5 max)]
```

**no prefix-exclude**

**Context**

```
config>router>ldp>aggregate-prefix-match
```

**Description**

This command specifies the policy name containing the prefixes to be excluded from the aggregate prefix match procedures. In this case, LDP will perform an exact match of a specific FEC element prefix as opposed to a longest match of one or more LDP FEC element prefixes, against this prefix when it receives a FEC-label binding or when a change to this prefix occurs in the routing table.

The `no` form of this command removes all policies from the configuration.

**Default**

no prefix-exclude.

egress-statistics

**Syntax**

```
egress-statistics
```

**Context**

```
config>router>ldp
```

**Description**

This command provides the context for the user to enter the LDP FEC prefix for the purpose of enabling egress data path statistics at the ingress LER for this FEC.

**Default**

none

fec-prefix

**Syntax**

```
[no] fec-prefix ip-prefix[/mask]
```

**Context**

```
config>router>ldp>egr-stats
```

**Description**

This command configures statistics in the egress data path at the ingress LER or LSR for an LDP FEC. The user must execute the `no shutdown` command for this command to effectively enable statistics.

The egress data path counters will be updated for both originating and transit packets. Originating packets may be service packets or IP user and control packets forwarded over the LDP LSP when used as an IGP shortcut. Transit packets of the FEC which are label switched on this node.

When ECMP is enabled and multiple paths exist for a FEC, the same set of counters are updated for each packet forwarded over any of the NHLFEs associated with this FEC and for as long as this FEC is active.

The statistics can be enabled on prefix FECs imported from both LDP neighbors and T-LDP neighbors (LDP over RSVP). Only /32 FEC prefixes are accepted. Service FECs, i.e., FEC 128 and FEC 129 are not valid.

The `no` form of this command disables the statistics in the egress data path and removes the accounting policy association from the LDP FEC.

**Default**

none
accounting-policy

Syntax  accounting-policy acct-policy-id
no accounting-policy

Context config>router>ldp>egr-stats

Description This command associates an accounting policy to the MPLS instance. An accounting policy must be defined before it can be associated else an error message is generated. The no form of this command removes the accounting policy association.

Default none

Parameters acct-policy-id — Enter the accounting policy-id as configured in the config>log>accounting-policy context.

Values  1 — 99

collect-stats

Syntax  [no] collect-stats

Context config>router>ldp>egr-stats

Description This command enables accounting and statistical data collection. When applying accounting policies the data, by default, is collected in the appropriate records and written to the designated billing file. When the no collect-stats command is issued the statistics are still accumulated by the forwarding engine. However, the CPU will not obtain the results and write them to the billing file. If a subsequent collect-stats command is issued then the counters written to the billing file include all the traffic while the no collect-stats command was in effect.

Default collect-stats

export

Syntax  export policy-name [policy-name …upto 5 max]
no export

Context config>router>ldp

Description This command specifies the export route policies used to determine which routes are exported to LDP. Policies are configured in the config>router>policy-options context.

If no export policy is specified, non-LDP routes will not be exported from the routing table manager to LDP. LDP-learned routes will be exported to LDP neighbors. Present implementation of export policy (outbound filtering) can be used “only” to add FECs for label propagation. The export policy does not control propagation of FECs that an LSR receives from its neighbors.
If multiple policy names are specified, the policies are evaluated in the order they are specified. The first policy that matches is applied. If multiple export commands are issued, the last command entered will override the previous command. A maximum of 5 policy names can be specified.

The no form of the command removes all policies from the configuration.

**Default**

**no export** — No export route policies specified.

**Parameters**

`policy-name` — The export route policy name. Allowed values are any string up to 32 characters long composed of printable, 7-bit ASCII characters. If the string contains special characters (#, $, spaces, etc.), the entire string must be enclosed within double quotes.

The specified name(s) must already be defined.

---

**fast-reroute**

**Syntax**

```
[no] fast-reroute
```

**Context**

`config>router>ldp`

**Description**

This command enables LDP Fast-Reroute (FRR) procedures. When enabled, LDP uses both the primary next-hop and LFA next-hop, when available, for resolving the next-hop of an LDP FEC against the corresponding prefix in the routing table. This will result in LDP programming a primary NHLFE and a backup NHLFE into the forwarding engine for each next-hop of a FEC prefix for the purpose of forwarding packets over the LDP FEC.

When any of the following events occurs, LDP instructs in the fast path the forwarding engines to enable the backup NHLFE for each FEC next-hop impacted by this event:

- An LDP interface goes operationally down, or is admin shutdown.
- An LDP session to a peer went down as the result of the Hello or Keep-Alive timer expiring.
- The TCP connection used by a link LDP session to a peer went down, due say to next-hop tracking of the LDP transport address in RTM, which brings down the LDP session.
- A BFD session, enabled on a T-LDP session to a peer, times-out and as a result the link LDP session to the same peer and which uses the same TCP connection as the T-LDP session goes also down.
- A BFD session enabled on the LDP interface to a directly connected peer, times out and brings down the link LDP session to this peer.

The `tunnel-down-dump-time` option or the `label-withdrawal-delay` option, when enabled, does not cause the corresponding timer to be activated for a FEC as long as a backup NHLFE is still available.

Note that because LDP can detect the loss of a neighbor/next-hop independently, it is possible that it switches to the LFA next-hop while IGP is still using the primary next-hop. Also, when the interface for the previous primary next-hop is restored, IGP may re-converge before LDP completed the FEC exchange with it neighbor over that interface. This may cause LDP to de-program the LFA next-hop from the FEC and blackhole traffic. In order to avoid this situation, it is recommended to enable IGP-LDP synchronization on the LDP interface.

When the SPF computation determines there is more than one primary next-hop for a prefix, it will not program any LFA next-hop in RTM. Thus, the LDP FEC will resolve to the multiple primary next-hops that provide the required protection.
The **no** form of this command disables LDP FRR.

**Default**

no fast-reroute

### export-tunnel-table

**Syntax**

```plaintext
[no] export-tunnel-table policy-name
```

**Context**

config>router>ldp

**Description**

This command applies a tunnel table export policy to LDP for the purpose of learning BGP labeled routes from the CPM tunnel table and stitching them to LDP FEC for the same prefix.

The user enables the stitching of routes between LDP and BGP by configuring separately tunnel table route export policies in both protocols and enabling the advertising of RFC 3107, *Carrying Label Information in BGP-4*, formatted labeled routes for prefixes learned from LDP FECs.

The route export policy in BGP instructs BGP to listen to LDP route entries in the CPM Tunnel Table. If a /32 LDP FEC prefix matches an entry in the export policy, BGP originates a BGP labeled route, stitches it to the LDP FEC, and re-distributes the BGP labeled route to its iBGP neighbors.

The user adds LDP FEC prefixes with the statement ‘**from protocol ldp**’ in the configuration of the existing BGP export policy at the global level, the peer-group level, or at the peer level using the commands:

- `configure>router:bgp>export policy-name`
- `configure>router:bgp>group>export policy-name`
- `configure>router:bgp>group>neighbour>export policy-name`

To indicate to BGP to evaluate the entries with the ‘**from protocol ldp**’ statement in the export policy when applied to a specific BGP neighbor, a new argument is added to the existing advertise-label command:

`configure>router:bgp>group>neighbour>advertise-label ipv4 include-ldp-prefix`

Without the new **include-ldp-prefix** argument, only core IPv4 routes learned from RTM are advertised as BGP labeled routes to the neighbor. No stitching of LDP FEC to the BGP labeled route will be performed for this neighbor even if the same prefix was learned from LDP.

The tunnel table route export policy in LDP instructs LDP to listen to BGP route entries in the CPM Tunnel Table. If a /32 BGP labeled route matches a prefix entry in the export policy, LDP originates an LDP FEC for the prefix, stitches it to the BGP labeled route, and re-distributes the LDP FEC to its iBGP neighbors.

The user can add BGP labeled route prefixes with the statement ‘**from protocol bgp**’ in the configuration of the LDP tunnel table export policy. Note that the ‘**from protocol**’ statement has an effect only when the protocol value is ldp. Policy entries with protocol values of rsvp, bgp, or any value other than ldp are ignored at the time the policy is applied to LDP.

The **no** form of the command removes the policy from the configuration.

**Default**

no export-tunnel-table — no tunnel table export route policy is specified.

**Parameters**

`policy-name` — The export-tunnel-table route policy name. Allowed values are any string up to 32 characters long composed of printable, 7-bit ASCII characters excluding double quotes. If the
Generic Commands

string contains spaces, use double quotes to delimit the start and end of the string. The specified name(s) must already be defined.

**fec-originate**

**Syntax**

```
fec-originate ip-prefix/mask [advertised-label in-label] next-hop ip-address [swap-label out-label]
```

```
fec-originate ip-prefix/mask [advertised-label in-label] pop
```

```
no fec-originate ip-prefix/mask next-hop ip-address
```

```
no fec-originate ip-prefix/mask pop
```

**Context**

`config>router>ldp`

**Description**

This command defines a way to originate a FEC (with a swap action) for which the LSR is not egress, or to originate a FEC (with a pop action) for which the LSR is egress.

**Parameters**

- `ip-prefix/mask` — Specify information for the specified IP prefix and mask length.
- `next-hop` — Specify the IP address of the next hop of the prefix.
- `advertised-label` — Specify the label advertised to the upstream peer. If not configured, then the label advertised should be from the label pool. If the configured static label is not available then the IP prefix is not advertised.
- `out-label` — Specify the LSR to swap the label. If configured, then the LSR should swap the label with the configured swap-label. If not configured, then the default action is pop if the next-hop parameter is not defined.

NOTE: The next-hop, advertised-label, swap-label parameters are all optional. If next-hop is configured but no swap label specified, then it will be a swap with label 3, such as, pop and forward to the next-hop. If the next-hop and swap-label are configured, then it is a regular swap. If no parameters are specified, then a pop and route is performed.

**Values**

- `16 — 1048575`

- `in-label` — Specifies the number of labels to send to the peer associated with this FEC.

**Values**

- `32 — 1023`

- `pop` — Specifies to pop the label and transmit without the label.

**graceful-restart**

**Syntax**

```
[no] graceful-restart
```

**Context**

`config>router>ldp`

**Description**

This command enables graceful restart helper.

The `no` form of the command disables graceful restart.

**Default**

`no graceful-restart (disabled)` — Graceful-restart must be explicitly enabled.
implicit-null-label

Syntax       [no] implicit-null-label
Context      config>router>ldp
Description  This command enables the use of the implicit null label. Use this command to signal the IMPLICIT NULL option for all LDP FECs for which this node is the egress LER.
             The no form of this command disables the signaling of the implicit null label.
Default      no implicit-null-label

maximum-recovery-time

Syntax       maximum-recovery-time interval
no maximum-recovery-time
Context      config>router>ldp
Description  This command configures the local maximum recovery time.
             The no form of the command returns the default value.
Default      120
Parameters   interval — Specifies the length of time in seconds.
             Values      15 — 1800

neighbor-liveness-time

Syntax       neighbor-liveness-time interval
no neighbor-liveness-time
Context      config>router>ldp
Description  This command configures the neighbor liveness time.
             The no form of the command returns the default value.
Default      120
Parameters   interval — Specifies the length of time in seconds.
             Values      5 — 300
**label-withdrawal-delay**

**Syntax**
```plaintext
label-withdrawal-delay seconds
```

**Context**
```plaintext
config>router>ldp
```

**Description**
This command specifies the time interval, in seconds, LDP will delay for the withdrawal of FEC-label binding it distributed to its neighbors when FEC is de-activated. When the timer expires, LDP then sends a label withdrawal for the FEC to all its neighbours. This is applicable only to LDP transport tunnels (IPv4 prefix FECs) and is not applicable to pseudowires (service FECs).

**Default**
no label-withdrawal-delay

**Parameters**
seconds — Specifies the time that LDP delays the withdrawal of FEC-label binding it distributed to its neighbors when FEC is de-activated.

**Values**
3 — 120

**ldp-frr**

**Syntax**
```plaintext
ldp-frr
```

**Context**
```plaintext
config>router>ldp
```

**Description**
This command enables LDP Fast-Reroute (FRR) procedures. When enabled, LDP uses both the primary next-hop and LFA next-hop, when available, for resolving the next-hop of an LDP FEC against the corresponding prefix in the routing table. This results in LDP programming a primary NHLFE and a backup NHLFE into the forwarding engine for each next-hop of a FEC prefix for the purpose of forwarding packets over the LDP FEC.

When any of the following events occurs, LDP instructs in the fast path the forwarding engines to enable the backup NHLFE for each FEC next-hop impacted by this event:

1. An LDP interface goes operationally down, or is admin shutdown.
2. An LDP session to a peer went down as the result of the Hello or Keep-Alive timer expiring.
3. The TCP connection used by a link LDP session to a peer went down, due say to next-hop tracking of the LDP transport address in RTM, which brings down the LDP session.
4. A BFD session, enabled on a T-LDP session to a peer, times-out and as a result the link LDP session to the same peer and which uses the same TCP connection as the T-LDP session goes also down.
5. A BFD session enabled on the LDP interface to a directly connected peer, times-out and brings down the link LDP session to this peer.

The tunnel-down-dump-time option or the label-withdrawal-delay option, when enabled, does not cause the corresponding timer to be activated for a FEC as long as a backup NHLFE is still available.

Note that because LDP can detect the loss of a neighbor/next-hop independently, it is possible that it switches to the LFA next-hop while IGP is still using the primary next-hop. Also, when the interface for the previous primary next-hop is restored, IGP may re-converge before LDP completed the FEC exchange with its neighbor over that interface. This may cause LDP to de-program the LFA next-hop from the FEC and blackhole traffic. In order to avoid this situation, it is recommended to enable IGP-LDP synchronization on the LDP interface.
When the SPF computation determines there is more than one primary next-hop for a prefix, it will not program any LFA next-hop in RTM. Thus, the LDP FEC will resolve to the multiple primary next-hops that provide the required protection.

The no form of this command disables LDP FRR.

**Default**
no ldp-frr

**Parameters**

seconds — Specifies the time that LDP delays the withdrawal of FEC-label binding it distributed to its neighbors when FEC is de-activated.

**Values**
3 — 120

---

### tunnel-down-damp-time

**Syntax**
tunnel-down-damp-time seconds
no tunnel-down-damp-time

**Context**
config>router>ldp

**Description**
This command specifies the time interval, in seconds, that LDP waits before posting a tunnel down event to the Tunnel Table Manager (TTM).

When LDP can no longer resolve a FEC and de-activates it, it de-programs the NHLFE in the data path. It will however delay deleting the LDP tunnel entry in the TTM until the tunnel-down-damp-time timer expires. This means users of the LDP tunnel, such as SDPs (all services) and BGP (L3 VPN), will not be notified immediately. Traffic is still blackholed because the forwarding engine NHLFE has been de-programmed.

If the FEC gets resolved before the tunnel-down-damp-time timer expires, then LDP programs the forwarding engine with the new NHLFE and performs a tunnel modify event in TTM updating the dampened entry in TTM with the new NHLFE information. If the FEC does not get resolved and the tunnel-down-damp-time timer expires, LDP posts a tunnel down event to TTM which deletes the LDP tunnel.

The no form of this command then tunnel down events are not damped.

**Parameters**

seconds — Specifies the time interval, in seconds, that LDP waits before posting a tunnel down event to the Tunnel Table Manager.

---

### keepalive

**Syntax**
keepalive timeout factor
no keepalive

**Context**
config>router>ldp>if-params
config>router>ldp>if-params>if
config>router>ldp>targ-session
config>router>ldp>targ-session>peer

**Description**
This command configures the time interval, in seconds, that LDP waits before tearing down the session. The factor parameter derives the keepalive interval.
If no LDP messages are exchanged for the configured time interval, the LDP session is torn down. Keepalive timeout is usually three times the keepalive interval. To maintain the session permanently, regardless of the activity, set the value to zero.

When LDP session is being set up, the keepalive timeout is negotiated to the lower of the two peers. Once a operational value is agreed upon, the keepalive factor is used to derive the value of the keepalive interval.

The `no` form of the command at the interface-parameters and targeted-session levels sets the `keepalive timeout` and the `keepalive factor` to the default value.

The `no` form of the command, at the interface level, sets the `keepalive timeout` and the `keepalive factor` to the value defined under the `interface-parameters` level.

The `no` form of the command, at the peer level, will set the `keepalive timeout` and the `keepalive factor` to the value defined under the `targeted-session` level.

Note that the session needs to be flapped for the new args to operate.

<table>
<thead>
<tr>
<th>Default Context</th>
<th>timeout</th>
<th>factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>config&gt;router&gt;ldp&gt;if-params</td>
<td>30</td>
<td>3</td>
</tr>
<tr>
<td>config&gt;router&gt;ldp&gt;targ-session</td>
<td>40</td>
<td>4</td>
</tr>
<tr>
<td>config&gt;router&gt;ldp&gt;if-params&gt;if</td>
<td>Inherits values from interface-parameters context.</td>
<td></td>
</tr>
<tr>
<td>config&gt;router&gt;ldp&gt;targ-session&gt;peer</td>
<td>Inherits values from targeted-session context.</td>
<td></td>
</tr>
</tbody>
</table>

**Parameters**

`timeout` — Configures the time interval, expressed in seconds, that LDP waits before tearing down the session.

**Values**

1 — 65535

`factor` — Specifies the number of keepalive messages, expressed as a decimal integer, that should be sent on an idle LDP session in the keepalive timeout interval.

**Values**

1 — 255

**local-lsr-id**

**Syntax**

`local-lsr-id (system | interface)
no local-lsr-id`

**Context**

config>router>ldp>interface-parameters>interface

**Description**

This command enables the use of the address of the local LDP interface as the LSR-ID to establish a link LDP adjacency and session with a directly connected LDP peer.

By default, the LDP session uses the system interface address as the LSR-ID unless explicitly configured using the above command. Note however that the system interface must always be configured on the router or the LDP protocol will not come up on the node. There is no requirement to include it in any routing protocol though.

At initial configuration, the LDP session to the peer will remain down while the interface is down.
If the user changes the LSR-ID on the fly between system and interface values while the LDP session is up, LDP will immediately tear down the session and will attempt to re-establish it using the new LSR-ID.

If the interface used as LSR-ID goes down, then the LDP session goes down.

Note that when the interface option is selected, the transport connection (TCP) for the link LDP session will also use the address of the local LDP interface as the transport address. If system is the value configured in the `configure>router>ldp>interface-parameters>interface>transport-address` context it will be overridden.

The **no** form of the command returns to the default behavior in which case the system interface address is used as the LSR-ID.

**Default**

- `system`

---

**local-lsr-id**

**Syntax**

```plaintext
local-lsr-id interface-name
no local-lsr-id
```

**Context**

`config>router>ldp>targeted-session>peer`

**Description**

This command enables the use the use of the address of a specific interface as the LSR-ID for the hello adjacency of a T-LDP session. The interface can be a regular interface or a loopback interface, including the system interface.

By default, a T-LDP session uses the system interface address as the LSR-ID. Note however that the system interface must always be configured on the router or the LDP protocol will not come up on the node. There is no requirement to include it in any routing protocol though.

At initial configuration, the T-LDP session will remain down while the specified interface is down. LDP will not try to bring it up using the system interface.

If the user changes the LSR-ID on the fly while the T-LDP session is up, LDP will immediately tear down the session and will attempt to establish one using the new LSR-ID regardless of operational state of new specified interface.

If the interface used as LSR-ID goes down, then the T-LDP session will go down.

The user configured LSR-ID is used exclusively for extended peer discovery to establish the T-LDP hello adjacency. It is also used as the transport address for the TCP session of the LDP session when it is bootstrapped by the T-LDP hello adjacency. The user configured LSR-ID is however not used in basic peer discovery to establish a link-level LDP hello adjacency.

The **no** form of this command returns to the default behavior in which case the system interface address is used as the LSR-ID.

**Default**

- `no local-lsr-id`

**Parameters**

- `interface-name` — Specifies the name, up to 32 characters in length, of the network IP interface. An interface name cannot be in the form of an IP address. If the string contains special characters (#, $, spaces, etc.), the entire string must be enclosed within double quotes.
Generic Commands

tunneling

Syntax    [no] tunneling
Context    config>router>ldp>targ-session>peer
Description This command enables LDP over tunnels.
              The no form of the command disables tunneling.
Default    no tunneling
lsp

Syntax   [no] lsp lsp-name

Context   config>router>ldp>targ-session>tunneling

Description   This command configures a specific LSP destined to this peer and to be used for tunneling of LDP FEC over RSVP. A maximum of 4 RSVP LSPs can be explicitly used for tunneling LDP FECs to the T-LDP peer.

It is not necessary to specify any RSVP LSP in this context unless there is a need to restrict the tunneling to selected LSPs. All RSVP LSPs with a to address matching that of the T-LDP peer are eligible by default. The user can also exclude specific LSP names by using the ldp-over-rsvp exclude command in the configure->router->mpls->lsp lsp-name context.
Interface Parameters Commands

interface-parameters

Syntax interface-parameters
Context config>router>ldp
Description This command enables the context to configure LDP interfaces and parameters applied to LDP interfaces.

bfd

Syntax bfd
Context config>router>ldp>if-params

bfd-enable

Syntax [no] bfd-enable
Context config>router>ldp>if-params>if
Description This command enables tracking of the Hello adjacency to an LDP peer using BFD.

When this command is enabled on an LDP interface, LDP registers with BFD and starts tracking the LSR-id of all peers it formed Hello adjacencies with over that LDP interface. The LDP hello mechanism is used to determine the remote address to be used for the BFD session. The parameters used for the BFD session, that is, transmit-interval, receive-interval, and multiplier are those configured under the IP interface in existing implementation: config>router>interface>bfd

If a BFD session fails then the associated LDP adjacency is also declared down and LDP will immediately begin its re-convergence.

When multiple links exist to the same LDP peer, a Hello adjacency is established over each link and a separate BFD session is enabled on each LDP interface. If a BFD session times out on a specific link, LDP will immediately associate the LDP session with one of the remaining Hello adjacencies and trigger the LDP FRR procedures. As soon as the last Hello adjacency goes down due to BFD timing out, the LDP session goes down and the LDP FRR procedures will be triggered.

The no form of this command disables BFD on the LDP interface.

Default no bfd-enable
hello

**Syntax**

```
hello timeout factor
no hello
```

**Context**

```
config>router>ldp>if-params
config>router>ldp>if-params>if
config>router>ldp>targ-session
config>router>ldp>targ-session>peer
```

**Description**

This command configures the time interval to wait before declaring a neighbor down. The *factor* parameter derives the hello interval.

Hold time is local to the system and sent in the hello messages to the neighbor. Hold time cannot be less than three times the hello interval. The hold time can be configured globally (applies to all LDP interfaces) or per interface. The most specific value is used.

When LDP session is being set up, the holddown time is negotiated to the lower of the two peers. Once a operational value is agreed upon, the hello factor is used to derive the value of the hello interval.

The **no** form of the command at the interface-parameters and targeted-session level sets the *hello timeout* and the *hello factor* to the default values.

The **no** form of the command, at the interface level, will set the *hello timeout* and the *hello factor* to the value defined under the interface-parameters level.

The **no** form of the command, at the peer level, will set the *hello timeout* and the *hello factor* to the value defined under the targeted-session level.

Note that the session needs to be flapped for the new args to operate.

**Default**

<table>
<thead>
<tr>
<th>Context</th>
<th>Timeout</th>
<th>Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>config&gt;router&gt;ldp&gt;if-params</td>
<td>15</td>
<td>3</td>
</tr>
<tr>
<td>config&gt;router&gt;ldp&gt;targ-session</td>
<td>45</td>
<td>3</td>
</tr>
<tr>
<td>config&gt;router&gt;ldp&gt;if-params&gt;if</td>
<td></td>
<td></td>
</tr>
<tr>
<td>config&gt;router&gt;ldp&gt;targ-session&gt;peer</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Inherits values from interface-parameters context.

Inherits values from targeted-session context.

**Parameters**

*timeout* — Configures the time interval, in seconds, that LDP waits before a neighbor down.

- **Values**
  - 1 — 65535

*factor* — Specifies the number of keepalive messages that should be sent on an idle LDP session in the hello timeout interval.

- **Values**
  - 1 — 255
Interface Parameters Commands

interface

Syntax  

[no] interface ip-int-name

Context  

config>router>ldp>if-params

Description  

This command enables LDP on the specified IP interface.

The no form of the command deletes the LDP interface and all configuration information associated with the LDP interface.

The LDP interface must be disabled using the shutdown command before it can be deleted.

Parameters  

ip-int-name — The name of an existing interface. If the string contains special characters (#, $, spaces, etc.), the entire string must be enclosed within double quotes.

transport-address

Syntax  

transport-address {interface | system}

no transport-address

Context  

config>router>ldp>if-params

config>router>ldp>if-params>if

Description  

This command configures the transport address to be used when setting up the LDP TCP sessions. The transport address can be configured as interface or system. The transport address can be configured globally (applies to all LDP interfaces) or per interface. The most specific value is used.

With the transport-address command, you can set up the LDP interface to the connection which can be set to the interface address or the system address. However, there can be an issue of which address to use when there are parallel adjacencies. This situation can not only happen with parallel links, it could be a link and a targeted adjacency since targeted adjacencies request the session to be set up only to the system IP address.

Note that the transport-address value should not be interface if multiple interfaces exist between two LDP neighbors. Depending on the first adjacency to be formed, the TCP endpoint is chosen. In other words, if one LDP interface is set up as transport-address interface and another for transport-address system, then, depending on which adjacency was set up first, the TCP endpoint addresses are determined. After that, because the hello contains the LSR ID, the LDP session can be checked to verify that it is set up and then match the adjacency to the session.

Note that for any given ILDP interface, as the local-lsr-id parameters is changed to interface, the transport-address configuration loses effectiveness. Since it will be ignored and the ILDP session will always use the relevant interface IP address as transport-address even though system is chosen.
The **no** form of the command, at the global level, sets the transport address to the default value. The **no** form of the command, at the interface level, sets the transport address to the value defined under the global level.

**Default**

- **system** — The system IP address is used.

**Parameters**

- **interface** — The IP interface address is used to set up the LDP session between neighbors. The transport address interface cannot be used if multiple interfaces exist between two neighbors, since only one LDP session is set up between two neighbors.
- **system** — The system IP address is used to set up the LDP session between neighbors.

---

**multicast-traffic**

**Syntax**

```plaintext
[no] multicast-traffic
```

**Context**

```
config>router>ldp>
```

**Description**

This command enables P2MP multicast traffic forwarding on the interface.

The **no** form of command disables P2MP LDP multicast traffic on the interface. P2MP tree branching out on the interface would not withdraw label map from the peer session on interface shutdown or multicast traffic is disabled. Session may exist on multiple parallel interfaces. Only forwarding entry is changed when interface is shutdown or multicast traffic support is disabled.

Note that LDP may choose to egress the mLDP tree over this interface, but if this it is enabled (multicast-traffic disabled), the dataplane will not forward traffic on this branch.

**Default**

- **multicast-traffic enable**

---

**mp-mbb-time**

**Syntax**

```plaintext
[no] mp-mbb-time
```

**Context**

```
config>router>ldp>
```

**Description**

This command configures the maximum time a P2MP transit/bud node must wait before switching over to the new path if the new node does not send MBB TLV to inform of the availability of data plane.

The **no** form of command should configure the default timer of 3 seconds.

**Default**

- **3 seconds**

**Parameters**

- **interval** — seconds.

**Values**

- **1-10 seconds**
Peer Parameters Commands

peer-parameters

Syntax    peer-parameters
Context    config>router>ldp
Description  This command enables the context to configure peer specific parameters.

peer

Syntax    [no] peer ip-address
Context    config>router>ldp>peer-parameters
Description  This command configures parameters for an LDP peer.
Default none
Parameters  ip-addr — The IP address of the LDP peer in dotted decimal notation.

auth-keychain

Syntax    auth-keychain name
Context    config>router>ldp>peer-parameters>peer
Description  This command configures TCP authentication keychain to use for the session.
Parameters  name — Specifies the name of the keychain to use for the specified TCP session or sessions. This keychain allows the rollover of authentication keys during the lifetime of a session up to 32 characters in length. Peer address has to be the TCP session transport address.

authentication-key

Syntax    authentication-key [authentication-key | hash-key] [hash | hash2]
no authentication-key
Context    config>router>ldp>peer-parameters>peer
Description  This command specifies the authentication key to be used between LDP peers before establishing sessions. Authentication uses the MD-5 message-based digest. Peer address has to be the TCP session transport address.
The no form of this command disables authentication.
Default  none

Parameters

- **authentication-key** — The authentication key. The key can be any combination of ASCII characters up to 16 characters in length (unencrypted). If spaces are used in the string, enclose the entire string in quotation marks (“ ”).

- **hash-key** — The hash key. The key can be any combination of up to 33 alphanumeric characters. If spaces are used in the string, enclose the entire string in quotation marks (“ ”).

  This is useful when a user must configure the parameter, but, for security purposes, the actual unencrypted key value is not provided.

- **hash** — Specifies the key is entered in an encrypted form. If the hash keyword is not used, the key is assumed to be in a non-encrypted, clear text form. For security, all keys are stored in encrypted form in the configuration file with the hash parameter specified.

- **hash2** — Specifies the key is entered in a more complex encrypted form. If the hash2 parameter is not used, the less encrypted hash form is assumed.

### dod-label-distribution

**Syntax**

[no] dod-label-distribution

**Context**

config>router>ldp>peer-parameters>peer

**Description**

This command enables the use of the LDP Downstream-on-Demand (DoD) label distribution procedures.

When this option is enabled, LDP will set the A-bit in the Label Initialization message when the LDP session to the peer is established. When both peers set the A-bit, they will both use the DoD label distribution method over the LDP session [rfc5036].

This feature can only be enabled on a link-level LDP session and therefore will apply to prefix labels only, not service labels.

As soon as the link LDP session comes up, the 7x50 will send a label request to its DoD peer for the FEC prefix corresponding to the peer’s LSR-id. The DoD peer LSR-id is found in the basic Hello discovery messages the peer used to establish the Hello adjacency with the 7x50.

Similarly if the 7x50 and the directly attached DoD peer entered into extended discovery and established a targeted LDP session, the 7x50 will immediately send a label request for the FEC prefix corresponding to the peer’s LSR-id found in the extended discovery messages.

However, the 7x50 node will not advertise any <FEC, label> bindings, including the FEC of its own LSR-id, unless the DoD peer requested it using a Label Request Message.

When the DoD peer sends a label request for any FEC prefix, the 7x50 will reply with a <FEC, label> binding for that prefix if the FEC was already activated on the 7x50. If not, the 7x50 replies with a notification message containing the status code of “no route.” The 7x50 will not attempt in the latter case to send a label request to the next-hop for the FEC prefix when the LDP session to this next-hop uses the DoD label distribution mode. Hence the reference to single-hop LDP DoD procedures.

As soon as the link LDP session comes up, the 7x50 will send a label request to its DoD peer for the FEC prefix corresponding to the peer’s LSR-id. The DoD peer LSR-id is found in the basic Hello discovery messages the peer used to establish the Hello adjacency with the 7x50.
Similarly if the 7x50 and the directly attached DoD peer entered into extended discovery and established a targeted LDP session, the 7x50 will immediately send a label request for the FEC prefix corresponding to the peer’s LSR-id found in the extended discovery messages. Peer address has to be the peer LSR-ID address.

The `no` form of this command disables the DoD label distribution with an LDP neighbor.

```
Default
no dod-label-distribution
```

### export-prefixes

**Syntax**

```
[no] export-prefixes policy-name
```

**Context**

```
config>router>ldp>peer-parameters>peer
```

**Description**

This command specifies the export route policy used to determine which prefixes received from other LDP and T-LDP peers are re-distributed to this LDP peer via the LDP/T-LDP session to this peer. A prefix that is filtered out (deny) will not be exported. A prefix that is filtered in (accept) will be exported.

If no export policy is specified, all FEC prefixes learned will be exported to this LDP peer. This policy is applied in addition to the global LDP policy and targeted session policy.

Policies are configured in the `config>router>policy-options` context. A maximum of five policy names can be specified. Peer address has to be the peer LSR-ID address.

The `no` form of the command removes the policy from the configuration.

```
Default
no export-prefixes - no export route policy is specified
```

**Parameters**

`policy-name` — The export-prefix route policy name. Allowed values are any string up to 32 characters long composed of printable, 7-bit ASCII characters excluding double quotes. If the string contains spaces, use double quotes to delimit the start and end of the string. The specified name(s) must already be defined.

### fec129-cisco-interop

**Syntax**

```
[no] fec129-cisco-interop
```

**Context**

```
config>router>ldp>peer-parameters>peer
```

**Description**

This command specifies whether LDP will provide translation between non-compliant FEC 129 formats of Cisco. Peer LDP sessions must be manually configured towards the non-compliant Cisco PEs.

When enabled, Cisco non-compliant format will be used to send and interpret received label release messages i.e. the FEC129 SAI1 and TAI1 fields will be reversed.

When the disabled, Cisco non-compliant format will not be used or supported. Peer address has to be the peer LSR-ID address.

The `no` form of the command returns the default.

```
Default
no fec129-cisco-interop
```

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import-prefixes

**Syntax**  
```
[no] import-prefixes policy-name
```

**Context**  
```
config>router>ldp>peer-parameters>peer
```

**Description**  
This command configures the import FEC prefix policy to determine which prefixes received from this LDP peer are imported and installed by LDP on this node. If resolved these FEC prefixes are then re-distributed to other LDP and T-LDP peers. A FEC prefix that is filtered out (deny) will not be imported. A FEC prefix that is filtered in (accept) will be imported.

If no import policy is specified, the node will import all prefixes received from this LDP/T-LDP peer. This policy is applied in addition to the global LDP policy and targeted session policy.

Policies are configured in the `config>router>policy-options` context. A maximum of five policy names can be specified. Peer address has to be the peer LSR-ID address.

The **no** form of the command removes the policy from the configuration.

**Default**  
noclass import-prefixes - no import route policy is specified

**Parameters**  
- `policy-name` — The import-prefix route policy name. Allowed values are any string up to 32 characters long composed of printable, 7-bit ASCII characters excluding double quotes. If the string contains spaces, use double quotes to delimit the start and end of the string. The specified name(s) must already be defined

---

path-mtu-discovery

**Syntax**  
```
path-mtu-discovery
no path-mtu-discovery
```

**Context**  
```
config>router>ldp>peer-parameters>peer
```

**Description**  
This command enables Path MTU discovery for the associated TCP connections. When enabled, the MTU for the associated TCP session is initially set to the egress interface MTU. The DF bit is also set so that if a router along the path of the TCP connection cannot handle a packet of a particular size without fragmenting, it sends back an ICMP message to set the path MTU for the given session to a lower value that can be forwarded without fragmenting.

**Default**  
no path-mtu-discovery

---

ttl-security

**Syntax**  
```
ttl-security min-ttl-value
no ttl-security
```

**Context**  
```
config>router>ldp>peer-parameters>peer
```

**Description**  
This command configures TTL security parameters for incoming packets. When the feature is enabled, BGP/LDP will accept incoming IP packets from a peer only if the TTL value in the packet is greater than or equal to the minimum TTL value configured for that peer. Peer address has to be the TCP session transport address.
The `no` form of the command disables TTL security.

**Default**
```
no ttl-security
```

**Parameters**

`min-ttl-value` — Specify the minimum TTL value for an incoming packet.

**Values**

```
1 — 255
```

### prefer-tunnel-in-tunnel

**Syntax**

```
[no] prefer-tunnel-in-tunnel
```

**Context**

```
config>router>ldp
```

**Description**

This command specifies to use tunnel-in-tunnel over a simple LDP tunnel. Specifically, the user packets for LDP FECs learned over this targeted LDP session can be sent inside an RSVP LSP which terminates on the same egress router as the destination of the targeted LDP session. The user can specify an explicit list of RSVP LSP tunnels under the Targeted LDP session or LDP will perform a lookup in the Tunnel Table Manager (TTM) for the best RSVP LSP. In the former case, only the specified LSPs will be considered to tunnel LDP user packets. In the latter case, all LSPs available to the TTM and which terminate on the same egress router as this targeted LDP session will be considered. In both cases, the metric specified under the LSP configuration is used to control this selection.

Note that the lookup in the TTM will prefer a LDP tunnel over an LDP-over-RSVP tunnel if both are available. Also note that the tunneling operates on the dataplane only. Control packets of this targeted LDP session are sent over the IGP path.

### shortcut-transit-ttl-propagate

**Syntax**

```
[no] shortcut-transit-ttl-propagate
```

**Context**

```
config>router>ldp
config>router>mpls
```

**Description**

This command configures the TTL handling of transit packets for all LSP shortcuts originating on this ingress LER. It applies to all LDP or RSVP LSPs that are used to resolve static routes, BGP routes, and IGP routes.

The user can enable or disable the propagation of the TTL from the header of an IP packet into the header of the resulting MPLS packet independently for local and transit packets forwarded over an LSP shortcut.

By default, the feature propagates the TTL from the header of transit IP packets into the label stack of the resulting MPLS packets forwarded over the LSP shortcut. This is referred to as Uniform mode.

When the `no` form of the command is enabled, TTL propagation is disabled on all transit IP packets received on any IES interface and destined to a route that is resolved to the LSP shortcut. In this case, a TTL of 255 is programmed onto the pushed label stack. This is referred to as Pipe mode.

**Default**

```
shortcut-transit-ttl-propagate
```
shortcut-local-ttl-propagate

Syntax  

[no] shortcut-local-ttl-propagate

Context  

config>router>ldp  
config>router>mpls

Description  

This command configures the TTL handling of locally generated packets for all LSP shortcuts originating on this ingress LER. It applies to all LDP or RSVP LSPs that are used to resolve static routes, BGP routes, and IGP routes.

The user can enable or disable the propagation of the TTL from the header of an IP packet into the header of the resulting MPLS packet independently for local and transit packets forwarded over an LSP shortcut.

Local IP packets include ICMP Ping, traceroute, and OAM packets, that are destined to a route that is resolved to the LSP shortcut. Transit IP packets are all IP packets received on any IES interface and destined to a route that is resolved to the LSP shortcut.

By default, the feature propagates the TTL from the header of locally generated IP packets into the label stack of the resulting MPLS packets forwarded over the LSP shortcut. This is referred to as Uniform mode.

When the no form of the above command is enabled, TTL propagation is disabled on all locally generated IP packets, including ICMP Ping, traceroute, and OAM packets, that are destined to a route that is resolved to the LSP shortcut. In this case, a TTL of 255 is programmed onto the pushed label stack. This is referred to as Pipe mode.

Default  

shortcut-local-ttl-propagate
Targeted Session Commands

targeted-session

Syntax targeted-session
Context config>router>ldp
Description This command configures targeted LDP sessions. Targeted sessions are LDP sessions between non-directly connected peers. Hello messages are sent directly to the peer platform instead of to all the routers on this subnet multicast address.
The discovery messages for an indirect LDP session are addressed to the specified peer and not to the multicast address.
Default none

bfd-enable

Syntax [no] bfd-enable
Context config>router>ldp>targ-session>peer
Description This command enables the bidirectional forwarding detection (BFD) session for the selected TLDP session. By enabling BFD for a selected targeted session, the state of that session is tied to the state of the underneath BFD session between the two nodes.
The parameters used for the BFD are set via the BFD command under the IP interface.
The no form of this command removes the TLDP session operational state binding to the central BFD session one.
Default no bfd-enable
disable-targeted-session

Syntax  
[no] disable-targeted-session

Context  
config>router>ldp>targ-session

Description  
This command disables support for SDP triggered automatic generated targeted sessions. Targeted sessions are LDP sessions between non-directly connected peers. The discovery messages for an indirect LDP session are addressed to the specified peer and not to the multicast address.

The no form of the command enables the set up of any targeted sessions.

Default  
no disable-targeted-session

peer

Syntax  
[no] peer ip-address

Context  
config>router>ldp>targeted-session

Description  
This command configures parameters for an LDP peer.

Default  
none

Parameters  
ip-address — The IP address of the LDP peer in dotted decimal notation.

export-prefixes

Syntax  
export-prefixes policy-name [policy-name...(up to 5 max)]

Context  
config>router>ldp>targeted-session

Description  
This command specifies the export route policy used to determine which FEC prefix label bindings are exported from a targeted LDP session. A route that is filtered out (deny) will not be exported. A route that is filtered in (accept) will be exported.

If no export policy is specified, all bindings learned through a targeted LDP session will be exported to all targeted LDP peers. This policy is applied in addition to the global LDP policy.

Policies are configured in the config>router>policy-options context. A maximum of five policy names can be specified.

The no form of the command removes the policy from the configuration.

Parameters  
policy-name — The export policy name. Allowed values are any string up to 32 characters long composed of printable, 7-bit ASCII characters. If the string contains special characters (#, $, spaces, etc.), the entire string must be enclosed within double quotes.
import-prefixes

**Syntax**

import-prefixes *policy-name* [policy-name...(up to 5 max)]

no import-prefixes

**Context**

config>router>ldp>targeted-session

**Description**

This command configures the import route policy to determine which FEC prefix label bindings are accepted from targeted LDP neighbors into this node. A label binding that is filtered out (deny) will not be imported. A route that is filtered in (accept) will be imported.

If no import policy is specified, this node session will accept all bindings from configured targeted LDP neighbors. This policy is applied in addition to the global LDP policy.

Policies are configured in the `config>router>policy-options` context. A maximum of five policy names can be specified.

The `no` form of the command removes the policy from the configuration.

**Parameters**

*policy-name* — The import policy name. Allowed values are any string up to 32 characters long composed of printable, 7-bit ASCII characters. If the string contains special characters (#, $, spaces, etc.), the entire string must be enclosed within double quotes.
Show LDP Commands

adv-adj-addr-only

Syntax
adv-adj-addr-only

Context
show>router>ldp

Description
This command displays the local interfaces used to establish hello adjacencies with an LDP peer.

Output

*A:*SR4>config>router>ldp>peer-params# peer 110.20.1.1 adv-adj-addr-only
*A:*SR4>config>router>ldp>peer-params#
*A:*SR4>config>router>ldp>peer-params# show router ldp session
  - session [-ip-addr[:label-space]>] [session-type] [state <state>] [summary|detail]
  - session [-ip-addr[:label-space]>] local-addresses [sent|recv] [ip-addr <ip-address>]
  - session [-ip-addr[:label-space]>] statistics [packet-type] [session-type]
    <ip-addr[:label-space]> : ip-addr - a.b.c.d
    label-space - [0..65535]
    <statistics> : keyword - display statistics
    <packet-type> : hello|keepalive|init|label|notification|address - keywords
    <session-type> : link|targeted|both
    <state> : up - Established
down - Initialized, OpenRecv, OpenSent, Nonexistent
  <summary|detail> : summary|detail
  <local-addresses> : keyword
  <sent|recv> : keyword
  <ip-address> : a.b.c.d

*A:*SR4>config>router>ldp>peer-params# show router ldp session 110.20.1.1 local-addresses
===============================================================================
LDP Session Local-Addresses
===============================================================================
-------------------------------------------------------------------------------
Session with Peer 110.20.1.1:0, Local 110.20.1.3:0
-------------------------------------------------------------------------------
Sent Addresses: 6.2.6.3 6.2.7.3 6.2.49.3 6.2.57.3 110.20.1.3 200.0.0.3
Recv Addresses:
===============================================================================
*A:*SR4>config>router>ldp>peer-params# peer 110.20.1.1 no adv-adj-addr-only
*A:*SR4>config>router>ldp>peer-params# show router ldp session 110.20.1.1 local-addresses
===============================================================================
LDP Session Local-Addresses
===============================================================================
-------------------------------------------------------------------------------
Session with Peer 110.20.1.1:0, Local 110.20.1.3:0
-------------------------------------------------------------------------------
Sent Addresses: 1.2.11.3 1.2.12.3 1.2.111.3 1.2.121.3 6.2.6.3 6.2.7.3 6.2.49.3 6.2.50.3 6.2.57.3 6.2.58.3 6.2.61.3 6.2.71.3 10.100.40.3 34.34.34.34 35.35.35.35 60.60.60.60 71.17.71.1 88.88.87.1 88.88.88.1 88.88.89.1 104.104.0.3 104.104.1.3 104.104.2.3 104.104.3.3
110.20.3.2 110.20.3.3 110.20.3.4 110.20.3.5
110.20.3.6 110.20.3.7 110.20.3.8 110.20.3.9
110.20.3.10 110.20.3.11 110.20.3.12 110.20.3.13
110.20.3.14 110.20.3.15 110.20.3.16 110.20.3.17
110.20.3.18 110.20.3.19 110.20.3.20 110.20.3.21
110.20.3.22 110.20.3.23 110.20.3.24 110.20.3.25
110.20.3.26 110.20.3.27 110.20.3.28 110.20.3.29
110.20.3.30 110.20.3.31 150.50.0.3 150.50.1.3
150.50.2.3 150.50.3.3 150.50.4.3 150.50.5.3
150.50.6.3 150.50.7.3 150.50.8.3 150.50.9.3
150.50.10.3 150.50.11.3 150.50.12.3 150.50.13.3
150.50.20.3 150.50.21.3 150.50.22.3 150.50.23.3
150.50.24.3 150.50.25.3 150.50.26.3 150.50.27.3
150.50.28.3 150.50.29.3 150.50.30.3 150.50.31.3
150.50.32.3 150.50.33.3 150.50.40.3 150.50.41.3
150.50.42.3 150.50.43.3 150.50.44.3 150.50.45.3
150.50.46.3 150.50.47.3 150.50.48.3 150.50.49.3
150.50.50.3 150.50.51.3 150.50.52.3 150.50.53.3
150.50.60.3 150.50.61.3 150.50.62.3 150.50.63.3
150.50.64.3 150.50.65.3 150.50.66.3 150.50.67.3
150.50.68.3 150.50.69.3 150.50.70.3 150.50.71.3
150.50.72.3 150.50.73.3 150.60.30.3 150.60.31.3
150.60.31.10 150.60.31.19 150.60.31.27 150.60.31.35
150.60.31.43 150.60.31.51 150.60.31.59 150.60.31.67
150.60.31.75 150.60.31.83 150.60.31.98 150.60.31.106
150.60.70.3 150.60.71.3 150.60.71.10 150.60.71.19
150.60.71.27 150.60.71.35 150.60.71.43 150.60.71.51
150.60.71.59 150.60.71.67 150.60.71.75 150.60.71.83
150.60.71.98 150.60.71.106 150.60.75.3 150.60.76.3
150.60.78.35 150.60.78.37 150.60.78.45 150.60.78.53
150.60.78.57 150.60.78.65 150.60.78.73 150.60.78.81
150.60.78.83 150.60.78.91 150.60.78.99 150.60.78.107
170.70.90.3 170.70.91.3 180.60.100.3 180.60.110.3
180.100.3.3 193.127.0.1 200.0.0.3 203.0.0.3
Recv Addresses: 40.40.1.1 40.40.2.1

===============================================================================
*A:*SR4>config-router-ldp>peer-params#
*A:*SR4>config-router-ldp>peer-params# peer 110.20.1.1 adv-adj-addr-only
*A:*SR4>config-router-ldp>peer-params# show router ldp session 110.20.1.1 local-addresses sent
===============================================================================
LDP Session Local-Addresses
===============================================================================
-------------------------------------------------------------------------------
Session with Peer 110.20.1.1:0, Local 110.20.1.3:0
-------------------------------------------------------------------------------
Sent Addresses: 6.2.6.3 6.2.7.3 6.2.49.3 6.2.57.3 110.20.1.3 200.0.0.3
===============================================================================
*A:*SR4>config-router-ldp>peer-params# show router ldp session 110.20.1.1 local-addresses recv
===============================================================================
LDP Session Local-Addresses
===============================================================================
-------------------------------------------------------------------------------
Session with Peer 110.20.1.1:0, Local 110.20.1.3:0
-------------------------------------------------------------------------------
Recv Addresses: 6.2.6.1 6.2.7.1 6.2.49.1 6.2.50.1 6.2.57.1 6.2.58.1 6.2.61.1 6.2.71.1
7.1.1.1 7.1.2.1 7.1.3.1 7.1.4.1 7.1.5.1 7.1.6.1 7.1.7.1 7.1.8.1
7.2.247.1 7.2.248.1 7.2.249.1 7.2.250.1
7.3.1.1 7.3.2.1 7.3.3.1 7.3.4.1
7.3.5.1 7.3.6.1 7.3.7.1 7.3.8.1
7.3.9.1 7.3.10.1 7.3.11.1 7.3.12.1
7.3.13.1 7.3.14.1 7.3.15.1 7.3.16.1
7.3.17.1 7.3.18.1 7.3.19.1 7.3.20.1
7.3.21.1 7.3.22.1 7.3.23.1 7.3.24.1
7.3.25.1 7.3.26.1 7.3.27.1 7.3.28.1
7.3.29.1 7.3.30.1 7.3.31.1 7.3.32.1
7.3.33.1 7.3.34.1 7.3.35.1 7.3.36.1
7.3.37.1 7.3.38.1 7.3.39.1 7.3.40.1
7.3.41.1 7.3.42.1 7.3.43.1 7.3.44.1
7.3.45.1 7.3.46.1 7.3.47.1 7.3.48.1
7.3.49.1 7.3.50.1 7.3.51.1 7.3.52.1
7.3.53.1 7.3.54.1 7.3.55.1 7.3.56.1
7.3.57.1 7.3.58.1 7.3.59.1 7.3.60.1
7.3.61.1 7.3.62.1 7.3.63.1 7.3.64.1
7.3.65.1 7.3.66.1 7.3.67.1 7.3.68.1
7.3.69.1 7.3.70.1 7.3.71.1 7.3.72.1
7.3.73.1 7.3.74.1 7.3.75.1 7.3.76.1
7.3.77.1 7.3.78.1 7.3.79.1 7.3.80.1
7.3.81.1 7.3.82.1 7.3.83.1 7.3.84.1
7.3.85.1 7.3.86.1 7.3.87.1 7.3.88.1
7.3.89.1 7.3.90.1 7.3.91.1 7.3.92.1
7.3.93.1 7.3.94.1 7.3.95.1 7.3.96.1
7.3.97.1 7.3.98.1 7.3.99.1 7.3.100.1
7.3.101.1 7.3.102.1 7.3.103.1 7.3.104.1
7.3.105.1 7.3.106.1 7.3.107.1 7.3.108.1
7.3.109.1 7.3.110.1 7.3.111.1 7.3.112.1
7.3.113.1 7.3.114.1 7.3.115.1 7.3.116.1
7.3.117.1 7.3.118.1 7.3.119.1 7.3.120.1
7.3.121.1 7.3.122.1 7.3.123.1 7.3.124.1
7.3.125.1 7.4.1.1 7.4.2.1 7.4.3.1
7.4.4.1 7.4.5.1 7.4.6.1 7.4.7.1
7.4.8.1 7.4.9.1 7.4.10.1 7.4.11.1
7.4.12.1 7.4.13.1 7.4.14.1 7.4.15.1
7.4.16.1 7.4.17.1 7.4.18.1 7.4.19.1
7.4.20.1 7.4.21.1 7.4.22.1 7.4.23.1
7.4.24.1 7.4.25.1 7.4.26.1 7.4.27.1
7.4.28.1 7.4.29.1 7.4.30.1 7.4.31.1
7.4.32.1 7.4.33.1 7.4.34.1 7.4.35.1
7.4.36.1 7.4.37.1 7.4.38.1 7.4.39.1
7.4.40.1 7.4.41.1 7.4.42.1 7.4.43.1
7.4.44.1 7.4.45.1 7.4.46.1 7.4.47.1
7.4.48.1 7.4.49.1 7.4.50.1 7.4.51.1
7.4.52.1 7.4.53.1 7.4.54.1 7.4.55.1
7.4.56.1 7.4.57.1 7.4.58.1 7.4.59.1
7.4.60.1 7.4.61.1 7.4.62.1 7.4.63.1
7.4.64.1 7.4.65.1 7.4.66.1 7.4.67.1
7.4.68.1 7.4.69.1 7.4.70.1 7.4.71.1
7.4.72.1 7.4.73.1 7.4.74.1 7.4.75.1
7.4.76.1 7.4.77.1 7.4.78.1 7.4.79.1
7.4.80.1 7.4.81.1 7.4.82.1 7.4.83.1
7.4.84.1 7.4.85.1 7.4.86.1 7.4.87.1
7.4.88.1 7.4.89.1 7.4.90.1 7.4.91.1
7.4.92.1 7.4.93.1 7.4.94.1 7.4.95.1
7.4.96.1 7.4.97.1 7.4.98.1 7.4.99.1
7.4.100.1 7.4.101.1 7.4.102.1 7.4.103.1
7.4.104.1 7.4.105.1 7.4.106.1 7.4.107.1
7.4.108.1 7.4.109.1 7.4.110.1 7.4.111.1
7.4.112.1 7.4.113.1 7.4.114.1 7.4.115.1
**auth-keychain**

**Syntax**

auth-keychain [keychain]

**Context**

show>router>ldp

**Description**

This command displays LDP sessions using a particular authentication key-chain.

**Parameters**

- **keychain** — Specifies an existing keychain name.

**Sample Output**

```
*ALA-48>config>router>ldp# show router ldp auth-keychain

LDP Peers

<table>
<thead>
<tr>
<th>Peer</th>
<th>TTL Security</th>
<th>Min-TTL-Value</th>
<th>Authentication</th>
<th>Auth key chain</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.20.1.3</td>
<td>Disabled</td>
<td>n/a</td>
<td>Disabled</td>
<td>eta_keychain1</td>
</tr>
</tbody>
</table>

No. of Peers: 1
```

```
*ALA-48>config>router>ldp#
```
Show Commands

bindings

Syntax

```
bindings [fec-type fec-type [detail | summary]] [session ip-addr[:label-space]]
bindings [fec-type p2mp] [p2mp <identifier> root <ip-address>] [detail | summary] [session ip-addr[:label-space]]
bindings [label-type] [start-label [end-label]]
bindings (prefix ip-prefix/mask [detail]) [session ip-addr[:label-space]]
bindings active [prefix ip-prefix/mask][summary | egress-nh ip-prefix/mask | egress-if port-id | egress-lsp tunnel-id]
bindings active [fec-type prefixes] [prefix <ip-prefix/mask>] [egress-nh <ip-prefix/mask> | egress-if <port-id> | egress-lsp <tunnel-id>] [summary]
bindings active [fec-type p2mp] [p2mp-id <identifier> root <ip-address>] [egress-nh <ip-address>] [egress-if <ip-prefix/mask>] [egress-if <port-id>] [egress-lsp <tunnel-id>] [summary]
bindings service-id service-id [detail]
bindings vc-type vc-type [{vc-id vc-id | agi agi}] [session ip-addr[:lab el-space]]
bindings vc-type vc-type agi <agi> sail-type2 <global-id:prefix:ac-id> tail-type2 <global_id:prefix:ac_id> [detail]
bindings p2mp-id <identifier> root <ip-address> [detail]
```

Context

```
show>router>ldp
```

Description

This command displays the contents of the label information base.

Parameters

- `fec-type fec-type` — Specify the kind of FEC that the label mapping, withdraw, release and request messages are referring to.

  - `detail` — Displays detailed information.
  - `summary` — Displays information in a summarized format.

- `session ip-addr` — displays configuration information about LDP sessions.

- `ip-prefix` — Specify information for the specified IP prefix and mask length. Host bits must be 0.

- `mask` — Specifies the 32-bit address mask used to indicate the bits of an IP address that are being used for the subnet address.

  **Values**

  - `0 — 32`

- `label-space` — Specifies the label space identifier that the router is advertising on the interface.

  **Values**

  - `0 — 65535`

- `start-label` — Specifies a label value to begin the display.

  **Values**

  - `16 — 1048575`

- `end-label` — Specifies a label value to end the display.

  **Values**

  - `17 — 1048575`

- `vc-type` — Specifies the VC type to display.

  **Values**

  - `ethernet`, `vlan`, `mirror`

- `vc-id` — Specifies the VC ID to display.

  **Values**

  - `1 — 4294967295`
service-id — Specifies the service ID number to display.

Values 1 — 2147483647

egress-lsp tunnel-id —

Values 0 — 4294967295

egress-if port-id — Specifies the egress interface port ID.

Values slot[/mda[/port]] or slot/mda/port[.channel]

    aps-id    aps-group-id[.channel]
    aps       keyword
    group-id  1— 64
    ccag-id   slot/mda/path-id[cc-type]
    path-id   a, b
    cc-type   .sap-net, .net-sap

Output LDP Bindings Output — The following table describes the LDP bindings fields.

<table>
<thead>
<tr>
<th>Label</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Legend</td>
<td>U: Label In Use</td>
</tr>
<tr>
<td></td>
<td>N: Label Not In Use</td>
</tr>
<tr>
<td></td>
<td>W: Label Withdrawn</td>
</tr>
<tr>
<td></td>
<td>S: Status Signaled Up</td>
</tr>
<tr>
<td></td>
<td>D: Status Signaled Down</td>
</tr>
<tr>
<td></td>
<td>E: Epipe service</td>
</tr>
<tr>
<td></td>
<td>V: VPLS service</td>
</tr>
<tr>
<td></td>
<td>M: Mirror service</td>
</tr>
<tr>
<td></td>
<td>WP: Label Withdraw Pending</td>
</tr>
<tr>
<td></td>
<td>TLV: (Type, Length: Value)</td>
</tr>
<tr>
<td>Type</td>
<td>The service type exchanging labels in the SDP. The possible types displayed are VPLS, Epipe, Spoke, and Unknown.</td>
</tr>
<tr>
<td>VCId</td>
<td>The value used by each end of an SDP tunnel to identify the VC.</td>
</tr>
<tr>
<td>SvcID</td>
<td>The unique service identification number identifying the service in the service domain.</td>
</tr>
<tr>
<td>SDPId</td>
<td>The SDP number identifying the SDP in the service domain.</td>
</tr>
<tr>
<td>Peer</td>
<td>The IP address of the peer.</td>
</tr>
<tr>
<td>EgrIntf/LspId</td>
<td>Displays the LSP Tunnel ID (not the LSP path ID).</td>
</tr>
<tr>
<td>Inglbl</td>
<td>The ingress LDP label.</td>
</tr>
<tr>
<td></td>
<td>U — Label in use.</td>
</tr>
<tr>
<td></td>
<td>R — Label released.</td>
</tr>
<tr>
<td>EgrLbl</td>
<td>The egress LDP label.</td>
</tr>
<tr>
<td>LMTU</td>
<td>The local MTU value.</td>
</tr>
<tr>
<td>RMTU</td>
<td>The remote MTU value.</td>
</tr>
</tbody>
</table>
Sample Output

*A:Dut-A# show router ldp bindings active

Legend:  (S) - Static       (M) - Multi-homed Secondary Support
        (B) - BGP Next Hop (BU) - Alternate Next-hop for Fast Re-Route

LDP Prefix Bindings (Active)

<table>
<thead>
<tr>
<th>Prefix</th>
<th>Op</th>
<th>IngLbl</th>
<th>EgrLbl</th>
<th>EgrIntf/LspId</th>
<th>EgrNextHop</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.20.1.1/32</td>
<td>Pop</td>
<td>131071</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>10.20.1.2/32</td>
<td>Push</td>
<td>131071</td>
<td>1/1/1</td>
<td>--</td>
<td>10.10.1.2</td>
</tr>
<tr>
<td>10.20.1.2/32</td>
<td>Push</td>
<td>262141BU</td>
<td>1/1/2</td>
<td>10.10.2.3</td>
<td></td>
</tr>
<tr>
<td>10.20.1.2/32</td>
<td>Swap</td>
<td>131070</td>
<td>1/1/1</td>
<td>10.10.1.2</td>
<td></td>
</tr>
<tr>
<td>10.20.1.2/32</td>
<td>Swap</td>
<td>131069BU</td>
<td>1/1/1</td>
<td>10.10.1.2</td>
<td></td>
</tr>
<tr>
<td>10.20.1.2/32</td>
<td>Push</td>
<td>131069BU</td>
<td>1/1/1</td>
<td>10.10.1.2</td>
<td></td>
</tr>
<tr>
<td>10.20.1.2/32</td>
<td>Swap</td>
<td>262143</td>
<td>1/1/2</td>
<td>10.10.2.3</td>
<td></td>
</tr>
<tr>
<td>10.20.1.2/32</td>
<td>Swap</td>
<td>131069</td>
<td>1/1/1</td>
<td>10.10.2.3</td>
<td></td>
</tr>
<tr>
<td>10.20.1.2/32</td>
<td>Push</td>
<td>131068</td>
<td>1/1/1</td>
<td>10.10.2.3</td>
<td></td>
</tr>
<tr>
<td>10.20.1.2/32</td>
<td>Push</td>
<td>262140BU</td>
<td>1/1/2</td>
<td>10.10.2.3</td>
<td></td>
</tr>
<tr>
<td>10.20.1.2/32</td>
<td>Swap</td>
<td>131068</td>
<td>1/1/1</td>
<td>10.10.2.3</td>
<td></td>
</tr>
<tr>
<td>10.20.1.2/32</td>
<td>Swap</td>
<td>262139</td>
<td>1/1/2</td>
<td>10.10.2.3</td>
<td></td>
</tr>
<tr>
<td>10.20.1.2/32</td>
<td>Push</td>
<td>131066</td>
<td>1/1/1</td>
<td>10.10.2.3</td>
<td></td>
</tr>
<tr>
<td>10.20.1.2/32</td>
<td>Push</td>
<td>262138BU</td>
<td>1/1/2</td>
<td>10.10.2.3</td>
<td></td>
</tr>
<tr>
<td>10.20.1.2/32</td>
<td>Swap</td>
<td>131066</td>
<td>1/1/1</td>
<td>10.10.2.3</td>
<td></td>
</tr>
</tbody>
</table>

No. of Prefix Active Bindings: 21

LDP P2MP Bindings (Active)

<table>
<thead>
<tr>
<th>P2MP-Id</th>
<th>RootAddr</th>
<th>Interface</th>
<th>Op</th>
<th>IngLbl</th>
<th>EgrLbl</th>
<th>EgrIntf/LspId</th>
<th>EgrNextHop</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

No Matching Entries Found

*A:Dut-A# show router ldp bindings

LDP LSR ID: 10.20.1.1

Legend:  U - Label In Use, N - Label Not In Use, W - Label Withdrawn
        S - Status Signaled Up,  D - Status Signaled Down
### LDP Prefix Bindings

<table>
<thead>
<tr>
<th>Prefix</th>
<th>Peer</th>
<th>IngLbl</th>
<th>EgrLbl</th>
<th>EgrIntf/</th>
<th>EgrNextHop</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.20.1.1/32</td>
<td>10.20.1.2</td>
<td>131071U</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>10.20.1.1/32</td>
<td>10.20.1.3</td>
<td>131071U</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>10.20.1.2/32</td>
<td>10.20.1.2</td>
<td>131070U</td>
<td>131071</td>
<td>1/1/1</td>
<td>10.10.1.2</td>
</tr>
<tr>
<td>10.20.1.2/32</td>
<td>10.20.1.3</td>
<td>131069U</td>
<td>262141</td>
<td>1/1/2</td>
<td>10.10.2.3</td>
</tr>
<tr>
<td>10.20.1.3/32</td>
<td>10.20.1.2</td>
<td>131068U</td>
<td>131069</td>
<td>1/1/1</td>
<td>10.10.1.2</td>
</tr>
<tr>
<td>10.20.1.3/32</td>
<td>10.20.1.3</td>
<td>131068U</td>
<td>262140</td>
<td>1/1/2</td>
<td>10.10.2.3</td>
</tr>
<tr>
<td>10.20.1.4/32</td>
<td>10.20.1.2</td>
<td>131067U</td>
<td>131068</td>
<td>1/1/1</td>
<td>10.10.1.2</td>
</tr>
<tr>
<td>10.20.1.4/32</td>
<td>10.20.1.3</td>
<td>131068U</td>
<td>262139</td>
<td>1/1/2</td>
<td>10.10.2.3</td>
</tr>
<tr>
<td>10.20.1.5/32</td>
<td>10.20.1.2</td>
<td>131067U</td>
<td>131067</td>
<td>1/1/1</td>
<td>10.10.1.2</td>
</tr>
<tr>
<td>10.20.1.5/32</td>
<td>10.20.1.3</td>
<td>131067U</td>
<td>262138</td>
<td>1/1/2</td>
<td>10.10.2.3</td>
</tr>
</tbody>
</table>

No. of Prefix Bindings: 12

### LDP P2MP Bindings

<table>
<thead>
<tr>
<th>P2MP-Id</th>
<th>RootAddr</th>
<th>Interface</th>
<th>Peer</th>
<th>IngLbl</th>
<th>EgrLbl</th>
<th>EgrIntf/</th>
<th>EgrNextHop</th>
</tr>
</thead>
</table>

No Matching Entries Found

### LDP Service FEC 128 Bindings

<table>
<thead>
<tr>
<th>Type</th>
<th>VCId</th>
<th>SvcId</th>
<th>SDPId</th>
<th>Peer</th>
<th>IngLbl</th>
<th>EgrLbl</th>
<th>LMTU</th>
<th>RMTU</th>
</tr>
</thead>
</table>

No Matching Entries Found

### LDP Service FEC 129 Bindings

<table>
<thead>
<tr>
<th>Type</th>
<th>SvcId</th>
<th>SDPId</th>
<th>Peer</th>
<th>IngLbl</th>
<th>EgrLbl</th>
<th>LMTU</th>
<th>RMTU</th>
</tr>
</thead>
</table>

No Matching Entries Found

*A:SRL-A# show router ldp bindings service-id 100 detail

LDP LSR ID: 1.1.1.1

Legend: U - Label In Use, N - Label Not In Use, W - Label Withdrawn

S - Status Signaled Up, D - Status Signaled Down

E - Epipe Service, V - VPLS Service, M - Mirror Service


P - Ipipe Service, WP - Label Withdraw Pending, C - Cpipe Service
TLV - (Type, Length: Value)

LDP Service Binding

<table>
<thead>
<tr>
<th>Type</th>
<th>E-Eth</th>
<th>VcId</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>SvcId</td>
<td>100</td>
<td>SdpId</td>
<td>100</td>
</tr>
<tr>
<td>Peer Address</td>
<td>2.2.2.2</td>
<td>Vc-switching</td>
<td>No</td>
</tr>
<tr>
<td>LMTU</td>
<td>986</td>
<td>RMTU</td>
<td>986</td>
</tr>
<tr>
<td>Egr. Lbl</td>
<td>130812D</td>
<td>Egr. Ctrl Word</td>
<td>No</td>
</tr>
<tr>
<td>Egr. Flags</td>
<td>None</td>
<td>Egr. Status Bits : Supported (0x1e)</td>
<td></td>
</tr>
<tr>
<td>Ing. Lbl</td>
<td>130808U</td>
<td>Ing. Ctrl Word</td>
<td>No</td>
</tr>
<tr>
<td>Ing. Flags</td>
<td>None</td>
<td>Ing. Status Bits : Supported (0x16)</td>
<td></td>
</tr>
<tr>
<td>No. of VC Labels:</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*A:SR1-A#*  
*A:SRU4>config>router>ldp# show router ldp bindings fec-type prefixes*  
LDP LSR ID: 110.20.1.4

<table>
<thead>
<tr>
<th>Prefix</th>
<th>Peer</th>
<th>EgrLbl</th>
<th>EgrIntf/LspId</th>
<th>EgrNextHop</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1.1.0/24</td>
<td>10.20.1.22</td>
<td>--</td>
<td>1301</td>
<td>--</td>
</tr>
<tr>
<td>1.2.10.0/24</td>
<td>10.20.1.22</td>
<td>--</td>
<td>618</td>
<td>--</td>
</tr>
<tr>
<td>1.2.11.0/24</td>
<td>10.20.1.22</td>
<td>--</td>
<td>617</td>
<td>--</td>
</tr>
<tr>
<td>1.2.12.0/24</td>
<td>10.20.1.22</td>
<td>--</td>
<td>619</td>
<td>--</td>
</tr>
<tr>
<td>1.2.101.0/24</td>
<td>10.20.1.22</td>
<td>--</td>
<td>656</td>
<td>--</td>
</tr>
<tr>
<td>1.2.111.0/24</td>
<td>10.20.1.22</td>
<td>--</td>
<td>341</td>
<td>--</td>
</tr>
<tr>
<td>1.2.121.0/24</td>
<td>10.20.1.22</td>
<td>--</td>
<td>346</td>
<td>--</td>
</tr>
<tr>
<td>1.38.38.0/24</td>
<td>10.20.1.22</td>
<td>--</td>
<td>624</td>
<td>--</td>
</tr>
<tr>
<td>1.38.39.0/24</td>
<td>10.20.1.22</td>
<td>--</td>
<td>625</td>
<td>--</td>
</tr>
<tr>
<td>1.38.138.0/24</td>
<td>10.20.1.22</td>
<td>--</td>
<td>368</td>
<td>--</td>
</tr>
<tr>
<td>1.38.139.0/24</td>
<td>10.20.1.22</td>
<td>--</td>
<td>626</td>
<td>--</td>
</tr>
<tr>
<td>...</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>222.0.0.0/10</td>
<td>10.20.1.22</td>
<td>--</td>
<td>298</td>
<td>--</td>
</tr>
<tr>
<td>222.0.0.10</td>
<td>110.20.1.15</td>
<td>--</td>
<td>128741</td>
<td>--</td>
</tr>
<tr>
<td>222.9.69.0/24</td>
<td>10.20.1.22</td>
<td>--</td>
<td>1402</td>
<td>--</td>
</tr>
<tr>
<td>222.9.69.0/24</td>
<td>110.20.1.15</td>
<td>--</td>
<td>128778</td>
<td>--</td>
</tr>
</tbody>
</table>

No. of Prefix Bindings: 2939

*A:SRU4>config>router>ldp#*  
*A:SRU4# show router ldp bindings fec-type p2mp*  
LDP LSR ID: 110.20.1.4

<table>
<thead>
<tr>
<th>Prefix</th>
<th>Peer</th>
<th>EgrLbl</th>
<th>EgrNextHop</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1.1.0/24</td>
<td>10.20.1.22</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>1.2.10.0/24</td>
<td>10.20.1.22</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>1.2.11.0/24</td>
<td>10.20.1.22</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>1.2.12.0/24</td>
<td>10.20.1.22</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>1.2.101.0/24</td>
<td>10.20.1.22</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>1.2.111.0/24</td>
<td>10.20.1.22</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>1.2.121.0/24</td>
<td>10.20.1.22</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>1.38.38.0/24</td>
<td>10.20.1.22</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>1.38.39.0/24</td>
<td>10.20.1.22</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>1.38.138.0/24</td>
<td>10.20.1.22</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>1.38.139.0/24</td>
<td>10.20.1.22</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>222.0.0.0/10</td>
<td>10.20.1.22</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>222.0.0.10</td>
<td>110.20.1.15</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>222.9.69.0/24</td>
<td>10.20.1.22</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>222.9.69.0/24</td>
<td>110.20.1.15</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>
### LDP P2MP Bindings

<table>
<thead>
<tr>
<th>P2MP-Id</th>
<th>RootAddr</th>
<th>Interface</th>
<th>Peer</th>
<th>IngLbl</th>
<th>EgrLbl</th>
<th>EgrIntf/EgrNextHop</th>
<th>LspId</th>
</tr>
</thead>
<tbody>
<tr>
<td>8193</td>
<td>110.20.1.4</td>
<td>74728</td>
<td>10.100.10.10 --</td>
<td>5738</td>
<td>3/1/6</td>
<td>180.100.4.10</td>
<td></td>
</tr>
<tr>
<td>8194</td>
<td>110.20.1.4</td>
<td>74729</td>
<td>10.100.10.10 --</td>
<td>7089</td>
<td>3/1/6</td>
<td>180.100.4.10</td>
<td></td>
</tr>
<tr>
<td>8195</td>
<td>110.20.1.4</td>
<td>74730</td>
<td>10.100.10.10 --</td>
<td>5766</td>
<td>3/1/6</td>
<td>180.100.4.10</td>
<td></td>
</tr>
<tr>
<td>8196</td>
<td>110.20.1.4</td>
<td>74731</td>
<td>10.100.10.10 --</td>
<td>6826</td>
<td>3/1/6</td>
<td>180.100.4.10</td>
<td></td>
</tr>
<tr>
<td>8197</td>
<td>110.20.1.4</td>
<td>74732</td>
<td>10.100.10.10 --</td>
<td>7412</td>
<td>3/1/6</td>
<td>180.100.4.10</td>
<td></td>
</tr>
<tr>
<td>8198</td>
<td>110.20.1.4</td>
<td>74733</td>
<td>10.100.10.10 --</td>
<td>6548</td>
<td>3/1/6</td>
<td>180.100.4.10</td>
<td></td>
</tr>
<tr>
<td>8199</td>
<td>110.20.1.4</td>
<td>74734</td>
<td>10.100.10.10 --</td>
<td>6544</td>
<td>3/1/6</td>
<td>180.100.4.10</td>
<td></td>
</tr>
<tr>
<td>8200</td>
<td>110.20.1.4</td>
<td>74735</td>
<td>10.100.10.10 --</td>
<td>5736</td>
<td>3/1/6</td>
<td>180.100.4.10</td>
<td></td>
</tr>
<tr>
<td>8201</td>
<td>110.20.1.4</td>
<td>74736</td>
<td>10.100.10.10 --</td>
<td>7718</td>
<td>3/1/6</td>
<td>180.100.4.10</td>
<td></td>
</tr>
</tbody>
</table>

Press any key to continue (Q to quit)

A: both2# show router ldp bindings fec-type services

---

### LDP Service Bindings

<table>
<thead>
<tr>
<th>Type</th>
<th>VCId</th>
<th>SvcId</th>
<th>SDPId</th>
<th>Peer</th>
<th>IngLbl</th>
<th>EgrLbl</th>
<th>LMTU</th>
<th>RMTU</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-Eth</td>
<td>100</td>
<td>1</td>
<td>1</td>
<td>1.1.1.30</td>
<td>131067U</td>
<td>131068S</td>
<td>1500</td>
<td>1500</td>
</tr>
<tr>
<td>E-Eth</td>
<td>500</td>
<td>5</td>
<td>1</td>
<td>1.1.1.30</td>
<td>131066W</td>
<td>131066</td>
<td>3960</td>
<td>3960</td>
</tr>
</tbody>
</table>

No. of VC Labels: 2

---

*A:SRU4# show router ldp bindings session 10.8.100.15

---

LDP LSR ID: 110.20.1.4

### LDP Prefix Bindings

No Matching Entries Found

---

### LDP Service FEC 128 Bindings

No Matching Entries Found
### LDP Service FEC 129 Bindings

<table>
<thead>
<tr>
<th>Type</th>
<th>SvcId</th>
<th>SDPId</th>
<th>Peer</th>
<th>IngLbl</th>
<th>EgrLbl</th>
<th>LMTU</th>
<th>RMTU</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

No Matching Entries Found

*A:SRU4#

A:ALA-12# show router ldp bindings ingress-label 2048 131071

LDP LSR ID: 10.20.1.10

Legend:  U - Label In Use,  R - Label Released

#### LDP Prefix Bindings

<table>
<thead>
<tr>
<th>Prefix</th>
<th>Peer</th>
<th>IngLbl</th>
<th>EgrLbl</th>
<th>EgrIntf</th>
<th>EgrNextHop</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.20.1.10/32</td>
<td>10.20.1.3</td>
<td>131069U</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

No. of Prefix Bindings: 1

### LDP Service Bindings

<table>
<thead>
<tr>
<th>Type</th>
<th>VCId</th>
<th>SvcId</th>
<th>SDPId</th>
<th>Peer</th>
<th>IngLbl</th>
<th>EgrLbl</th>
<th>LMTU</th>
<th>RMTU</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

No Matching Entries Found

*A:ALA-12#

A:SRU4# show router ldp bindings active

Legend:  (S) - Static

#### LDP Prefix Bindings (Active)

<table>
<thead>
<tr>
<th>Prefix</th>
<th>Op</th>
<th>IngLbl</th>
<th>EgrLbl</th>
<th>EgrIntf/LspId</th>
<th>EgrNextHop</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.20.1.20/32</td>
<td>Push</td>
<td>0</td>
<td>3/2/1</td>
<td>10.100.30.20</td>
<td></td>
</tr>
<tr>
<td>10.20.1.20/32</td>
<td>Swap</td>
<td>131041</td>
<td>0</td>
<td>10.100.30.20</td>
<td></td>
</tr>
<tr>
<td>10.20.1.22/32</td>
<td>Push</td>
<td>0</td>
<td>3/2/7</td>
<td>160.60.60.2</td>
<td></td>
</tr>
<tr>
<td>10.20.1.22/32</td>
<td>Swap</td>
<td>131039</td>
<td>0</td>
<td>160.60.60.2</td>
<td></td>
</tr>
<tr>
<td>10.161.201.0/24</td>
<td>Push</td>
<td>0</td>
<td>3/2/7</td>
<td>160.60.60.2</td>
<td></td>
</tr>
<tr>
<td>110.20.1.1/32</td>
<td>Push</td>
<td>0</td>
<td>3/2/1</td>
<td>10.100.30.20</td>
<td></td>
</tr>
<tr>
<td>110.20.1.1/32</td>
<td>Swap</td>
<td>131038</td>
<td>0</td>
<td>10.100.30.20</td>
<td></td>
</tr>
<tr>
<td>110.20.1.4/32</td>
<td>Pop</td>
<td>3</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>160.60.70.0/24</td>
<td>Push</td>
<td>0</td>
<td>3/2/7</td>
<td>160.60.60.2</td>
<td></td>
</tr>
<tr>
<td>160.60.70.0/24</td>
<td>Swap</td>
<td>131036</td>
<td>0</td>
<td>160.60.60.2</td>
<td></td>
</tr>
<tr>
<td>160.60.80.0/24</td>
<td>Push</td>
<td>0</td>
<td>3/2/7</td>
<td>160.60.60.2</td>
<td></td>
</tr>
<tr>
<td>160.60.80.0/24</td>
<td>Swap</td>
<td>129982</td>
<td>0</td>
<td>160.60.60.2</td>
<td></td>
</tr>
</tbody>
</table>

No. of Prefix Bindings: 13

*A:SRU4# show router ldp bindings prefix 10.20.1.3/32 detail

LDP LSR ID: 10.20.1.2
### LDP Prefix Binding

<table>
<thead>
<tr>
<th>Prefix</th>
<th>10.20.1.3/32</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ing Lbl</td>
<td>130996U</td>
</tr>
<tr>
<td>Egr Lbl</td>
<td>131017</td>
</tr>
<tr>
<td>Egr Int/LspId</td>
<td>1331017</td>
</tr>
<tr>
<td>EgrNextHop</td>
<td>133017</td>
</tr>
<tr>
<td>Egr. Flags</td>
<td>None</td>
</tr>
<tr>
<td>Ing. Flags</td>
<td>None</td>
</tr>
</tbody>
</table>

- **Legend:**
  - U - Label In Use
  - N - Label Not In Use
  - W - Label Withdrawn
  - WP - Label Withdraw Pending

---

<table>
<thead>
<tr>
<th>Prefix</th>
<th>10.20.1.3/32</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ing Lbl</td>
<td>130996U</td>
</tr>
<tr>
<td>Egr Lbl</td>
<td>3</td>
</tr>
<tr>
<td>Egr Int/LspId</td>
<td>3</td>
</tr>
<tr>
<td>EgrNextHop</td>
<td>3</td>
</tr>
<tr>
<td>Egr. Flags</td>
<td>None</td>
</tr>
<tr>
<td>Ing. Flags</td>
<td>None</td>
</tr>
</tbody>
</table>

---

<table>
<thead>
<tr>
<th>Prefix</th>
<th>10.20.1.3/32</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ing Lbl</td>
<td>130996U</td>
</tr>
<tr>
<td>Egr Lbl</td>
<td>130969</td>
</tr>
<tr>
<td>Egr Int/LspId</td>
<td>130969</td>
</tr>
<tr>
<td>EgrNextHop</td>
<td>130969</td>
</tr>
<tr>
<td>Egr. Flags</td>
<td>None</td>
</tr>
<tr>
<td>Ing. Flags</td>
<td>None</td>
</tr>
</tbody>
</table>

---

<table>
<thead>
<tr>
<th>Prefix</th>
<th>10.20.1.3/32</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ing Lbl</td>
<td>130996U</td>
</tr>
<tr>
<td>Egr Lbl</td>
<td>131005</td>
</tr>
<tr>
<td>Egr Int/LspId</td>
<td>131005</td>
</tr>
<tr>
<td>EgrNextHop</td>
<td>131005</td>
</tr>
<tr>
<td>Egr. Flags</td>
<td>None</td>
</tr>
<tr>
<td>Ing. Flags</td>
<td>None</td>
</tr>
</tbody>
</table>

---

<table>
<thead>
<tr>
<th>Prefix</th>
<th>10.20.1.3/32</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ing Lbl</td>
<td>130996U</td>
</tr>
<tr>
<td>Egr Lbl</td>
<td>130993</td>
</tr>
<tr>
<td>Egr Int/LspId</td>
<td>130993</td>
</tr>
<tr>
<td>EgrNextHop</td>
<td>130993</td>
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<tr>
<td>Egr. Flags</td>
<td>None</td>
</tr>
<tr>
<td>Ing. Flags</td>
<td>None</td>
</tr>
</tbody>
</table>

---

<table>
<thead>
<tr>
<th>Prefix</th>
<th>10.20.1.3/32</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ing Lbl</td>
<td>130996U</td>
</tr>
<tr>
<td>Egr Lbl</td>
<td>131017</td>
</tr>
<tr>
<td>Egr Int/LspId</td>
<td>131017</td>
</tr>
<tr>
<td>EgrNextHop</td>
<td>131017</td>
</tr>
<tr>
<td>Egr. Flags</td>
<td>None</td>
</tr>
<tr>
<td>Ing. Flags</td>
<td>None</td>
</tr>
</tbody>
</table>

---

<table>
<thead>
<tr>
<th>Prefix</th>
<th>10.20.1.3/32</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ing Lbl</td>
<td>130996U</td>
</tr>
<tr>
<td>Egr Lbl</td>
<td>3</td>
</tr>
<tr>
<td>Egr Int/LspId</td>
<td>3</td>
</tr>
<tr>
<td>EgrNextHop</td>
<td>3</td>
</tr>
<tr>
<td>Egr. Flags</td>
<td>None</td>
</tr>
<tr>
<td>Ing. Flags</td>
<td>None</td>
</tr>
</tbody>
</table>
**Show Commands**

```
Egr. Flags : None                  Ing. Flags : None
Prefix : 10.20.1.3/32
-------------------------------------------------------------------------------
Ing Lbl  : 130996U                 Peer : 10.10.4.4
Egr Lbl  : 130969
Egr Int/LspId : --
EgrNextHop : --
Egr. Flags : None                  Ing. Flags : None
-------------------------------------------------------------------------------
Prefix : 10.20.1.3/32
-------------------------------------------------------------------------------
Ing Lbl  : 130996U                 Peer : 10.10.12.3
Egr Lbl  : 3
Egr Int/LspId : lag-1
EgrNextHop : 10.10.12.3
Egr. Flags : None                  Ing. Flags : None
Metric : 333                       Mtu : 1500
===============================================================================
No. of Prefix Bindings: 9
===============================================================================
*A:Dut-B#
```

discovery

**Syntax**

discovery {{peer [ip-address]} | {interface [ip-int-name]}} [state state] [detail] [adjacency-type type]

**Context**

show>router>ldp

**Description**

This command displays the status of the interfaces participating in LDP discovery.

**Parameters**

- **peer ip-address** — Specifies to display the IP address of the peer.
- **interface ip-int-name** — The name of an existing interface. If the string contains special characters (#, $, spaces, etc.), the entire string must be enclosed within double quotes.
- **state state** — Specifies to display the current operational state of the adjacency.
  - Values: established, trying, down
- **detail** — Specifies to display detailed information.
- **adjacency-type type** — Specifies to display the adjacency type.
  - Values: link, targeted

**Output**

LDP Discovery Output — The following table describes LDP discovery output fields.

<table>
<thead>
<tr>
<th>Label</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface Name</td>
<td>The name of the interface.</td>
</tr>
<tr>
<td>Local Addr</td>
<td>The IP address of the originating (local) router.</td>
</tr>
<tr>
<td>Peer Addr</td>
<td>The IP address of the peer.</td>
</tr>
<tr>
<td>Adj Type</td>
<td>The adjacency type between the LDP peer and LDP session is targeted.</td>
</tr>
<tr>
<td>Label</td>
<td>Description (Continued)</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-----------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>State</td>
<td>Established — The adjacency is established.</td>
</tr>
<tr>
<td></td>
<td>Trying — The adjacency is not yet established.</td>
</tr>
<tr>
<td>No. of Hello Adjacencies</td>
<td>The total number of hello adjacencies discovered.</td>
</tr>
<tr>
<td>Up Time</td>
<td>The amount of time the adjacency has been enabled.</td>
</tr>
<tr>
<td>Hold-Time Remaining</td>
<td>The time left before a neighbor is declared to be down.</td>
</tr>
<tr>
<td>Hello Mesg Recv</td>
<td>The number of hello messages received for this adjacency.</td>
</tr>
<tr>
<td>Hello Mesg Sent</td>
<td>The number of hello messages that have been sent for this adjacency.</td>
</tr>
<tr>
<td>Remote Cfg Seq No</td>
<td>The configuration sequence number that was in the hello received when this adjacency started up. This configuration sequence number changes when there is a change of configuration.</td>
</tr>
<tr>
<td>Remote IP Address</td>
<td>The IP address used on the remote end for the LDP session.</td>
</tr>
<tr>
<td>Local Cfg Seq No</td>
<td>The configuration sequence number that was used in the hello sent when this adjacency started up. This configuration sequence number changes when there is a change of configuration.</td>
</tr>
<tr>
<td>Local IP Address</td>
<td>The IP address used locally for the LDP session.</td>
</tr>
</tbody>
</table>

**Sample Output**

*A:*SRU4>config>router>ldp# show router ldp discovery

<table>
<thead>
<tr>
<th>Interface Name</th>
<th>Local Addr</th>
<th>Peer Addr</th>
<th>AdjType</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>110.20.1.4</td>
<td>10.8.100.15</td>
<td>Targ</td>
<td>Estab</td>
</tr>
<tr>
<td>N/A</td>
<td>110.20.1.4</td>
<td>10.20.1.20</td>
<td>Targ</td>
<td>Estab</td>
</tr>
<tr>
<td>N/A</td>
<td>110.20.1.4</td>
<td>10.100.11.1</td>
<td>Targ</td>
<td>Estab</td>
</tr>
<tr>
<td>N/A</td>
<td>110.20.1.4</td>
<td>110.20.1.11</td>
<td>Targ</td>
<td>Estab</td>
</tr>
<tr>
<td>N/A</td>
<td>110.20.1.4</td>
<td>110.20.1.2</td>
<td>Targ</td>
<td>Estab</td>
</tr>
<tr>
<td>N/A</td>
<td>110.20.1.4</td>
<td>110.20.1.3</td>
<td>Targ</td>
<td>Estab</td>
</tr>
<tr>
<td>N/A</td>
<td>110.20.1.4</td>
<td>110.20.1.6</td>
<td>Targ</td>
<td>Estab</td>
</tr>
<tr>
<td>N/A</td>
<td>110.20.1.4</td>
<td>110.20.1.5</td>
<td>Targ</td>
<td>Estab</td>
</tr>
<tr>
<td>N/A</td>
<td>110.20.1.4</td>
<td>110.20.1.6</td>
<td>Targ</td>
<td>Estab</td>
</tr>
<tr>
<td>N/A</td>
<td>110.20.1.4</td>
<td>110.20.1.51</td>
<td>Targ</td>
<td>Estab</td>
</tr>
<tr>
<td>N/A</td>
<td>110.20.1.4</td>
<td>110.20.1.52</td>
<td>Targ</td>
<td>Estab</td>
</tr>
<tr>
<td>N/A</td>
<td>110.20.1.4</td>
<td>110.20.1.53</td>
<td>Targ</td>
<td>Estab</td>
</tr>
<tr>
<td>N/A</td>
<td>110.20.1.4</td>
<td>110.20.1.55</td>
<td>Targ</td>
<td>Estab</td>
</tr>
<tr>
<td>N/A</td>
<td>110.20.1.4</td>
<td>110.20.1.56</td>
<td>Targ</td>
<td>Estab</td>
</tr>
<tr>
<td>N/A</td>
<td>110.20.1.4</td>
<td>110.20.1.110</td>
<td>Targ</td>
<td>Estab</td>
</tr>
<tr>
<td>N/A</td>
<td>110.20.1.4</td>
<td>110.20.1.150</td>
<td>Targ</td>
<td>Estab</td>
</tr>
<tr>
<td>N/A</td>
<td>110.20.1.4</td>
<td>220.220.1.6</td>
<td>Targ</td>
<td>Estab</td>
</tr>
<tr>
<td>aps-1</td>
<td>110.20.1.4</td>
<td>110.20.1.3</td>
<td>Link</td>
<td>Estab</td>
</tr>
<tr>
<td>aps-2</td>
<td>110.20.1.4</td>
<td>110.20.1.3</td>
<td>Link</td>
<td>Estab</td>
</tr>
<tr>
<td>aps-3</td>
<td>110.20.1.4</td>
<td>110.20.1.3</td>
<td>Link</td>
<td>Estab</td>
</tr>
</tbody>
</table>
sr4-1         110.20.1.4   110.20.1.3     Link    Estab
ess-7-1       110.20.1.4   110.20.1.5     Link    Estab
ess-7-2       110.20.1.4   110.20.1.5     Link    Estab
ess-7-3       110.20.1.4   110.20.1.5     Link    Estab
ess-7-4       110.20.1.4   110.20.1.5     Link    Estab
ess-7-5       110.20.1.4   110.20.1.5     Link    Estab
hubA           110.20.1.4   110.20.1.3     Link    Estab
hubA           110.20.1.4   110.20.1.5     Link    Estab
hubA           110.20.1.4   200.0.0.1      Link    Estab
germ-1         110.20.1.4   110.20.1.110    Link    Estab
src-1.1        170.70.51.4   224.0.0.2      Link    Trying
src-1.2        170.70.52.4   224.0.0.2      Link    Trying
src-1.3        170.70.53.4   224.0.0.2      Link    Trying
src-1.4        170.70.54.4   224.0.0.2      Link    Trying
src-1.5        170.70.55.4   224.0.0.2      Link    Trying
src-1.6        170.70.56.4   224.0.0.2      Link    Trying
src-1.7        170.70.57.4   224.0.0.2      Link    Trying
src-1.8        170.70.58.4   224.0.0.2      Link    Trying
src-1.9        170.70.59.4   224.0.0.2      Link    Trying
src-1.10       170.70.60.4   224.0.0.2      Link    Trying
src-1          110.20.1.4   33.66.32.1      Link    Estab
src-3          110.20.1.4   33.66.33.1      Link    Estab
aps-8          110.20.1.4   33.66.34.1      Link    Estab
aps-9          110.20.1.4   33.66.35.1      Link    Estab
srr-1          110.20.1.4   11.22.10.2      Link    Estab
srr-2          110.20.1.4   11.22.11.2      Link    Estab
srr-3          110.20.1.4   11.1.1.1        Link    Estab
aps-11         110.20.1.4   11.22.13.2      Link    Estab
gsr1           110.20.1.4   10.8.100.15     Link    Estab
gsr2           110.20.1.4   10.20.1.22      Link    Estab
g7600          180.50.80.4   224.0.0.2      Link    Trying
m160           110.20.1.4   10.20.1.20      Link    Estab

No. of Hello Adjacencies: 52

*A:SRU4>config>router>ldp#

*A:SRU4>config>router>ldp# show router ldp discovery peer 10.8.100.15

LDP Hello Adjacencies

Interface Name     Local Addr     Peer Addr     AdjType State
N/A                110.20.1.4     10.8.100.15   Targ Estab

No. of Hello Adjacencies: 1

*A:SRU4>config>router>ldp#

*A:SRU4>config>router>ldp# show router ldp discovery detail

LDP Hello Adjacencies (Detail)

Peer 10.8.100.15

Local Address    : 110.20.1.4     Peer Address   : 10.8.100.15
Adacency Type    : Targeted      State          : Established
Up Time          : 0d 12:39:38   Hold Time Remaining : 43
Hello Mesg Recv: 10403 Hello Mesg Sent: 3243
Local IP Address: 110.20.1.4 Remote IP Address: 10.8.100.15
Local Hello Timeout: 45 Remote Hello Timeout: 90
Local Cfg Seq No: 1828354504 Remote Cfg Seq No: 0
-------------------------------------------------------------------------------
Peer 10.20.1.20
-------------------------------------------------------------------------------
Local Address: 110.20.1.4 Peer Address: 10.20.1.20
Adjacency Type: Targeted State: Established
Up Time: 0d 12:39:57 Hold Time Remaining: 40
Hello Mesg Recv: 7495 Hello Mesg Sent: 3244
Local IP Address: 110.20.1.4 Remote IP Address: 10.20.1.20
Local Hello Timeout: 45 Remote Hello Timeout: 45
Local Cfg Seq No: 572902976 Remote Cfg Seq No: 1
-------------------------------------------------------------------------------
Interface "gsr2"
-------------------------------------------------------------------------------
Local Address: 110.20.1.4 Peer Address: 10.20.1.22
Adjacency Type: Link State: Established
Up Time: 0d 12:40:41 Hold Time Remaining: 11
Hello Mesg Recv: 10414 Hello Mesg Sent: 11260
Local IP Address: 160.60.60.4 Remote IP Address: 160.60.60.2
Local Hello Timeout: 15 Remote Hello Timeout: 15
Local Cfg Seq No: 1911286684 Remote Cfg Seq No: 0
-------------------------------------------------------------------------------
Interface "g7600"
-------------------------------------------------------------------------------
Local Address: 180.50.80.4 Peer Address: 224.0.0.2
Adjacency Type: Link State: Trying
-------------------------------------------------------------------------------
Interface "m160"
-------------------------------------------------------------------------------
Local Address: 110.20.1.4 Peer Address: 10.20.1.20
Adjacency Type: Link State: Established
Up Time: 0d 12:40:47 Hold Time Remaining: 14
Hello Mesg Recv: 10450 Hello Mesg Sent: 11262
Local IP Address: 10.100.30.4 Remote IP Address: 10.100.30.20
Local Hello Timeout: 15 Remote Hello Timeout: 15
Local Cfg Seq No: 2523051834 Remote Cfg Seq No: 1
===============================================================================
*A:SRU4>config>router>ldp#
interface

Syntax  
interface [ip-int-name | ip-address] [detail]

Context  
show>router>ldp

Description  
This command displays configuration information about LDP interfaces.

Parameters  

- ip-int-name — The name of an existing interface. If the string contains special characters (#, $, spaces, etc.), the entire string must be enclosed within double quotes.

- ip-address — The IP address of the LDP neighbor.

- detail — Displays detailed information.

Output  

LDP Interface Output — The following table describes the LDP interface output fields.

<table>
<thead>
<tr>
<th>Label</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface</td>
<td>Specifies the interface associated with the LDP instance.</td>
</tr>
<tr>
<td>Adm Up</td>
<td>The LDP is administratively enabled.</td>
</tr>
<tr>
<td>Adm Down</td>
<td>The LDP is administratively disabled.</td>
</tr>
<tr>
<td>Opr Up</td>
<td>The LDP is operationally enabled.</td>
</tr>
<tr>
<td>Opr Down</td>
<td>The LDP is operationally disabled.</td>
</tr>
<tr>
<td>Hello Factor</td>
<td>The value by which the hello timeout should be divided to give the hello time, for example, the time interval, in seconds, between LDP hello messages. LDP uses hello messages to discover neighbors and to detect loss of connectivity with its neighbors.</td>
</tr>
<tr>
<td>Hold Time</td>
<td>The hello time, also known as hold time. It is the time interval, in seconds, that LDP waits before declaring a neighbor to be down. Hello timeout is local to the system and is sent in the hello messages to a neighbor.</td>
</tr>
<tr>
<td>KA Factor</td>
<td>The value by which the keepalive timeout should be divided to give the keepalive time, for example, the time interval, in seconds, between LDP keepalive messages. LDP keepalive messages are sent to keep the LDP session from timing out when no other LDP traffic is being sent between the neighbors.</td>
</tr>
<tr>
<td>KA Timeout</td>
<td>The time interval, in seconds, that LDP waits before tearing down a session. If no LDP messages are exchanged during this time interval, the LDP session is torn down. Generally the value is configured to be 3 times the keepalive time (the time interval between successive LDP keepalive messages).</td>
</tr>
<tr>
<td>Auth Enabled</td>
<td>Authentication using MD5 message based digest protocol is enabled.</td>
</tr>
<tr>
<td>Auth Disabled</td>
<td>No authentication is used.</td>
</tr>
<tr>
<td>No. of Interface</td>
<td>The total number of LDP interfaces.</td>
</tr>
</tbody>
</table>
Sample Output

*A:SR4# show router ldp interface detail
LDP Interfaces (Detail)
Interface "aps-1"
-------------------------------------------------------------------------------
Admin State        : Up                  Oper State       : Down
Oper Down Reason   : instanceDown
Hold Time          : 45                  Hello Factor     : 3
Keepalive Timeout  : 30                  Keepalive Factor : 3
Transport Addr     : System              Last Modified    : 07/26/11 02:09:50
Active Adjacencies : 0
Tunneling          : Disabled
Lsp Name           : None
Local LSR          : System
BFD Status         : Disabled
Multicast Traffic  : Enabled
-------------------------------------------------------------------------------

*A:SRU4>config>router>ldp# show router ldp interface hubA
LDP Interfaces
Interface               Adm Opr  Hello  Hold  KA     KA      Transport
Factor Time  Factor Timeout Address
-------------------------------------------------------------------------------
hubA                     Up  Up   3      15    3      30      System
-------------------------------------------------------------------------------
No. of Interfaces: 1

*A:SRU4>config>router>ldp#

*A:SRU4>config>router>ldp# show router ldp interface hubA detail
LDP Interfaces (Detail)
Interface "hubA"
-------------------------------------------------------------------------------
Admin State        : Up                  Oper State       : Up
Hold Time          : 15                  Hello Factor     : 3
Keepalive Timeout  : 30                  Keepalive Factor : 3
Transport Addr     : System              Last Modified    : 03/03/2010 19:47:34
Active Adjacencies : 3
Tunneling          : Disabled
Lsp Name           : None
Local LSR          : System
BFD Status         : Disabled
-------------------------------------------------------------------------------

*A:SRU4>config>router>ldp#
Show Commands

fec-egress-stats

Syntax  fec-egress-stats [ip-prefix/mask]
        fec-egress-stats active

Context  show>router>ldp

Description  This command displays LDP prefix FECs egress statistics.

Parameters  ip-prefix — Specify information for the specified IP prefix and mask length. Host bits must be 0.

mask — Specifies the 32-bit address mask used to indicate the bits of an IP address that are being
used for the subnet address.

Values  0 — 32
**fec-originate**

**Syntax**

```
fec-originate [ip-prefix/mask] [operation-type]
```

**Context**

```
show>router>ldp
```

**Description**

This command displays LDP static prefix FECs.

**Parameters**

- `ip-prefix` — Specify information for the specified IP prefix and mask length. Host bits must be 0.
- `mask` — Specifies the 32-bit address mask used to indicate the bits of an IP address that are being used for the subnet address.

**Values**

- `0 — 32`

- `operation-type` — Specify the operation type to display.

**Values**

- `pop`, `swap`

**Output**

**FEC Originate Output** — The following table describes the FEC originate parameters output fields.

<table>
<thead>
<tr>
<th>Label</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>Prefix</code></td>
<td>Specifies the static prefix FEC.</td>
</tr>
<tr>
<td><code>NH Type</code></td>
<td>Specifies the type of next-hop represented by this row entry.</td>
</tr>
<tr>
<td><code>NextHop</code></td>
<td>The IP address of the next-hop.</td>
</tr>
<tr>
<td><code>IngLabel</code></td>
<td>Specifies the label that is advertised to the upstream peer.</td>
</tr>
<tr>
<td><code>EgrLabel</code></td>
<td>Specifies the egress label associated with this next-hop entry.</td>
</tr>
<tr>
<td><code>OperIngLabel</code></td>
<td>Specifies the actual or operational value of the label that was advertised to the upstream peer.</td>
</tr>
</tbody>
</table>

*SRU4# show router ldp fec-originate

```
Prefix         NHType NextHop IngLabel EgrLabel OperIngLabel
-----------------------------------------------------------------------------
24.1.0.0/16    Pop     n/a      --         --         0
24.1.0.1/32    Pop     n/a      --         --         0
24.1.0.2/32    Pop     n/a      --         --         0
24.1.0.3/32    Pop     n/a      --         --         0
24.1.0.4/32    Pop     n/a      --         --         0
```
**parameters**

**Syntax**

parameters

**Context**

show>router>ldp

**Description**

This command displays configuration information about LDP parameters.

**Output**

**LDP Parameters Output** — The following table describes the LDP parameters output fields.

<table>
<thead>
<tr>
<th>Label</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keepalive Timeout</td>
<td>The time interval, in seconds, that LDP waits before tearing down a session. If no LDP messages are exchanged during this time interval, the LDP session is torn down. Generally the value is configured to be 3 times the keepalive time (the time interval between successive LDP keepalive messages).</td>
</tr>
<tr>
<td>Timeout Factor</td>
<td>The value by which the keepalive timeout should be divided to give the keepalive time, for example, the time interval, in seconds, between LDP keepalive messages. LDP keepalive messages are sent to keep the LDP session from timing out when no other LDP traffic is being sent between the neighbors.</td>
</tr>
<tr>
<td>Hold Time</td>
<td>The hello time, also known as hold time. It is the time interval, in seconds, that LDP waits before declaring a neighbor to be down. Hello timeout is local to the system and is sent in the hello messages to a neighbor.</td>
</tr>
<tr>
<td>Hello Factor</td>
<td>The value by which the hello timeout should be divided to give the hello time, for example, the time interval, in seconds, between LDP hello messages. LDP uses hello messages to discover neighbors and to detect loss of connectivity with its neighbors.</td>
</tr>
<tr>
<td>Auth</td>
<td>Enabled — Authentication using MD5 message based digest protocol is enabled. Disabled — No authentication is used.</td>
</tr>
</tbody>
</table>
### Admin Status
- **inService** — The LDP is administratively enabled.
- **outService** — The LDP is administratively disabled.

### Deaggregated FECs
- **False** — LDP aggregates multiple prefixes into a single Forwarding Equivalence Class (FEC) and advertises a single label for the FEC. This value is only applicable to LDP interfaces and not for targeted sessions.
- **True** — LDP de-aggregates prefixes into multiple FECs.

### Propagate Policy
The Propagate Policy value specifies whether the LSR should generate FECs and which FECs it should generate.
- **system** — LDP will distribute label bindings only for the router's system IP address.
- **interface** — LDP will distribute label bindings for all LDP interfaces.
- **all** — LDP will distribute label bindings for all prefixes in the routing table.
- **none** — LDP will not distribute any label bindings.

### Transport Address
- **interface** — The interface's IP address is used to set up the LDP session between neighbors. If multiple interfaces exist between two neighbors, the 'interface' mode cannot be used since only one LDP session is actually set up between the two neighbors.
- **system** — The system's IP address is used to set up the LDP session between neighbors.

### Label-Retention
- **liberal** — All advertised label mappings are retained whether they are from a valid next hop or not. When the label distribution value is downstream unsolicited, a router may receive label bindings for the same destination for all its neighbors. Labels for the non-next hops for the FECs are retained in the software but not used. When a network topology change occurs where a non-nexthop becomes a true next hop, the label received earlier is then used.
- **conservative** — Advertised label mappings are retained only if they will be used to forward packets; for example if the label came from a valid next hop. Label bindings received from non-next hops for each FEC are discarded.

### Control Mode
- **ordered** — Label bindings are not distributed in response to a label request until a label binding has been received from the next hop for the destination.
- **independent** — Label bindings are distributed immediately in response to a label request even if a label binding has not yet been received from the next hop for the destination.
### Sample Output

```
*A:SRU4>config>router>ldp# show router ldp parameters
===============================================================================
LDP Parameters (LSR ID 110.20.1.4)
------------------------------------------------------------------
Graceful Restart Parameters
------------------------------------------------------------------
Nbor Liveness Time : 5 sec                               Max Recovery Time : 30
```
Interface Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keepalive Timeout</td>
<td>30 sec</td>
</tr>
<tr>
<td>Keepalive Factor</td>
<td>3</td>
</tr>
<tr>
<td>Hold Time</td>
<td>15 sec</td>
</tr>
<tr>
<td>Hello Factor</td>
<td>3</td>
</tr>
<tr>
<td>Propagate Policy</td>
<td>system</td>
</tr>
<tr>
<td>Transport Address</td>
<td>system</td>
</tr>
<tr>
<td>Deaggregate FECs</td>
<td>False</td>
</tr>
<tr>
<td>Route Preference</td>
<td>9</td>
</tr>
<tr>
<td>Label Distribution</td>
<td>downstreamUnsolicited</td>
</tr>
<tr>
<td>Label Retention</td>
<td>liberal</td>
</tr>
<tr>
<td>Control Mode</td>
<td>ordered</td>
</tr>
<tr>
<td>Loop Detection</td>
<td>none</td>
</tr>
</tbody>
</table>

Targeted Session Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keepalive Timeout</td>
<td>40 sec</td>
</tr>
<tr>
<td>Keepalive Factor</td>
<td>4</td>
</tr>
<tr>
<td>Hold Time</td>
<td>45 sec</td>
</tr>
<tr>
<td>Hello Factor</td>
<td>3</td>
</tr>
<tr>
<td>Passive Mode</td>
<td>False</td>
</tr>
<tr>
<td>Targeted Sessions</td>
<td>Enabled</td>
</tr>
</tbody>
</table>

*A:SRU4>config>router>ldp#

**peer**

**Syntax**

`peer [ip-address] [detail]`

**Context**

`show>router>ldp`

**Description**

This command displays configuration information about LDP peers.

**Parameters**

- `ip-address` — The IP address of the LDP peer.
- `detail` — Displays detailed information.

**Output**

**LDP Peer Output** — The following table describes LDP peer output.

<table>
<thead>
<tr>
<th>Label</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peer</td>
<td>The IP address of the peer.</td>
</tr>
<tr>
<td>Adm Up</td>
<td>The LDP is administratively enabled.</td>
</tr>
<tr>
<td>Adm Down</td>
<td>The LDP is administratively disabled.</td>
</tr>
<tr>
<td>Opr Up</td>
<td>The LDP is operationally enabled.</td>
</tr>
<tr>
<td>Opr Down</td>
<td>The LDP is operationally disabled.</td>
</tr>
<tr>
<td>Hello Factor</td>
<td>The value by which the hello timeout should be divided to give the hello time, for example, the time interval, in seconds, between LDP hello messages. LDP uses hello messages to discover neighbors and to detect loss of connectivity with its neighbors.</td>
</tr>
<tr>
<td>Hold Time</td>
<td>The hello time or hold time. The time interval, in seconds, that LDP waits before declaring a neighbor to be down. Hello timeout is local to the system and is sent in the hello messages to a neighbor.</td>
</tr>
</tbody>
</table>
Show Commands

<table>
<thead>
<tr>
<th>Label</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>KA Factor</td>
<td>The value by which the keepalive timeout should be divided to give the keepalive time, for example, the time interval, in seconds, between LDP keepalive messages. LDP keepalive messages are sent to keep the LDP session from timing out when no other LDP traffic is being sent between the neighbors.</td>
</tr>
<tr>
<td>KA Timeout</td>
<td>The time interval, in seconds, that LDP waits before tearing down a session. If no LDP messages are exchanged during this time interval, the LDP session is torn down. Generally the value is configured to be 3 times the keepalive time (the time interval between successive LDP keepalive messages).</td>
</tr>
<tr>
<td>Auth</td>
<td>Enabled — Authentication using MD5 message based digest protocol is enabled. Disabled — No authentication is used.</td>
</tr>
<tr>
<td>Passive Mode</td>
<td>The mode used to set up LDP sessions. This value is only applicable to targeted sessions and not to LDP interfaces.</td>
</tr>
<tr>
<td>True —</td>
<td>LDP responds only when it gets a connect request from a peer and will not attempt to actively connect to its neighbors.</td>
</tr>
<tr>
<td>False —</td>
<td>LDP actively tries to connect to its peers.</td>
</tr>
<tr>
<td>Auto Create</td>
<td>Specifies if a targeted peer was automatically created through service manager. For an LDP interface, this value is always false.</td>
</tr>
<tr>
<td>No. of Peers</td>
<td>The total number of LDP peers.</td>
</tr>
<tr>
<td>Tunneling</td>
<td>Enabled — Tunneling is enabled. Disabled — No tunneling is used.</td>
</tr>
<tr>
<td>LSP</td>
<td>The LSP name.</td>
</tr>
</tbody>
</table>

Sample Output

*A:SR4# show router ldp peer detail
-------------------------------------------------------------------------------
LDP Peers (Detail)
-------------------------------------------------------------------------------
Peer 10.8.100.15
-------------------------------------------------------------------------------
   Admin State       : Up  Oper State       : Down
   Oper Down Reason  : instanceDown  Hello Factor  : 3
   Hold Time         : 45      Keepalive Factor : 4
   Keepalive Timeout : 40      Last Modified  : 07/26/11 02:09:50
   Passive Mode      : Disabled Last Modified  : 07/26/11 02:09:50
   Active Adjacencies: 0       Auto Created  : No
   Tunneling         : Enabled  Lsp Name      : None
   Lsp Name          : None     Local LSR     : None

 KA Factor
The value by which the keepalive timeout should be divided to give the keepalive time, for example, the time interval, in seconds, between LDP keepalive messages. LDP keepalive messages are sent to keep the LDP session from timing out when no other LDP traffic is being sent between the neighbors.

 KA Timeout
The time interval, in seconds, that LDP waits before tearing down a session. If no LDP messages are exchanged during this time interval, the LDP session is torn down. Generally the value is configured to be 3 times the keepalive time (the time interval between successive LDP keepalive messages).

 Auth
Enabled — Authentication using MD5 message based digest protocol is enabled.
Disabled — No authentication is used.

 Passive Mode
The mode used to set up LDP sessions. This value is only applicable to targeted sessions and not to LDP interfaces.
True — LDP responds only when it gets a connect request from a peer and will not attempt to actively connect to its neighbors.
False — LDP actively tries to connect to its peers.

 Auto Create
Specifies if a targeted peer was automatically created through service manager. For an LDP interface, this value is always false.

 No. of Peers
The total number of LDP peers.

 Tunneling
Enabled — Tunneling is enabled.
Disabled — No tunneling is used.

 LSP
The LSP name.
BFD Status : Disabled
Multicast Traffic : Disabled

*A:SRU4>config>router>ldp# show router ldp peer

LDP Peers

<table>
<thead>
<tr>
<th>Peer</th>
<th>Adm</th>
<th>Opr</th>
<th>Hello Factor</th>
<th>Hold Time</th>
<th>KA Factor</th>
<th>KA Timeout</th>
<th>Passive Mode</th>
<th>Auto Created</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.8.100.15</td>
<td>Up</td>
<td>Up</td>
<td>3</td>
<td>45</td>
<td>4</td>
<td>40</td>
<td>Disabled</td>
<td>No</td>
</tr>
<tr>
<td>10.20.1.20</td>
<td>Up</td>
<td>Up</td>
<td>3</td>
<td>45</td>
<td>4</td>
<td>40</td>
<td>Disabled</td>
<td>No</td>
</tr>
<tr>
<td>10.20.1.22</td>
<td>Up</td>
<td>Up</td>
<td>3</td>
<td>45</td>
<td>4</td>
<td>40</td>
<td>Disabled</td>
<td>No</td>
</tr>
<tr>
<td>10.100.1.1</td>
<td>Up</td>
<td>Up</td>
<td>3</td>
<td>45</td>
<td>4</td>
<td>40</td>
<td>Disabled</td>
<td>No</td>
</tr>
<tr>
<td>110.20.1.1</td>
<td>Up</td>
<td>Up</td>
<td>3</td>
<td>45</td>
<td>4</td>
<td>40</td>
<td>Disabled</td>
<td>No</td>
</tr>
<tr>
<td>110.20.1.2</td>
<td>Up</td>
<td>Up</td>
<td>3</td>
<td>45</td>
<td>4</td>
<td>40</td>
<td>Disabled</td>
<td>No</td>
</tr>
<tr>
<td>110.20.1.3</td>
<td>Up</td>
<td>Up</td>
<td>3</td>
<td>45</td>
<td>4</td>
<td>40</td>
<td>Disabled</td>
<td>No</td>
</tr>
<tr>
<td>110.20.1.5</td>
<td>Up</td>
<td>Up</td>
<td>3</td>
<td>45</td>
<td>4</td>
<td>40</td>
<td>Disabled</td>
<td>No</td>
</tr>
<tr>
<td>110.20.1.6</td>
<td>Up</td>
<td>Up</td>
<td>3</td>
<td>45</td>
<td>4</td>
<td>40</td>
<td>Disabled</td>
<td>No</td>
</tr>
<tr>
<td>110.20.1.51</td>
<td>Up</td>
<td>Up</td>
<td>3</td>
<td>45</td>
<td>4</td>
<td>40</td>
<td>Disabled</td>
<td>No</td>
</tr>
<tr>
<td>110.20.1.52</td>
<td>Up</td>
<td>Up</td>
<td>3</td>
<td>45</td>
<td>4</td>
<td>40</td>
<td>Disabled</td>
<td>No</td>
</tr>
<tr>
<td>110.20.1.53</td>
<td>Up</td>
<td>Up</td>
<td>3</td>
<td>45</td>
<td>4</td>
<td>40</td>
<td>Disabled</td>
<td>No</td>
</tr>
<tr>
<td>110.20.1.55</td>
<td>Up</td>
<td>Up</td>
<td>3</td>
<td>45</td>
<td>4</td>
<td>40</td>
<td>Disabled</td>
<td>No</td>
</tr>
<tr>
<td>110.20.1.56</td>
<td>Up</td>
<td>Up</td>
<td>3</td>
<td>45</td>
<td>4</td>
<td>40</td>
<td>Disabled</td>
<td>No</td>
</tr>
<tr>
<td>110.20.1.110</td>
<td>Up</td>
<td>Up</td>
<td>3</td>
<td>45</td>
<td>4</td>
<td>40</td>
<td>Disabled</td>
<td>No</td>
</tr>
<tr>
<td>110.20.1.150</td>
<td>Up</td>
<td>Up</td>
<td>3</td>
<td>45</td>
<td>4</td>
<td>40</td>
<td>Disabled</td>
<td>No</td>
</tr>
<tr>
<td>220.220.1.6</td>
<td>Up</td>
<td>Up</td>
<td>3</td>
<td>45</td>
<td>4</td>
<td>40</td>
<td>Disabled</td>
<td>No</td>
</tr>
</tbody>
</table>

No. of Peers: 17

*A:SRU4>config>router>ldp#

*A:SRU4>config>router>ldp# show router ldp peer detail

LDP Peers (Detail)

Peer 10.8.100.15

<table>
<thead>
<tr>
<th>Admin State</th>
<th>Oper State</th>
<th>Hold Time</th>
<th>Hello Factor</th>
<th>Keepalive Timeout</th>
<th>Keepalive Factor</th>
<th>Passive Mode</th>
<th>Last Modified</th>
<th>Auto Created</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up</td>
<td>Up</td>
<td>45</td>
<td>3</td>
<td>40</td>
<td>4</td>
<td>Disabled</td>
<td>03/03/2010 19:47:34</td>
<td>No</td>
</tr>
</tbody>
</table>

Peer 10.20.1.20

<table>
<thead>
<tr>
<th>Admin State</th>
<th>Oper State</th>
<th>Hold Time</th>
<th>Hello Factor</th>
<th>Keepalive Timeout</th>
<th>Keepalive Factor</th>
<th>Passive Mode</th>
<th>Last Modified</th>
<th>Auto Created</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up</td>
<td>Up</td>
<td>45</td>
<td>3</td>
<td>40</td>
<td>4</td>
<td>Disabled</td>
<td>03/03/2010 19:47:34</td>
<td>No</td>
</tr>
</tbody>
</table>
Show Commands

BFD Status : Disabled

Peer 220.220.1.6

Admin State : Up  Oper State : Up
Hold Time : 45  Hello Factor : 3
Keepalive Timeout : 40  Keepalive Factor : 4
Passive Mode : Disabled  Last Modified : 03/03/2010 19:47:34
Active Adjacencies : 0  Auto Created : No
Tunneling : Disabled
Lsp Name : None
Local LSR : None
BFD Status : Disabled

*A:SRU4>config>router>ldp# show router ldp peer 10.8.100.15 detail

LDP peer-parameters output — The following table describes LDP peer-parameters output.

<table>
<thead>
<tr>
<th>Label</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peer</td>
<td>The IP address of the peer.</td>
</tr>
<tr>
<td>TTL security</td>
<td>Enabled — LDP peering sessions protected.</td>
</tr>
<tr>
<td></td>
<td>Disabled — LDP peering sessions unprotected.</td>
</tr>
</tbody>
</table>

peer-parameters

Syntax peer-parameters peer-ip-address

Context show>router>ldp

Description This command displays LDP peer information.

Parameters peer-ip-address — Specify the peer IP address.
Sample Output

*A:SRR# show router ldp peer-parameters
-----------------------------------------------------------------------------------------------
LDP Peers
-----------------------------------------------------------------------------------------------
Peer : 10.8.100.15
 -------------------------------------------------------------------------------
TTL Security       : Disabled               Min-TTL            : n/a
Authentication Key : Enabled                DOD                : Disabled
Auth key chain     : n/a
FEC129 Cisco Inter*: Disabled               Path MTU Discovery:: Disabled
Import Policies    : None               Export Policies    : None
-------------------------------------------------------------------------------
Peer : 10.20.1.20
 -------------------------------------------------------------------------------
TTL Security       : Disabled               Min-TTL            : n/a
Authentication Key : Disabled                DOD                : Disabled
Auth key chain     : n/a
FEC129 Cisco Inter*: Disabled               Path MTU Discovery:: Disabled
Import Policies    : None               Export Policies    : None
-------------------------------------------------------------------------------
*A:SRU4>config>router>ldp# show router ldp peer-parameters
-----------------------------------------------------------------------------------------------
LDP Peers
-----------------------------------------------------------------------------------------------
Peer : 10.8.100.15
 -------------------------------------------------------------------------------
TTL Security       : Disabled               Min-TTL            : n/a
Authentication Key : Enabled                DOD                : Disabled
Auth key chain     : n/a
FEC129 Cisco Inter*: Disabled               Path MTU Discovery:: Disabled
Import Policies    : None               Export Policies    : None
-------------------------------------------------------------------------------
Peer : 10.20.1.20
 -------------------------------------------------------------------------------
TTL Security       : Disabled               Min-TTL            : n/a
Authentication Key : Disabled                DOD                : Disabled
Auth key chain     : n/a
FEC129 Cisco Inter*: Disabled               Path MTU Discovery:: Disabled
Import Policies    : None               Export Policies    : None
-------------------------------------------------------------------------------
...
Show Commands

<table>
<thead>
<tr>
<th>Configuration Item</th>
<th>Status</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>TTL Security</td>
<td>Enabled</td>
<td>Min-TTL: 255</td>
</tr>
<tr>
<td>Authentication Key</td>
<td>Enabled</td>
<td>DOD: Disabled</td>
</tr>
<tr>
<td>Auth key chain</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>FEC129 Cisco Inter</td>
<td>Disabled</td>
<td></td>
</tr>
<tr>
<td>Import Policies</td>
<td>None</td>
<td>Export Policies: None</td>
</tr>
</tbody>
</table>

No. of Peers: 17

* indicates that the corresponding row element may have been truncated.
*A:SRU4>config>router>ldp#
session

Syntax  
session [ip-addr[:label-space]] [detail | statistics [packet-type]] [session-type]

Context  
show>router>ldp

Description  
This command displays configuration information about LDP sessions.

Parameters  
  
  ip-address — Specify the IP address of the LDP peer.
  
  label-space — Specifies the label space identifier that the router is advertising on the interface.

  Values  
  0 — 65535

  detail — Displays detailed information.

  statistics packet-type — Specify the packet type.

  Values  
  hello, keepalive, init, label, notification, address

  session-type — Specifies to display the session type.

  Values  
  link, targeted, both

Output  
LDP Session Output — The following table describes LDP session output fields.

Label | Description
--- | ---
Peer LDP ID | The IP address of the LDP peer.
Adj Type | The adjacency type between the LDP peer and LDP session is targeted.
 | Link — Specifies that this adjacency is a result of a link hello.
 | Targeted — Specifies that this adjacency is a result of a targeted hello.
State | Established — The adjacency is established.
 | Trying — The adjacency is not yet established.
Msg Sent | The number of messages sent.
Msg Rcvd | The number of messages received.
Up Time | The amount of time the adjacency has been enabled.

Sample Output

*A:SRU4>config>router>ldp# show router ldp session
---
Peb LDP Id | Adj Type | State | Msg Sent | Msg Rcvd | Up Time
--- | --- | --- | --- | --- | ---
1.1.1.1:0 | Link | Nonexistent | 2 | 1 | 0d 00:00:04
10.8.100.15:0 | Both | Nonexistent | 14653 | 21054 | 0d 12:48:25
10.20.1.10:0 | Both | Established | 105187 | 84837 | 0d 12:48:27
<table>
<thead>
<tr>
<th>Peer LDP Id</th>
<th>Adj Type</th>
<th>State</th>
<th>Msg Sent</th>
<th>Msg Recv</th>
<th>Up Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.20.1.20:0</td>
<td>Both</td>
<td>Established</td>
<td>105204</td>
<td>84859</td>
<td>0d 12:49:05</td>
</tr>
</tbody>
</table>

No. of Sessions: 1

*A:SRU4>config>router>ldp# show router ldp session detail

Session with Peer 10.8.100.15:0

<table>
<thead>
<tr>
<th>Adjacency Type</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>: Both</td>
<td>: Noneexistent</td>
</tr>
<tr>
<td>Up Time</td>
<td>: 0d 00:50:30</td>
</tr>
<tr>
<td>Max PDU Length</td>
<td>: 4096</td>
</tr>
<tr>
<td>Link Adjacencies</td>
<td>: 1</td>
</tr>
<tr>
<td>Local Address</td>
<td>: 110.20.1.4</td>
</tr>
<tr>
<td>Local TCP Port</td>
<td>: 0</td>
</tr>
<tr>
<td>Local KA Timeout</td>
<td>: 30</td>
</tr>
<tr>
<td>Mesg Sent</td>
<td>: 951</td>
</tr>
<tr>
<td>FECs Sent</td>
<td>: 0</td>
</tr>
<tr>
<td>GR State</td>
<td>: Capable</td>
</tr>
<tr>
<td>Nbr Liveness Time</td>
<td>: 10.8.100.15</td>
</tr>
<tr>
<td>Number of Restart</td>
<td>: 0</td>
</tr>
<tr>
<td>P2MP</td>
<td>: Not Capable</td>
</tr>
<tr>
<td>Dynamic Capability</td>
<td>: Not Capable</td>
</tr>
<tr>
<td>Advertise</td>
<td>: Address/Servi*</td>
</tr>
</tbody>
</table>

Session with Peer 10.20.1.20:0

*A:SRU4>config>router>ldp# show router ldp session detail

LDP Sessions (Detail)

Legend: DoD - Downstream on Demand (for address FEC's only)
DU - Downstream Unsolicited
### Session with Peer 1.1.1.1:0

<table>
<thead>
<tr>
<th>Adjacency Type</th>
<th>State</th>
<th>Nonexistent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up Time</td>
<td>0d 00:00:22</td>
<td></td>
</tr>
<tr>
<td>Max PDU Length</td>
<td>4096</td>
<td></td>
</tr>
<tr>
<td>Link Adjacencies</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Local Address</td>
<td>110.20.1.4</td>
<td>Peer Address: 1.1.1.1</td>
</tr>
<tr>
<td>Local TCP Port</td>
<td>0</td>
<td>Peer TCP Port: 0</td>
</tr>
<tr>
<td>Local KA Timeout</td>
<td>30</td>
<td>Peer KA Timeout: 30</td>
</tr>
<tr>
<td>Mesg Sent</td>
<td>5</td>
<td>Mesg Recv: 2</td>
</tr>
<tr>
<td>FECs Sent</td>
<td>0</td>
<td>FECs Recv: 0</td>
</tr>
<tr>
<td>GR State</td>
<td>Capable</td>
<td>Label Distribution: DU</td>
</tr>
<tr>
<td>Nbr Liveness Time</td>
<td>0</td>
<td>Max Recovery Time: 0</td>
</tr>
<tr>
<td>Number of Restart</td>
<td>0</td>
<td>Last Restart Time: Never</td>
</tr>
<tr>
<td>Advertise</td>
<td>Address</td>
<td></td>
</tr>
</tbody>
</table>

### Session with Peer 10.8.100.15:0

<table>
<thead>
<tr>
<th>Adjacency Type</th>
<th>State</th>
<th>Nonexistent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up Time</td>
<td>0d 12:49:26</td>
<td></td>
</tr>
<tr>
<td>Max PDU Length</td>
<td>4096</td>
<td></td>
</tr>
<tr>
<td>Link Adjacencies</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Local Address</td>
<td>110.20.1.4</td>
<td>Peer Address: 10.8.100.15</td>
</tr>
<tr>
<td>Local TCP Port</td>
<td>0</td>
<td>Peer TCP Port: 0</td>
</tr>
<tr>
<td>Local KA Timeout</td>
<td>30</td>
<td>Peer KA Timeout: 30</td>
</tr>
<tr>
<td>Mesg Sent</td>
<td>14672</td>
<td>Mesg Recv: 21081</td>
</tr>
<tr>
<td>FECs Sent</td>
<td>0</td>
<td>FECs Recv: 0</td>
</tr>
<tr>
<td>GR State</td>
<td>Capable</td>
<td>Label Distribution: DU</td>
</tr>
<tr>
<td>Nbr Liveness Time</td>
<td>0</td>
<td>Max Recovery Time: 0</td>
</tr>
<tr>
<td>A:cpm-a#</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Session with Peer 200.0.0.1:0

<table>
<thead>
<tr>
<th>Adjacency Type</th>
<th>State</th>
<th>Nonexistent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up Time</td>
<td>0d 00:00:02</td>
<td></td>
</tr>
<tr>
<td>Max PDU Length</td>
<td>4096</td>
<td></td>
</tr>
<tr>
<td>Link Adjacencies</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Local Address</td>
<td>110.20.1.4</td>
<td>Peer Address: 200.0.0.1</td>
</tr>
<tr>
<td>Local TCP Port</td>
<td>0</td>
<td>Peer TCP Port: 0</td>
</tr>
<tr>
<td>Local KA Timeout</td>
<td>30</td>
<td>Peer KA Timeout: 30</td>
</tr>
<tr>
<td>Mesg Sent</td>
<td>1</td>
<td>Mesg Recv: 1</td>
</tr>
<tr>
<td>FECs Sent</td>
<td>0</td>
<td>FECs Recv: 0</td>
</tr>
<tr>
<td>GR State</td>
<td>Capable</td>
<td>Label Distribution: DU</td>
</tr>
<tr>
<td>Nbr Liveness Time</td>
<td>0</td>
<td>Max Recovery Time: 0</td>
</tr>
<tr>
<td>Number of Restart</td>
<td>0</td>
<td>Last Restart Time: Never</td>
</tr>
<tr>
<td>Advertise</td>
<td>Address</td>
<td></td>
</tr>
</tbody>
</table>
**status**

**Syntax**  
status

**Context**  
show>router>ldp

**Description**  
This command displays LDP status information.

**Output**  
LDP Status Output — The following table describes LDP status output fields.

<table>
<thead>
<tr>
<th>Label</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admin State</td>
<td>Up — The LDP is administratively enabled.</td>
</tr>
<tr>
<td></td>
<td>Down — The LDP is administratively disabled.</td>
</tr>
<tr>
<td>Oper State</td>
<td>Up — The LDP is operationally enabled.</td>
</tr>
<tr>
<td></td>
<td>Down — The LDP is operationally disabled.</td>
</tr>
<tr>
<td>Created at</td>
<td>The date and time when the LDP instance was created.</td>
</tr>
<tr>
<td>Up Time</td>
<td>The time, in hundredths of seconds, that the LDP instance has been</td>
</tr>
<tr>
<td></td>
<td>operationally up.</td>
</tr>
<tr>
<td>Last Change</td>
<td>The date and time when the LDP instance was last modified.</td>
</tr>
<tr>
<td>Oper Down Events</td>
<td>The number of times the LDP instance has gone operationally down</td>
</tr>
<tr>
<td></td>
<td>since the instance was created.</td>
</tr>
<tr>
<td>Active Adjacencies</td>
<td>The number of active adjacencies (established sessions) associated with the</td>
</tr>
<tr>
<td></td>
<td>LDP instance.</td>
</tr>
<tr>
<td>Active Sessions</td>
<td>The number of active sessions (session in some form of creation) associated</td>
</tr>
<tr>
<td></td>
<td>with the LDP instance.</td>
</tr>
<tr>
<td>Active Interfaces</td>
<td>The number of active (operationally up) interfaces associated with the LDP</td>
</tr>
<tr>
<td></td>
<td>instance.</td>
</tr>
<tr>
<td>Inactive Interfaces</td>
<td>The number of inactive (operationally down) interfaces associated with the</td>
</tr>
<tr>
<td></td>
<td>LDP instance.</td>
</tr>
<tr>
<td>Active Peers</td>
<td>The number of active LDP peers.</td>
</tr>
<tr>
<td>Inactive Peers</td>
<td>The number of inactive LDP peers.</td>
</tr>
<tr>
<td>Addr FECs Sent</td>
<td>The number of labels that have been sent to the peer associated with this</td>
</tr>
<tr>
<td></td>
<td>FEC.</td>
</tr>
<tr>
<td>Addr FECsRecv</td>
<td>The number of labels that have been received from the peer associated with</td>
</tr>
<tr>
<td></td>
<td>this FEC.</td>
</tr>
<tr>
<td>Serv FECs Sent</td>
<td>The number of labels sent to the peer associated with this FEC.</td>
</tr>
<tr>
<td>Serv FECsRecv</td>
<td>The number of labels received from the peer associated with this FEC.</td>
</tr>
<tr>
<td>Attempted Sessions</td>
<td>The total number of attempted sessions for this LDP instance.</td>
</tr>
<tr>
<td>Label</td>
<td>Description</td>
</tr>
<tr>
<td>--------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>No Hello Err</td>
<td>The total number of “Session Rejected” or “No Hello Error” notification messages sent or received by this LDP instance.</td>
</tr>
<tr>
<td>Param Adv Err</td>
<td>The total number of “Session Rejected” or “Parameters Advertisement Mode Error” notification messages sent or received by this LDP instance.</td>
</tr>
<tr>
<td>Max PDU Err</td>
<td>The total number of “Session Rejected” or “Parameters Max PDU Length Error” notification messages sent or received by this LDP instance.</td>
</tr>
<tr>
<td>Label Range Err</td>
<td>The total number of “Session Rejected” or “Parameters Label Range Error” notification messages sent or received by this LDP instance.</td>
</tr>
<tr>
<td>Bad LDP Id Err</td>
<td>The number of bad LDP identifier fatal errors detected for sessions associated with this LDP instance.</td>
</tr>
<tr>
<td>Bad PDU Len Err</td>
<td>The number of bad PDU length fatal errors detected for sessions associated with this LDP instance.</td>
</tr>
<tr>
<td>Bad Mesg Len Err</td>
<td>The number of bad message length fatal errors detected for sessions associated with this LDP instance.</td>
</tr>
<tr>
<td>Bad TLV Len Err</td>
<td>The number of bad TLV length fatal errors detected for sessions associated with this LDP instance.</td>
</tr>
<tr>
<td>Malformed TLV Err</td>
<td>The number of malformed TLV value fatal errors detected for sessions associated with this LDP instance.</td>
</tr>
<tr>
<td>Shutdown Notif Sent</td>
<td>The number of shutdown notifications sent related to sessions associated with this LDP instance.</td>
</tr>
<tr>
<td>Keepalive Expired Err</td>
<td>The number of session Keepalive timer expired errors detected for sessions associated with this LDP instance.</td>
</tr>
<tr>
<td>Shutdown Notif Recv</td>
<td>The number of shutdown notifications received related to sessions associated with this LDP instance.</td>
</tr>
</tbody>
</table>

**Sample Output**

*A:* SRR# show router ldp status

LDP Status for LSR ID 110.20.1.2

<table>
<thead>
<tr>
<th>Admin State</th>
<th>Oper State</th>
<th>Created at</th>
<th>Oper Time</th>
<th>Oper Down Reason</th>
<th>Oper Down Events</th>
<th>Last Change</th>
<th>Tunn Down Damp Time</th>
<th>Label Withdraw Del*</th>
<th>Implicit Null Label</th>
<th>Short. TTL Prop Lo*</th>
<th>Short. TTL Prop Tran*</th>
<th>Import Policies</th>
<th>Export Policies</th>
<th>Tunl Exp Policies</th>
<th>Agg Prefix Policies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up</td>
<td>Up</td>
<td>07/26/11</td>
<td>00:15:20:48</td>
<td>n/a</td>
<td>12</td>
<td>07/26/11</td>
<td>06:05:46</td>
<td>120 sec</td>
<td>Disabled</td>
<td>Disabled</td>
<td>Disabled</td>
<td>None</td>
<td>None</td>
<td>from-proto-bgp</td>
<td>True</td>
</tr>
</tbody>
</table>
**Show Commands**

```
FRR                : Enabled
Dynamic Capability : False    P2MP Capability : True
MP MBB Capability  : True     MP MBB Time    : 3
Active Adjacencies : 10       Active Sessions : 6
Active Interfaces  : 34       Inactive Interfaces : 3
Active Peers      : 18        Inactive Peers  : 1
Addr FECs Sent    : 3066      Addr FECs Recv : 3066
Serv FECs Sent    : 0         Serv FECs Recv : 0
P2MP FECs Sent    : 600       P2MP FECs Recv : 1200
Attempted Sessions: 8575
No Hello Err       : 24        Param Adv Err  : 0
Max PDU Err        : 0         Label Range Err: 0
Bad LDP Id Err     : 18020     Bad FDU Len Err: 0
Bad Mesg LenErr    : 0         Bad TLV Len Err: 0
Unknown TLV Err    : 0         Keepalive Expired Err: 1751
Malformed TLV Err  : 0         Shutdown Notif Sent: 10
Serv FECs Sent     : 0         Shutdown Notif Recv : 0
                     * indicates that the corresponding row element may have been truncated.
```

```
*A:SRU4# show router ldp status

LDP Status for LSR ID 10.20.1.2

Admin State        : Up       Oper State           : Up
Created at         : 11/19/2010 23:45:01  Up Time              : 68d 01:00:07
Oper Down Reason   : n/a                  Oper Down Events     : 0
Last Change        : 11/19/2010 23:45:01  Tunn Down Damp Time  : 3 sec
Label Withdraw Del*: 0 sec                Implicit Null Label  : Disabled
Short. TTL Prop Lo*: Enabled              Short. TTL Prop Tran*: Enabled
Import Policies    : None                 Export Policies      : None
Tunl Exp Policies  : None
Aggregate Prefix   : False
Agg Prefix Policies: None
Dynamic Capability : False    P2MP Capability : True
MP MBB Capability  : True     MP MBB Time    : 3
Active Adjacencies : 3        Active Sessions : 1
Active Interfaces  : 3        Inactive Interfaces : 9
Active Peers      : 0        Inactive Peers  : 0
Addr FECs Sent    : 1        Addr FECs Recv : 1
Serv FECs Sent    : 0        Serv FECs Recv : 0
Attempted Sessions: 0
No Hello Err       : 0        Param Adv Err  : 0
Max PDU Err        : 0         Label Range Err: 0
Bad LDP Id Err     : 0         Bad FDU Len Err: 0
Bad Mesg LenErr    : 0         Bad TLV Len Err: 0
Unknown TLV Err    : 0
Malformed TLV Err  : 0         Keepalive Expired Err: 0
Shutdown Notif Sent: 0
Shutdown Notif Recv : 0
                     * indicates that the corresponding row element may have been truncated.
```

```
*B:Dut-B# show router ldp status

LDP Status for LSR ID 10.20.1.2

Admin State        : Up       Oper State           : Up
Created at         : 11/19/2010 23:45:01  Up Time              : 68d 01:00:07
Oper Down Reason   : n/a                  Oper Down Events     : 0
Last Change        : 11/19/2010 23:45:01  Tunn Down Damp Time  : 3 sec
Label Withdraw Del*: 0 sec                Implicit Null Label  : Disabled
Short. TTL Prop Lo*: Enabled              Short. TTL Prop Tran*: Enabled
Import Policies    : None                 Export Policies      : None
Tunl Exp Policies  : None
Aggregate Prefix   : False
Agg Prefix Policies: None
Dynamic Capability : False    P2MP Capability : True
MP MBB Capability  : True     MP MBB Time    : 3
Active Adjacencies : 3        Active Sessions : 1
Active Interfaces  : 3        Inactive Interfaces : 9
Active Peers      : 0        Inactive Peers  : 0
Addr FECs Sent    : 1        Addr FECs Recv : 1
Serv FECs Sent    : 0        Serv FECs Recv : 0
Attempted Sessions: 0
No Hello Err       : 0        Param Adv Err  : 0
Max PDU Err        : 0         Label Range Err: 0
Bad LDP Id Err     : 0         Bad FDU Len Err: 0
Bad Mesg LenErr    : 0         Bad TLV Len Err: 0
Unknown TLV Err    : 0
Malformed TLV Err  : 0         Keepalive Expired Err: 0
Shutdown Notif Sent: 0
Shutdown Notif Recv : 0
                     * indicates that the corresponding row element may have been truncated.
```

```
*A:SRU4# show router ldp statistics-summary

Statistics Summary

LDP FEC Prefix egress statistics : 0

*A:SRU4#
```

```
*A:SRR#

*B:Dut-B#
```
Clear Commands

fec-egress-statistics

Syntax  fec-egress-statistics [ip-prefix/mask]
Context  clear>router>ldp
Description  This command clears LDP FEC egress statistics.

   ip-prefix — Specify information for the specified IP prefix and mask length. Host bits must be 0.
   mask — Specifies the 32-bit address mask used to indicate the bits of an IP address that are being used
           for the subnet address.

   Values  0 — 32

instance

Syntax  instance
Context  clear>router>ldp
Description  This command resets the LDP instance.

interface

Syntax  interface [ip-int-name]
Context  clear>router>ldp
Description  This command restarts or clears statistics for LDP interfaces.

   Parameters  ip-int-name — The name of an existing interface. If the string contains special characters (#, $,
               spaces, etc.), the entire string must be enclosed within double quotes.

peer

Syntax  peer [ip-address] [statistics]
Context  clear>router>ldp
Description  This command restarts or clears statistics for LDP targeted peers.

   Parameters  ip-address — The IP address of a targeted peer.
               statistics — Clears only the statistics for a targeted peer
Show Commands

session

Syntax    session [ip-addr[:label-space]] [statistics]
Context   clear>router>ldp
Description This command restarts or clears statistics for LDP sessions.
Parameters

label-space — Specifies the label space identifier that the router is advertising on the interface.

Values 0 — 65535

statistics — Clears only the statistics for a session.

statistics

Syntax    statistics
Context   clear>router>ldp
Description This command clears LDP instance statistics.
Debug Commands

The following output shows debug LDP configurations discussed in this section.

A:ALA-12# debug router ldp peer 10.10.10.104
A:ALA-12>debug>router>ldp# show debug ldp
  debug
  router "Base"
    ldp peer 10.10.10.104
      event
      bindings
      messages
    exit
    packet
      hello
      init
      keepalive
    label
    exit
    exit
    exit
  exit
A:ALA-12>debug>router>ldp#

ldp

Syntax [no] ldp

Context debug>router

Description Use this command to configure LDP debugging.

interface

Syntax [no] interface interface-name

Context debug>router>ldp

Description Use this command for debugging an LDP interface.

Parameters interface-name — The name of an existing interface.

peer

Syntax [no] peer ip-address

Context debug>router>ldp

Description Use this command for debugging an LDP peer.
Show Commands

Parameters  

ip-address — The IP address of the LDP peer.

event

Syntax  

[no] event

Context  

debug>router>ldp>if

debug>router>ldp>peer

Description  

This command configures debugging for specific LDP events.

bindings

Syntax  

[no] bindings

Context  

debug>router>ldp>peer>event

Description  

This command displays debugging information about addresses and label bindings learned from LDP peers for LDP bindings.

The no form of the command disables the debugging output.

messages

Syntax  

[no] messages

Context  

debug>router>ldp>if>event

debug>router>ldp>peer>event

Description  

This command displays specific information (for example, message type, source, and destination) regarding LDP messages sent to and received from LDP peers.

The no form of the command disables debugging output for LDP messages.

packet

Syntax  

packet [detail]

no packet

Context  

debug>router>ldp>if

debug>router>ldp>peer

Description  

This command enables debugging for specific LDP packets.

The no form of the command disables the debugging output.

Parameters  

detail — Displays detailed information.
**hello**

**Syntax**

```plaintext
hello [detail]
no hello
```

**Context**

debug>router>ldp>if>packet
debug>router>ldp>peer>packet

**Description**

This command enables debugging for LDP hello packets.
The `no` form of the command disables the debugging output.

**Parameters**

- `detail` — Displays detailed information.

**init**

**Syntax**

```plaintext
init [detail]
no init
```

**Context**

debug>router>ldp>peer>packet

**Description**

This command enables debugging for LDP Init packets.
The `no` form of the command disables the debugging output.

**Parameters**

- `detail` — Displays detailed information.

**keepalive**

**Syntax**

```plaintext
[no] keepalive
```

**Context**

debug>router>ldp>peer>packet

**Description**

This command enables debugging for LDP Keepalive packets.
The `no` form of the command disables the debugging output.

**label**

**Syntax**

```plaintext
label [detail]
no label
```

**Context**

debug>router>ldp>peer>packet

**Description**

This command enables debugging for LDP Label packets.
The `no` form of the command disables the debugging output.

**Parameters**

- `detail` — Displays detailed information.
Show Commands
Standards and Protocol Support

Standards Compliance
IEEE 802.1ab-REV/D3 Station and Media Access Control Connectivity Discovery
IEEE 802.1d Bridging
IEEE 802.1p/Q VLAN Tagging
IEEE 802.1s Multiple Spanning Tree
IEEE 802.1w Rapid Spanning Tree Protocol
IEEE 802.1x Port Based Network Access Control
IEEE 802.1ad Provider Bridges
IEEE 802.1ah Provider Backbone Bridges
IEEE 802.1ag Service Layer OAM
IEEE 802.3ah Ethernet in the First Mile
IEEE 802.1ak Multiple MAC Registration Protocol
IEEE 802.3 10BaseT
IEEE 802.3ad Link Aggregation
IEEE 802.3ae 10Gbps Ethernet
IEEE 802.3ah Ethernet OAM
IEEE 802.3u 100BaseTX
IEEE 802.3x Flow Control
IEEE 802.3z 100BaseSX/LX
ITU-T Y.1731 OAM functions and mechanisms for Ethernet based networks
ITU-T G.8031 Ethernet linear protection switching
ITU-T G.8032 Ethernet Ring Protection Switching (version 2)

Protocol Support
OSPF
RFC 1765 OSPF Database Overflow
RFC 2328 OSPF Version 2
RFC 2370 Opaque LSA Support
RFC 2740 OSPF for IPv6 (OSPFv3) draft-ietf-ospf-ospfv3-update-14.txt
RFC 3101 OSPF NSSA Option
RFC 3137 OSPF Stub Router Advertisement
RFC 3623 Graceful OSPF Restart – GR helper
RFC 3630 Traffic Engineering (TE) Extensions to OSPF Version 2
RFC 4203 - Shared Risk Link Group (SRLG) sub-TLV
RFC 5185 OSPF Multi-Area Adjacency
RFC 3623 Graceful OSPF Restart — GR helper
RFC 3630 Traffic Engineering (TE) Extensions to OSPF Version 2
RFC 4203 for Shared Risk Link Group (SRLG) sub-TLV

BGP
RFC 1397 BGP Default Route Advertisement
RFC 1772 Application of BGP in the Internet
RFC 1965 Confederations for BGP
RFC 1997 BGP Communities Attribute
RFC 2385 Protection of BGP Sessions via MD5
RFC 2439 BGP Route Flap Dampening
RFC 2547bis BGP/MPLS VPNs
RFC 2918 Route Refresh Capability for BGP-4
RFC 3107 Carrying Label Information in BGP-4
RFC 3392 Capabilities Advertisement with BGP4
RFC 4271 BGP-4 (previously RFC 1771)
RFC 4360 BGP Extended Communities Attribute
RFC 4364 BGP/MPLS IP Virtual Private Networks (VPNs) (previously RFC 2547bis BGP/MPLS VPNs)
RFC 4456 BGP Route Reflection: Alternative to Full-mesh IBGP (previously RFC 1966 & 2796)
RFC 4486 Subcodes for BGP Graceful Restart Notification Message
RFC 4577 OSPF as the Provider/ Customer Edge Protocol for BGP/ MPLS IP Virtual Private Networks (VPNs)

RFC 4659 BGP-MPLS IP Virtual Private Network (VPN) Extension for IPv6 VPN
RFC 4684 Constrained Route Distribution for Border Gateway Protocol/MultiProtocol Label Switching (BGP/MPLS) Internet Protocol (IP) Virtual Private Networks (VPNs)
RFC 4724 Graceful Restart Mechanism for BGP – GR helper
RFC 4760 Multi-protocol Extensions for BGP
RFC 4798 Connecting IPv6 Islands over IPv4 MPLS Using IPv6 Provider Edge Routers (6PE)
RFC 4893 BGP Support for Four-octet AS Number Space
RFC 5004 Avoid BGP Best Path Transitions from One External to Another
RFC 5065 Confederations for BGP (obsoletes 3065)
RFC 5291 Outbound Route Filtering Capability for BGP-4
RFC 5575 Dissemination of Flow Specification Rules
RFC 5668 4-Octet AS Specific BGP Extended Community
draft-ietf-idr-add-paths
draft-ietf-idr-best-external

IS-IS
RFC 1142 OSI IS-IS Intra-domain Routing Protocol (ISO 10589)
RFC 1195 Use of OSI IS-IS for routing in TCP/IP & dual environments
RFC 2763 Dynamic Hostname Exchange for IS-IS
RFC 2966 Domain-wide Prefix Distribution with Two-Level IS-IS
RFC 2973 IS-IS Mesh Groups
RFC 3373 Three-Way Handshake for Intermediate System to Intermediate System (IS-IS) Point-to-Point Adjacencies
Standards and Protocols

RFC 3567 Intermediate System to Intermediate System (ISIS) Cryptographic Authentication
RFC 3719 Recommendations for Interoperable Networks using IS-IS
RFC 3784 Intermediate System to Intermediate System (IS-IS) Extensions for Traffic Engineering (TE)
RFC 3787 Recommendations for Interoperable IP Networks
RFC 3847 Restart Signaling for IS-IS – GR helper
RFC 4205 for Shared Risk Link Group (SRLG) TLV
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IPSec
RFC 2401 Security Architecture for the Internet Protocol
RFC 2409 The Internet Key Exchange (IKE)
RFC 3706 IKE Dead Peer Detection
RFC 3947 Negotiation of NAT-Traversal in the IKE
RFC 3948 UDP Encapsulation of IPsec ESP Packets
draft-ietf-ipsec-isakmp-xauth-06.txt – Extended Authentication within ISAKMP/Oakley (XAUTH)
draft-ietf-ipsec-isakmp-modecfg-05.txt – The ISAKMP Configuration Method

IPv6
RFC 1981 Path MTU Discovery for IPv6
RFC 2375 IPv6 Multicast Address Assignments
RFC 2460 Internet Protocol, Version 6 (IPv6) Specification
RFC 2461 Neighbor Discovery for IPv6
RFC 2462 IPv6 Stateless Address Autoconfiguration
RFC 2463 Internet Control Message Protocol (ICMPv6) for the Internet Protocol Version 6 Specification
RFC 2464 Transmission of IPv6 Packets over Ethernet Networks
RFC 2529 Transmission of IPv6 over IPv4 Domains without Explicit Tunnels
RFC 2545 Use of BGP-4 Multiprotocol Extension for IPv6 Inter-Domain Routing
RFC 2710 Multicast Listener Discovery (MLD) for IPv6
RFC 3006 Unicast-Prefix-based IPv6 Multicast Addresses
RFC 3315 Dynamic Host Configuration Protocol for IPv6
RFC 3587 IPv6 Global Unicast Address Format
RFC 3590 Source Address Selection for the Multicast Listener Discovery (MLD) Protocol
RFC 3810 Multicast Listener Discovery Version 2 (MLDv2) for IPv6
RFC 4007 IPv6 Scoped Address Architecture
RFC 4193 Unique Local IPv6 Unicast Addresses
RFC 4291 IPv6 Addressing Architecture
RFC 4552 Authentication/Confidentiality for OSPFv3
RFC 4659 BGP-MLPS IP Virtual Private Network (VPN) Extension for IPv6 VPN
RFC 5072 IP Version 6 over PPP
RFC 5095 Deprecation of Type 0 Routing Headers in IPv6
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Multicast
RFC 1112 Host Extensions for IP Multicasting (Snoping)
RFC 2236 Internet Group Management Protocol, (Snoping)
RFC 3376 Internet Group Management Protocol, Version 3 (Snoping)
RFC 2362 Protocol Independent Multicast-Sparse Mode (PIM-SM)
RFC 3618 Multicast Source Discovery Protocol (MSDP)
RFC 3446 Anycast Rendezvous Point (RP) mechanism using Protocol Independent Multicast (PIM) and Multicast Source Discovery Protocol (MSDP)
RFC 4604 Using IGMPv3 and MLDv2 for Source-Specific Multicast
RFC 4607 Source-Specific Protocol Independent Multicast in 232/8
RFC 4610 Anycast-RP Using Protocol Independent Multicast (PIM)
RFC 5186, Internet Group Management Protocol Version 3 (IGMPv3)/ Multicast Listener Discovery Version 2 (MLDv2) and Multicast Routing Protocol Interaction
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RFC 3956: Embedding the Rendezvous Point (RP) Address in an IPv6 Multicast Address

MPLS — General
RFC 2430 A Provider Architecture
RFC 2474 Definition of the DS Field the IPv4 and IPv6 Headers (Rev)
RFC 2597 Assured Forwarding PHB Group (rev3260)
RFC 2598 An Expedited Forwarding PHB
RFC 3031 MPLS Architecture
RFC 3032 MPLS Label Stack Encoding
RFC 3443 Time To Live (TTL) Processing in Multi-Protocol Label Switching (MPLS) Networks
RFC 4182 Removing a Restriction on the use of MPLS Explicit NULL
RFC 3140 Per-Hop Behavior Identification Codes
RFC 4905, Encapsulation methods for transport of layer 2 frames over MPLS
RFC 5332 MPLS Multicast Encapsulations

MPLS — LDP
RFC 3037 LDP Applicability
Standards and Protocols

RFC 3478 Graceful Restart Mechanism for LDP – GR helper
RFC 5036 LDP Specification
RFC 5283 LDP extension for Inter-Area LSP
RFC 5443 LDP IG P Synchronization
draft-ietf-mpls-ldp-p2mp-05 LDP Extensions for Point-to-Multipoint and Multipoint-to-Multipoint LSP
draft-ietf-mpls-mdlp-in-band-signaling-05 Multipoint LDP in-band signaling for Point-to-Multipoint and Multipoint-to-Multipoint Label Switched Paths

MPLS — OAM
RFC 4379 Detecting Multi-Protocol Label Switched (MPLS) Data Plane Failures
RFC 6425 Detecting Data Plane Failures in Point-to-Multipoint Multiprotocol Label Switching (MPLS) - Extensions to LSP Ping

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RFC 768 UDP
RFC 1350 The TFTP Protocol (Rev.
RFC 791 IP
RFC 792 ICMP
RFC 793 TCP
RFC 826 ARP
RFC 854 Telnet
RFC 951 BootP (rev)
RFC 1519 CDR
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RFC 1812 Requirements for IPv4 Routers
RFC 2347 TFTP option Extension
RFC 2328 TFTP Blocksize Option
RFC 2349 TFTP Timeout Interval and Transfer Size option
RFC 2401 Security Architecture for Internet Protocol
RFC 2428 FTP Extensions for IPv6 and NATs
RFC 3596 DNS Extensions to Support IP version 6
draft-ietf-bfd-mib-00.txt Bidirectional Forwarding Detection Management Information Base
RFC 5880 Bidirectional Forwarding Detection

RFC 5881 BFD IPv4 and IPv6 (Single Hop)
RFC 5883 BFD for Multihop Paths

VRRP
RFC 2787 Definitions of Managed Objects for the Virtual Router Redundancy Protocol
RFC 3768 Virtual Router Redundancy Protocol
RFC 5798, Virtual Router Redundancy Protocol Version 3 for IPv4 and IPv6

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RFC 1332 PPP IPCP
RFC 1377 PPP OSINLCP
RFC 1638/2878PPP BCP
RFC 1661 PPP (rev RFC2151)
RFC 1662 PPP in HDLC-like Framing
RFC 1877 PPP Internet Protocol Control Protocol Extensions for Name Server Addresses
RFC 1989 PPP Link Quality Monitoring
RFC 1990 The PPP Multilink Protocol (MP)
RFC 1994 PPP Challenge Handshake Authentication Protocol (CHAP)
RFC 2615 PPP over SONET/SDH
RFC 2516 A Method for Transmitting PPP Over Ethernet
RFC 2686 The Multi-Class Extension to Multi-Link PPP

Frame Relay
FRF.1.2 - PVC User-to-Network Interface (UNI) Implementation Agreement
FRF.5 - Frame Relay/ATM PVC Network Interworking Implementation
FRF.2.2 - PVC Network-to-Network Interface (NNI) Implementation Agreement.
FRF.12 Frame Relay Fragmentation Implementation Agreement
FRF.16.1 Multilink Frame Relay UNI/NNI Implementation Agreement
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ATM
- RFC 1626 Default IP MTU for use over ATM AAL5
- RFC 2514 Definitions of Textual Conventions and OBJECT IDENTITIES for ATM Management
- RFC 2515 Definition of Managed Objects for ATM Management
- RFC 2684 Multiprotocol Encapsulation over ATM Adaptation Layer 5
- AF-TM-0121.000 Traffic Management Principles and Functions version 11/95
- ITU-T Recommendation I.610 - B-ISDN Operation and Maintenance
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- GR-1248-CORE - Generic Requirements for Operations of ATM Network Elements (NEs). Issue 3
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- AF-TM-0150.00 Addendum to Traffic Management v4.1 optional minimum desired cell rate indication for UBR
- AF-PHY-0086.001, Inverse Multiplexing for ATM (IMA) Specification Version 1.1

DHCP
- RFC 2131 Dynamic Host Configuration Protocol (REV)
- RFC 3046 DHCP Relay Agent Information Option (Option 82)
- RFC 1534 Interoperation between DHCP and BOOTP

VPLS
- RFC 4762 Virtual Private LAN Services Using LDP
- RFC5501: Requirements for Multicast Support in Virtual Private LAN Services (previously draft-ietf-12vpn-vpls-mcast-reqts-04)
- draft-ietf-12vpn-vpls-mcast-reqts-04
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- RFC 3985 Pseudo Wire Emulation Edge-to-Edge (PWE3)
- RFC 4385 Pseudo Wire Emulation Edge-to-Edge (PWE3) Control Word for Use over an MPLS PSN
- RFC 3916 Requirements for Pseudo-Wire Emulation Edge-to-Edge (PWE3)
- RFC 4717 Encapsulation Methods for Transport ATM over MPLS Networks (draft-ietf-pwe3-atm-encap-10.txt)
- RFC 4816 PWE3 ATM Transparent Cell Transport Service (draft-ietf-pwe3-cell-transport-04.txt)
- RFC 4448 Encapsulation Methods for Transport of Ethernet over MPLS Networks (draft-ietf-pwe3-ethernet-encap-11.txt)
- RFC 4619 Encapsulation Methods for Transport of Frame Relay over MPLS Networks (draft-ietf-pwe3-frame-relay-07.txt)
- RFC 4446 IANA Allocations for PWE3
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- RFC 5085, Pseudowire Virtual Circuit Connectivity Verification (VCCV): A Control Channel for Pseudowires
- RFC 5659 An Architecture for Multi-Segment Pseudowire Emulation Edge-to-Edge
- draft-ietf-12vpn-vpws-iw-oam-02.txt, OAM Procedures for VPWS Interworking
- RFC6310, Pseudowire (PW) OAM Message Mapping
draft-ietf-12vpn-arp-mediatio-19.txt, ARP Mediation for IP Interworking of Layer 2 VPN
- RFC6073, Segmented Pseudowire (draft-ietf-pwe3-segmented-pw-18.txt)
draft-ietf-pwe3-dynamic-ms-pw-14.txt, Dynamic Placement of Multi Segment Pseudo Wires
draft-ietf-pwe3-redundancy-bit-06.txt, Pseudowire Preferential Forwarding Status bit definition
draft-ietf-pwe3-redundancy-06.txt, Pseudowire (PW) Redundancy
- RFC6391 Flow Aware Transport of Pseudowires over an MPLS PSN
- MFA Forum 9.0.0 The Use of Virtual trunks for ATM/MPLS Control Plane Interworking
- MFA Forum 12.0.0 Multiservice Interworking - Ethernet over MPLS
- MFA forum 13.0.0 - Fault Management for Multiservice Interworking v1.0
- MFA Forum 16.0.0 – Multiservice Interworking - IP over MPLS

ANCP/L2CP
- RFC5851 ANCP framework
- draft-ietf-ancp-protocol-02.txt ANCP Protocol

Voice/Video Performance
- ITU-T Rec. P.564 - Conformance testing for voice over IP transmission quality assessment models
- ITU-T G.1020 - Appendix I - Performance Parameter Definitions for Quality of Speech and other Voiceband Applications Utilizing IP Networks- Mean Absolute Packet Delay Variation & Markov Models.

CIRCUIT EMULATION
- RFC 4553 Structure-Agnostic Time Division Multiplexing (TDM) over Packet (SAToP)
- RFC 5086 Structure-Aware Time Division Multiplexed (TDM) Circuit Emulation Service over Packet Switched Network (CESoPSN)
MEF-8 Implementation Agreement for the Emulation of PDH Circuits over Metro Ethernet Networks, October 2004

RFC 5287 Control Protocol Extensions for the Setup of Time-Division Multiplexing (TDM) Pseudowires in MPLS Networks

SONET/SDH
ITU-G841 Telecommunication Standardization Section of ITU, Types and Characteristics of SDH Networks Protection Architecture, issued in October 1998 and as augmented by Corrigendum 1 issued in July 2002

RFC 5287 Control Protocol Extensions for the Setup of Time-Division Multiplexing (TDM) Pseudowires in MPLS Networks

SonET/SDH
ITU-G841 Telecommunication Standardization Section of ITU, Types and Characteristics of SDH Networks Protection Architecture, issued in October 1998 and as augmented by Corrigendum 1 issued in July 2002

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RFC 2865 Remote Authentication Dial In User Service
RFC 2866 RADIUS Accounting

SSH
RFC 4250 The Secure Shell (SSH) Protocol
draft-ietf-secsesh-architecture.txt SSH Protocol Architecture
draft-ietf-secsesh-userauth.txt SSH Authentication Protocol
draft-ietf-secsesh-transport.txt SSH Transport Layer Protocol
draft-ietf-secsesh-connection.txt SSH Connection Protocol
draft-ietf-secsesh-newmodes.txt SSH Transport Layer Encryption Modes

TACACS+
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RFC 2138 RADIUS
RFC 2206 RSVP-MIB
RFC 2452 IPv6 Management Information Base for the Transmission Control Protocol
RFC 2454 IPv6 Management Information Base for the User Datagram Protocol
RFC 2465 Management Information Base for IPv6: Textual Conventions and General Group
RFC 2558 SONET-MIB
RFC 2571 SNMP-Framework MIB
RFC 2572 SNMP-MPD-MIB

RFC 2573 SNMP-Target-&-notification-MIB
RFC 2574 SNMP-User-based-SMMIB
RFC 2575 SNMP-View-based-ACM-MIB
RFC 2576 SNMP-Community-MIB
RFC 2665 EtherLike-MIB
RFC 2819 RMON-MIB
RFC 2863 IF-MIB
RFC 2864 Inverted-stack-MIB
RFC 2987 VRRP-MIB
RFC 3014 Notification-log MIB
RFC 3019 IP Version 6 Management Information Base for The Multicast Listener Discovery Protocol
RFC 3164 Syslog
RFC 3273 HCRMON-MIB
RFC 3412 Message Processing and Dispatching for the Simple Network Management Protocol (SNMP)
RFC 3413 Simple Network Management Protocol (SNMP) Applications
RFC 3414 User-based Security Model (USM) for version 3 of the Simple Network Management Protocol (SNMPv3)
RFC 3418 SNMP MIB
RFC 4292 IP-Forward-MIB
RFC 4293 MIB for the Internet Protocol
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draft-ietf-mpls-ldp-mib-07.txt
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IANA-IFType-MIB
IEEE8023-LAG-MIB

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TIMETRA-ATM-MIB.mib
TIMETRA-BGP-MIB.mib
TIMETRA-BSX-NG-MIB.mib
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TIMETRA-CHASSIS-MIB.mib
TIMETRA-CLEAR-MIB.mib
TIMETRA-FILTER-MIB.mib
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