Junos® OS for EX Series Ethernet Switches

MPLS Feature Guide for EX4600 Switches

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Junos® OS for EX Series Ethernet Switches MPLS Feature Guide for EX4600 Switches
Release 14.1X53

The information in this document is current as of the date on the title page.

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Documentation and Release Notes

To obtain the most current version of all Juniper Networks® technical documentation, see the product documentation page on the Juniper Networks website at http://www.juniper.net/techpubs/.

If the information in the latest release notes differs from the information in the documentation, follow the product Release Notes.

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Supported Platforms

For the features described in this document, the following platforms are supported:

- EX Series

Using the Examples in This Manual

If you want to use the examples in this manual, you can use the **load merge** or the **load merge relative** command. These commands cause the software to merge the incoming configuration into the current candidate configuration. The example does not become active until you commit the candidate configuration.

If the example configuration contains the top level of the hierarchy (or multiple hierarchies), the example is a *full example*. In this case, use the **load merge** command.

If the example configuration does not start at the top level of the hierarchy, the example is a *snippet*. In this case, use the **load merge relative** command. These procedures are described in the following sections.

Merging a Full Example

To merge a full example, follow these steps:

1. From the HTML or PDF version of the manual, copy a configuration example into a text file, save the file with a name, and copy the file to a directory on your routing platform.

   For example, copy the following configuration to a file and name the file **ex-script.conf**. Copy the **ex-script.conf** file to the **/var/tmp** directory on your routing platform.

   ```
   system {
     scripts {
       commit {
         file ex-script.xsl;
       }
     }
   }
   interfaces {
     fxp0 {
       disable;
       unit 0 {
         family inet {
           address 10.0.0.1/24;
         }
       }
     }
   }
   ```

2. Merge the contents of the file into your routing platform configuration by issuing the **load merge** configuration mode command:

   ```
   [edit]
   user@host# load merge /var/tmp/ex-script.conf
   load complete
   ```

Merging a Snippet

To merge a snippet, follow these steps:

1. From the HTML or PDF version of the manual, copy a configuration snippet into a text file, save the file with a name, and copy the file to a directory on your routing platform.

   For example, copy the following snippet to a file and name the file **ex-script-snippet.conf**. Copy the **ex-script-snippet.conf** file to the **/var/tmp** directory on your routing platform.

   ```
   commit {
     file ex-script-snippet.xsl; }
   ```

2. Move to the hierarchy level that is relevant for this snippet by issuing the following configuration mode command:

```
[edit]
user@host# edit system scripts
[edit system scripts]
```

3. Merge the contents of the file into your routing platform configuration by issuing the **load merge relative** configuration mode command:

```
[edit system scripts]
user@host# load merge relative /var/tmp/ex-script-snippet.conf
load complete
```

For more information about the **load** command, see CLI Explorer.

Documentation Conventions

Table 1 on page xv defines notice icons used in this guide.

Table 1: Notice Icons

Icon	Meaning	Description
	Informational note	Indicates important features or instructions.
	Caution	Indicates a situation that might result in loss of data or hardware damage.
	Warning	Alerts you to the risk of personal injury or death.
	Laser warning	Alerts you to the risk of personal injury from a laser.
	Tip	Indicates helpful information.
	Best practice	Alerts you to a recommended use or implementation.

Table 2 on page xv defines the text and syntax conventions used in this guide.

Table 2: Text and Syntax Conventions

Convention	Description	Examples
Bold text like this	Represents text that you type.	To enter configuration mode, type the **configure** command: user@host> **configure**

Table 2: Text and Syntax Conventions *(continued)*

Convention	Description	Examples
`Fixed-width text like this`	Represents output that appears on the terminal screen.	`user@host>` **show chassis alarms** `No alarms currently active`
Italic text like this	• Introduces or emphasizes important new terms. • Identifies guide names. • Identifies RFC and Internet draft titles.	• A policy *term* is a named structure that defines match conditions and actions. • *Junos OS CLI User Guide* • RFC 1997, *BGP Communities Attribute*
Italic text like this	Represents variables (options for which you substitute a value) in commands or configuration statements.	Configure the machine's domain name: [edit] root@# **set system domain-name** *domain-name*
Text like this	Represents names of configuration statements, commands, files, and directories; configuration hierarchy levels; or labels on routing platform components.	• To configure a stub area, include the **stub** statement at the **[edit protocols ospf area area-id]** hierarchy level. • The console port is labeled **CONSOLE**.
< > (angle brackets)	Encloses optional keywords or variables.	**stub <default-metric** ***metric*****>;**
| (pipe symbol)	Indicates a choice between the mutually exclusive keywords or variables on either side of the symbol. The set of choices is often enclosed in parentheses for clarity.	**broadcast | multicast** **(*string1* | *string2* | *string3*)**
# (pound sign)	Indicates a comment specified on the same line as the configuration statement to which it applies.	**rsvp { # Required for dynamic MPLS only**
[ ] (square brackets)	Encloses a variable for which you can substitute one or more values.	**community name members [** ***community-ids*** **]**

Indention and braces ({ })	Identifies a level in the configuration hierarchy.	[edit]
		routing-options {
		  static {
		  route default {
		  nexthop *address*;
		  retain;
		  }
		  }
		}

; (semicolon)	Identifies a leaf statement at a configuration hierarchy level.	
GUI Conventions		
Bold text like this	Represents graphical user interface (GUI) items you click or select.	• In the Logical Interfaces box, select **All Interfaces**. • To cancel the configuration, click **Cancel**.

Table 2: Text and Syntax Conventions *(continued)*

Convention	Description	Examples
> (bold right angle bracket)	Separates levels in a hierarchy of menu selections.	In the configuration editor hierarchy, select **Protocols>Ospf**.

Documentation Feedback

We encourage you to provide feedback, comments, and suggestions so that we can improve the documentation. You can provide feedback by using either of the following methods:

- Online feedback rating system—On any page of the Juniper Networks TechLibrary site at http://www.juniper.net/techpubs/index.html, simply click the stars to rate the content, and use the pop-up form to provide us with information about your experience. Alternately, you can use the online feedback form at http://www.juniper.net/techpubs/feedback/.
- E-mail—Send your comments to **techpubs-comments@juniper.net**. Include the document or topic name, URL or page number, and software version (if applicable).

Requesting Technical Support

Technical product support is available through the Juniper Networks Technical Assistance Center (JTAC). If you are a customer with an active J-Care or Partner Support Service support contract, or are covered under warranty, and need post-sales technical support, you can access our tools and resources online or open a case with JTAC.

- JTAC policies—For a complete understanding of our JTAC procedures and policies, review the *JTAC User Guide* located at http://www.juniper.net/us/en/local/pdf/resource-guides/7100059-en.pdf.
- Product warranties—For product warranty information, visit http://www.juniper.net/support/warranty/.
- JTAC hours of operation—The JTAC centers have resources available 24 hours a day, 7 days a week, 365 days a year.

Self-Help Online Tools and Resources

For quick and easy problem resolution, Juniper Networks has designed an online self-service portal called the Customer Support Center (CSC) that provides you with the following features:

- Find CSC offerings: http://www.juniper.net/customers/support/
- Search for known bugs: http://www2.juniper.net/kb/
- Find product documentation: http://www.juniper.net/techpubs/
- Find solutions and answer questions using our Knowledge Base: http://kb.juniper.net/

- Download the latest versions of software and review release notes: http://www.juniper.net/customers/csc/software/
- Search technical bulletins for relevant hardware and software notifications: http://kb.juniper.net/InfoCenter/
- Join and participate in the Juniper Networks Community Forum: http://www.juniper.net/company/communities/
- Open a case online in the CSC Case Management tool: http://www.juniper.net/cm/

To verify service entitlement by product serial number, use our Serial Number Entitlement (SNE) Tool: https://tools.juniper.net/SerialNumberEntitlementSearch/

Opening a Case with JTAC

You can open a case with JTAC on the Web or by telephone.

- Use the Case Management tool in the CSC at http://www.juniper.net/cm/.
- Call 1-888-314-JTAC (1-888-314-5822 toll-free in the USA, Canada, and Mexico).

For international or direct-dial options in countries without toll-free numbers, see http://www.juniper.net/support/requesting-support.html.

PART 1

MPLS

- Using MPLS on page 3
- Configuration Statements and Command Statements for MPLS on page 69

CHAPTER 1

Using MPLS

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MPLS Overview For QFX Switches and EX4600

MPLS is a protocol that uses labels to route packets instead of using IP addresses. In a traditional network, each switch performs an IP routing lookup, determines a next-hop based on its routing table, and then forwards a packet to that next-hop. With MPLS, only the first device does a routing lookup, and, instead of finding the next-hop, finds the ultimate destination along with a path to that destination. The path of an MPLS packet is called a label-switched path (LSP).

MPLS applies one or more labels to a packet so it can follow the LSP to the destination. Each switch pops off its label and sends the packet to the next switch label in the sequence.

The Junos OS includes everything you need to configure MPLS. You do not need to install any additional programs or protocols. MPLS is supported on switches with a subset of the commands supported on routers. The Junos MPLS-configured switches can interact with each other and with Junos MPLS-configured routers.

MPLS has the following advantages over conventional packet forwarding:

- Packets arriving on different ports can be assigned different labels.
- A packet arriving at a particular provider edge (PE) switch can be assigned a label that is different from that of the same packet entering the network at a different PE switch. As a result, forwarding decisions that depend on the ingress PE switch can be easily made.
- Sometimes it is desirable to force a packet to follow a particular route that is explicitly chosen at or before the time the packet enters the network, rather than letting it follow the route chosen by the normal dynamic routing algorithm as the packet travels through the network. In MPLS, a label can be used to represent the route so that the packet need not carry the identity of the explicit route.

This topic describes:

- Why Use MPLS? on page 4
- Why Not Use MPLS? on page 5
- How Do I Configure MPLS? on page 5
- What Does the MPLS Protocol Do? on page 6
- How Does MPLS Interface to Other Protocols? on page 7
- If I Have Used Cisco MPLS, What Do I Need to Know? on page 7

Why Use MPLS?

MPLS reduces the use of the forwarding table by using labels instead of the forwarding table. The size of forwarding tables on a switch are limited by silicon and using exact matching for forwarding to destination devices is cheaper than buying more sophisticated hardware. In addition, MPLS allows you to control where and how traffic is routed on your network – this is called traffic engineering.

Some reasons to use MPLS instead of another switching solution are:

- MPLS can connect different technologies that would not otherwise be compatible---service providers have this compatibility issue when connecting clients with different autonomous systems in their networks. In addition, MPLS has a feature called Fast Reroute that provides alternate backups for paths – this prevents network degradation in case of a switch failure.
- · Other IP-based encapsulations such as Generic Route Encapsulation (GRE) or Virtual Extensible Local Area Networks (VXLAN) support only two levels of hierarchy, one for the transport tunnel and one piece of metadata. Using virtual servers means that you need multiple hierarchy levels. For example, one label is needed for top-of-rack (ToR), one label for the egress port that identifies the server, and one for the virtual server.

Why Not Use MPLS?

There are no protocols to auto-discover MPLS enabled nodes. MPLS protocol just exchanges label values for an LSP. They do not create the LSPs.

You must build the MPLS mesh, switch by switch. We recommend using scripts for this repetitive process.

MPLS hides suboptimal topologies from BGP where multiple exits may exist for the same route.

Large LSPs are limited by the circuits they traverse. You can work around this by creating multiple, parallel LSPs.

How Do I Configure MPLS?

There are three types of switches you must set up for MPLS:

- Label Edge Router/Switch (LER) or ingress node to the MPLS network. This switch encapsulates the packets.
- Label Switching Routers/Switches (LSR). One or more switches that transfer MPLS packets in the MPLS network.
- Egress router/switch is the final MPLS device that removes the last label before packets leave the MPLS network.

Service providers (SP) use the term provider router (P) for a backbone router/switch doing label switching only. The customer-facing router at the SP is called a provider edge router (PE). Each customer needs a customer edge router (CE) to communicate with the PE. Customer facing routers typically can terminate IP addresses, L3VPNs, L2VPNs/pseudowires, and VPLS before packets are transferred to the CE.

Configure the MPLS LER (Ingress) Switch and the Egress Switch

To configure MPLS, you must first create one or more named paths on the ingress and egress routers. For each path, you can specify some or all transit routers in the path, or you can leave it empty.

Configure LSRs for MPLS

Configure one or more MPLS LSRs by following these steps:

1. Configure interfaces on each switch to transmit and receive MPLS packets using the usual interface command with MPLS appended. For example:

   ```
   [edit interfaces ge-0/0/0 unit 0] family mpls;
   ```

2. Add those same interfaces under [edit protocols mpls]. For example:

   ```
   [edit protocols mpls]
     interface ge-0/0/0;
   ```

3. Configure the interfaces on each switch to handle MPLS labels with a protocol. For example, for LDP:

   ```
   [edit protocols ldp]
     Interface ge-0/0/0.0;
   ```

   To watch a demo of these configurations, see https://www.youtube.com/watch?v=xegWBCUJ4tE.

What Does the MPLS Protocol Do?

Multiprotocol Label Switching (MPLS) is an Internet Engineering Task Force (IETF)-specified framework that provides for the designation, routing, forwarding and switching of traffic flows through the network. In addition, MPLS:

- Specifies mechanisms to manage traffic flows of various granularities, such as flows between different hardware, machines, or even flows between different applications.
- Remains independent of the layer-2 and layer-3 protocols.
- Provides a means to map IP addresses to simple, fixed-length labels used by different packet-forwarding and packet-switching technologies.
- Interfaces to existing routing protocols, such as Resource ReSerVation Protocol (RSVP) and Open Shortest PathFirst (OSPF).
- Supports IP, ATM, and Frame Relay layer-2 protocols.
- Uses these additional technologies:
  - FRR: MPLS Fast Reroute improves convergence during a failure by mapping out alternate LSPs in advance.
  - Link Protection/ Next-hop backup: A bypass LSP is created for every possible link failure.
  - Node Protection/ Next-hop backup: A bypass LSP is created for every possible switch (node) failure.
  - VPLS: Creates Ethernet multipoint switching service over MPLS and emulates functions of an L2 switch.
  - L3VPN: IP-based VPN customers get individual virtual routing domains.

How Does MPLS Interface to Other Protocols?

Some of the protocols that work with MPLS are:

- RSVP-TE: Resource Reservation Protocol - Traffic Engineering reserves bandwidth for LSPs.
- LDP: Label Distribution Protocol is the defacto protocol used for distribution of MPLS packets and is usually configured to tunnel inside RSVP-TE.
- IGP: Interior Gateway Protocol is a routing protocol. Edge routers (PE-routers) run BGP between themselves to exchange external (customer) prefixes. Edge and core (P) routers run IGP (usually OSPF or IS-IS) to find optimum path toward BGP next hops. P- and PE-routers use LDP to exchange labels for known IP prefixes (including BGP next hops). LDP indirectly builds end-to-end LSPs across the network core.
- BGP: Border Gateway Protocol (BGP) is allows policy-based routing to take place, using TCP as its transport protocol on port 179 to establish connections. The Junos OS routing protocol software includes BGP version 4. You do not configure BGP---configuring interfaces with MPLS and LDP/RSVP establishes the labels and the ability to transmit packets. BGP automatically determines the routes packets take.
- OSPF and ISIS: These protocols are used for routing between the MPLS PE and CE. Open Shortest Path First (OSPF) is perhaps the most widely used interior gateway protocol (IGP) in large enterprise networks. IS-IS, another link-state dynamic routing protocol, is more common in large service provider networks. Assuming you're running L3VPN to your customers, on the SP edge between the PE and the CE you can run any protocol that your platform supports as a VRF aware instance.

If I Have Used Cisco MPLS, What Do I Need to Know?

Cisco Networks and Juniper Networks use different terminology.

What Cisco Calls:	Juniper Calls:
affinities	admin-groups
autoroute announce	TE shortcuts
forwarding adjacency	LSP-advertise
tunnel	LSP
make-before-break	adaptive
application-window	adjust-interval
shared risk link groups	fate-sharing

Related Documentation

- MPLS Feature Support on QFX Series and EX4600 Switches on page 17

- Understanding MPLS Components on page 8
- Understanding MPLS Label Operations on page 11
- Understanding CoS MPLS EXP Classifiers and Rewrite Rules on page 27
- *Junos OS MPLS Applications Library for Routing Devices*

Understanding MPLS Components

MPLS devices include a number of components. While some components are required for all MPLS applications, others might not be, depending on the specific application.

This topic includes:

- Provider Edge Switches on page 8
- Provider Switch on page 9
- Components Required for All Switches in the MPLS Network on page 9

Provider Edge Switches

To implement MPLS on a network, you must configure two provider edge (PE) switches—an ingress PE switch and an egress PE switch. In addition, you must configure one or more provider switches as transit switches within the network to support the forwarding of MPLS packets.

The ingress PE switch (the entry point to the MPLS tunnel) receives a packet, analyzes it, and pushes an MPLS label onto it. This label places the packet in a forwarding equivalence class (FEC) and determines its handling and destination through the MPLS tunnel. The egress PE switch (the exit point from the MPLS tunnel) pops the MPLS label off the outgoing packet.

Within an MPLS tunnel, the network traffic is bidirectional. Therefore, each PE switch can be configured to be both an ingress switch and an egress switch, depending on the direction of the traffic.

The following MPLS components are configured on the PE switches but not on the provider switches:

- MPLS Protocol and Label-Switched Paths on page 8
- IP Over MPLS for Customer Edge Interfaces on page 9
- BGP Layer 3 VPN Configuration on page 9
- Routing Instances for Layer 3 VPN on page 9

MPLS Protocol and Label-Switched Paths

Each PE switch must be configured to support the MPLS protocol. You must also configure label-switched paths (LSPs) at the **[edit protocols mpls]** hierarchy level.

IP Over MPLS for Customer Edge Interfaces

You can configure the customer edge interfaces of the PE switches for IP over MPLS using a Layer 3 interface and a static route from the ingress PE switch to the egress PE switch. See "Configuring MPLS on Provider Edge Switches" on page 39.

BGP Layer 3 VPN Configuration

If you are implementing a Layer 3 virtual private network (VPN), you must configure the BGP routing protocol on the PE switches.

Routing Instances for Layer 3 VPN

If you are implementing a Layer 3 VPN, you must configure a routing instance. A routing instance is a collection of routing tables, interfaces, and routing protocol parameters. The set of interfaces belongs to the routing tables, and the routing protocol parameters control the information in the routing tables.

QFX Series and EX4600 devices support VPN routing and forwarding (VRF) routing instances for Layer 3 VPNs.

Each routing instance has a unique name and a corresponding IP unicast table. For example, if you configure a routing instance with the name **my-instance**, its corresponding IP unicast table will be **my-instance.inet.0**. All routes for **my-instance** are installed in **my-instance.inet.0**.

Provider Switch

You must configure one or more provider switches as transit switches within the network to support the forwarding of MPLS packets. You can add provider switches without changing the configuration of the PE switches.

A provider switch does not analyze packets. It refers to an MPLS label forwarding table and swaps one label for another. The new label determines the next hop along the MPLS tunnel. A provider switch cannot perform push or pop operations.

Components Required for All Switches in the MPLS Network

The following MPLS components are configured on both the PE switches and the provider switches:

- Interior Gateway Protocol on page 9
- MPLS Protocol on page 10
- RSVP on page 10
- Family mpls on page 10

Interior Gateway Protocol

MPLS works in coordination with OSPF as the interior gateway protocol (IGP). Therefore, you must configure OSPF as the IGP on the loopback interface and CE-facing interfaces of both the PE switches and the provider switches.

The CE-facing interfaces can be either Gigabit Ethernet or 10-Gigabit Ethernet interfaces, and they can be configured as either individual interfaces or as aggregated Ethernet interfaces.

NOTE: The CE-facing interfaces cannot be configured with VLAN tagging or a VLAN ID. When you configure them to belong to **family mpls**, they are removed from the default VLAN if they were members of that VLAN. They operate as an exclusive tunnel for MPLS traffic.

MPLS Protocol

You must enable the MPLS protocol on all switches that participate in the MPLS network and apply it to the core interfaces of both the PE and provider switches. You do not need to apply it to the loopback interface because the MPLS protocol uses the framework established by the RSVP signaling protocol to create LSPs. On the PE switches, the configuration of the MPLS protocol must also include the definition of an LSP.

RSVP

RSVP is a signaling protocol that allocates and distributes labels throughout an MPLS network. RSVP sets up unidirectional paths between the ingress PE switch and the egress PE switch. RSVP makes the LSPs dynamic; it can detect topology changes and outages and establish new LSPs to allow traffic to move around a failure.

You must enable RSVP and apply it to the loopback interface and the core interface of both the PE and provider switches. The path message contains the configured information about the resources required for the LSP to be established.

When the egress PE switch receives the path message, it sends a reservation message back to the ingress PE switch. This reservation message is passed along from switch to switch along the same path as the original path message. Once the ingress PE switch receives this reservation message, an RSVP path is established.

The established LSP stays active as long as the RSVP session remains active. RSVP continues activity through the transmissions and responses to RSVP path and reservation messages. If the messages stop for three minutes, the RSVP session terminates and the LSP is lost.

RSVP runs as a separate software process in Junos OS and is not in the packet-forwarding path.

Family mpls

You must configure the core interfaces used for MPLS traffic to belong to **family mpls**.

NOTE: You can enable **family mpls** on either individual interfaces or on aggregated Ethernet interfaces. You cannot enable it on tagged VLAN interfaces.

Related Documentation

- MPLS Feature Support on QFX Series and EX4600 Switches on page 17
- Understanding Using MPLS-Based Layer 3 VPNs on Switches on page 14
- Understanding CoS MPLS EXP Classifiers and Rewrite Rules on page 27
- Configuring MPLS on Provider Edge Switches on page 39
- Configuring MPLS on Provider Switches on page 42
- *Configuring Rewrite Rules for MPLS EXP Classifiers*
- *Configuring a Global MPLS EXP Classifier*
- *Configuring Ethernet over MPLS (L2 Circuit)*
- *Junos OS MPLS Applications Library for Routing Devices*
- *Junos OS VPNs Library for Routing Devices*

Understanding MPLS Label Operations

In the traditional packet-forwarding paradigm, as a packet travels from one switch to the next, an independent forwarding decision is made at each hop. The IP network header is analyzed and the next hop is chosen based on this analysis and on the information in the routing table. In an MPLS environment, the analysis of the packet header is made only once, when a packet enters the MPLS tunnel (that is, the path used for MPLS traffic).

When an IP packet enters a label-switched path (LSP), the ingress provider edge (PE) switch examines the packet and assigns it a label based on its destination, placing the label in the packet's header. The label transforms the packet from one that is forwarded based on its IP routing information to one that is forwarded based on information associated with the label. The packet is then forwarded to the next provider switch in the LSP. This switch and all subsequent switches in the LSP do not examine any of the IP routing information in the labeled packet. Rather, they use the label to look up information in their label forwarding table. They then replace the old label with a new label and forward the packet to the next switch in the path. When the packet reaches the egress PE switch, the label is removed, and the packet again becomes a native IP packet and is forwarded based on its IP routing information.

This topic describes:

- MPLS Label-Switched Paths and MPLS Labels on page 11
- Reserved Labels on page 12
- MPLS Label Operations on page 12
- Penultimate-Hop Popping and Ultimate-Hop Popping on page 14

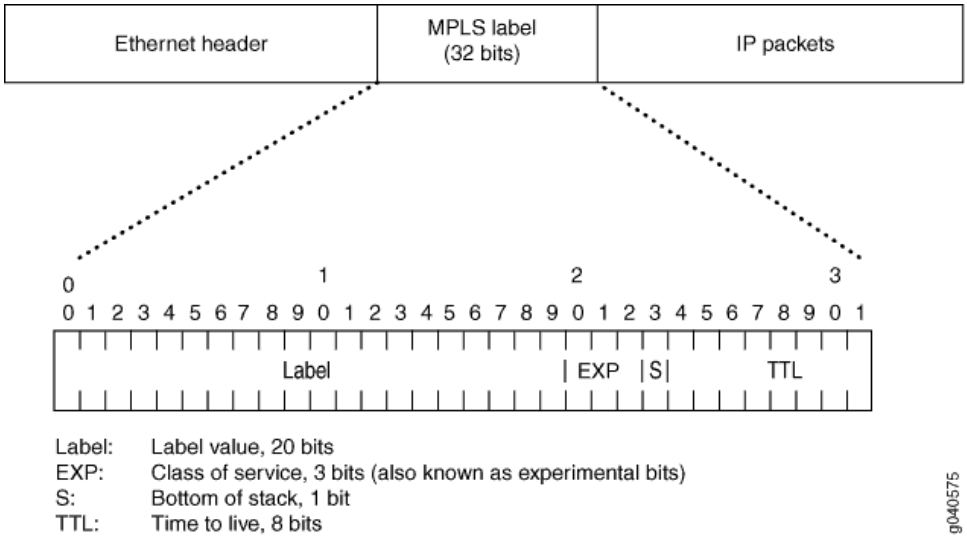
MPLS Label-Switched Paths and MPLS Labels

When a packet enters the MPLS network, it is assigned to an LSP. Each LSP is identified by a label, which is a short (20-bit), fixed-length value at the front of the MPLS label (32 bits). Labels are used as lookup indexes for the label forwarding table. For each label, this table stores forwarding information. Because no additional parsing or lookup is done

on the encapsulated packet, MPLS supports the transmission of any other protocols within the packet payload.

Figure 1 on page 12 shows the encoding of a single label. The encoding appears after data link layer headers, but before any network layer header.

Figure 1: Label Encoding



Reserved Labels

Labels range from 0 through 1,048,575. Labels 0 through 999,999 are for internal use.

Some of the reserved labels (in the range 0 through 15) have well-defined meanings. The following reserved labels are used by QFX Series and EX4600 devices:

- 0, IPv4 Explicit Null label—This value is valid only when it is the sole label entry (no label stacking). It indicates that the label must be popped on receipt. Forwarding continues based on the IP version 4 (IPv4) packet.
- 1, Router Alert label—When a packet is received with a top label value of 1, it is delivered to the local software module for processing.
- 3, Implicit Null label—This label is used in the signaling protocol (RSVP) only to request label popping by the downstream switch. It never actually appears in the encapsulation. Labels with a value of 3 must not be used in the data packet as real labels. No payload type (IPv4 or IPv6) is implied with this label.

MPLS Label Operations

QFX Series and EX4600 devices support the following MPLS label operations:

- Push
- Pop
- Swap

NOTE: There is a limit with regard to the number of labels that QFX and EX4600 devices can affix (push operations) to the label stack or remove (pop operations) from the label stack.

- For Push operations—As many as three labels are supported.
- For Pop operations—As many as two labels are supported.

The push operation affixes a new label to the top of the IP packet. For IPv4 packets, the new label is the first label. The time to live (TTL) field value in the packet header is derived from the IP packet header. The push operation cannot be applied to a packet that already has an MPLS label.

The pop operation removes a label from the beginning of the packet. Once the label is removed, the TTL is copied from the label into the IP packet header, and the underlying IP packet is forwarded as a native IP packet

The swap operation removes an existing MPLS label from an IP packet and replaces it with a new MPLS label, based on the following:

- Incoming interface
- Label
- Label forwarding table

Figure 2 on page 13 shows an IP packet without a label arriving on the customer edge interface (ge-0/0/1) of the ingress PE switch. The ingress PE switch examines the packet and identifies that packet's destination as the egress PE switch. The ingress PE switch applies label 100 to the packet and sends the MPLS packet to its outgoing MPLS core interface (ge-0/0/5). The MPLS packet is transmitted on the MPLS tunnel through the provider switch, where it arrives at interface ge-0/0/5 with label 100. The provider switch swaps label 100 with label 200 and forwards the MPLS packet through its core interface (ge-0/0/7) to the next hop on the tunnel, which is the egress PE switch. The egress PE switch receives the MPLS packet through its core interface (ge-0/0/7), removes the MPLS label, and sends the IP packet out of its customer edge interface (ge-0/0/1) to a destination that is beyond the tunnel.

Figure 2: MPLS Label Swapping

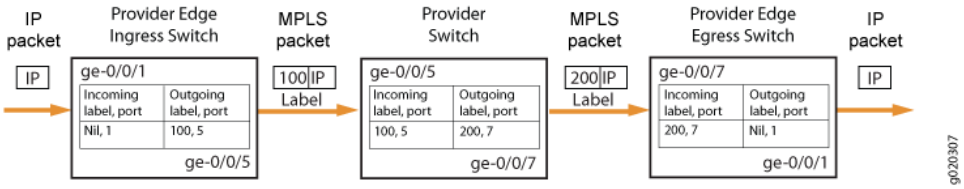


Figure 2 on page 13 shows the path of a packet as it passes in one direction from the ingress PE switch to the egress PE switch. However, the MPLS configuration also allows traffic to travel in the reverse direction. Thus, each PE switch operates as both an ingress switch and an egress switch.

Penultimate-Hop Popping and Ultimate-Hop Popping

The switches enable penultimate-hop popping (PHP) by default with IP over MPLS configurations. With PHP, the penultimate provider switch is responsible for popping the MPLS label and forwarding the traffic to the egress PE switch. The egress PE switch then performs an IP route lookup and forwards the traffic. This reduces the processing load on the egress PE switch, because it is not responsible for popping the MPLS label.

- The default advertised label is label 3 (Implicit Null label). If label 3 is advertised, the penultimate-hop switch removes the label and sends the packet to the egress PE switch.
- If ultimate-hop popping is enabled, label 0 (IPv4 Explicit Null label) is advertised and the egress PE switch of the LSP removes the label.

Related Documentation

- Understanding MPLS Components on page 8
- Configuring MPLS on Provider Edge Switches on page 39
- Configuring MPLS on Provider Switches on page 42
- *Junos OS MPLS Applications Library for Routing Devices*
- *Junos OS VPNs Library for Routing Devices*

Understanding Using MPLS-Based Layer 3 VPNs on Switches

On the QFX Series and on EX4600, you can use MPLS-based Layer 3 virtual private networks (VPNs) to securely connect geographically diverse sites across an MPLS network. MPLS services can be used to connect various sites to a backbone network and to ensure better performance for low-latency applications such as voice over IP (VoIP) and other business-critical functions.

A VPN uses a public telecommunications infrastructure, such as the Internet, to provide remote offices or individual users with secure access to their organization's network. VPNs are designed to provide the same level of performance and security as privately owned or leased networks but without the attendant costs.

This topic describes:

- MPLS-Based Layer 3 VPNs on page 14

MPLS-Based Layer 3 VPNs

In Junos OS, Layer 3 VPNs are based on RFC 4364, *BGP/MPLS IP Virtual Private Networks*. RFC 4364 defines a mechanism by which service providers can use their IP backbones to provide VPN services to their customers. A Layer 3 VPN is a set of sites that share common routing information and whose connectivity is controlled by a collection of policies. The sites that make up a Layer 3 VPN are connected over a provider's existing public Internet backbone.

Customer networks, because they are private, can use either public or private addresses, as defined in RFC 1918, *Address Allocation for Private Internets*. When customer networks that use private addresses connect to the public Internet infrastructure, the private addresses might overlap with the same private addresses used by other network users. BGP/MPLS VPNs solve this problem by adding a VPN identifier prefix to each address from a particular VPN site, thereby creating an address that is unique both within the VPN and on the public Internet. In addition, each VPN has its own VPN-specific routing table that contains the routing information for that VPN only. Two different VPNs can use overlapping addresses. Each route within a VPN is assigned an MPLS label (for example, MPLS-ARCH, MPLS-BGP, or MPLS-ENCAPS). When BGP distributes a VPN route, it also distributes an MPLS label for that route. Before a customer data packet travels across the service provider's backbone, it is encapsulated along with the MPLS label that corresponds to the route within the customer's VPN that is the best match based on the packet's destination address. This MPLS packet is further encapsulated with another MPLS label or with an IP, so that it gets tunneled across the backbone to the egress provider edge (PE) switch. Thus, the backbone core switches do not need to know the VPN routes.

QFX5100 switches also support interprovider VPNs, and carrier-of-carriers VPNs. For more information, see "Interprovider and Carrier-of-Carriers VPNs" on page 34

Related Documentation

- Understanding MPLS Label Operations on page 11
- Understanding MPLS Components on page 8
- *Example: Configuring MPLS-Based Layer 2 VPNs*
- *Example: Configuring MPLS-Based Layer 3 VPNs on EX Series Switches*

MPLS Configuration Guidelines

When configuring MPLS on QFX Series devices or on EX4600, note that the number of IP prefixes supported depends on the specific platform being used. See the scale specifications in the data sheet of your device for additional information.

- We recommend the following:
  - If your ingress provider edge (PE) switch needs to support more than 8000 external IP prefixes, use a larger capacity device as an ingress PE switch.
  - If you use a switch as a route reflector for BGP labeled routes, use it as a dedicated route reflector (that is, the switch must not participate in managing data traffic).
  - If you use a switch as a PE switch or as a route reflector for BGP labeled routes, configure routing policies on the PE switch and the route reflector to filter external IP routes from the routing table.

    The configuration example for a routing policy named fib_policy (at the **[edit policy-options** and **[edit routing-options** hierarchy levels) to filter BGP labeled routes from the inet.0 routing table is given below:

    ```
    user@switch# show policy-options
    policy-statement fib_policy {
    ```

```
    from {
      protocol bgp;
      rib inet.0;
    }
    then reject;
}
```

```
user@switch# show routing-options
forwarding-table {
  export fib_policy;
}
```

- Packet fragmentation using the **allow-fragmentation** statement at the **[edit protocols mpls path-mtu]** hierarchy level is not supported on QFX Series devices or on the EX4600 switch. Therefore, you must ensure that the maximum transmission unit (MTU) values configured on every MPLS interface is sufficient to handle MPLS packets. The packets whose size exceeds the MTU value of an interface will be dropped.

Related Documentation

- Configuring MPLS on Provider Edge Switches on page 39
- Configuring MPLS on Provider Switches on page 42
- *Configuring a Global MPLS EXP Classifier*
- *Configuring Rewrite Rules for MPLS EXP Classifiers*
- MPLS Feature Support on QFX Series and EX4600 Switches on page 17

MPLS Feature Support on QFX Series and EX4600 Switches

Multiprotocol Label Switching (MPLS) is a set of procedures for augmenting network layer packets with label stacks, thereby turning them into labeled packets. Service providers frequently use MPLS. Simply put, where traditional networks' routers each perform an IP lookup to determine the next hop, an MPLS network's first device does a routing lookup for the final destination instead of the next hop. A label is then applied to the packet—this is called packet switching. The final destination device removes the label.

A number of Juniper Networks switches are capable of running a subset of MPLS and can therefore communicate, not only with each other, but with Juniper Networks routers running MPLS. This topic describes the major MPLS features that are supported on QFX Series switches and on one EX Series switch, the EX4600. Be sure to check for any exceptions to this support in "MPLS Limitations on QFX Series and EX4600 Switches" on page 20.

NOTE: **EX4600 uses the same chipset as QFX5100—this is why the EX4600 switch is discussed here along with QFX Series switches. Other EX Series switches also support MPLS but with a different feature set.**

This topic describes:

- MPLS Commands Supported by QFX Series and EX4600 Switches on page 17
- MPLS Features Supported by QFX Series and EX4600 Switches on page 17

MPLS Commands Supported by QFX Series and EX4600 Switches

QFX Series and EX4600 switches support a subset of MPLS features. The command-line interface (CLI) for switches displays all MPLS related configuration statements, even those that are not supported. However, configuring those unsupported statements on a switch has no effect on the operation of the switch.

MPLS Features Supported by QFX Series and EX4600 Switches

Table 3 on page 17 lists the major MPLS features supported on QFX Series and EX4600 switches. It also lists the Juniper Networks Junos operating system (Junos OS) release in which they were introduced.

Table 3: MPLS Features with Junos OS Release Support

Feature	QFX3500	QFX5100	EX4600
QFX standalone switch as an MPLS provider edge (PE) switch or provider switch	12.2X50-D10	13.2X51-D15 VC/VCF (14.1X53-D30)	14.1X53-D15
MPLS provider edge (PE) switch or provider switch	12.2X50-D10	13.2X51-D15 VC/VCF (14.1X53-D30)	14.1X53-D15

Table 3: MPLS Features with Junos OS Release Support *(continued)*

Feature	QFX3500	QFX5100	EX4600
Route reflector for BGP labeled routes	12.2X50-D10	13.2X51-D15 VC/VCF (14.1X53-D30)	14.1X53-D15
Label edge router (LER)	12.2X50-D10	13.2X51-D15 VC/VCF (14.1X53-D30)	14.1X53-D15
Label switch router (LSR)	12.2X50-D10	13.2X51-D15 VC/VCF (14.1X53-D30)	14.1X53-D15
Border Gateway Protocol (BGP) labeled unicast	12.2X50-D10	13.2X51-D15 VC/VCF (14.1X53-D30)	14.1X53-D15
Carrier-over-carrier and inter-provider BGP L3 VPN	14.1X53-D15	14.1X53-D15 VC/VCF (14.1X53-D30)	not supported
Class of Service (CoS or QoS) for MPLS traffic	12.3X50-D10	13.2X51-D15 VC/VCF (14.1X53-D30)	14.1X53-D15
Ethernet-over-MPLS (L2 circuit)	14.1X53-D10	14.1X53-D10 VC/VCF (14.1X53-D30)	15.1X53-D15
Entropy labels	not supported	not supported	not supported
Fast Reroute (FRR),one-to-one local protection and many-to-one local protection	14.1X53-D10	14.1X53-D10 VC/VCF (not supported)	not supported
FRR using detours and secondary LSP	not supported	not supported	not supported
Firewall filters	12.3X50-D10	13.2X51-D15 VC/VCF (14.1X53-D30)	14.1X53-D15
Flow-Aware Transport of Pseudowires (FAT) Flow Labels	not supported	not supported VC/VCF (not supported)	not supported
Graceful restart for Open Shortest Path First (OSPF) and Resource Reservation Protocol (RSVP)	12.2X50-D10	13.2X51-D15 VC/VCF (14.1X53-D30)	13.2X51-D25

Table 3: MPLS Features with Junos OS Release Support *(continued)*

Feature	QFX3500	QFX5100	EX4600
Intermediate System to Intermediate System (IS-IS) routing protocol as an interior gateway protocol (IGP) for MPLS. IS-IS interior gateway protocol traffic engineering (TE)	12.2X50-D10	13.2X51-D15 VC/VCF (14.1X53-D30)	14.1X53-D15
IP-over-MPLS label-switched paths (LSPs) both static and dynamic links	12.2X50-D10	13.2X51-D15 VC/VCF (14.1X53-D30)	14.1X53-D15
IPv6 over an MPLS IPv4 network (6PE) Layer 3 VPN 6PE	12.3X50-D10	13.2X51-D15 VC/VCF (14.1X53-D30)	14.1X53-D15
IPv6 over an MPLS core network	not supported	not supported VC/VCF (not supported)	not supported
Label Distribution Protocol (LDP) signaling over RSVP	12.2X50-D10	13.2X51-D15 VC/VCF (14.1X53-D30)	14.1X53-D15
Layer 3 VPNs IPv4	12.3X50-D10	13.2X51-D15 VC/VCF (14.1X53-D30)	14.1X53-D15
Integrated bridging and routing (IRB) over an MPLS core network	not supported	14.1X53-D40	not supported
MTU signaling in RSVP	12.3X50-D10	13.2X51-D15 VC/VCF (14.1X53-D30)	14.1X53-D15
Object access method (OAM) including MPLS ping, traceroute and BFD	12.3X50-D10	13.2X51-D15 VC/VCF (14.1X53-D30)	14.1X53-D15
Open Shortest Path First traffic engineering (OSPF TE)	14.1X53-D10	14.1X53-D15 VC/VCF (not supported)	14.1X53-D15
OSPFv2 as an interior gateway protocol	12.2X50-D10	13.2X51-D15 VC/VCF (14.1X53-D30)	13.2X51-D25
Pseudowire-over-aggregated Ethernet interfaces (core-facing interface)	14.1X53-D10	14.1X53-D15 VC/VCF (14.1X53-D30)	14.1X53-D15
Resource Reservation Protocol (RSVP), bandwidth and auto-bandwidth	12.2X50-D10	13.2X51-D15 VC/VCF (14.1X53-D30)	14.1X53-D15

Table 3: MPLS Features with Junos OS Release Support *(continued)*

Feature	QFX3500	QFX5100	EX4600
RSVP fast reroute including link-protection, node-link-protection, FRR using detours, and secondary LSP	14.1X53-D15	14.1X53-D15 VC/VCF (not supported)	not supported
RSVP Traffic engineering (used to establish LSPs) with IS-IS and OSPF extensions	12.2X50-D10	13.2X51-D15 VC/VCF (14.1X53-D30)	14.1X53-D15
SNMP MIB support	12.2X50-D10	13.2X51-D15 VC/VCF (14.1X53-D30)	14.1X53-D15
Static and dynamic LSPs	12.2X50-D10	13.2X51-D10 VC/VCF (14.1X53-D30)	14.1X53-D15
Traffic Engineering (TE)	13.1X51-D10	13.1X51-D10	14.1X53-D15
TE auto-bandwidth and RSVP bandwidth	13.1X51-D10	13.1X51-D10	14.1X53-D15
Virtual routing and forwarding (VRF) label support	12.2X50-D10	13.2X51-D15 VC/VCF (14.1X53-D30)	14.1X53-D15

Related Documentation

- MPLS Limitations on QFX Series and EX4600 Switches on page 20
- MPLS Configuration Guidelines on page 15

MPLS Limitations on QFX Series and EX4600 Switches

Multiprotocol Label Switching (MPLS) is fully implemented on routers, while switches support a subset of the MPLS features. The limitations of each switch are listed in a separate section here, even though many of the limitations are duplicates that apply to more than one switch.

- MPLS Limitations on QFX3500 Switches on page 21
- MPLS Limitations on QFX5100 and EX4600 Switches on page 21
- MPLS Limitations on QFX5100 Virtual Chassis and Virtual Chassis Fabric on page 23

MPLS Limitations on QFX3500 Switches

- If you configure the BGP labeled unicast address family (using the **labeled-unicast** statement at the **[edit protocols bgp family inet]** hierarchy level) on a QFX switch or on an EX4600 switch deployed as a route reflector for BGP labeled routes, path selection will occur at the route reflector, and a single best path will be advertised. This will result in loss of BGP multipath information.
- Fast reroute is supported, however the **include-all** and **include-any** options for fast reroute are not supported. For more information, see *Fast Reroute Overview*.
- MPLS-based circuit cross-connects (CCC) is not supported—only circuit-based pseudowires are supported.
- MTU signaling in RSVP and discovery is supported in Control Plane. However, this cannot be enforced in data plane.
- With Layer 2 (L2) circuit-based pseudowires, if multiple equal-cost RSVP label-switched paths (LSPs) are available to reach a Layer 2 Circuit neighbor, one LSP is randomly used for forwarding. Use this feature to specify LSPs for specific L2 circuit traffic to load-share the traffic in the MPLS core.
- Configuring an MPLS firewall filter on a switch that is deployed as an egress provider edge (PE) switch has no effect.
- Configuring the **revert-timer** statement at the **[edit protocols mpls]** hierarchy level has no effect.

MPLS Limitations on QFX5100 and EX4600 Switches

- On a QFX5100 switch, you can observe traffic drop after changing your configuration to enable VLAN tagged for MPLS packets. As a result of packet capture, a QFX5100 switch can swap the wrong VLAN ID for MPLS packets.
- Even though both QFX5100 and EX4600 switches use the same chipset, MPLS support differs. EX4600 switches support only basic MPLS functionality while QFX5100 switches support some of the more advanced features. See "MPLS Feature Support on QFX Series and EX4600 Switches" on page 17 for details.
- On a QFX5100 switch, configuring Integrated Bridging and Routing (IRB) interfaces on the MPLS core is implemented on the switch by using TCAM rules. This is due to a chip limitation on the switch that only allows for a limited amount of TCAM space. 1K TCAM space is allocated for IRB. If multiple IRBs exist, make sure that you have enough available TCAM space on the switch. To check the TCAM space, see TCAM Filter Space Allocation and Verification in QFX Devices.
- If you configure the BGP labeled unicast address family (using the **labeled-unicast** statement at the **[edit protocols bgp family inet]** hierarchy level) on a QFX switch or on an EX4600 switch deployed as a route reflector for BGP labeled routes, path selection will occur at the route reflector, and a single best path will be advertised. This will result in loss of BGP multipath information.

- Fast reroute (FRR) on regular interfaces is supported, however the **include-all** and **include-any** options for FRR are not supported. For more information, see *Fast Reroute Overview*.
- FRR is not supported on MPLS over IRB interfaces.
- MPLS-based circuit cross-connects (CCC) is not supported—only circuit-based pseudowires are supported.
- Configuring link aggregation groups (LAGs) on UNI ports for Layer 2 circuits is not supported.
- MTU signaling in RSVP and discovery is supported in the control plane. However, this cannot be enforced in data plane.
- With L2 circuit-based pseudowires, if multiple equal-cost RSVP LSP's are available to reach a Layer 2 circuit neighbor, one LSP is randomly used for forwarding. Use this feature to specify LSPs for specific L2 circuit traffic to load-share the traffic in the MPLS core.
- Configuring an MPLS firewall filter on a switch that is deployed as an egress provider edge (PE) switch has no effect.
- Configuring the **revert-timer** statement at the **[edit protocols mpls]** hierarchy level has no effect.
- These are hardware limitations for both EX4600 MPLS and QFX5100 MPLS switches:
  - Push of a maximum of 3 labels is supported in MPLS edge switch if label swap is not done.
  - Push of a maximum of 2 labels is supported in MPLS edge switch if label swap is done.
  - Pop at line rate is supported is supported for a maximum of 2 labels.
  - Global label space is supported but interface-specific label space is not supported.
  - MPLS ECMP on PHY node with BOS=1 is not supported for single labels.
  - QFX switches with Broadcom chips do not support separate next hops for the same label with different S bits (S-0 and S-1). This includes QFX3500, QFX3600, QFX5100, and QFX5200 switches.
  - On the QFX5100 switch, the MPLS MTU command can cause unexpected behavior—this is due to SDK chipset limitations on this platform.
- These LDP features are not supported on QFX5100 switches:
  - LDP multipoint
  - LDP link protection
  - LDP bidirectional forwarding detection (BFD)
  - LDP operation administration and management (OAM)
  - LDP multicast-only fast reroute (MoFRR)

MPLS Limitations on QFX5100 Virtual Chassis and Virtual Chassis Fabric

The following MPLS features are not supported by QFX5100 VC and QFX5100 VCF:

- Next-hop LSP Details in section 2.2.6.1
- BFD including BFD triggered FRR
- L2VPN based on BGP (VPWS / draft Kompella)
- VPLS
- Extended-vlan-ccc
- Pseudo-wire protection using Ethernet OAM
- Local switching of pseudo-wire
- Pseudowire fault detection based on VCCV
- QFX switches with Broadcom chips do not support separate next hops for the same label with different S bits (S-0 and S-1). This includes QFX3500, QFX3600, and QFX5100 switches.

Related Documentation

- MPLS Feature Support on QFX Series and EX4600 Switches on page 17

Understanding BGP

BGP is an exterior gateway protocol (EGP) that is used to exchange routing information among routers in different autonomous systems (ASs). BGP routing information includes the complete route to each destination. BGP uses the routing information to maintain a database of network reachability information, which it exchanges with other BGP systems. BGP uses the network reachability information to construct a graph of AS connectivity, which enables BGP to remove routing loops and enforce policy decisions at the AS level.

Multiprotocol BGP (MBGP) extensions enable BGP to support IP version 6 (IPv6). MBGP defines the attributes MP_REACH_NLRI and MP_UNREACH_NLRI, which are used to carry IPv6 reachability information. Network layer reachability information (NLRI) update messages carry IPv6 address prefixes of feasible routes.

BGP allows for policy-based routing. You can use routing policies to choose among multiple paths to a destination and to control the redistribution of routing information.

BGP uses TCP as its transport protocol, using port 179 for establishing connections. Running over a reliable transport protocol eliminates the need for BGP to implement update fragmentation, retransmission, acknowledgment, and sequencing.

The Junos OS routing protocol software supports BGP version 4. This version of BGP adds support for Classless Interdomain Routing (CIDR), which eliminates the concept of network classes. Instead of assuming which bits of an address represent the network by looking at the first octet, CIDR allows you to explicitly specify the number of bits in the network address, thus providing a means to decrease the size of the routing tables. BGP version 4 also supports aggregation of routes, including the aggregation of AS paths.

This section discusses the following topics:

- Autonomous Systems on page 24
- AS Paths and Attributes on page 24
- External and Internal BGP on page 25
- Multiple Instances of BGP on page 25

Autonomous Systems

An *autonomous system* (AS) is a set of routers that are under a single technical administration and normally use a single interior gateway protocol and a common set of metrics to propagate routing information within the set of routers. To other ASs, an AS appears to have a single, coherent interior routing plan and presents a consistent picture of what destinations are reachable through it.

AS Paths and Attributes

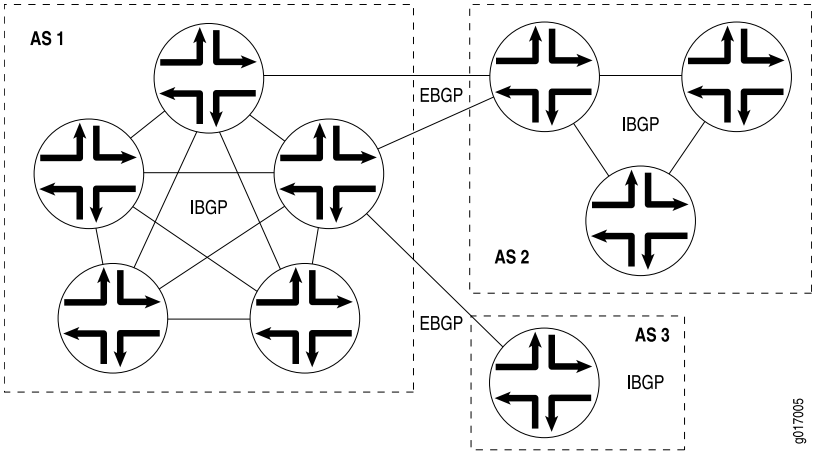
The routing information that BGP systems exchange includes the complete route to each destination, as well as additional information about the route. The route to each destination is called the *AS path*, and the additional route information is included in *path attributes*. BGP uses the AS path and the path attributes to completely determine the network topology. Once BGP understands the topology, it can detect and eliminate

routing loops and select among groups of routes to enforce administrative preferences and routing policy decisions.

External and Internal BGP

BGP supports two types of exchanges of routing information: exchanges among different ASs and exchanges within a single AS. When used among ASs, BGP is called *external BGP* (EBGP) and BGP sessions perform *inter-AS routing*. When used within an AS, BGP is called *internal BGP* (IBGP) and BGP sessions perform *intra-AS routing*. Figure 3 on page 25 illustrates ASs, IBGP, and EBGP.

Figure 3: ASs, EBGP, and IBGP



A BGP system shares network reachability information with adjacent BGP systems, which are referred to as *neighbors* or *peers*.

BGP systems are arranged into *groups*. In an IBGP group, all peers in the group—called *internal peers*—are in the same AS. Internal peers can be anywhere in the local AS and do not have to be directly connected to one another. Internal groups use routes from an IGP to resolve forwarding addresses. They also propagate external routes among all other internal routers running IBGP, computing the next hop by taking the BGP next hop received with the route and resolving it using information from one of the interior gateway protocols.

In an EBGP group, the peers in the group—called *external peers*—are in different ASs and normally share a subnet. In an external group, the next hop is computed with respect to the interface that is shared between the external peer and the local router.

Multiple Instances of BGP

You can configure multiple instances of BGP at the following hierarchy levels:

- **[edit routing-instances *routing-instance-name* protocols]**
- **[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols]**

Multiple instances of BGP are primarily used for Layer 3 VPN support.

IGP peers and external BGP (EBGP) peers (both nonmultihop and multihop) are all supported for routing instances. BGP peering is established over one of the interfaces configured under the **routing-instances** hierarchy.

NOTE: When a BGP neighbor sends BGP messages to the local routing device, the incoming interface on which these messages are received must be configured in the same routing instance that the BGP neighbor configuration exists in. This is true for neighbors that are a single hop away or multiple hops away.

Routes learned from the BGP peer are added to the **instance-name.inet.0** table by default. You can configure import and export policies to control the flow of information into and out of the instance routing table.

For Layer 3 VPN support, configure BGP on the provider edge (PE) router to receive routes from the customer edge (CE) router and to send the instances' routes to the CE router if necessary. You can use multiple instances of BGP to maintain separate per-site forwarding tables for keeping VPN traffic separate on the PE router.

You can configure import and export policies that allow the service provider to control and rate-limit traffic to and from the customer.

You can configure an EBGP multihop session for a VRF routing instance. Also, you can set up the EBGP peer between the PE and CE routers by using the loopback address of the CE router instead of the interface addresses.

Related Documentation

- *BGP Routes Overview*
- *BGP Messages Overview*

Understanding CoS MPLS EXP Classifiers and Rewrite Rules

You can use class of service (CoS) within MPLS networks to prioritize certain types of traffic during periods of congestion by applying packet classifiers and rewrite rules to the MPLS traffic. (For information about DSCP and IEEE 802.1p classifiers and general information about classifiers, see *Understanding CoS Classifiers*. For information about DSCP and IEEE 802.1p rewrite rules, see *Understanding CoS Rewrite Rules*.)

When a packet enters a customer-edge interface on the ingress provider edge (PE) switch, the switch associates the packet with a particular CoS servicing level before placing the packet onto the label-switched path (LSP). The switches within the LSP utilize the CoS value set at the ingress PE switch. The CoS value that was embedded in the classifier is translated and encoded in the MPLS header by means of the experimental (EXP) bits.

EXP classifiers map incoming MPLS packets to a forwarding class and a loss priority, and assign MPLS packets to output queues based on the forwarding class mapping. EXP classifiers are behavior aggregate (BA) classifiers.

EXP rewrite rules change (rewrite) the CoS value of the EXP bits in outgoing packets on the egress queues of the switch so that the new (rewritten) value matches the policies of a targeted peer. Policy matching allows the downstream routing platform or switch in a neighboring network to classify each packet into the appropriate service group.

NOTE: **There is no default EXP classifier. There is no default EXP rewrite rule. If you want to classify incoming MPLS packets using the EXP bits, you must configure a global EXP classifier. If you want to rewrite the EXP bit value at the egress interface, you must configure EXP rewrite rules and apply them to logical interfaces.**

EXP classifiers and rewrite rules are applied only to interfaces that are configured as family mpls (for example, set interfaces xe-0/0/35 unit 0 family mpls.)

This topic includes:

- EXP Classifiers on page 27
- EXP Rewrite Rules on page 28
- Schedulers on page 29

EXP Classifiers

Unlike DSCP and IEEE 802.1p BA classifiers, EXP classifiers are global to the switch and apply to all switch interfaces that are configured as **family mpls**. When you configure and apply an EXP classifier, MPLS traffic on all **family mpls** interfaces uses the EXP classifier, even on interfaces that also have a fixed classifier. If an interface has both an EXP classifier and a fixed classifier, the EXP classifier is applied to MPLS traffic and the fixed classifier is applied to all other traffic.

Also unlike DSCP and IEEE 802.1p BA classifiers, there is no default EXP classifier. If you want to classify MPLS traffic based on the EXP bits, you must explicitly configure an EXP classifier and apply it the switch interfaces. Each EXP classifier has eight entries that correspond to the eight EXP CoS values (0 through 7, which correspond to bits 000 through 111).

You can configure as many EXP classifiers as you want. However, the switch uses only one MPLS EXP classifier as a global classifier on all interfaces. After you configure an MPLS EXP classifier, you can configure it as the global EXP classifier by including the EXP classifier in the **[edit class-of-service system-defaults classifiers exp]** hierarchy. All switch interfaces use the global EXP classifier to classify MPLS traffic.

Only one EXP classifier can be configured as the global EXP classifier at any time. If you want to change the global EXP classifier, delete the global EXP classifier configuration (use the **user@switch# delete class-of-service system-defaults classifiers exp** configuration statement), then configure the new global EXP classifier.

If an EXP classifier is not configured, then if a fixed classifier is applied to the interface, the MPLS traffic uses the fixed classifier. If no EXP classifier and no fixed classifier is applied to the interface, MPLS traffic is treated as best-effort traffic. DSCP classifiers are not applied to MPLS traffic.

Because the EXP classifier is global, you cannot configure some ports to use a fixed IEEE 802.1p classifier for MPLS traffic on some interfaces and the global EXP classifier for MPLS traffic on other interfaces. When you configure a global EXP classifier, all MPLS traffic on all interfaces uses the EXP classifier.

NOTE: The switch uses only the outermost label of incoming EXP packets for classification.

NOTE: MPLS packets with 802.1Q tags are not supported.

EXP Rewrite Rules

As MPLS packets enter or exit a network, edge switches might be required to alter the class-of-service (CoS) settings of the packets. EXP rewrite rules set the value of the EXP CoS bits within the header of the outgoing MPLS packet on **family mpls** interfaces. Each rewrite rule reads the current forwarding class and loss priority associated with the packet, locates the chosen CoS value from a table, and writes that CoS value into the packet header, replacing the old CoS value. EXP rewrite rules apply only to MPLS traffic.

EXP rewrite rules apply only to logical interfaces. You cannot apply EXP rewrite rules to physical interfaces.

There are no default EXP rewrite rules. If you want to rewrite the EXP value in MPLS packets, you must configure EXP rewrite rules and apply them to logical interfaces. If no rewrite rules are applied, all MPLS labels that are pushed have a value of zero (0). The EXP value remains unchanged on MPLS labels that are swapped.

You can configure as many EXP rewrite rules as you want, but you can only apply 16 EXP rewrite rules at any time on the switch. On a given logical interface, all pushed MPLS labels have the same EXP rewrite rule applied to them. You can apply different EXP rewrite rules to different logical interfaces on the same physical interface.

You can apply an EXP rewrite rule to an interface that has a DSCP, DSCP IPv6, or IEEE 802.1p rewrite rule. Only MPLS traffic uses the EXP rewrite rule. MPLS traffic does not use DSCP or DSCP IPv6 rewrite rules.

If the switch is performing penultimate hop popping (PHP), EXP rewrite rules do not take effect. If both an EXP classifier and an EXP rewrite rule are configured on the switch, then the EXP value from the last popped label is copied into the inner label. If either an EXP classifier or an EXP rewrite rule (but not both) is configured on the switch, then the inner label EXP value is sent unchanged.

NOTE: On each physical interface, either all forwarding classes that are being used on the interface must have rewrite rules configured or no forwarding classes that are being used on the interface can have rewrite rules configured. On any physical port, do not mix forwarding classes with rewrite rules and forwarding classes without rewrite rules.

Schedulers

The schedulers for using CoS with MPLS are the same as for the other CoS configurations on the switch. Default schedulers are provided only for the best-effort, fcoe, no-loss, and network-control forwarding classes. If you configure a custom forwarding class for MPLS traffic, you need to configure a scheduler to support that forwarding class and provide bandwidth to that forwarding class. See *Understanding CoS Output Queue Schedulers* and *Example: Configuring Queue Schedulers* for more information.

Related Documentation

- *Understanding CoS Classifiers*
- *Understanding Applying CoS Classifiers and Rewrite Rules to Interfaces*
- *Configuring a Global MPLS EXP Classifier*
- *Configuring Rewrite Rules for MPLS EXP Classifiers*
- *Configuring CoS Bits for an MPLS Network*

Understanding Ethernet-over-MPLS (L2 Circuit)

Ethernet-over-MPLS allows sending Layer 2 (L2) Ethernet frames transparently over MPLS Ethernet-over-MPLS uses a tunneling mechanism for Ethernet traffic through an MPLS-enabled Layer 3 core. It encapsulates Ethernet protocol data units (PDUs) inside MPLS packets and forwards the packets, using label stacking, across the MPLS network This technology has applications in service provider, enterprise and data center environments. For disaster recovery purposes, data centers are hosted in multiple sites that are geographically distant and interconnected using a WAN network.

NOTE: A Layer 2 circuit is similar to a circuit cross-connect (CCC), except that multiple Layer 2 circuits can be transported over a single label-switched path (LSP) tunnel between two provider edge (PE) routers. In contrast, each CCC requires a dedicated LSP

- Ethernet-over-MPLS in Data Centers on page 30

Ethernet-over-MPLS in Data Centers

For disaster recovery purposes, data centers are hosted in multiple sites that are geographically distant and interconnected using a WAN network. These data centers require L2 connectivity between them for the following reasons:

- To replicate the storage over Fiber Channel IP (FCIP). FCIP works only on the same broadcast domain.
- To run a dynamic routing protocol between the sites.
- To support High Availability clusters that interconnect the nodes hosted in the various data centers.

Related Documentation

- *Configuring Ethernet over MPLS (L2 Circuit)*

MPLS for Carrier-over-Carrier and Inter-Provider VPNs

You can configure Multiprotocol Label Switching (MPLS) on both QFX Series devices and on EX4600 switches (14.1x53-D15) to increase transport efficiency in the network. MPLS services can be used to connect various sites to a backbone network and to ensure better performance for low-latency applications such as voice over IP (VoIP) and other business-critical functions. This topic describes some additional benefits and implementations for MPLS Layer 3 VPN networks.

Customer networks are private and can use either public addresses or private addresses. When customer networks that use private addresses connect to the public Internet infrastructure, the private addresses might overlap with private addresses being used by other network users. MPLS BGP VPNS solve this problem by adding a route distinguisher prefix to the route, a VPN-IPvr address.

The VPN-IPv4 addresses are used only for routes exchanged between provider edge (PE) switches via BGP. When an egress PE switch receives a VPN-IPv4 route, it convert it back to an IPv4 route by removing the route distinguisher before sending the packet to its connected CE router. Route distinguishers are used only between the PE switches, so that common IPv4 addresses from different VPNs are differentiated. PE switches are the only devices in the provider network that are required to maintain external routes. The provider switches maintain only the service provider's internal routes; provider switches do not maintain VPN routes.

The customer of a VPN service provider might be another service provider rather than an end customer. The customer service provider depends on the VPN service provider to deliver VPN transport services between the customer service provider's regional networks or points of presence (POPs).

- Customer service provider sites with different autonomous system (AS) numbers— VPN transit provider supports *carrier-of-carrier* VPN services for the *inter-provider* VPN service.
- Customer service provider sites with same AS numbers— VPN transit service provider supports *carrier-of-carrier* VPN services.

Related Documentation

- MPLS Feature Support on QFX Series and EX4600 Switches on page 17
- Understanding MPLS Components on page 8
- Understanding MPLS Label Operations on page 11
- Understanding CoS MPLS EXP Classifiers and Rewrite Rules on page 27
- *Junos OS MPLS Applications Library for Routing Devices*

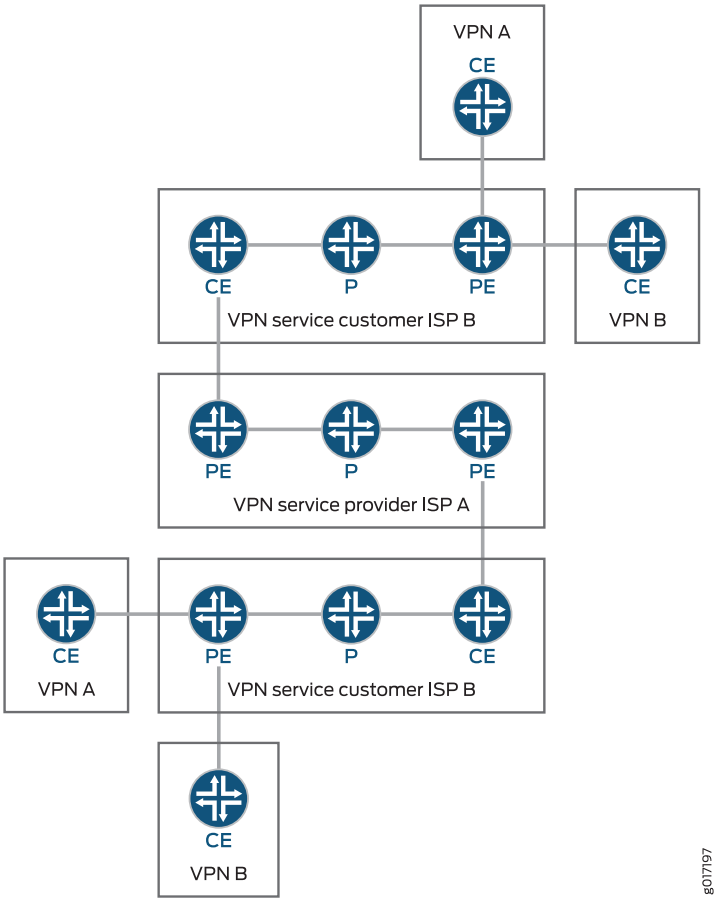
Carrier-of-Carriers VPNs

The customer of a VPN service provider might be a service provider for the end customer. The following are the two main types of carrier-of-carriers VPNs (as described in RFC 4364:

- "Internet Service Provider as the Customer" on page 33—The VPN customer is an ISP that uses the VPN service provider's network to connect its geographically disparate regional networks. The customer does not have to configure MPLS within its regional networks.
- "VPN Service Provider as the Customer" on page 33—The VPN customer is itself a VPN service provider offering VPN service to its customers. The carrier-of-carriers VPN service customer relies on the backbone VPN service provider for inter-site connectivity. The customer VPN service provider is required to run MPLS within its regional networks.

Figure 4 on page 32 illustrates the network architecture used for a carrier-of-carriers VPN service.

Figure 4: Carrier-of-Carriers VPN Architecture



This topic covers the following:

- Internet Service Provider as the Customer on page 33
- VPN Service Provider as the Customer on page 33

Internet Service Provider as the Customer

In this type of carrier-of-carriers VPN configuration, ISP A configures its network to provide Internet service to ISP B. ISP B provides the connection to the customer wanting Internet service, but the actual Internet service is provided by ISP A.

This type of carrier-of-carriers VPN configuration has the following characteristics:

- The carrier-of-carriers VPN service customer (ISP B) does not need to configure MPLS on its network.
- The carrier-of-carriers VPN service provider (ISP A) must configure MPLS on its network.
- MPLS must also be configured on the CE routers and PE routers connected together in the carrier-of-carriers VPN service customer's and carrier-of-carriers VPN service provider's networks.

VPN Service Provider as the Customer

A VPN service provider can have customers that are themselves VPN service providers. In this type of configuration, also called a hierarchical or recursive VPN, the customer VPN service provider's VPN-IPv4 routes are considered external routes, and the backbone VPN service provider does not import them into its VRF table. The backbone VPN service provider imports only the customer VPN service provider's internal routes into its VRF table.

The similarities and differences between interprovider and carrier-of-carriers VPNs are shown in Table 4 on page 33.

Table 4: Comparison of Interprovider and Carrier-of-Carriers VPNs

Feature	ISP Customer	VPN Service Provider Customer
Customer edge device	AS border router	PE router
IBGP sessions	Carry IPv4 routes	Carry external VPN-IPv4 routes with associated labels
Forwarding within the customer network	MPLS is optional	MPLS is required

Related Documentation

- MPLS Feature Support on QFX Series and EX4600 Switches on page 17
- Interprovider and Carrier-of-Carriers VPNs on page 34
- *Interprovider VPNs*

Interprovider and Carrier-of-Carriers VPNs

All interprovider and carrier-of-carriers VPNs share the following characteristics:

- Each interprovider or carrier-of-carriers VPN customer must distinguish between internal and external customer routes.
- Internal customer routes must be maintained by the VPN service provider in its PE routers.
- External customer routes are carried only by the customer's routing platforms, not by the VPN service provider's routing platforms.

The key difference between interprovider and carrier-of-carriers VPNs is whether the customer sites belong to the same AS or to separate ASs:

- *Interprovider VPNs*—The customer sites belong to different ASs. You need to configure EBGP to exchange the customer's external routes.
- "Carrier-of-Carriers VPNs" on page 32—The customer sites belong to the same AS. You need to configure IBGP to exchange the customer's external routes.

In general, each service provider in a VPN hierarchy is required to maintain its own internal routes in its P routers, and the internal routes of its customers in its PE routers. By recursively applying this rule, it is possible to create a hierarchy of VPNs.

The following are definitions of the types of PE routers specific to interprovider and carrier-of-carriers VPNs:

- The AS border router is located at the AS border and handles traffic leaving and entering the AS.
- The end PE router is the PE router in the customer VPN; it is connected to the CE router at the end customer's site.

Related Documentation

- Carrier-of-Carriers VPNs on page 32
- *Interprovider VPNs*
- MPLS Feature Support on QFX Series and EX4600 Switches on page 17

Graceful Restart and MPLS-Related Protocols

This section contains the following topics:

- LDP on page 35
- RSVP on page 35
- CCC and TCC on page 35

LDP

LDP graceful restart enables a router whose LDP control plane is undergoing a restart to continue to forward traffic while recovering its state from neighboring routers. It also enables a router on which helper mode is enabled to assist a neighboring router that is attempting to restart LDP.

During session initialization, a router advertises its ability to perform LDP graceful restart or to take advantage of a neighbor performing LDP graceful restart by sending the graceful restart TLV. This TLV contains two fields relevant to LDP graceful restart: the reconnect time and the recovery time. The values of the reconnect and recovery times indicate the graceful restart capabilities supported by the router.

The reconnect time is configured in Junos OS as 60 seconds and is not user-configurable. The reconnect time is how long the helper router waits for the restarting router to establish a connection. If the connection is not established within the reconnect interval, graceful restart for the LDP session is terminated. The maximum reconnect time is 120 seconds and is not user-configurable. The maximum reconnect time is the maximum value that a helper router accepts from its restarting neighbor.

When a router discovers that a neighboring router is restarting, it waits until the end of the recovery time before attempting to reconnect. The recovery time is the length of time a router waits for LDP to restart gracefully. The recovery time period begins when an initialization message is sent or received. This time period is also typically the length of time that a neighboring router maintains its information about the restarting router, so it can continue to forward traffic.

You can configure LDP graceful restart both in the master instance for the LDP protocol and for a specific routing instance. You can disable graceful restart at the global level for all protocols, at the protocol level for LDP only, and for a specific routing instance only.

RSVP

RSVP graceful restart enables a router undergoing a restart to inform its adjacent neighbors of its condition. The restarting router requests a grace period from the neighbor or peer, which can then cooperate with the restarting router. The restarting router can still forward MPLS traffic during the restart period; convergence in the network is not disrupted. The restart is not visible to the rest of the network, and the restarting router is not removed from the network topology. RSVP graceful restart can be enabled on both transit routers and ingress routers. It is available for both point-to-point LSPs and point-to-multipoint LSPs.

CCC and TCC

CCC and TCC graceful restart enables Layer 2 connections between customer edge (CE) routers to restart gracefully. These Layer 2 connections are configured with the **remote-interface-switch** or **lsp-switch** statements. Because these CCC and TCC connections have an implicit dependency on RSVP LSPs, graceful restart for CCC and TCC uses the RSVP graceful restart capabilities.

RSVP graceful restart must be enabled on the provider edge (PE) routers and provider (P) routers to enable graceful restart for CCC and TCC. Also, because RSVP is used as the signaling protocol for signaling label information, the neighboring router must use helper mode to assist with the RSVP restart procedures.

Related Documentation

- *Graceful Restart Concepts*
- *Graceful Restart System Requirements*
- *Configuring Graceful Restart for MPLS-Related Protocols*
- *Configuring Graceful Restart*

Types of LSPs

There are three types of LSPs:

- Static LSPs—For static paths, you must manually assign labels on all routers involved (ingress, transit, and egress). No signaling protocol is needed. This procedure is similar to configuring static routes on individual routers. Like static routes, there is no error reporting, liveliness detection, or statistics reporting.
- LDP-signaled LSPs—See *LDP Introduction*.
- RSVP-signaled LSPs—For signaled paths, RSVP is used to set up the path and dynamically assign labels. (RSVP signaling messages are used to set up signaled paths.) You configure only the ingress router. The transit and egress routers accept signaling information from the ingress router, and they set up and maintain the LSP cooperatively. Any errors encountered while establishing an LSP are reported to the ingress router for diagnostics. For signaled LSPs to work, a version of RSVP that supports tunnel extensions must be enabled on all routers.

There are two types of RSVP-signaled LSPs:

- Explicit-path LSPs—All intermediate hops of the LSP are manually configured. The intermediate hops can be strict, loose, or any combination of the two. Explicit path LSPs provide you with complete control over how the path is set up. They are similar to static LSPs but require much less configuration.
- Constrained-path LSPs—The intermediate hops of the LSP are automatically computed by the software. The computation takes into account information provided by the topology information from the IS-IS or OSPF link-state routing protocol, the current network resource utilization determined by RSVP, and the resource requirements and constraints of the LSP. For signaled constrained-path LSPs to work, either the IS-IS or OSPF protocol and the IS-IS or OSPF traffic engineering extensions must be enabled on all routers.

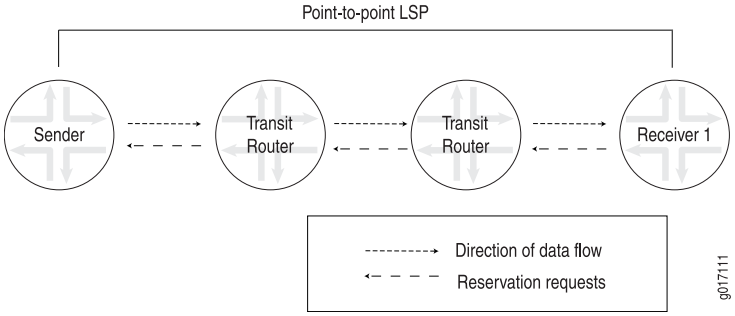
RSVP Overview

The RSVP protocol is used by routers to deliver quality-of-service (QoS) requests to all nodes along data flow path(s) and to establish and maintain state for the requested

service. RSVP requests generally result in resource reservations in each node along the data path. RSVP has the following attributes:

- Makes resource reservations for unidirectional data flows.
- Allows the receiver of a data flow to initiate and maintain the resource reservation used for that flow, as shown in Figure 5 on page 37.
- Maintains a soft state in routers and hosts, providing graceful support for dynamic membership changes and automatic adaptation to routing changes.
- Depends upon present and future routing protocols, but is not a routing protocol itself.
- Provides several reservation models or styles to fit a variety of applications.
- Supports both IPv4 and IPv6. Note, you can configure the Junos OS to tunnel IPv6 over an MPLS-based IPv4 network. For more information, see the *Junos OS MPLS Applications Library for Routing Devices*.

Figure 5: RSVP Reservation Request and Data Flow



MTU Signaling in RSVP

The maximum transmission unit (MTU) is the largest size packet or frame, in bytes, that can be sent in a network. An MTU that is too large might cause retransmissions. Too small an MTU might cause the router to send and handle relatively more header overhead and acknowledgments. There are default values for MTUs associated with various protocols. You can also explicitly configure an MTU on an interface.

When an LSP is created across a set of links with different MTU sizes, the ingress router does not know what the smallest MTU is on the LSP path. By default, the MTU for an LSP is 1,500 bytes.

If this MTU is larger than the MTU of one of the intermediate links, traffic might be dropped, because MPLS packets cannot be fragmented. Also, the ingress router is not aware of this type of traffic loss, because the control plane for the LSP would still function normally.

To prevent this type of packet loss in MPLS LSPs, you can configure MTU signaling in RSVP. This feature is described in RFC 3209. Juniper Networks supports the Integrated Services object for MTU signaling in RSVP. The Integrated Services object is described in RFCs 2210 and 2215. MTU signaling in RSVP is disabled by default.

To avoid packet loss due to MTU mismatches, the ingress router needs to do the following:

- Signal the MTU on the RSVP LSP—To prevent packet loss from an MTU mismatch, the ingress router needs to know what the smallest MTU value is along the path taken by the LSP. Once this MTU value is obtained, the ingress router can assign it to the LSP.
- Fragment packets—Using the assigned MTU value, packets that exceed the size of the MTU can be fragmented into smaller packets on the ingress router before they are encapsulated in MPLS and sent over the RSVP-signaled LSP.

Once both MTU signaling and packet fragmentation have been enabled on an ingress router, any route resolving to an RSVP LSP on this router uses the signaled MTU value. For information about how to configure this feature, see *Configuring MTU Signaling in RSVP*.

The following sections describe how MTU signaling in RSVP works:

- *How the Correct MTU Is Signaled in RSVP*
- *Determining an Outgoing MTU Value*
- *MTU Signaling in RSVP Limitations*

Ethernet Pseudowire Overview

An Ethernet pseudowire is used to carry Ethernet or 802.3 Protocol Data Units (PDUs) over an MPLS network enabling service providers to offer emulated Ethernet services over existing MPLS networks. Ethernet or 802.3 PDUs are encapsulated within the pseudowire to provide a point-to-point Ethernet service. For the point-to-point Ethernet service, the following fault management features are supported:

- The IEEE 802.3ah standard for Operation, Administration, and Management (OAM). You can configure IEEE 802.3ah OAM link-fault management on Ethernet point-to-point direct links or links across Ethernet repeaters.

  Ethernet OAM link-fault management can be used for physical link-level fault detection and management. It uses a new, optional sublayer in the data link layer of the OSI model. Ethernet OAM can be implemented on any full-duplex point-to-point or emulated point-to-point Ethernet link. A system-wide implementation is not required; OAM can be deployed on particular interfaces of a router. Transmitted Ethernet OAM messages or OAM PDUs are of standard length, untagged Ethernet frames within the normal frame length limits in the range 64–1518 bytes.
- Ethernet connectivity fault management (CFM) to monitor the physical link between two routers.
  - Connection protection using the continuity check protocol for fault monitoring . The continuity check protocol is a neighbor discovery and health check protocol that discovers and maintains adjacencies at the VLAN or link level.
  - Path protection using the linktrace protocol for path discovery and fault verification . Similar to IP traceroute, the linktrace protocol maps the path taken to a destination MAC address through one or more bridged networks between the source and destination.

Related Documentation

- *Configuring 802.3ah OAM Link-Fault Management*
- *Pseudowire Overview for ACX Series Universal Access Routers*
- *TDM Pseudowires Overview*
- *ATM Pseudowire Overview*

Configuring MPLS on Provider Edge Switches

To implement MPLS, you must configure two provider edge (PE) switches—an ingress PE switch and an egress PE switch—and at least one provider switch. You can configure the customer edge (CE) interfaces on the PE switches of the MPLS network using IP over MPLS.

This topic describes how to configure an ingress PE switch and an egress PE switch using IP over MPLS:

1. Configuring the Ingress PE Switch on page 39
2. Configuring the Egress PE Switch on page 40

Configuring the Ingress PE Switch

To configure the ingress PE switch:

1. Configure an IP address for the loopback interface and the core interfaces:

```
[edit interfaces]
user@switch# set lo0 unit 0 family inet address 192.168.10.1/32
user@switch# set xe-0/0/5 unit 0 family inet address 10.1.5.1/24
user@switch# set xe-0/0/6 unit 0 family inet address 10.1.6.1/24
```

NOTE: You cannot use routed VLAN interfaces (RVIs) or Layer 3 subinterfaces as core interfaces.

2. Configure OSPF on the loopback interface and the core interfaces:

NOTE: You can use the switch address as an alternative to the loopback interface.

```
[edit protocols ospf]
user@switch# set area 0.0.0.0 interface lo0.0
user@switch# set area 0.0.0.0 interface xe-0/0/5.0
user@switch# set area 0.0.0.0 interface xe-0/0/6.0
```

3. Configure OSPF traffic engineering:

```
[edit protocols ospf]
user@switch# set traffic-engineering
```

4. Configure RSVP on the loopback interface and the core interfaces:

```
[edit protocols rsvp]
user@switch# set interface lo0.0
```

```
user@switch# set interface xe-0/0/5.0
user@switch# set interface xe-0/0/6.0
```

5. Configure MPLS traffic engineering.

```
[edit protocols mpls]
user@switch# set traffic-engineering
```

6. Configure MPLS on the core interfaces:

```
[edit protocols mpls]
user@switch# set interface xe-0/0/5.0
user@switch# set interface xe-0/0/6.0
```

7. Configure **family mpls** on the logical units of the core interfaces, thereby identifying the interfaces that will be used for forwarding MPLS packets:

```
[edit interfaces]
user@switch# set xe-0/0/5 unit 0 family mpls
user@switch# set xe-0/0/6 unit 0 family mpls
```

8. Configure a customer edge interface as a Layer 3 routed interface, specifying an IP address:

```
[edit interfaces]
user@switch# set xe-0/0/3 unit 0 family inet address 121.100.10.1/16
```

9. Configure this Layer 3 customer edge interface for the routing protocol:

```
[edit]
user@switch# set protocols ospf area 0.0.0 interface xe-0/0/3.0
```

10. Configure an LSP on the ingress PE switch (192.168.10.1) to send IP packets over MPLS to the egress PE switch (192.168.12.1):

```
[edit protocols mpls]
user@switch# set label-switched-path lsp_1 to 192.168.12.1
```

11. Disable constrained-path LSP computation for this LSP:

```
[edit protocols mpls]
user@switch# set label-switched-path lsp_1 no-cspf
```

12. Configure a static route from the ingress PE switch to the egress PE switch, thereby indicating to the routing protocol that the packets will be forwarded over the MPLS LSP that has been set up to that destination:

```
[edit routing-options]
user@switch# set static route 2.2.2.0/24 next-hop 192.168.10.1
user@switch# set static route 2.2.2.0/24 resolve
```

Configuring the Egress PE Switch

To configure the egress PE switch:

1. Configure an IP address for the loopback interface and the core interfaces:

```
[edit interfaces]
user@switch# set lo0 unit 0 family inet address 192.168.12.1/32
user@switch# set xe-0/0/5 unit 0 family inet address 10.1.20.1/24
user@switch# set xe-0/0/6 unit 0 family inet address 10.1.21.1/24
```

NOTE: You cannot use routed VLAN interfaces (RVIs) or Layer 3 subinterfaces as core interfaces.

2. Configure OSPF on the loopback interface and the core interfaces:

NOTE: You can use the switch address as an alternative to the loopback interface.

```
[edit protocols ospf]
user@switch# set area 0.0.0.0 interface lo0.0
user@switch# set area 0.0.0.0 interface xe-0/0/5.0
user@switch# set area 0.0.0.0 interface xe-0/0/6.0
```

3. Configure RSVP on the loopback interface and the core interfaces:

```
[edit protocols rsvp]
user@switch# set rsvp interface lo0.0
user@switch# set rsvp interface xe-0/0/5.0
user@switch# set rsvp interface xe-0/0/6.0
```

4. Configure MPLS on the core interfaces:

```
[edit protocols mpls]
user@switch# set interface xe-0/0/5.0
user@switch# set interface xe-0/0/6.0
```

5. Configure **family mpls** on the logical units of the core interfaces, thereby identifying the interfaces that will be used for forwarding MPLS packets:

```
[edit interfaces]
user@switch# set xe-0/0/5 unit 0 family mpls
user@switch# set xe-0/0/6 unit 0 family mpls
```

6. Configure a customer edge interface as a Layer 3 routed interface, specifying an IP address:

```
[edit interfaces]
user@switch# set xe-0/0/3 unit 0 family inet address 2.2.2.1/16
```

7. Configure this Layer 3 customer edge interface for the routing protocol:

```
[edit]
user@switch# set protocols ospf area 0.0.0.0 interface xe-0/0/3
```

8. Configure an LSP on the egress PE switch (192.168.12.1) to send IP packets over MPLS to the ingress PE switch (192.168.10.1):

```
[edit protocols mpls]
user@switch# set label-switched-path lsp_2 to 192.168.10.1
```

9. Disable constrained-path LSP computation for this LSP:

```
[edit protocols mpls]
user@switch# set label-switched-path lsp_2 no-cspf
```

10. Configure a static route from the ingress PE switch to the egress PE switch, thereby indicating to the routing protocol that the packets will be forwarded over the MPLS LSP that has been set up to that destination:

```
[edit routing-options]
user@switch#  set static route 121.121.121.0/24 next-hop 192.168.12.1
user@switch# set static route 121.121.121.0/24 resolve
```

Related Documentation

- MPLS Configuration Guidelines on page 15
- Configuring MPLS on Provider Switches on page 42
- MPLS Feature Support on QFX Series and EX4600 Switches on page 17
- Understanding MPLS Components on page 8

- Understanding CoS MPLS EXP Classifiers and Rewrite Rules on page 27

Configuring MPLS on Provider Switches

To implement MPLS, you must configure at least one provider switch as a transit switch for the MPLS packets.

MPLS requires the configuration of an interior gateway protocol (OSPF) and a signaling protocol (RSVP) on the core interfaces and the loopback interface of all the switches. This procedure includes the configuration of OSPF on the provider switch.

To configure the provider switch, complete the following tasks:

1. Configure OSPF on the loopback and core interfaces:

   NOTE: You can use the switch address as an alternative to the loopback interface.

   ```
   [edit protocols ospf]
   user@switch# set area 0.0.0.0 interface lo0.0
   user@switch# set area 0.0.0.0 interface xe-0/0/5.0
   user@switch# set area 0.0.0.0 interface xe-0/0/6.0
   user@switch# set area 0.0.0.0 interface ae0
   ```

   NOTE: You cannot use routed VLAN interfaces (RVIs) or Layer 3 subinterfaces as core interfaces.

2. Configure MPLS on the core interfaces:

   ```
   [edit protocols mpls]
   user@switch# set interface xe-0/0/5.0
   user@switch# set interface xe-0/0/6.0
   user@switch# set interface ae0
   ```

3. Configure RSVP on the loopback interface and the core interfaces:

   ```
   [edit protocols rsvp]
   user@switch# set interface lo0.0
   user@switch# set interface xe-0/0/5.0
   user@switch# set interface xe-0/0/6.0
   user@switch# set interface ae0
   ```

4. Configure an IP address for the loopback interface and the core interfaces:

   ```
   [edit interfaces]
   user@switch# set lo0 unit 0 family inet address 127.1.1.1/32
   user@switch# set xe-0/0/5 unit 0 family inet address 10.1.5.1/24
   user@switch# set xe-0/0/6 unit 0 family inet address 10.1.6.1/24
   user@switch# set ae0 unit 0 family inet address 10.1.9.2/24
   ```

5. Configure **family mpls** on the logical units of the core interfaces, thereby identifying the interfaces that will be used for forwarding MPLS packets:

   ```
   [edit interfaces]
   user@switch# set xe-0/0/5 unit 0 family mpls
   user@switch# set xe-0/0/6 unit 0 family mpls
   ```

```
user@switch# set ae0 unit 0 family mpls
```

NOTE: You can configure family mpls on either individual interfaces or aggregated Ethernet interfaces. You cannot configure it on tagged VLAN interfaces.

Related Documentation

- Configuring MPLS on Provider Edge Switches on page 39
- MPLS Configuration Guidelines on page 15
- MPLS Feature Support on QFX Series and EX4600 Switches on page 17
- Understanding MPLS Components on page 8
- Understanding CoS MPLS EXP Classifiers and Rewrite Rules on page 27

Configuring Static Label Switched Paths for MPLS

Configuring static label-switched paths (LSPs) for MPLS is similar to configuring static routes on individual switches. As with static routes, there is no error reporting, liveliness detection, or statistics reporting.

To configure static LSPs, configure the ingress PE switch and each provider switch along the path up to and including the egress PE switch.

For the ingress PE switch, configure which packets to tag (based on the packet's destination IP address), configure the next switch in the LSP, and the tag to apply to the packet. Manually assigned labels can have values from 0 through 1,048,575.

For the transit switches in the path, configure the next switch in the path and the tag to apply to the packet. Manually assigned labels can have values from 1,000,000 through 1,048,575.

The egress PE switch removes the label and forwards the packet to the IP destination. However, if the previous switch removed the label, the egress switch examines the packet's IP header and forwards the packet toward its IP destination.

Before you configure a static LSP, you must configure the basic components for an MPLS network:

- Configure two PE switches. See "Configuring MPLS on Provider Edge Switches" on page 39.

NOTE: Do not configure LSPs at the [edit protocols mpls label-switched-path] hierarchy level on the PE switches.

- Configure one or more provider switches. See "Configuring MPLS on Provider Switches" on page 42.

This topic describes how to configure an ingress PE switch, one or more provider switches, and an egress PE switch for static LSP:

1. Configuring the Ingress PE Switch on page 44
2. Configuring the Provider and the Egress PE Switch on page 44

Configuring the Ingress PE Switch

To configure the ingress PE switch:

1. Configure an IP address for every core interface:

   ```
   [edit interfaces]
   user@switch# set interface-name unit logical-unit-number family inet address address
   ```

   NOTE: You cannot use routed VLAN interfaces (RVIs) or Layer 3 subinterfaces as core interfaces.

2. Configure the name associated with the static LSP:

   ```
   [edit protocols mpls]
   user@switch# set static-label-switched-path lsp-name
   ```

3. Configure the next hop switch for the LSP:

   ```
   [edit protocols mpls]
   user@switch# set static-label-switched-path lsp-name ingress next-hop address-of-next-hop
   ```

4. Specify the address of the egress switch for the LSP:

   ```
   [edit protocols mpls]
   user@switch# set static-label-switched-path lsp-name ingress to address-of-egress-switch
   ```

5. Configure the new label that you want to add to the top of the label stack:

   ```
   [edit protocols mpls]
   user@switch# set static-label-switched-path lsp-name ingress push out-label
   ```

Configuring the Provider and the Egress PE Switch

To configure a static LSP for MPLS on the provider and egress PE switch:

1. Configure a transit static LSP:

   ```
   [edit protocols mpls]
   user@switch# set static-label-switched-path lsp-name transit incoming-label
   ```

2. Configure the next hop switch for the LSP:

   ```
   [edit protocols mpls]
   user@switch# set static-label-switched-path lsp-name transit incoming-label next-hop
   address-of-next-hop
   ```

3. Only for provider switches, remove the label at the top of the label stack and replace it with the specified label:

   ```
   [edit protocols mpls]
   user@switch# set static-label-switched-path lsp-name transit incoming-label swap out-label
   ```

4. Only for the egress PE switch, remove the label at the top of the label stack:

NOTE: If there is another label in the stack, that label becomes the label at the top of the label stack. Otherwise, the packet is forwarded as a native protocol packet (typically, as an IP packet).

```
[edit protocols mpls]
user@switch# set static-label-switched-path lsp-name transit incoming-label pop
```

Related Documentation

- Configuring MPLS on Provider Edge Switches on page 39
- Configuring MPLS on Provider Switches on page 42
- Understanding MPLS Label Operations on page 11

Configuring MPLS Firewall Filters and Policers

You can configure firewall filters to filter MPLS traffic. To use an MPLS firewall filter, you must first configure the filter and then apply it to an interface you have configured for forwarding MPLS traffic. You can also configure a policer for the MPLS filter to police (that is, rate-limit) the traffic on the interface to which the filter is attached.

NOTE: You can configure ingress MPLS firewall filters only. Egress MPLS firewall filters are not supported. You cannot apply MPLS firewall filters to loopback interfaces.

When you configure an MPLS firewall filter, you define filtering criteria (terms, with match conditions) for the packets and an action (action, or action modifier) for the switch to take if the packets match the filtering criteria.

- Table 5 on page 45 describes the match conditions you can configure for MPLS firewall filters at the **[edit firewall family mpls filter *filter-name* term *term-name* from]** hierarchy level.

NOTE: If a packet has multiple MPLS labels, the filter applies the match conditions to only the bottom label in the label stack.

Table 5: Supported Match Conditions for MPLS Firewall Filters

Match Condition	Description
exp *number*	Experimental (EXP) bit number or range of bit numbers in the MPLS header of a packet. For *number*, you can specify one or more values from 0 through 7 in binary, decimal or hexadecimal format, as given below: • A single EXP bit—for example, **exp 3** • Several EXP bits—for example, **exp 0,4** • A range of EXP bits—for example, **exp [0-5]**

Table 5: Supported Match Conditions for MPLS Firewall Filters *(continued)*

Match Condition	Description
label *number*	MPLS label value or range of label values in the MPLS header of a packet. For *number*, you can specify one or more values from 0 through 1048575 in decimal or hexadecimal format, as given below: • A single label—for example, **label 3** • Several labels—for example, **label 0,4** • A range of labels—for example, **label [0-5]**

- Table 6 on page 46 describes the actions you can configure for MPLS firewall filters at the **[edit firewall family mpls filter *filter-name* term *term-name* then]** hierarchy level.

Table 6: Supported Actions for MPLS Firewall Filters

Action	Description
accept	Accept a packet
count *counter-name*	Count the number of packets that pass this filter or term. NOTE: We recommend that you configure a counter for each term in a firewall filter, so that you can monitor the number of packets that match the conditions specified in each filter term.
discard	Discard a packet silently without sending an Internet Control Message Protocol (ICMP) message
policer	Starting with Junos OS 13.2X51-D15, you can send traffic matched by an MPLS filter to a two-color policer.
three-color-policer	Starting with Junos OS 13.2X51-D15, you can send traffic matched by an MPLS filter to a three-color policer.

- Configuring an MPLS Firewall Filter on page 46
- Applying an MPLS Firewall Filter to an MPLS Interface on page 47
- Configuring Policers for LSPs on page 47

Configuring an MPLS Firewall Filter

To configure an MPLS firewall filter:

1. Configure the filter name, term name, and at least one match condition—for example, match on MPLS packets with EXP bits set to either 0 or 4:

   ```
   [edit firewall family mpls]
   user@switch# set filter ingress-exp-filter term term-one from exp 0,4
   ```

2. In each firewall filter term, specify the actions to take if the packet matches all the conditions in that term—for example, count MPLS packets with EXP bits set to either 0 or 4:

```
[edit firewall family mpls filter ingress-exp-filter term term-one then]
user@switch# set count counter0
user@switch# set accept
```

Applying an MPLS Firewall Filter to an MPLS Interface

To apply the MPLS firewall filter to an interface you have configured for forwarding MPLS traffic (using the **family mpls** statement at the **[edit interfaces *interface-name* unit *unit-number*]** hierarchy level):

NOTE: You can apply firewall filters only to filter MPLS packets that enter an interface.

1. Apply the firewall filter to an MPLS interface—for example, apply the firewall filter to interface xe-0/0/5:

   ```
   [edit interfaces]
   user@switch# set xe-0/0/5 unit 0 family mpls filter input ingress-exp-filter
   ```

2. Review your configuration and issue the **commit** command:

   ```
   [edit interfaces]
   user@switch# commit
   commit complete
   ```

Configuring Policers for LSPs

Starting with Junos OS 13.2X51-D15, you can send traffic matched by an MPLS filter to a two-color policer or three-color policer. MPLS LSP policing allows you to control the amount of traffic forwarded through a particular LSP. Policing helps to ensure that the amount of traffic forwarded through an LSP never exceeds the requested bandwidth allocation. LSP policing is supported on regular LSPs, LSPs configured with DiffServ-aware traffic engineering, and multiclass LSPs. You can configure multiple policers for each multiclass LSP. For regular LSPs, each LSP policer is applied to all of the traffic traversing the LSP. The policer's bandwidth limitations become effective as soon as the total sum of traffic traversing the LSP exceeds the configured limit.

You configure the multiclass LSP and DiffServ-aware traffic engineering LSP policers in a filter. The filter can be configured to distinguish between the different class types and apply the relevant policer to each class type. The policers distinguish between class types based on the EXP bits.

You configure LSP policers under the **family any** filter. The **family any** filter is used because the policer is applied to traffic entering the LSP. This traffic might be from different families: IPv6, MPLS, and so on. You do not need to know what sort of traffic is entering the LSP, as long as the match conditions apply to all types of traffic.

When configuring MPLS LSP policers, be aware of the following limitations:

- LSP policers are supported for packet LSPs only.
- LSP policers are supported for unicast next hops only. Multicast next hops are not supported.
- The LSP policer runs before any output filters.
- Traffic sourced from the Routing Engine (for example, ping traffic) does not take the same forwarding path as transit traffic. This type of traffic cannot be policed.

Related Documentation

- MPLS Feature Support on QFX Series and EX4600 Switches on page 17
- *Supported MPLS Scaling Values*
- *Overview of Policers*

Example: Configuring MPLS-Based Layer 3 VPNs

You can implement an MPLS-based Layer 3 virtual private network (VPN) on QFX switches to interconnect sites for customers who want the service provider to handle all the Layer 3 routing functions. To support an MPLS-based Layer 3 VPN, you need to add components of the Layer 3 VPN to the configuration of the two provider edge (PE) switches. You do not need to change the configuration of the provider switches.

This example shows how to configure an MPLS-based Layer 3 VPN spanning two corporate sites:

- Requirements on page 48
- Overview and Topology on page 48
- Configuring the Local PE Switch on page 51
- Configuring the Remote PE Switch on page 54

Requirements

This example uses the following software and hardware components:

- Junos OS Release 12.3 or later for the QFX Series
- Three QFX switches

Before you configure the Layer 3 VPN components, you must configure the basic components for an MPLS network:

- Configure two PE switches. See "Configuring MPLS on Provider Edge Switches" on page 39.
- Configure one or more provider switches. See "Configuring MPLS on Provider Switches" on page 42.

Overview and Topology

Layer 3 VPNs allow customers to leverage the service provider's technical expertise to ensure efficient site-to-site routing. The customer's customer edge (CE) switch uses a

routing protocol such as BGP or OSPF to communicate with the service provider's provider edge (PE) switch to carry IP prefixes across the network. MPLS-based Layer 3 VPNs use only IP over MPLS; other protocol packets are not supported. This example includes two PE switches, PE1 and PE2.

In the basic MPLS configuration of the PE switches using IP over MPLS, the PE switches were configured to use OSPF as the routing protocol between the MPLS switches and RSVP as the signaling protocol. Traffic engineering was enabled. A label-switched path (LSP) was configured.

The following components must be added to the PE switches for an MPLS-based Layer 3 VPN:

- BGP group with **family inet-vpn unicast**
- Routing instance with instance type **vrf**

Figure 6 on page 49 illustrates the topology of this MPLS-based Layer 3 VPN.

Figure 6: MPLS-Based Layer 3 VPN

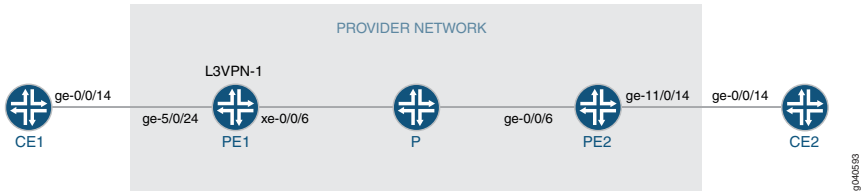


Table 7 on page 49 shows the settings of the customer edge interface on the local CE switch.

Table 7: Local CE Switch in the MPLS-Based Layer 3 VPN Topology

Property	Settings	Description
Local CE switch hardware	QFX switch	CE1
Customer edge interface	**ge-0/0/14 unit 0** **family inet** **address 51.51.0.14/16**	Interface that connects CE1 to PE1.

Table 8 on page 49 shows the settings of the customer edge interface on the remote CE switch.

Table 8: Remote CE Switch in the MPLS-Based Layer 3 VPN Topology

Property	Settings	Description
Remote CE switch hardware	QFX switch	CE2
Customer edge interface	**ge-0/0/14 unit 0** **family inet** **address 11.22.26.1/16**	Interface that connects CE2 to PE2.

Table 9 on page 50 shows the Layer 3 VPN components of the local PE switch.

Table 9: Layer 3 VPN Components of the Local PE Switch

Property	Settings	Description
Local PE switch hardware	QFX switch	PE1
Customer edge interface	**ge-5/0/24 unit 0** **family inet** **address 51.51.0.1/16**	Connects PE1 to CE1. NOTE: The **family inet** configuration should already have been completed as part of the basic MPLS configuration of the PE switch for IP over MPLS. It is included here to show what was specified for that portion of the configuration.
Core interface	**xe-0/0/6 unit 0** **family inet address 60.0.0.60/16** **family mpls**	Connects PE1 to P. NOTE: This portion of the configuration should already have been completed as part of the basic MPLS configuration. It is included here to show what was specified for that portion of the configuration.
Loopback interface	**lo0 unit 0** **family inet address 21.21.21.21/32**	NOTE: This portion of the configuration should already have been completed as part of the basic MPLS configuration. It is included here to show what was specified for that portion of the configuration.
BGP	**bgp**	Added for the Layer 3 VPN configuration.
Routing instance	**L3VPN-1**	Added for the Layer 3 VPN configuration.

Table 10 on page 51 shows the Layer 3 VPN components of the remote PE switch.

Table 10: Layer 3 VPN Components of the Remote PE Switch

Property	Settings	Description
Remote PE switch hardware	QFX switch	PE2
Customer edge interface	**ge-0/0/14 unit 0** **family inet** **address 11.22.26.14/16**	Connects PE2 to CE2. For the Layer 3 VPN configuration, added **family mpls**. NOTE: The **family inet** configuration should already have been completed as part of the basic MPLS configuration of the PE switch for IP over MPLS. It is included here to show what was specified for that portion of the configuration.
Core interface	**xe-0/0/6 unit 0** **family inet address 60.2.0.60/16** **family mpls**	Connects PE1 to P. NOTE: This portion of the configuration should already have been completed as part of the basic MPLS configuration. It is included here to show what was specified for that portion of the configuration.
Loopback interface	**lo0 unit 0** **family inet address 22.22.22.22/32**	NOTE: This portion of the configuration should already have been completed as part of the basic MPLS configuration. It is included here to show what was specified for that portion of the configuration.
BGP	**bgp**	Added for the Layer 3 VPN configuration.
Routing instances	**L3VPN-1**	Added for the Layer 3 VPN configuration.

Configuring the Local PE Switch

CLI Quick Configuration

To quickly configure the Layer 3 VPN components on the local PE switch, copy the following commands and paste them into the switch terminal window of PE1:

```
[edit]
set protocols bgp local-address 21.21.21.21 family inet-vpn unicast
set protocols bgp group PE1-PE2 type internal
set protocols bgp neighbor 22.22.22.22
set routing-instances L3VPN-1 instance-type vrf
set routing-instances L3VPN-1 description "BETWEEN PE1 AND PE2"
set routing-instances L3VPN-1 interface ge-0/0/14.0
set routing-instances L3VPN-1 route-distinguisher 21:21
set routing-instances L3VPN-1 vrf-target target:21:21
set routing-instances L3VPN-1 vrf-table-label
set routing-options router-id 21.21.21.21
set routing-options autonomous-system 10
```

Step-by-Step Procedure

To configure the Layer 3 VPN components on the local PE switch:

1. Configure BGP, specifying the loopback address as the local address and specifying **family inet-vpn unicast**:

   ```
   [edit protocols bgp]
   user@switchPE1# set local-address 21.21.21.21 family inet-vpn unicast
   ```

2. Configure the BGP group, specifying the group name and type:

   ```
   [edit protocols bgp]
   user@switchPE1# set group PE1-PE2 type internal
   ```

3. Configure the BGP neighbor, specifying the loopback address of the remote PE switch as the neighbor's address:

   ```
   [edit protocols bgp]
   user@switchPE1# set neighbor 22.22.22.22
   ```

4. Configure the routing instance, specifying the routing-instance name and using **vrf** as the instance type:

   ```
   [edit routing-instances]
   user@switchPE1# set L3VPN-1 instance-type vrf
   ```

5. Configure a description for this routing instance:

   ```
   [edit routing-instances]
   user@switchPE1# set L3VPN-1 description "BETWEEN PE1 AND PE2"
   ```

6. Configure the routing instance to use a route distinguisher:

   ```
   [edit routing-instances]
   user@switchPE1# set L3VPN-1 route-distinguisher 21:21
   ```

   NOTE: Each routing instance that you configure on a PE switch must have a unique route distinguisher associated with it. VPN routing instances require a route distinguisher to allow BGP to distinguish between potentially identical network layer reachability information (NLRI) messages received from different VPNs. If you configure different VPN routing instances with the same route distinguisher, the commit fails.

7. Configure the VPN routing and forwarding (VRF) target of the routing instance:

   ```
   [edit routing-instances]
   user@switchPE1# set L3VPN-1 vrf-target target:21:21
   ```

   NOTE: You can create more complex policies by explicitly configuring VRF import and export policies using the import and export options. See the *Junos OS VPNs Library for Routing Devices*.

8. Configure this routing instance with **vrf-table-label**, which maps the inner label of a packet to a specific VPN routing and forwarding (VRF) table and allows the examination of the encapsulated IP header:

   ```
   [edit routing-instances]
   ```

```
user@switchPE1# set L3VPN-1 vrf-table-label
```

9. Configure the router ID and autonomous system (AS):

NOTE: We recommend that you explicitly configure the router identifier under the [edit routing-options] hierarchy level to avoid unpredictable behavior if the interface address on a loopback interface changes.

```
[edit routing-options]
user@switchPE1# set router-id 21.21.21.21 autonomous-system 10
```

Results Display the results of the configuration:

```
user@switchPE1>  show configuration

  interfaces {
    ge-0/0/14 {
      unit 0 {
        family inet {
          address 51.51.0.1/16;
        }
      }
    }
    lo0 {
      unit 0 {
        family inet {
          address 21.21.21.21/32;
        }
      }
    }
    xe-0/0/6 {
      unit 0 {
        family inet {
          address 60.0.0.60/16;
        }
        family mpls;
      }
    }
    protocols {
      mpls {
        label-switched-path 21-22 {
          from 21.21.21.21;
          to 22.22.22.22;
          no-cspf;
        }
        interface xe-0/0/6.0;
        interface lo0.0;
      bgp {
        local-address 21.21.21.21;
        family inet-vpn {
          unicast;
        }
        group PE1-PE2 {
          type internal;
          neighbor 22.22.22.22;
```

```
    }
  }
  ospf
    traffic-engineering;
    area 0.0.0.0 {
      interface lo0.0;
      interface xe-0/0/6.0;
    }
  }
}
routing-instances {
  L3VPN-1 {
    instance-type vrf;
    description "BETWEEN PE1 AND PE2";
    route-distinguisher 21:21;
    vrf-target target:21:21;
    vrf-table-label;
  }
routing-options {
  router-id 21.21.21.21;
  autonomous-system 10;
```

Configuring the Remote PE Switch

CLI Quick Configuration

To quickly configure the Layer 3 VPN components on the remote PE switch, copy the following commands and paste them into the switch terminal window of PE2:

```
[edit]
set protocols bgp local-address 22.22.22.22 family inet-vpn unicast
set protocols bgp group PE1-PE2 type internal
set protocols bgp neighbor 21.21.21.21
set routing-instances L3VPN-1 instance-type vrf
set routing-instances L3VPN-1 description "BETWEEN PE1 AND PE2"
set routing-instances L3VPN-1 interface ge-11/0/14.0
set routing-instances L3VPN-1 route-distinguisher 21:21
set routing-instances L3VPN-1 vrf-target target:21:21
set routing-instances L3VPN-1 vrf-table-label;
set routing-options router-id 22.22.22.22
set routing-options autonomous-system 10
```

Step-by-Step Procedure

To configure Layer 3 VPN components on the remote PE switch:

1. Configure BGP, specifying the loopback address as the local address and specifying **family inet-vpn unicast**:

   ```
   [edit protocols bgp]
   user@switchPE2# set local-address 22.22.22.22 family inet-vpn unicast
   ```

2. Configure the BGP group, specifying the group name and type:

   ```
   [edit protocols bgp]
   user@switchPE2# set group PE1-PE2 type internal
   ```

3. Configure the BGP neighbor, specifying the loopback address of the remote PE switch as the neighbor's address:

   ```
   [edit protocols bgp]
   user@switchPE2# set neighbor 21.21.21.21
   ```

4. Configure the routing instance, specifying the routing-instance name and using **vrf** as the instance type:

```
[edit routing-instances]
user@switchPE2# set L3VPN-1 instance-type vrf
```

5. Configure a description for this routing instance:

```
[edit routing-instances]
user@switchPE1# set L3VPN-1 description "BETWEEN PE1 AND PE2"
```

6. Configure the routing instance to apply to the customer edge interface:

```
[edit routing-instances]
user@switchPE2# set L3VPN-1 interface ge-0/0/14.0
```

7. Configure the routing instance to use a route distinguisher, using the format *ip-address:number*:

```
[edit routing-instances]
user@switchPE2# set L3VPN-1 route-distinguisher 21:21
```

8. Configure the VPN routing and forwarding (VRF) target of the routing instance:

```
[edit routing-instances]
user@switchPE2# set L3VPN-1 vrf-target target:21:21
```

9. Configure this routing instance with **vrf-table-label**, which maps the inner label of a packet to a specific VPN routing and forwarding (VRF) table and allows the examination of the encapsulated IP header.

```
[edit routing-instances]
user@switchPE2# set L3VPN-1 vrf-tabel-label
```

10. Configure the router ID and autonomous system (AS):

```
[edit routing-options]
user@switchPE2# set router-id 22.22.22.22 autonomous-system 10
```

Results Display the results of the configuration:

```
user@switchPE2> show configuration

interfaces {
    ge-0/0/14 {
        unit 0 {
            family inet {
                address 11.22.26.14/16;
            }
        }
    }
    lo0 {
        unit 0 {
            family inet {
                address 22.22.22.22/32;
            }
        }
    }
    xe-0/0/6 {
        unit 0 {
            family inet {
                address 60.2.0.60/16;
            }
            family mpls;
        }
    }
    protocols {
        mpls {
```

```
    label-switched-path 22-21 {
      from 22.22.22.22;
      to 21.21.21.21;
      no-cspf;
    }
    interface xe-0/0/6.0;
    interface lo0.0;
  bgp {
    local-address 22.22.22.22;
    family inet-vpn {
      unicast;
    }
    group PE1-PE2 {
      type internal;
      neighbor 21.21.21.21;
    }
  }
  ospf {
    traffic-engineering;
    area 0.0.0.0 {
      interface ge-0/0/14.0;
      interface lo0.0;
      interface xe-0/0/6.0;
    }
  }
}
routing-instances {
  L3VPN-1 {
    instance-type vrf;
    description"BETWEEN PE1 AND PE2";
    route-distinguisher 21:21;
    vrf-target target:21:21;
    vrf-table-label;
  }
routing-options {
  router-id 22.22.22.22;
  autonomous-system 10;
```

Related Documentation

- Configuring MPLS on Provider Edge Switches on page 39
- Configuring MPLS on Provider Switches on page 42

Example: Tunneling IPv6 Traffic over MPLS IPv4 Networks

This example shows how to configure Junos OS to tunnel IPv6 over an MPLS-based IPv4 network. External BGP (EBGP) is used between the customer edge (CE) and provider edge (PE) devices. The remote CE devices have different AS numbers for loop detection.

- Requirements on page 57
- Overview on page 57
- Configuration on page 59
- Verification on page 65

Requirements

No special configuration beyond device initialization is required before you configure this example.

Overview

Detailed information about the Juniper Networks implementation of IPv6 over MPLS is described in the following Internet drafts:

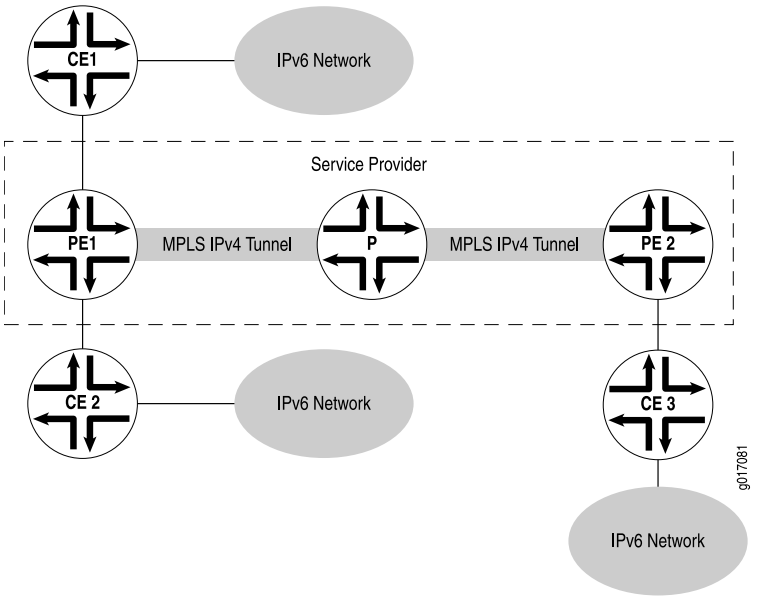
- Internet draft draft-ietf-l3vpn-bgp-ipv6-07.txt, *BGP-MPLS IP VPN extension for IPv6 VPN* (expires January 2006)
- Internet draft draft-ooms-v6ops-bgp-tunnel-06.txt, *Connecting IPv6 Islands over IPv4 MPLS using IPv6 Provider Edge Routers* (expires July 2006)

These Internet drafts are available on the IETF website at **http://www.ietf.org/**.

This example shows you how to interconnect a two IPv6 networks over an IPv4-based network core, giving you the ability to provide IPv6 service without having to upgrade the routers in your core network. Multiprotocol Border Gateway Protocol (MP-BGP) is configured to exchange routes between the IPv6 networks, and data is tunneled between these IPv6 networks by means of IPv4-based MPLS.

In Figure 7 on page 57, PE1 and PE2 are dual-stack BGP routers or switches, meaning they have both IPv4 and IPv6 stacks. The PE devices link the IPv6 networks through the customer edge (CE) routers or switches to the IPv4 core network. The CE devices and the PE devices connect through a link layer that can carry IPv6 traffic. The PE devices use IPv6 on the CE router-facing interfaces and use IPv4 and MPLS on the core-facing interfaces. Note that one of the connected IPv6 networks could be the global IPv6 Internet.

Figure 7: IPv6 Networks Linked by MPLS IPv4 Tunnels



The two PE devices are linked through an MP-BGP session using IPv4 addresses. They use the session to exchange IPv6 routes with an IPv6 (value 2) address family indicator (AFI) and a subsequent AFI (SAFI) (value 4). Each PE router sets the next hop for the IPv6 routes advertised on this session to its own IPv4 address. Because MP-BGP requires the BGP next hop to correspond to the same address family as the network layer reachability information (NLRI), this IPv4 address needs to be embedded within an IPv6 format.

The PE devices can learn the IPv6 routes from the CE devices connected to them using MP-BGP or through static configuration. Note that if BGP is used as the PE-router-to-CE-router protocol, the MP-BGP session between the PE device and CE device could occur over an IPv4 or IPv6 Transmission Control Protocol (TCP) session. Also, the BGP routes exchanged on that session would have SAFI unicast. You must configure an export policy to pass routes between IBGP and EBGP, and between BGP and any other protocol.

The PE routers have MPLS LSPs routed to each others' IPv4 addresses. IPv4 provides signaling for the LSPs by means of RSVP. These LSPs are used to resolve the next-hop addresses of the IPv6 routes learned from MP-BGP. The next hops use IPv4-mapped IPv6 addresses, while the LSPs use IPv4 addresses.

The PE devices always advertise IPv6 routes to each other using a label value of 2, the explicit null label for IPv6 as defined in RFC 3032, *MPLS Label Stack Encoding*. As a consequence, each of the forwarding next hops for the IPv6 routes learned from remote PE routers normally push two labels. The inner label is 2 (this label could be different if the advertising PE device is not a Juniper Networks routing or switching platform), and the outer label is the LSP label. If the LSP is a single-hop LSP, then only Label 2 is pushed.

It is also possible for the PE devices to exchange plain IPv6 routes using SAFI unicast. However, there is one major advantage in exchanging labeled IPv6 routes. The penultimate-hop router for an MPLS LSP can pop the outer label and then send the packet with the inner label as an MPLS packet. Without the inner label, the penultimate-hop router would need to discover whether the packet is an IPv4 or IPv6 packet to set the protocol field in the Layer 2 header correctly.

When the PE1 device in Figure 7 on page 57 receives an IPv6 packet from the CE1 device, it performs a lookup in the IPv6 forwarding table. If the destination matches a prefix learned from the CE2 device, then no labels need to be pushed and the packet is simply sent to the CE2 device. If the destination matches a prefix that was learned from the PE2 device, then the PE1 router pushes two labels onto the packet and sends it to the Provider router. The inner label is 2 and the outer label is the LSP label for the PE2 router.

Each provider router in the service provider's network handles the packet as it would any MPLS packet, swapping labels as it passes from provider router to provider router. The penultimate-hop provider router for the LSP pops the outer label and sends the packet to the PE2 router. When the PE2 router receives the packet, it recognizes the IPv6 explicit null label on the packet (Label 2). It pops this label and treats it as an IPv6 packet, performing a lookup in the IPv6 forwarding table and forwarding the packet to the CE3 router.

This example includes the following settings:

- In addition to configuring the **family inet6** statement on all the CE router–facing interfaces, you must also configure the statement on all the core-facing interfaces running MPLS. Both configurations are necessary because the router must be able to process any IPv6 packets it receives on these interfaces. You should not see any regular IPv6 traffic arrive on these interfaces, but you will receive MPLS packets tagged with Label 2. Even though Label 2 MPLS packets are sent in IPv4, these packets are treated as native IPv6 packets.
- You enable IPv6 tunneling by including the **ipv6-tunneling** statement in the configuration for the PE routers. This statement allows IPv6 routes to be resolved over an MPLS network by converting all routes stored in the inet.3 routing table to IPv4-mapped IPv6 addresses and then copying them into the inet6.3 routing table. This routing table can be used to resolve next hops for both inet6 and inet6-vpn routes.

  NOTE: BGP automatically runs its import policy even when copying routes from a primary routing table group to a secondary routing table group. If IPv4 labeled routes arrive from a BGP session (for example, when you have configured the **labeled-unicast** statement at the **[edit protocols bgp family inet]** hierarchy level on the PE router), the BGP neighbor's import policy also accepts IPv6 routes, since the neighbor's import policy is run while doing the copy operation to the inet6.3 routing table.

- When you configure MP-BGP to carry IPv6 traffic, the IPv4 MPLS label is removed at the destination PE router. The remaining IPv6 packet without a label can then be forwarded to the IPv6 network. To enable this, include the **explicit-null** statement in the BGP configuration.

Configuration

CLI Quick Configuration

To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

Device PE1

```
set interfaces xe-0/0/5 unit 2 family inet6 address ::10.1.1.2/126
set interfaces xe-0/0/5 unit 2 family mpls
set interfaces xe-0/0/6 unit 5 family inet address 10.1.1.5/30
set interfaces xe-0/0/6 unit 5 family inet6
set interfaces xe-0/0/6 unit 5 family mpls
set interfaces lo0 unit 2 family inet address 1.1.1.2/32
set protocols mpls ipv6-tunneling
set protocols mpls interface xe-0/0/5.2
set protocols mpls interface xe-0/0/6.5
set protocols bgp group toCE1 type external
set protocols bgp group toCE1 local-address ::10.1.1.2
set protocols bgp group toCE1 family inet6 unicast
set protocols bgp group toCE1 export send-bgp6
set protocols bgp group toCE1 peer-as 1
set protocols bgp group toCE1 neighbor ::10.1.1.1
```

```
set protocols bgp group toPE2 type internal
set protocols bgp group toPE2 local-address 1.1.1.2
set protocols bgp group toPE2 family inet6 labeled-unicast explicit-null
set protocols bgp group toPE2 export next-hop-self
set protocols bgp group toPE2 export send-v6
set protocols bgp group toPE2 neighbor 1.1.1.4
set protocols ospf area 0.0.0.0 interface xe-0/0/6.5
set protocols ospf area 0.0.0.0 interface lo0.2 passive
set protocols rsvp interface xe-0/0/6.5
set policy-options policy-statement next-hop-self then next-hop self
set policy-options policy-statement send-bgp6 from family inet6
set policy-options policy-statement send-bgp6 from protocol bgp
set policy-options policy-statement send-bgp6 then accept
set policy-options policy-statement send-v6 from family inet6
set policy-options policy-statement send-v6 from protocol bgp
set policy-options policy-statement send-v6 from protocol direct
set policy-options policy-statement send-v6 then accept
set routing-options router-id 1.1.1.2
set routing-options autonomous-system 2
```

Device PE2

```
set interfaces xe-0/0/5 unit 10 family inet address 10.1.1.10/30
set interfaces xe-0/0/5 unit 10 family inet6
set interfaces xe-0/0/5 unit 10 family mpls
set interfaces xe-0/0/6 unit 13 family inet6 address ::10.1.1.13/126
set interfaces xe-0/0/6 unit 13 family mpls
set interfaces lo0 unit 4 family inet address 1.1.1.4/32
set protocols mpls ipv6-tunneling
set protocols mpls interface xe-0/0/5.10
set protocols mpls interface xe-0/0/6.13
set protocols bgp group toPE1 type internal
set protocols bgp group toPE1 local-address 1.1.1.4
set protocols bgp group toPE1 family inet6 labeled-unicast explicit-null
set protocols bgp group toPE1 export next-hop-self
set protocols bgp group toPE1 export send-v6
set protocols bgp group toPE1 neighbor 1.1.1.2
set protocols bgp group toCE3 type external
set protocols bgp group toCE3 local-address ::10.1.1.13
set protocols bgp group toCE3 family inet6 unicast
set protocols bgp group toCE3 export send-bgp6
set protocols bgp group toCE3 peer-as 3
set protocols bgp group toCE3 neighbor ::10.1.1.14
set protocols ospf area 0.0.0.0 interface xe-0/0/5.10
set protocols ospf area 0.0.0.0 interface lo0.4 passive
set protocols rsvp interface xe-0/0/5.10
set policy-options policy-statement next-hop-self then next-hop self
set policy-options policy-statement send-bgp6 from family inet6
set policy-options policy-statement send-bgp6 from protocol bgp
set policy-options policy-statement send-bgp6 then accept
set policy-options policy-statement send-v6 from family inet6
set policy-options policy-statement send-v6 from protocol bgp
set policy-options policy-statement send-v6 from protocol direct
set policy-options policy-statement send-v6 then accept
set routing-options router-id 1.1.1.4
set routing-options autonomous-system 2
```

Device P

```
set interfaces xe-0/0/5 unit 6 family inet address 10.1.1.6/30
set interfaces xe-0/0/5 unit 6 family inet6
set interfaces xe-0/0/5 unit 6 family mpls
set interfaces xe-0/0/6 unit 9 family inet address 10.1.1.9/30
set interfaces xe-0/0/6 unit 9 family inet6
set interfaces xe-0/0/6 unit 9 family mpls
set interfaces lo0 unit 3 family inet address 1.1.1.3/32
set protocols mpls interface xe-0/0/5.6
set protocols mpls interface xe-0/0/6.9
set protocols ospf area 0.0.0.0 interface xe-0/0/5.6
set protocols ospf area 0.0.0.0 interface xe-0/0/6.9
set protocols ospf area 0.0.0.0 interface lo0.3 passive
set protocols rsvp interface xe-0/0/5.6
set protocols rsvp interface xe-0/0/6.9
set routing-options router-id 1.1.1.3
set routing-options autonomous-system 2
```

Device CE1

```
set interfaces xe-0/0/5 unit 1 family inet6 address ::10.1.1.1/126
set interfaces xe-0/0/5 unit 1 family mpls
set interfaces lo0 unit 1 family inet6 address ::1.1.1.1/128
set protocols bgp group toPE1 type external
set protocols bgp group toPE1 local-address ::10.1.1.1
set protocols bgp group toPE1 family inet6 unicast
set protocols bgp group toPE1 export send-v6
set protocols bgp group toPE1 peer-as 2
set protocols bgp group toPE1 neighbor ::10.1.1.2
set policy-options policy-statement send-v6 from family inet6
set policy-options policy-statement send-v6 from protocol direct
set policy-options policy-statement send-v6 then accept
set routing-options router-id 1.1.1.1
set routing-options autonomous-system 1
```

Device CE3

```
set interfaces xe-0/0/5 unit 14 family inet6 address ::10.1.1.14/126
set interfaces xe-0/0/5 unit 14 family mpls
set interfaces lo0 unit 5 family inet6 address ::1.1.1.5/128
set protocols bgp group toPE2 type external
set protocols bgp group toPE2 local-address ::10.1.1.14
set protocols bgp group toPE2 family inet6 unicast
set protocols bgp group toPE2 export send-v6
set protocols bgp group toPE2 peer-as 2
set protocols bgp group toPE2 neighbor ::10.1.1.13
set policy-options policy-statement send-v6 from family inet6
set policy-options policy-statement send-v6 from protocol direct
set policy-options policy-statement send-v6 then accept
set routing-options router-id 1.1.1.5
set routing-options autonomous-system 3
```

Configuring Device PE1

Step-by-Step Procedure

The following example requires you to navigate various levels in the configuration hierarchy. For information about navigating the CLI, see *Using the CLI Editor in Configuration Mode* in the *CLI User Guide*.

To configure Device PE1:

1. Configure the interfaces.

```
[edit interfaces]
user@PE1# set xe-0/0/5 unit 2 family inet6 address ::10.1.1.2/126
user@PE1# set xe-0/0/5 unit 2 family mpls


user@PE1# set xe-0/0/6 unit 5 family inet address 10.1.1.5/30
user@PE1# set xe-0/0/6 unit 5 family inet6
user@PE1# set xe-0/0/6 unit 5 family mpls


user@PE1# set lo0 unit 2 family inet address 1.1.1.2/32
```

2. Configure MPLS on the interfaces.

```
[edit protocols mpls]
user@PE1# set ipv6-tunneling
user@PE1# set interface xe-0/0/5.2
user@PE1# set interface xe-0/0/6.5
```

3. Configure BGP.

```
[edit protocols bgp]
user@PE1# set group toCE1 type external
user@PE1# set group toCE1 local-address ::10.1.1.2
user@PE1# set group toCE1 family inet6 unicast
user@PE1# set group toCE1 export send-bgp6
user@PE1# set group toCE1 peer-as 1
user@PE1# set group toCE1 neighbor ::10.1.1.1


user@PE1# set group toPE2 type internal
user@PE1# set group toPE2 local-address 1.1.1.2
user@PE1# set group toPE2 family inet6 labeled-unicast explicit-null
user@PE1# set group toPE2 export next-hop-self
user@PE1# set group toPE2 export send-v6
user@PE1# set group toPE2 neighbor 1.1.1.4
```

4. Configure OSPF

```
[edit protocols ospf area 0.0.0.0]
user@PE1# set interface xe-0/0/6.5
user@PE1# set interface lo0.2 passive
```

5. Configure a signaling protocol.

```
[edit protocols]
user@PE1# set rsvp interface xe-0/0/6.5
```

6. Configure the routing policies.

```
[edit policy-options]
```

```
user@PE1# set policy-statement next-hop-self then next-hop self

user@PE1# set policy-statement send-bgp6 from family inet6
user@PE1# set policy-statement send-bgp6 from protocol bgp
user@PE1# set policy-statement send-bgp6 then accept

user@PE1# set policy-statement send-v6 from family inet6
user@PE1# set policy-statement send-v6 from protocol bgp
user@PE1# set policy-statement send-v6 from protocol direct
user@PE1# set policy-statement send-v6 then accept
```

7. Configure the router ID and the autonomous system (AS) number.

```
[edit routing-options]
user@PE1# set router-id 1.1.1.2
user@PE1# set autonomous-system 2
```

Results From configuration mode, confirm your configuration by entering the **show interfaces**, **show policy-options**, **show protocols**, and **show routing-options** commands. If the output does not display the intended configuration, repeat the instructions in this example to correct the configuration.

```
user@R1# show interfaces
xe-0/0/5 {
  unit 2 {
    family inet6 {
      address ::10.1.1.2/126;
    }
    family mpls;
  }
}
xe-0/0/6 {
  unit 5 {
    family inet {
      address 10.1.1.5/30;
    }
    family inet6;
    family mpls;
  }
}
lo0 {
  unit 2 {
    family inet {
      address 1.1.1.2/32;
    }
  }
}

user@R1# show policy-options
policy-statement next-hop-self {
  then {
    next-hop self;
  }
}
policy-statement send-bgp6 {
```

```
    from {
        family inet6;
        protocol bgp;
    }
    then accept;
}
policy-statement send-v6 {
    from {
        family inet6;
        protocol [ bgp direct ];
    }
    then accept;
}
```

```
user@R1# show protocols
mpls {
    ipv6-tunneling;
    interface xe-0/0/5.2;
    interface xe-0/0/6.5;
}
bgp {
    group toCE1 {
        type external;
        local-address ::10.1.1.2;
        family inet6 {
            unicast;
        }
        export send-bgp6;
        peer-as 1;
        neighbor ::10.1.1.1;
    }
    group toPE2 {
        type internal;
        local-address 1.1.1.2;
        family inet6 {
            labeled-unicast {
                explicit-null;
            }
        }
        export [ next-hop-self send-v6 ];
        neighbor 1.1.1.4;
    }
}
ospf {
    area 0.0.0.0 {
        interface xe-0/0/6.5;
        interface lo0.2 {
            passive;
        }
    }
}
rsvp {
    interface xe-0/0/6.5;
}
```

```
user@R1# show routing-options
router-id 1.1.1.2;
```

```
autonomous-system 2;
```

If you are done configuring the device, enter **commit** from configuration mode. Configure the other devices in the topology, as shown in "CLI Quick Configuration" on page 59.

Verification

Confirm that the configuration is working properly.

Verifying That the CE Devices Have Connectivity

Purpose Make sure that the tunnel is operating.

Action From operational mode, enter the **ping** command.

```
user@CE1> ping ::10.1.1.14
PING6(56=40+8+8 bytes) ::10.1.1.1 --> ::10.1.1.14
16 bytes from ::10.1.1.14, icmp_seq=0 hlim=61 time=10.687 ms
16 bytes from ::10.1.1.14, icmp_seq=1 hlim=61 time=9.239 ms
16 bytes from ::10.1.1.14, icmp_seq=2 hlim=61 time=1.842 ms

user@CE3> ping ::10.1.1.1
PING6(56=40+8+8 bytes) ::10.1.1.14 --> ::10.1.1.1
16 bytes from ::10.1.1.1, icmp_seq=0 hlim=61 time=1.484 ms
16 bytes from ::10.1.1.1, icmp_seq=1 hlim=61 time=1.338 ms
16 bytes from ::10.1.1.1, icmp_seq=2 hlim=61 time=1.351 ms
```

Meaning The IPv6 CE devices can communicate over the core IPv4 network.

Related Documentation

Verifying That MPLS Is Working Correctly

To verify that MPLS is working correctly, perform the following tasks:

1. Verifying the Physical Layer on the Switches on page 65
2. Verifying the Routing Protocol on page 66
3. Verifying the Core Interfaces Being Used for the MPLS Traffic on page 66
4. Verifying RSVP on page 67

Verifying the Physical Layer on the Switches

Purpose Verify that the interfaces are up. Perform this verification task on each of the switches.

Action

```
user@switch> show interfaces xe-* terse

Interface               Admin Link Proto    Local                 Remote
xe-0/0/0                up    up
xe-0/0/0.0              up    up
xe-0/0/1.0              up    up
xe-0/0/2.0              up    up
xe-0/0/3.0              up    up   inet       2.2.2.1/16
xe-0/0/4.0              up    up
xe-0/0/5.0              up    up   inet      10.1.5.1/24
                                   mpls
xe-0/0/6.0              up    up   inet      10.1.6.1/24
                                   mpls
```

Meaning The **show interfaces terse** command displays status information about the 10-Gigabit Ethernet interfaces on the switch. This output verifies that the interfaces are **up**. The output for the protocol family (Proto column) of the core interfaces (xe-0/0/5.0 and xe-0/0/6.0), shows that these interfaces are configured as both **inet** and **mpls**. The **Local** column for the core interfaces shows the IP address configured for these interfaces.

Verifying the Routing Protocol

Purpose Verify the state of the configured routing protocol. You should perform this verification task on each of the switches. The state should be **Full**. If you have configured OSPF as the routing protocol, use the **show ospf neighbor** command to verify that the routing protocol is communicating with the switch neighbors.

Action

```
user@switch> show ospf neighbor

Address          Interface              State     ID               Pri  Dead
127.1.1.1        xe-0/0/5               Full      10.10.10.10      128    39
```

Meaning The **show ospf neighbor** command displays the status of the routing protocol that has been configured on this switch. The output shows that the state is **Full**, meaning that the routing protocol is operating correctly—that is, hello packets are being exchanged between directly connected neighbors. For additional information on checking and monitoring routing protocols, see the *Junos OS Routing Protocols and Policies Command Reference* .

Verifying the Core Interfaces Being Used for the MPLS Traffic

Purpose Verify that the state of the MPLS interface is **Up**. You should perform this verification task on each of the switches.

Action

```
user@switch> show mpls interface

Interface        State       Administrative groups
ge–0/0/5           Up          <none>
ge–0/0/6           Up          <none>
```

Meaning The **show mpls interface** command displays the status of the core interfaces that have been configured to belong to **family mpls**. This output shows that the interface configured to belong to **family mpls** is up.

Verifying RSVP

Purpose Verify the state of the RSVP session. You should perform this verification task on each of the switches.

Action

```
user@switch> show rsvp session

Ingress RSVP: 1 sessions
To              From            State   Rt Style Labelin Labelout LSPname
127.1.1.3       127.1.1.1         Up       0  1 FF       -   300064 lsp_to_pe2_ge1
Total 1 displayed, Up 1, Down 0

Egress RSVP: 1 sessions
To              From            State   Rt Style Labelin Labelout LSPname
127.1.1.1       127.1.1.3         Up       0  1 FF  299968        - lsp_to_pe1_ge1
Total 1 displayed, Up 1, Down 0

Transit RSVP: 0 sessions
Total 0 displayed, Up 0, Down 0
```

Meaning This output confirms that the RSVP sessions are up.

Related Documentation

- Configuring MPLS on Provider Edge Switches on page 39
- Configuring MPLS on Provider Switches on page 42

CHAPTER 2

Configuration Statements and Command Statements for MPLS

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- Monitoring Commands for MPLS on page 145

Configuration Statements for MPLS

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MPLS Configuration Guidelines

When configuring MPLS on QFX Series devices or on EX4600, note that the number of IP prefixes supported depends on the specific platform being used. See the scale specifications in the data sheet of your device for additional information.

- We recommend the following:
  - If your ingress provider edge (PE) switch needs to support more than 8000 external IP prefixes, use a larger capacity device as an ingress PE switch.
  - If you use a switch as a route reflector for BGP labeled routes, use it as a dedicated route reflector (that is, the switch must not participate in managing data traffic).
  - If you use a switch as a PE switch or as a route reflector for BGP labeled routes, configure routing policies on the PE switch and the route reflector to filter external IP routes from the routing table.

    The configuration example for a routing policy named fib_policy (at the **[edit policy-options** and **[edit routing-options** hierarchy levels) to filter BGP labeled routes from the inet.0 routing table is given below:


```
user@switch# show policy-options
policy-statement fib_policy {
  from {
    protocol bgp;
    rib inet.0;
  }
  then reject;
}

user@switch# show routing-options
forwarding-table {
  export fib_policy;
}
```

- Packet fragmentation using the **allow-fragmentation** statement at the **[edit protocols mpls path-mtu]** hierarchy level is not supported on QFX Series devices or on the EX4600 switch. Therefore, you must ensure that the maximum transmission unit (MTU) values configured on every MPLS interface is sufficient to handle MPLS packets. The packets whose size exceeds the MTU value of an interface will be dropped.

Related Documentation

- Configuring MPLS on Provider Edge Switches on page 39
- Configuring MPLS on Provider Switches on page 42
- *Configuring a Global MPLS EXP Classifier*
- *Configuring Rewrite Rules for MPLS EXP Classifiers*
- MPLS Feature Support on QFX Series and EX4600 Switches on page 17

adaptive

Syntax adaptive;

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name*],
[edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name* (primary | secondary) *path-name*],
[edit protocols mpls label-switched-path *lsp-name*],
[edit protocols mpls label-switched-path *lsp-name* (primary | secondary) *path-name*]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for the QFX VC/VCF Series.

Description During reroute, do not double-count bandwidth on links shared by the old and new paths. Including this statement causes RSVP to use shared explicit (SE) reservation styles and assists in smooth transition during rerouting.

Default The configured object is disabled.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring Adaptive LSPs*

adjust-interval

Syntax adjust-interval *seconds*;

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name* auto-bandwidth],
[edit protocols mpls label-switched-path *lsp-name* auto-bandwidth]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for the QFX VC/VCF Series.

Description Specify the bandwidth reallocation interval.

Options ***seconds***—Bandwidth reallocation interval, in seconds.

Range: 300 through 315,360,000 seconds

Default: 86,400 seconds

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring Automatic Bandwidth Allocation for LSPs*

adjust-threshold

Syntax adjust-threshold *percent*;

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name* auto-bandwidth],
[edit protocols mpls label-switched-path *lsp-name* auto-bandwidth]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for the QFX VC/VCF Series.

Description Specify how sensitive the automatic bandwidth adjustment for a label-switched path (LSP) is to changes in bandwidth utilization.

Options *percent*—Bandwidth demand for the current bandwidth adjustment interval is determined and compared to the LSP's current bandwidth allocation. If the percentage difference in bandwidth is greater than or equal to the percentage specified by this statement, the LSP's bandwidth is adjusted to the current bandwidth demand.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring Automatic Bandwidth Allocation for LSPs*

admin-down

Syntax admin-down;

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name*],
[edit protocols mpls label-switched-path *lsp-name*]

Release Information Statement introduced in Junos OS Release 8.2.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for the QFX VC/VCF Series.

Description Set a nonpacket GMPLS LSP to the administrative down state. This statement does not affect control path setup or data forwarding for packet LSPs.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Allowing Non-Packet GMPLS LSPs to Establish Paths Through Routers Running the Junos OS*

advertisement-hold-time

Syntax advertisement-hold-time *seconds*;

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls],
[edit protocols mpls]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for the QFX VC/VCF Series.

Description Do not advertise when the LSP goes from up to down, for a certain period of time known as the hold time.

Options ***seconds***—Hold time, in seconds.

Range: 0 through 65,535 seconds

Default: 5 seconds

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Damping Advertisement of LSP State Changes*

associate-backup-pe-groups

Syntax associate-backup-pe-groups;

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name*],
[edit protocols mpls label-switched-path *lsp-name*]

Release Information Statement introduced in Junos OS Release 9.0.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for the QFX VC/VCF Series.

Description Enable an LSP to monitor the status of its destination PE router. You can configure multiple backup PE router groups using the same router's address. Backup PE router groups provide ingress PE router redundancy when point-to-multipoint LSPs are configured for multicast distribution. A failure of this LSP indicates to all of the backup PE router groups that the destination PE router is down. This statement is not tied to a specific backup PE router group. It applies to all groups that are interested in the status of the LSP to the destination address.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Enabling Point-to-Point LSPs to Monitor Egress PE Routers*

associate-lsp

Syntax

```
associate-lsp lsp-name {
   from from-ip-address;
}
```

Hierarchy Level [edit protocols mpls label-switched-path *lsp-name* oam]

Release Information Statement introduced in Junos OS Release 12.1.

Description Configure associated bidirectional label-switched paths (LSPs) on the two ends of an LSP for sending and receiving GAL and G-Ach OAM messages.

Options **from *from-ip-address***—(Optional) Source address for the associated LSP configuration.

If omitted, this is derived from the **to** address of the ingress LSP configuration.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Example: Configuring the MPLS Transport Profile for OAM*

auto-bandwidth

Syntax

```
auto-bandwidth {
  adjust-interval seconds;
  adjust-threshold percent;
  adjust-threshold-activate-bandwidthbps
  adjust-threshold-overflow-limit number;
  adjust-threshold-underflow-limit number;
  maximum-bandwidth bps;
  minimum-bandwidth bps;
  minimum-bandwidth-adjust-interval
  minimum-bandwidth-adjust-threshold-change
  minimum-bandwidth-adjust-threshold-value
  monitor-bandwidth;
}
```

Hierarchy Level [edit protocols mpls label-switched-path *lsp-name*]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.

Description Allow an MPLS tunnel to automatically adjust its bandwidth allocation based on the volume of traffic flowing through the tunnel.

Options The statements are explained separately.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Configuring Automatic Bandwidth Allocation for LSPs*
- *request mpls lsp adjust-autobandwidth*

auto-policing

Syntax

```
auto-policing {
  class all (drop | loss-priority-high | loss-priority-low);
  class ctnumber (drop | loss-priority-high | loss-priority-low);
}
```

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls],
[edit protocols mpls]

Release Information Statement introduced before Junos OS Release 7.4.

Description Enable the automatic policing of all the MPLS LSPs on the router or logical system.

Options

class all—Apply the same policer action to all the class types (**ct0**, **ct1**, **ct2**, and **ct3)**.

class ct*number*—Specific class type (**ct0**, **ct1**, **ct2**, or **ct3)** to which to apply a policer action.

Policer actions—You can specify the following policer actions:

Default: no action

- **drop**—Drop all packets.
- **loss-priority-high**—Set the packet loss priority (PLP) to high.
- **loss-priority-low**—Set the PLP to low.

Required Privilege Level
routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- policing (Protocols MPLS) on page 122
- *Configuring Automatic Policers*v

bandwidth (Fast Reroute, Signaled, and Multiclass LSPs)

Syntax

```
bandwidth bps {
  ct0 bps;
  ct1 bps;
  ct2 bps;
  ct3 bps;
}
```

Hierarchy Level

[edit logical-systems *logical-system-name* protocols mpls],
[edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name*],
[edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name* fast-reroute],
[edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name* (primary | secondary) *path-name*],
[edit protocols mpls],
[edit protocols mpls label-switched-path *lsp-name*],
[edit protocols mpls label-switched-path *lsp-name* fast-reroute],
[edit protocols mpls label-switched-path *lsp-name* (primary | secondary) *path-name*]

Release Information

Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for the QFX VC/VCF Series.

Description

When configuring an LSP, specify the traffic rate associated with the LSP.

When configuring fast reroute, allocate bandwidth for the reroute path. By default, no bandwidth is reserved for the rerouted path. The fast reroute bandwidth does not need to be identical to that allocated for the LSP itself.

When configuring a multiclass LSP, use the **ct*number bandwidth*** statements to specify the bandwidth to be allocated for each class type.

Options

bps—Bandwidth, in bits per second. You can specify this as an integer value. You can also use the abbreviations **k** (for a thousand), **m** (for a million), or **g** (for a billion).

Range: Any positive integer

Default: 0 (no bandwidth is reserved)

NOTE: On the ACX Series, *bps* is the only supported option.

ct*number bps*—Bandwidth for the specified class type, in bits per second. You can specify this as an integer value. If you do so, count your zeros carefully, or you can use the abbreviations **k** (for a thousand), **m** (for a million), or **g** (for a billion [also called a thousand million]).

Range: Any positive integer

Default: 0 (no bandwidth is reserved)

Required Privilege Level
routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring Fast Reroute*
- *Configuring the Bandwidth Value for LSPs*
- *Configuring LSPs for DiffServ-Aware Traffic Engineering*
- *Configuring Multiclass LSPs*

bandwidth-model

Syntax
```
bandwidth-model {
  extended-mam;
  mam;
  rdm;
}
```

Hierarchy Level
[edit logical-systems *logical-system-name* protocols mpls diffserv-te],
[edit protocols mpls diffserv-te]

Release Information
Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for the QFX VC/VCF Series.

Description
Configure the bandwidth model for differentiated services. Note that you cannot configure both bandwidth models at the same time.

Options
extended-mam—The extended maximum allocation model (MAM) is a bandwidth model based on MAM.

mam—The MAM is defined in RFC 4125, *Maximum Allocation Bandwidth Constraints Model for Diffserv-aware MPLS Traffic Engineering*.

rdm—The Russian dolls bandwidth allocation model (RDM) is defined in RFC 4127, *Russian Dolls Bandwidth Constraints Model for Diffserv-aware MPLS Traffic Engineering*. RDM makes efficient use of bandwidth by allowing the class types to share bandwidth.

Required Privilege Level
routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring Routers for DiffServ-Aware Traffic Engineering*

bandwidth-percent

Syntax bandwidth-percent *percentage*;

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name* fast-reroute],
[edit protocols mpls label-switched-path *lsp-name* fast-reroute]

Release Information Statement introduced before Junos OS Release 7.4.

Description Configure the percentage of bandwidth to reserve for the detour path in case the primary path for a traffic engineered LSP or a multiclass LSP fails. The percentage configured indicates the percentage of the protected path's bandwidth that is reserved for the detour path.

Options ***percentage***—The percentage of the protected path's bandwidth that is reserved for the detour path.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Configuring Fast Reroute*
- *Configuring LSPs for DiffServ-Aware Traffic Engineering*
- *Configuring Multiclass LSPs*

bypass (Static LSP)

Syntax

```
bypass bypass-name {
  bandwidth bps;
  description string;
  next-hop (address | interface-name | address/interface-name);
  push out-label;
  to address;
}
```

Hierarchy Level

[edit logical-systems *logical-system-name* protocols mpls static-label-switched-path *lsp-name*],
[edit protocols mpls static-label-switched-path *lsp-name*]

Release Information

Statement introduced before Junos OS Release 10.1.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for the QFX VC/VCF Series.

Description

Configure specific bandwidth and path constraints for a bypass ingress LSP. It is possible to configure multiple bypass LSPs individually. If you do not, they all share the same path and bandwidth constraints.

The remaining statements are explained separately.

Required Privilege Level

routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Configuring Static LSPs*

class-of-service (Protocols MPLS)

Syntax class-of-service *cos-value*;

Hierarchy Level
[edit logical-systems *logical-system-name* protocols mpls],
[edit logical-systems *logical-system-name* protocols mpls static-label-switched-path *lsp-name* ingress],
[edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name*],
[edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name* (primary | secondary) *path-name*],
[edit protocols mpls],
[edit protocols mpls label-switched-path *lsp-name*],
[edit protocols mpls label-switched-path *lsp-name* (primary | secondary) *path-name*],
[edit logical-systems *logical-system-name* protocols mpls static-label-switched-path *lsp-name* ingress]

Release Information
Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description Class-of-service (CoS) value given to all packets in the LSP.

The CoS value might affect the scheduling or queuing algorithm of traffic traveling along an LSP.

Options ***cos-value***—CoS value. A higher value typically corresponds to a higher level of service.

Range: 0 through 7

Default: If you do not specify a CoS value, the IP precedence bits from the packet's IP header are used as the packet's CoS value.

Required Privilege Level
routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Configuring Class of Service for MPLS LSPs*
- *Configuring the Ingress Router for Static LSPs*
- *Configuring Static LSPs*

corouted-bidirectional

Syntax corouted-bidirectional;

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name*], [edit protocols mpls label-switched-path *lsp-name*]

Release Information Statement introduced in Junos OS Release 12.2.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for the QFX VC/VCF Series.

Description Specify that the label-switched path be established as a corouted bidirectional packet LSP. You cannot configure this statement at the same time as the **corouted-bidirectional-passive** statement.

Default This statement is disabled by default.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring Corouted Bidirectional LSPs*
- corouted-bidirectional-passive on page 84

corouted-bidirectional-passive

Syntax corouted-bidirectional-passive;

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name*], [edit protocols mpls label-switched-path *lsp-name*]

Release Information Statement introduced in Junos OS Release 12.2.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for the QFX VC/VCF Series.

Description Specify that the label-switched path be a passive LSP associated with a bidirectional LSP when it is signaled at the ingress router. This passive LSP enables the MPLS application to utilize the reverse LSP. You cannot configure this statement at the same time as the **corouted-bidirectional** statement.

Default This statement is disabled by default.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring Corouted Bidirectional LSPs*
- corouted-bidirectional on page 84

description (Protocols MPLS)

Syntax description *text*;

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name*],
[edit logical-systems *logical-system-name* protocols mpls
static-label-switched-path *lsp-name* bypass],
[edit logical-systems *logical-system-name* protocols mpls
static-label-switched-path *lsp-name* ingress],
[edit logical-systems *logical-system-name* protocols mpls
static-label-switched-path *lsp-name* transit *incoming-label*],
[edit protocols mpls label-switched-path *lsp-name*],
[edit protocols mpls static-label-switched-path *lsp-name* bypass],
[edit protocols mpls static-label-switched-path *lsp-name* ingress],
[edit protocols mpls static-label-switched-path *lsp-name* transit *incoming-label*]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description Provides a textual description of the LSP. Enclose any descriptive text that includes spaces in quotation marks (" "). Any descriptive text you include is displayed in the output of the **show mpls lsp detail** command and has no effect on the operation of the LSP.

Options ***text***—Provide a textual description of the LSP. The description text can be no more than 80 characters in length.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring a Text Description for LSPs*

diffserv-te

Syntax

```
diffserv-te {
  bandwidth-model {
    extended-mam;
    mam;
    rdm;
  }
  te-class-matrix {
    tenumber {
      priority priority;
      traffic-class {
        ctnumber priority priority;
      }
    }
  }
}
```

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls],
[edit protocols mpls]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description Specify properties for differentiated services in traffic engineering.

Options The statements are explained separately.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Configuring Routers for DiffServ-Aware Traffic Engineering*

disable (Protocols MPLS)

Syntax disable;

Hierarchy Level
[edit logical-systems *logical-system-name* protocols mpls],
[edit logical-systems *logical-system-name* protocols mpls interface *interface-name*],
[edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name*],
[edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name* auto-bandwidth],
[edit protocols mpls],
[edit protocols mpls interface *interface-name*],
[edit protocols mpls label-switched-path *lsp-name*]

Release Information
Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description Disable the functionality of the configured object.

Default The configured object is enabled (operational) unless explicitly disabled.

Required Privilege Level
routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Minimum MPLS Configuration*

encoding-type

Syntax encoding-type (ethernet | packet | pdh | sonet-sdh);

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name* lsp-attributes],
[edit protocols mpls label-switched-path *lsp-name* lsp-attributes]

Release Information Statement introduced before Junos OS Release 7.4.

Description Specify the encoding type of payload carried by the LSP. It can be any of the following:

- **ethernet**—Ethernet
- **packet**—Packet
- **pdh**—Plesiochronous digital hierarchy (PDH)
- **sonet-sdh**—SONET/SDH

Default packet

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring the Encoding Type*

exclude (for Fast Reroute)

Syntax (exclude [*group-names*] | no-exclude);

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name* fast-reroute],
[edit protocols mpls label-switched-path *lsp-name* fast-reroute]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced for QFX3500 and QFX 5100 in Junos OS Release 14.1X53-D10.

Description Control exclusion of administrative groups:

- **exclude**—Define the administrative groups to exclude for fast reroute.
- **no-exclude**—Disable administrative group exclusion.

Options ***group-names***—Names of one or more groups defined with the **admin-groups** statement.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring Fast Reroute*
- *admin-groups*

exclude-srlg

Syntax exclude-srlg;

Hierarchy Level
[edit protocols mpls],
[edit logical-systems logical-system-name protocols mpls],
[edit protocols mpls label-switched-path *path-name*],
[edit logical-systems *logical-system-name* protocols mpls label-switched-path *path-name*],
[edit protocols rsvp interface *interface-name* link-protection],
[edit logical-systems *logical-system-name* protocols rsvp interface *interface-name* link-protection],
[edit protocols rsvp interface *interface-name* link-protection bypass *destination*],
[edit logical-systems *logical-system-name* protocols rsvp interface *interface-name* link-protection bypass *destination*]

Release Information
Statement introduced in Junos OS Release 11.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description
Exclude Shared Risk Link Group (SRLG) links for the secondary path for critical links where it is imperative to keep the secondary and primary label-switched paths completely disjoint from any common SRLG.

When specified, the Constrained Shortest Path First (CSPF) algorithm excludes any link belonging to the set of SRLGs in the primary path. When not specified and if a link belongs to the set of SRLGs in the primary path, CSPF adds the SRLG cost to the metric, but still accepts the link for computing the path.

Required Privilege Level
routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Example: Excluding SRLG Links Completely for the Secondary LSP*

explicit-null (Protocols MPLS)

Syntax explicit-null;

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls],
[edit protocols mpls]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description Advertise label 0 to the egress router of an LSP.

Default If you do not include the **explicit-null** statement in the MPLS configuration, label 3 (implicit null) is advertised.

NOTE: Junos OS does not support explicit null routes with next hops to virtual tunnel (vt-) interfaces.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Configuring RSVP to Pop the Label on the Ultimate-Hop Router*

from (Protocols MPLS)

Syntax from *address*;

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name*], [edit protocols mpls label-switched-path *lsp-name*]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description Specify the source address to use for the LSP.

The address you specify does not affect the outgoing interface used by the LSP.

Default If you do not include this statement, the software automatically selects the loopback interface as the address.

Options ***address***—IP address.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Configuring the Ingress and Egress Router Addresses for LSPs*

gpid

Syntax gpid (ethernet | hdlc | ipv4 | pos-scrambling-crc-16 | pos-no-scrambling-crc-16 | pos-scrambling-crc-32 | pos-no-scrambling-crc-32 | ppp);

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name* lsp-attributes],
[edit protocols mpls label-switched-path *lsp-name* lsp-attributes]

Release Information Statement introduced before Junos OS Release 7.4.
pos-scrambling-crc-16, **pos-no-scrambling-crc-16**, **pos-scrambling-crc-32**, and **pos-no-scrambling-crc-32** options added in Junos OS Release 8.0.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description Specify the type of payload carried by the LSP. It can be any of the following:

- **ethernet**—Ethernet (GPID value: 33)
- **hdlc**—High-level Data Link Control (HDLC) (GPID value: 44)
- **ipv4**—IP version 4 (GPID value: 0x0800)
- **pos-no-scrambling-crc-16**—for interoperability with other vendors' equipment (GPID value: 29)
- **pos-no-scrambling-crc-32**—for interoperability with other vendors' equipment (GPID value: 30)
- **pos-scrambling-crc-16**—for interoperability with other vendors' equipment (GPID value: 31)
- **pos-scrambling-crc-32**—for interoperability with other vendors' equipment (GPID value: 32)
- **ppp**—Point-to-Point Protocol (PPP) (GPID value: 50)

Default ipv4

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring MPLS LSPs for GMPLS*

hop-limit

Syntax hop-limit *number*;

Hierarchy Level
[edit logical-systems *logical-system-name* protocols mpls],
[edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name*],
[edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name* fast-reroute],
[edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name* (primary | secondary) *path-name*],
[edit logical-systems *logical-system-name* protocols rsvp interface *interface-name* link-protection],
[edit logical-systems *logical-system-name* protocols rsvp interface *interface-name* link-protection bypass *bypass-name*],
[edit protocols mpls],
[edit protocols mpls label-switched-path *lsp-name*],
[edit protocols mpls label-switched-path *lsp-name* fast-reroute],
[edit protocols mpls label-switched-path *lsp-name* (primary | secondary) *path-name*],
[edit protocols rsvp interface *interface-name* link-protection],
[edit protocols rsvp interface *interface-name* link-protection bypass *bypass-name*]

Release Information
Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description Specify the maximum number of routers that an LSP can traverse. This limit can be applied to any of the following:

- LSPs—The configured hop limit includes the ingress and egress routers. You can specify a hop limit for an LSP and for both primary and secondary paths.
- Fast reroute detour—Specify the number of additional routers a fast reroute detour can traverse relative to the protected LSP. For example, if an LSP traverses 4 routers, any detour for the LSP can be no more than 10 router hops, including the ingress and egress routers.
- Link protection bypass—Specify the maximum number of routers that a link protection bypass can traverse.

Options *number*—Maximum number of hops.

Range: 2 through 255 (for an LSP or for a link protection bypass); 0 through 255 (for fast reroute)

Default: 255 (for an LSP or for a link protection bypass); 6 (for fast reroute)

Required Privilege Level
routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring Fast Reroute*
- *Limiting the Number of Hops in LSPs*

- *Configuring Link Protection on Interfaces Used by LSPs*

include-all (for Fast Reroute)

Syntax (include-all [*group-names*] | no-include-all);

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name* fast-reroute],
[edit protocols mpls label-switched-path *lsp-name* fast-reroute]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 14.1X53-D10 for the QFX Series.

Description Control inclusion of administrative groups:

- **include-all**—Define the administrative groups that must all be included for fast reroute.
- **no-include-all**—Disable administrative group inclusion.

Options *group-names*—One or more names of groups defined with the **admin-groups** statement.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring Fast Reroute*

include-any (for Fast Reroute)

Syntax (include-any [*group-names*] | no-include-any);

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name* fast-reroute],
[edit protocols mpls label-switched-path *lsp-name* fast-reroute]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 14.1X53-D10 for the QFX Series.

Description Control inclusion of administrative groups:

- **include-any**—Define the administrative groups to include for fast reroute.
- **no-include-any**—Disable administrative group inclusion.

Options *group-names*—One or more names of groups defined with the **admin-groups** statement.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring Fast Reroute*

ingress (LSP)

Syntax

```
ingress {
  bandwidth bps;
  class-of-service cos-value;
  description string;
  entropy-label;
  install {
    destination-prefix <active>;
  }
  link-protection bypass-name name;
  metric metric;
  next-hop (address | interface-name | address/interface-name);
  node-protection bypass-name name next-next-label label;
  no-install-to-address;
  policing {
    filter filter-name;
    no-auto-policing;
  }
  preference preference;
  push out-label;
  to address;
}
```

Hierarchy Level

[edit logical-systems *logical-system-name* protocols mpls static-label-switched-path *lsp-name*],
[edit protocols mpls static-label-switched-path *lsp-name*]

Release Information

Statement introduced in Junos OS Release 10.1.
entropy-label option introduced in Junos OS Release 14.1.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description

Configure an ingress LSR for a static LSP.

The remaining statements are explained separately

Required Privilege Level

routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Configuring Static LSPs*

install (Protocols MPLS)

Syntax

```
install {
  destination-prefix <active>;
}
```

Hierarchy Level

[edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name*],
[edit logical-systems *logical-system-name* protocols mpls static-label-switched-path *lsp-name* ingress],
[edit protocols mpls label-switched-path *lsp-name*],
[edit protocols mpls static-label-switched-path *lsp-name* ingress]

Release Information

Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description

Associate one or more prefixes with an LSP. When the LSP is up, all the prefixes are installed as entries into the inet.3 or inet6.3 routing table.

Options

active—(Optional) Install the route into the inet.0 or inet6.0 routing table. This allows you to issue a **ping** or **traceroute** command on this address.

destination-prefix—IPv4 or IPv6 address to associate with the LSP.

Required Privilege Level

routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Adding LSP-Related Routes to the inet.3 or inet6.3 Routing Table*

inter-domain

Syntax inter-domain;

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls label-switched-path *label-switched-path-name*],
[edit protocols mpls label-switched-path *label-switched-path-name*]

Release Information Statement introduced in Junos OS Release 10.2.

Description Allows the router to search for routes in the IGP database. You need to configure this statement on routers that might be unable to locate a path using intra-domain CSPF (by looking in the traffic engineering database (TED). When you configure inter-area or inter-AS LSPs, the **inter-domain** statement is required.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring an LSP Across ASs*
- *label-switched-path*

interface (Protocols MPLS)

Syntax

```
interface (interface-name | all) {
  disable;
  admin-group [ group-names ];
  srlg srlg-name;
}
```

Hierarchy Level

[edit logical-systems *logical-system-name* protocols mpls],
[edit protocols mpls]

Release Information

Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description

Enable MPLS on one or more interfaces.

Options

interface-name—Name of the interface on which to configure MPLS. To configure all interfaces, specify **all**. For details about specifying interfaces, see the *Junos OS Network Interfaces Library for Routing Devices*.

srlg *srlg-name*—Name of the SRLG to associate with an interface.

The remaining options are explained separately.

Required Privilege Level

routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Minimum MPLS Configuration*
- *Configuring Static LSPs*
- *Example: Configuring SRLG*

ipv6-tunneling

Syntax ipv6-tunneling;

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls],
[edit protocols mpls]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description Allow IPv6 routes to be resolved over an MPLS network by converting LDP and RSVP routes stored in the inet.3 routing table to IPv4-mapped IPv6 addresses and then copying them into the inet6.3 routing table. This routing table can be used to resolve next hops for both inet6 and inet6-vpn routes.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Example: Tunneling IPv6 Traffic over MPLS IPv4 Networks*

ldp-tunneling

Syntax ldp-tunneling;

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name*],
[edit protocols mpls label-switched-path *lsp-name*]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric

Description Enable the LSP to be used for LDP tunneling.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring Miscellaneous LDP Properties*

link-protection (Static LSPs)

Syntax link-protection bypass-name *name*;

Hierarchy Level
[edit logical-systems *logical-system-name* protocols mpls
static-label-switched-path *lsp-name* ingress],
[edit logical-systems *logical-system-name* protocols mpls
static-label-switched-path *lsp-name* transit *incoming-label*],
[edit protocols mpls static-label-switched-path *lsp-name* ingress],
[edit protocols mpls static-label-switched-path *lsp-name* transit *incoming-label*]

Release Information Statement introduced in Junos OS Release 10.1.

Description Enable link protection on the specified static LSP. Link protection helps to ensure that traffic sent over a specific interface to a neighboring router can continue to reach the router if that interface fails.

Default Link protection is disabled.

Options **bypass-name *name***—Bypass LSP name.

Required Privilege Level
routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring Static LSPs*
- *Example: Configuring Point-to-Multipoint LSPs with Static Routes*

log-updown (Protocols MPLS)

Syntax

```
log-updown {
  no-trap {
    mpls-lsp-traps;
    rfc3812-traps;
  }
  (syslog | no-syslog);
  trap;
  trap-path-down;
  trap-path-up;
}
```

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls],
[edit protocols mpls]

Release Information Statement introduced before Junos OS Release 7.4.
The **mpls-lsp-traps** and **rfc-3812-traps** options added in Junos OS Release 9.0.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description Log a message or send an SNMP trap whenever an LSP makes a transition from up to down, or vice versa, and whenever an LSP switches from one active path to another. Only the ingress router performs these operations.

NOTE: System log messages for LSPs are generated by default. To disable the default logging of messages for LSPs, configure the **no-syslog** option under the **log-updown** statement.

Default There is no default behavior for this statement. If you do not specify the options, the configuration cannot be committed.

Options **no-syslog**—Do not log a message to the system log file.

no-trap—Do not send an SNMP trap.

syslog—Log a message to the system log file.

trap—Send an SNMP trap.

trap-path-down—Send an SNMP trap when an LSP path goes down.

trap-path-up—Send an SNMP trap when an LSP path comes up.

The **no-trap** statement is explained separately.

Required Privilege Level
routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring System Log Messages and SNMP Traps for LSPs*
- *Network Management Administration Guide for Routing Devices*
- no-trap on page 111
- traceoptions (Protocols MPLS) on page 143

lsp-attributes

Syntax

```
lsp-attributes {
  encoding-type (ethernet | packet | pdh | sonet-sdh);
  gpid (ethernet | hdlc | ipv4 | pos-scrambling-crc-16 | pos-no-scrambling-crc-16 |
    pos-scrambling-crc-32 | pos-no-scrambling-crc-32 | ppp);
  signal-bandwidth type;
  switching-type (fiber | lambda | psc-1 | tdm);
}
```

Hierarchy Level
[edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name*], [edit protocols mpls label-switched-path *lsp-name*]

Release Information
Statement introduced before Junos OS Release 7.4.
pos-scrambling-crc-16, **pos-no-scrambling-crc-16**, **pos-scrambling-crc-32**, and **pos-no-scrambling-crc-32** options added in Junos OS Release 8.0.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description
Define the parameters signaled during LSP setup. These usually determine the nature of the resource (label) allocated for the LSP.

The options are explained separately.

Required Privilege Level
routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring MPLS LSPs for GMPLS*

lsp-ping-interval

Syntax lsp-ping-interval <time-interval>;

Hierarchy Level [edit protocols mpls oam]

Release Information Statement introduced in Junos OS Release 14.1.

Description Configure the time interval between label-switched path (LSP) ping messages.

Options **time-interval**—Configure the time interval in seconds between LSP ping messages.
Range: 30 through 3600 seconds

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring BFD for MPLS IPv4 LSPs*
- *lsp-ping-multiplier*

maximum-bandwidth (Protocols MPLS)

Syntax maximum-bandwidth *bps*;

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name* auto-bandwidth],
[edit protocols mpls label-switched-path *lsp-name* auto-bandwidth]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.

Description Specify the maximum amount of bandwidth in bits per second (bps).

Options *bps*—Maximum amount of bandwidth.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring Automatic Bandwidth Allocation for LSPs*

metric (Protocols MPLS)

Syntax metric *metric*;

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name*],
[edit logical-systems *logical-system-name* protocols mpls
static-label-switched-path *lsp-name* ingress],
[edit protocols mpls label-switched-path *lsp-name*],
[edit protocols mpls static-label-switched-path *lsp-name* ingress]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description Compare against another LSP or against an IGP route. To disable dynamic metric tracking, assign a fixed metric value to an LSP. If no metric is assigned, the LSP metric is dynamic and automatically tracks underlying IGP metrics.

Options ***metric***—LSP metric value.

Default: No metric assigned (dynamic)

Range: 1 through 16,777,215

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring LSP Metrics*

minimum-bandwidth

Syntax minimum-bandwidth *bps*;

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name*
auto-bandwidth],
[edit protocols mpls label-switched-path *lsp-name* auto-bandwidth]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.

Description Set the minimum bandwidth in bps for an LSP with automatic bandwidth allocation enabled.

Options ***bps***—Miniminum bandwidth for the LSP.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring Automatic Bandwidth Allocation for LSPs*

monitor-bandwidth

Syntax monitor-bandwidth;

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name* auto-bandwidth],
[edit protocols mpls label-switched-path *lsp-name* auto-bandwidth]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.

Description Do not automatically adjust bandwidth allocation. However, the maximum average bandwidth utilization is monitored on the LSP, and the information is recorded in the MPLS statistics file.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring Automatic Bandwidth Allocation for LSPs*

mpls-tp-mode

Syntax mpls-tp-mode;

Hierarchy Level [edit protocols mpls label-switched-path *lsp-name* oam],
[edit protocols mpls oam]

Release Information Statement introduced in Junos OS Release 12.1.

Description Enable GAL or G-Ach OAM operation without IP encapsulation on a label-switched path (LSP).

Include this statement at the **[edit protocols mpls oam]** hierarchy level to enable GAL or G-Ach OAM operation without IP encapsulation on all LSPs in the MPLS network. Include this statement at the **[edit protocols mpls label-switched-path *lsp-name* oam]** hierarchy level to enable GAL and G-Ach OAM operation without IP encapsulation on a specific LSP.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Example: Configuring the MPLS Transport Profile for OAM*

next-hop (Protocols MPLS)

Syntax next-hop (*address* | *interface-name* | *address/interface-name*);

Hierarchy Level
[edit logical-systems *logical-system-name* protocols mpls
static-label-switched-path *lsp-name* bypass],
[edit logical-systems *logical-system-name* protocols mpls
static-label-switched-path *lsp-name* ingress],
[edit logical-systems *logical-system-name* protocols mpls
static-label-switched-path *lsp-name* transit *incoming-label*],
[edit protocols mpls static-label-switched-path *lsp-name* bypass],
[edit protocols mpls static-label-switched-path *lsp-name* ingress],
[edit protocols mpls static-label-switched-path *lsp-name* transit *incoming-label*]

Release Information Statement introduced before Junos OS Release 7.4.

Description IP address of the next hop to the destination, specified as the IP address of the next hop, the interface name (for point-to-point interfaces only), or the ***address/interface-name*** to specify an IP address on an operational interface.

Options ***address***—IP address of the next-hop router.

interface-name—IP address of the outgoing interface. It must be a point-to-point interface. The name can be a simple or fully qualified domain name.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring Static LSPs*
- *Configuring Static LSPs*

no-cspf

Syntax no-cspf;

Hierarchy Level
[edit logical-systems *logical-system-name* protocols mpls],
[edit logical-systems *logical-system-name* protocols mplslabel-switched-path *lsp-name*],
[edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name* (primary | secondary) *path-name*],
[edit protocols mpls],
[edit protocols mpls label-switched-path *lsp-name*],
[edit protocols mpls label-switched-path *lsp-name* (primary | secondary) *path-name*]

Release Information
Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 12.3X50 for the QFX Series.

Description Disable constrained-path LSP computation.

An explicit-path LSP is completely configured through operator action. Once configured, it is initiated only along the explicitly specified path.

A constrained-path LSP relies on an ingress router to compute the complete path. The ingress router takes into account the following information during the computation:

- Interior gateway protocol (IGP) topology database
- Link utilization information from extensions in the IGP link-state database
- Administrative group information from extensions in the IGP link-state database
- LSP requirements, including bandwidth, hop count, and administrative group

Constrained-path LSPs can generally avoid link failures and congested links. They also permit recomputation (therefore, a new path) during topology changes or unsuccessful setup.

Default Constrained-path LSP computation enabled.

Required Privilege Level
routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Disabling Constrained-Path LSP Computation*
- *Configuring Explicit-Path LSPs*

no-decrement-ttl

Syntax no-decrement-ttl;

Hierarchy Level
[edit logical-systems *logical-system-name* protocols mpls],
[edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name*],
[edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name* (primary | secondary) *path-name*],
[edit protocols mpls],
[edit protocols mpls label-switched-path *lsp-name*],
[edit protocols mpls label-switched-path *lsp-name* (primary | secondary) *path-name*]

Release Information
Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 12.3X50 for the QFX Series.

Description Disable normal time-to-live (TTL) decrementing, which decrements the TTL field in the IP header by 1. This statement decrements the IP TTL by 1 before encapsulating the IP packet within an MPLS packet. When the penultimate router pops off the top label, it does not use the standard write-back procedure of writing the MPLS TTL into the IP TTL field. Therefore, the IP packet is decremented by 1. The ultimate router then decrements the packet by one more for a total cloud appearance of 2, thus hiding the network topology.

Default Normal TTL decrementing enabled; the TTL field value is decremented by 1 as the packet passes through each label-switched router in the LSP.

Required Privilege Level
routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Disabling Normal TTL Decrementing*
- no-propagate-ttl on page 110

no-install-to-address

Syntax no-install-to-address;

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name*],
[edit logical-systems *logical-system-name* protocols mpls
static-label-switched-path *lsp-name* ingress],
[edit protocols mpls label-switched-path *lsp-name*],
[edit protocols mpls static-label-switched-path *lsp-name* ingress]

Release Information Statement introduced in Junos OS Release 7.4.
Statement introduced in Junos OS Release 12.3X50 for the QFX Series.

Description Prevent the egress router address configured using the **to** statement from being installed into the inet.3 and inet.0 routing tables.

Default The egress router address for an LSP is installed into the inet.3 and inet.0 routing tables.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Preventing the Addition of Egress Router Addresses to Routing Tables*
- to on page 142

no-propagate-ttl

Syntax no-propagate-ttl;

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls],
[edit protocols mpls]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 12.3X50 for the QFX Series.

Description Disable normal time-to-live (TTL) decrementing. You configure this statement once per router, and it affects all RSVP-signaled or LDP-signaled LSPs. When this router acts as an ingress router for an LSP, it pushes an MPLS header with a TTL value of 255, regardless of the IP packet TTL. When the router acts as the penultimate router, it pops the MPLS header without writing the MPLS TTL into the IP packet.

When you add the **no-propagate-ttl** statement to the configuration or delete it from the configuration, the effect takes place immediately. There is no need to clear existing RSVP LSPs or LDP sessions.

Default Normal TTL decrementing enabled; the TTL field value is decremented by 1 as the packet passes through each label-switched router in the LSP.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Disabling Normal TTL Decrementing*
- *Example: Disabling Normal TTL Decrementing in a VRF Routing Instance* (on *Layer 3 VPNs Feature Guide for Routing Devices* or in the *Junos VPNs Configuration Guide*)
- no-decrement-ttl on page 108

no-trap

Syntax

```
no-trap {
  mpls-lsp-traps;
  rfc-3812-traps;
}
```

Hierarchy Level

[edit logical-systems *logical-system-name* protocols mpls log-updown],
[edit protocols mpls log-updown]

Release Information

Statement introduced before Junos OS Release 7.4.
The **mpls-lsp-traps** and **rfc-3812-traps** options added in Junos OS Release 9.0.
Statement introduced in Junos OS Release 12.3X50 for the QFX Series.

Description

Prevent the transmission of SNMP traps.

Options

mpls-lsp-traps—Block the MPLS LSP traps defined in the**rfc-3812-traps**, but allows the **rfc3812.mib** traps.

rfc-3812-traps—Block the traps defined in the **rfc3812.mib**, but allows the MPLS LSP traps defined in the **jnx-mpls.mib**.

Required Privilege Level

routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Configuring System Log Messages and SNMP Traps for LSPs*
- *Network Management Administration Guide for Routing Devices*
- traceoptions (Protocols MPLS) on page 143

node-link-protection (Protocols MPLS)

Syntax node-link-protection;

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name*], [edit protocols mpls label-switched-path *lsp-name*]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 14.1X53-D10 for the QFX Series and for EX4600 switches.

Description Enable node and link protection on the specified LSP. To fully enable node and link protection, you also need to include the **link-protection** statement at the **[edit protocols rsvp interface *interface-name*]** hierarchy level.

Default Node and link protection is disabled.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Configuring Node Protection or Link Protection for LSPs*
- MPLS Feature Support on QFX Series and EX4600 Switches on page 17
- Interprovider and Carrier-of-Carriers VPNs on page 34

node-protection (Static LSP)

Syntax node-protection bypass-name *name* next-next-label *label*;

Hierarchy Level
[edit logical-systems *logical-system-name* protocols mpls
static-label-switched-path *lsp-name* ingress],
[edit logical-systems *logical-system-name* protocols mpls
static-label-switched-path *lsp-name* transit *incoming-label*],
[edit protocols mpls static-label-switched-path *lsp-name* ingress],
[edit protocols mpls static-label-switched-path *lsp-name* transit *incoming-label*]

Release Information Statement introduced in JUNOS Release 10.1.

Description Enable node protection on the specified static bypass LSP. Node protection ensures that traffic from an LSP traversing a neighboring router can continue to reach its destination even if the neighboring router fails.

Default Node protection is disabled.

Options
bypass-name *name*—Bypass LSP name.

next-next-label *label*—Bypass LSP name.

Required Privilege Level
routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring Static LSPs*

oam (Protocols MPLS)

Syntax

```
oam {
  bfd-liveness-detection{
    failure-action teardown;
    minimum-interval milliseconds;
    minimum-receive-interval milliseconds;
    minimum-transmit-interval milliseconds;
    multiplier detection-time-multiplier;
  }
  lsp-ping-interval seconds;
  mpls-tp-mode;
}
```

Hierarchy Level

[edit protocols mpls],
[edit protocols mpls label-switched-path *lsp-name*]
[edit protocols mpls label-switched-path *lsp-name* primary *path-name*]

Release Information

Statement introduced in Junos OS Release 7.6.
lsp-ping-interval option introduced in Junos OS Release 9.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description

Enable Operation, Administration, and Maintenance (OAM) for RSVP-signaled LSPs.

Options

lsp-ping-interval *seconds*—Specify the duration of the LSP ping interval in seconds. To issue a ping on an RSVP-signaled LSP, use the **ping mpls rsvp** command.

The remaining statements are explained separately.

Required Privilege Level

routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Configuring BFD for MPLS IPv4 LSPs*

optimize-aggressive

Syntax optimize-aggressive;

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls],
[edit protocols mpls]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 12.3X50 for the QFX Series.

Description If enabled, the LSP reoptimization is based solely on the IGP metric. The reoptimization process ignores the available bandwidth ratio calculations, the least-fill 10 percent congestion improvement rule, and the hop-counts rule. This statement makes reoptimization more aggressive than the default.

Default Aggressive optimization is disabled.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Optimizing Signaled LSPs*

optimize-hold-dead-delay

Syntax optimized-hold-dead-delay *seconds*;

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls],
[edit logical-systems *logical-system-name* protocols mpls label-switch-path *lsp-name*],
[edit protocols mpls],
[edit protocols mpls label-switch-path *lsp-name*]

Description Allows you to specify the amount of time to delay the tear down of old paths after the router has switched traffic to new optimized paths. You only need to configure this statement on routers acting as the ingress for the affected LSPs (you do not need to configure this statement on transit or egress routers). The specified delay helps to ensure that old paths are not torn down before all routes have been switched over to the new optimized paths. This delay timer starts when the timer specified by the **optimize-switchover-dealy** statement has elapsed.

Options ***seconds***—Configure the time in seconds to wait before tearing down the old paths that were in use prior to the last LSP optimization.

Default: 60 seconds

Range: 0 through 65,535 seconds

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Optimizing Signaled LSPs*
- optimize-switchover-delay on page 117
- optimize-timer on page 118

optimize-switchover-delay

Syntax optimize-switchover-delay *seconds*;

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls],
[edit protocols mpls]

Release Information Statement introduced in Junos OS Release 11.1R1.
Statement introduced in Junos OS Release 12.3X50 for the QFX Series.

Description Delays the switch over of LSPs to newly optimized paths. You only need to configure this statement on routers acting as the ingress for the affected LSPs (you do not need to configure this statement on transit or egress routers). The specified delay helps to ensure that the new optimized paths have been established before traffic is switched over from the old paths.

Options ***seconds***—Configure the time in seconds to wait before switching LSPs to newly optimized paths.

Default: 1 second

Range: 1 through 900 seconds

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Optimizing Signaled LSPs*
- optimize-hold-dead-delay on page 116
- optimize-timer on page 118

optimize-timer (Protocols MPLS)

Syntax optimize-timer *seconds*;

Hierarchy Level
[edit logical-systems *logical-system-name* protocols mpls],
[edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name*],
[edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name* (primary | secondary) *path-name*],
[edit protocols mpls],
[edit protocols mpls label-switched-path *lsp-name*],
[edit protocols mpls label-switched-path *lsp-name* (primary | secondary) *path-name*]

Release Information
Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description Enable periodic reoptimization of an LSP that is already set up. If topology changes occur, an existing path might become suboptimal, and a subsequent recomputation might be able to determine a better path. This feature is useful only on LSPs for which constrained-path computation is enabled; that is, for which the **no-cspf** statement is not configured. Also, you only need to configure this statement on routers acting as the ingress for the affected LSPs (you do not need to configure this statement on transit or egress routers).

To avoid extensive resource consumption that might result because of frequent path recomputations, or to avoid destabilizing the network as a result of constantly changing LSPs, we recommend that you either leave the timer value sufficiently large or disable the timer value.

Default The optimize timer is disabled.

Options ***seconds***—Length of the optimize timer, in seconds.

Range: 0 through 65,535 seconds

Default: 0 seconds (the optimize timer is disabled)

Required Privilege Level
routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Optimizing Signaled LSPs*

path (Protocols MPLS)

Syntax

```
path path-name {
  (address | hostname) <strict | loose>;
}
```

Hierarchy Level

[edit logical-systems *logical-system-name* protocols mpls],
[edit protocols mpls]

Release Information

Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description

Create a named path and optionally specify the sequence of explicit routers that form the path.

You must include this statement when configuring explicit LSPs.

Options

address—IP address of each transit router in the LSP. You must specify the address or hostname of each transit router, although you do not need to list each transit router if its type is **loose**. As an option, you can include the ingress and egress routers in the path. Specify the addresses in order, starting with the ingress router (optional) or the first transit router, and continuing sequentially along the path until reaching the egress router (optional) or the router immediately before the egress router.

Default: If you do not specify any routers explicitly, no routing limitations are imposed on the LSP.

hostname—See ***address***.

Default: If you do not specify any routers explicitly, no routing limitations are imposed on the LSP.

loose—(Optional) Indicate that the next address in the **path** statement is a loose link. This means that the LSP can traverse through other routers before reaching this router.

Default: **strict**

path-name—Name that identifies the sequence of nodes that form an LSP. The name can contain up to 32 characters and can include letters, digits, periods, and hyphens. To include other characters or use a longer name, enclose the name in quotation marks. The name must be unique within the ingress router.

strict—(Optional) Indicate that the LSP must go to the next address specified in the **path** statement without traversing other nodes. This is the default.

Required Privilege Level

routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Creating Named Paths*

path-mtu

Syntax

```
path-mtu {
  allow-fragmentation;
  rsvp {
    mtu-signaling;
  }
}
```

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls],
[edit protocols mpls]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description Configure MTU options for MPLS paths, including packet fragmentation and MTU signaling.

The remaining statements are explained separately.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Configuring MTU Signaling in RSVP*

p2mp (Protocols MPLS)

Syntax p2mp *p2mp-lsp-name*;

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name*], [edit protocols mpls label-switched-path *lsp-name*]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description Specify an LSP as either a point-to-multipoint LSP or as a branch LSP of a point-to-multipoint LSP by specifying the point-to-multipoint LSP path name.

Options ***p2mp-lsp-name***—Name of the point-to-multipoint LSP path that identifies the sequence of nodes that form the point-to-multipoint LSP. The name can contain up to 32 characters and can include letters, digits, periods, and hyphens. To include other characters or use a longer name, enclose the name in quotation marks. The name must be unique within the ingress router.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Configuring Primary and Branch LSPs for Point-to-Multipoint LSPs*

policing (Protocols MPLS)

Syntax

```
policing {
  filter filter-name;
  no-auto-policing;
}
```

Hierarchy Level

[edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name*],
[edit logical-systems *logical-system-name* protocols mpls
static-label-switched-path *lsp-name* ingress],
[edit protocols mpls label-switched-path *lsp-name*],
[edit protocols mpls static-label-switched-path *lsp-name* ingress]

Release Information

Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description

Specify the policing filter for the LSP.

Options

filter *filter-name*—Specify the name of the policing filter.

no-auto-policing—Disable automatic policing on this LSP.

Required Privilege Level

routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Configuring MPLS Firewall Filters and Policers*
- auto-policing on page 78

pop

Syntax pop;

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls
static-label-switched-path *lsp-name* transit *incoming-label*],
[edit protocols mpls static-label-switched-path *lsp-name* transit *incoming-label*]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description Remove the label from the top of the label stack. If there is another label in the stack, that label becomes the label at the top of the label stack. Otherwise, the packet is forwarded as a native protocol packet (typically, as an IP packet).

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Configuring the Intermediate and Egress Routers for Static LSPs*
- swap on page 137

preference (Protocols MPLS)

Syntax preference *preference*;

Hierarchy Level
[edit logical-systems *logical-system-name* protocols mpls],
[edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name*],
[edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name* (primary | secondary) *path-name*],
[edit logical-systems *logical-system-name* protocols mpls static-label-switched-path *lsp-name* ingress],
[edit protocols mpls],
[edit protocols mpls label-switched-path *lsp-name*],
[edit protocols mpls label-switched-path *lsp-name* (primary | secondary) *path-name*],
[edit protocols mpls static-label-switched-path *lsp-name* ingress]

Release Information
Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description Preference for the route.

You can optionally configure multiple LSPs between the same pair of ingress and egress routers. This is useful for balancing the load among the LSPs because all LSPs, by default, have the same preference level. To prefer one LSP over another, set different preference levels for individual LSPs. The LSP with the lowest preference value is used. The default preference for LSPs is lower (more preferred) than all learned routes except direct interface routes.

Options
preference—Preference to assign to the route. A route with a lower preference value is preferred.

Range: 1 through 255

Default: 5 for static MPLS LSPs, 7 for RSVP MPLS LSPs, 9 for LDP MPLS LSPs

Required Privilege Level
routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring Preference Values for LSPs*
- *Configuring Static LSPs*
- *Configuring Static LSPs*

primary (Protocols MPLS)

Syntax

```
primary path-name {
  adaptive;
  admin-group {
    exclude [ group-names ];
    include-all [ group-names ];
    include-any [ group-names ];
  }
  bandwidth bps;
  class-of-service cos-value;
  hop-limit number;
  no-cspf;
  no-decrement-ttl;
  optimize-timer seconds;
  preference preference;
  priority setup-priority reservation-priority;
  (record | no-record);
  select (manual | unconditional);
  standby;
}
```

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name*], [edit protocols mpls label-switched-path *lsp-name*]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description Specify the primary path to use for an LSP. You can configure only one primary path.

You can optionally specify preference, CoS, and bandwidth values for the primary path, which override any equivalent values that you configure for the LSP (at the **[edit mpls label-switched-path *lsp-name*]** hierarchy level).

Options *path-name*—Name of a path that you created with the **path** statement.

The remaining statements are explained separately.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Configuring Primary and Secondary LSPs*

push

Syntax push *out-label*;

Hierarchy Level
[edit logical-systems *logical-system-name* protocols mpls
static-label-switched-path *lsp-name* bypass],
[edit logical-systems *logical-system-name* protocols mpls
static-label-switched-path *lsp-name* ingress],
[edit protocols mpls static-label-switched-path *lsp-name* bypass],
[edit protocols mpls static-label-switched-path *lsp-name* ingress]

Release Information
Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description Add a new label to the top of the label stack. This statement is used to configure static LSPs at ingress routers and to configure bypass LSPs for static LSPs.

Options ***out-label***—Manually assigned outgoing label value.

Range: 0 through 1,048,575.

Required Privilege Level
routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- pop on page 123
- swap on page 137
- *Configuring Static LSPs*

record

Syntax (record | no-record);

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls],
[edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name*],
[edit logical-systems *logical-system-name* protocols mpls label-switched-path (primary | secondary) *path-name*],
[edit protocols mpls],
[edit protocols mpls label-switched-path *lsp-name*],
[edit protocols mpls label-switched-path *lsp-name* (primary | secondary) *path-name*]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description Specify whether an LSP should actively record the routes in the path. Recording routes requires that all transit routers support the RSVP Record Route object. Recording routes can be useful for diagnostics and loop detection.

Default Record routes.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Disabling Path Route Recording*

retry-limit

Syntax retry-limit *number*;

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name*], [edit protocols mpls label-switched-path *lsp-name*],

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description Maximum number of times the ingress router tries to establish the primary path. This counter is reset each time a primary path is created successfully. When the limit is exceeded, no more connection attempts are made. Intervention is then required to restart the connection.

Options ***number***—Maximum number of tries to establish the primary path.

Range: 0 through 10,000

Default: 0 (The ingress node never stops trying to establish the primary path.)

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Configuring the Connection Between Ingress and Egress Routers*

revert-timer

Syntax revert-timer *seconds*;

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls],
[edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name*],
[edit protocols mpls],
[edit protocols mpls label-switched-path *lsp-name*]

Release Information Statement introduced before Junos OS Release 7.4.
BFD behavior modified in Junos OS Release 9.0.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description Specify the amount of time (in seconds) that an LSP must wait before traffic reverts to a primary path. If during this time the primary path experiences any connectivity problem or stability problem, the timer is restarted.

If you have configured BFD on the LSP, the Junos OS waits until the BFD session is restored before starting the revert timer counter.

If you have configured a value of 0 seconds for the **revert-timer** statement and traffic is switched to the secondary path, the traffic remains on that path indefinitely. It is never switched back to the primary path unless you intervene.

Options ***seconds***—Time in seconds.

Range: 0 through 65,535 seconds

Default: 60 seconds

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Configuring Primary and Secondary LSPs*

secondary (Protocols MPLS)

Syntax

```
secondary path-name {
  adaptive;
  admin-group {
    exclude [ group-names ];
    include-all [ group-names ];
    include-any [ group-names ];
  }
  bandwidth bps;
  class-of-service cos-value;
  hop-limit number;
  no-cspf;
  no-decrement-ttl;
  optimize-timer seconds;
  preference preference;
  priority setup-priority reservation-priority;
  (record | no-record);
  retry-limit number;
  retry-timer seconds;
  select (manual | unconditional);
  standby;
}
```

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name*], [edit protocols mpls label-switched-path *lsp-name*]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description Specify one or more secondary paths to use for the LSP. You can configure more than one secondary path. All secondary paths are equal, and the first one that is available is chosen.

You can specify secondary paths even if you have not specified any primary paths.

Optionally, you can specify preference, CoS, and bandwidth values for the secondary path, which override any equivalent values that you configure for the LSP (at the **[edit mpls label-switched-path]** hierarchy level).

Options ***path-name***—Name of a path that you created with the **path** statement.

The remaining statements are explained separately.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Configuring Primary and Secondary LSPs*

select

Syntax select (manual | unconditional);

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name* (primary | secondary) *path-name*],
[edit protocols mpls label-switched-path *lsp-name* (primary | secondary) *path-name*]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description Specify the conditions under which the path is selected to carry traffic. The **manual** and **unconditional** options are mutually exclusive.

Options

manual—The path is selected for carrying traffic if it is up and stable for at least the revert timer window (potentially before the revert timer has elapsed). Traffic is sent to other working paths if the current path is down or degraded (receiving errors).

unconditional—The path is always selected for carrying traffic, even if it is currently down or degraded (receiving errors).

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Configuring Primary and Secondary LSPs*

signal-bandwidth

Syntax signal-bandwidth *type*;

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name* lsp-attributes],
[edit protocols mpls label-switched-path *lsp-name* lsp-attributes]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description Specify the bandwidth encoding of the signal used for path computation and admission control.

Options *type*—Configure the type of bandwidth encoding used on the LSP. It can be any of the following values: **10gigether**, **ds1**, **ds3**, **e1**, **e3**, **ethernet**, **fastether**, **gigether**, **stm-1**, **stm-4**, **stm-16**, **stm-64**, **stm-256, sts-1**, **vt1-5**, or **vt2**.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring MPLS LSPs for GMPLS*

standby

Syntax standby;

Hierarchy Level
[edit logical-systems *logical-system-name* protocols mpls],
[edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name*],
[edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name* (primary | secondary) *path-name*],
[edit protocols mpls],
[edit protocols mpls label-switched-path *lsp-name*],
[edit protocols mpls label-switched-path *lsp-name* (primary | secondary) *path-name*]

Release Information
Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description Have the path remain up at all times to provide instant switchover if connectivity problems occur.

Required Privilege Level
routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring Hot Standby of Secondary Paths*

static-label-switched-path

Syntax

```
static-label-switched-path lsp-name {
  bypass bypass-name {
    bandwidth bps;
    description string;
    next-hop (address | interface-name | address/interface-name);
    push out-label;
    to address;
  }
  ingress {
    bandwidth bps;
    class-of-service cos-value;
    description string;
    install {
      destination-prefix <active>;
    }
    link-protection bypass-name name;
    metric metric;
    next-hop (address | interface-name | address/interface-name);
    node-protection bypass-name name next-next-label label;
    no-install-to-address;
    policing {
      filter filter-name;
      no-auto-policing;
    }
    preference preference;
    push out-label;
    to address;
  }
  transit incoming-label {
    bandwidth bps;
    description string;
    link-protection bypass-name name;
    next-hop (address | interface-name | address/interface-name);
    node-protection bypass-name name next-next-label label;
    pop;
    swap out-label;
  }
```

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls],
[edit protocols mpls]

Release Information Statement introduced in Junos OS Release 10.1.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description Configure a static LSP.

Options *lsp-name*—Name of the path.

The remaining statements are explained separately.

Required Privilege Level
routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring Static LSPs*

statistics (Protocols MPLS)

Syntax

```
statistics {
  auto-bandwidth;
  file filename <files number> <size size> <world-readable | no-world-readable>;
  interval seconds;
  no-transit-statistics;
}
```

Hierarchy Level

[edit logical-systems *logical-system-name* protocols mpls],
[edit protocols mpls]

Release Information

Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description

Enable MPLS statistics collection and reporting.

Options

file *filename*—(Optional) Name of the file to receive the output. We recommend that you place MPLS tracing output in the file mpls-stat in the /var/log directory.

files *number*—(Optional) Maximum number of trace files. When a trace file named *file* reaches its maximum size, it is renamed *file*.0, then *file*.1, and so on, until the maximum number of files is reached. Then, the oldest file is overwritten.

Range: 2 or more

Default: 2 files

If you specify a maximum number of files, you also must specify a maximum file size with the **size** option.

interval *seconds*—Interval at which to periodically collect statistics.

Range: 1 through 65,535

Default: 300 seconds

no-world-readable—(Optional) Prevent users from reading the log file.

size *size*—(Optional) Maximum size of each file, in kilobytes (KB), megabytes (MB), or gigabytes (GB). When a file named *file* reaches this size, it is renamed *file*.0. When the *file* again reaches its maximum size, *file*.0 is renamed *file*.1 and *file* is renamed *file*.0. This renaming scheme continues until the maximum number of files is reached. Then the oldest trace file is overwritten.

Syntax: Syntax: ***x*k** to specify KB, ***x*m** to specify MB, or ***x*g** to specify GB

Range: 10 KB through the maximum file size supported on your system

Default: 1 MB

If you specify a maximum file size, you also must specify a maximum number of files with the **files** option.

world-readable—(Optional) Enable users to read the log file.

The other statements are explained separately.

Required Privilege Level
routing and trace—To view this statement in the configuration.
routing-control and trace-control—To add this statement to the configuration.

Related Documentation
- *Configuring MPLS to Gather Statistics*
- *Configuring Automatic Bandwidth Allocation for LSPs*

swap

Syntax
swap *out-label*;

Hierarchy Level
[edit logical-systems *logical-system-name* protocols mpls static-label-switched-path *lsp-name* transit *incoming-label*],
[edit protocols mpls static-label-switched-path *lsp-name* transit *incoming-label*]

Release Information
Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description
Remove the label at the top of the label stack and replace it with the specified label. Manually assigned incoming labels can have values from 1,000,000 through 1,048,575. This statement is used to configure static LSPs at transit routers.

Options
out-label—Manually assigned outgoing label value.

Range: 0 through 1,048,575

Default: If you do not define the ***out-label*** option, the original label value remains unchanged.

Required Privilege Level
routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- pop on page 123
- push on page 126
- *Configuring Static LSPs*

switching-type

Syntax switching-type (fiber | lambda | psc-1 | tdm);

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name* lsp-attributes],
[edit protocols mpls label-switched-path *lsp-name* lsp-attributes]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description Specify the switching method for the LSP. The switching method can be one of the following values:

- **fiber**—Fiber switching
- **lambda**—Lambda switching
- **psc-1**—Packet switching
- **tdm**—Time-division multiplexing (TDM) switching

Default psc-1

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring MPLS LSPs for GMPLS*

traffic-engineering (Protocols MPLS)

Syntax traffic-engineering (bgp | bgp-igp | bgp-igp-both-ribs | mpls-forwarding);

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls],
[edit protocols mpls]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 12.1 for EX Series switches.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description Select whether MPLS performs traffic engineering on BGP destinations only or on both BGP and IGP destinations. Affects only LSPs originating from this routing device, not transit or egress LSPs.

Default bgp

Options

bgp—On BGP destinations only. Ingress routes are installed in the inet.3 routing table.

bgp-igp—On both BGP and IGP destinations. Ingress routes are installed in the inet.0 routing table. If IGP shortcuts are enabled, the shortcut routes are automatically installed in the inet.0 routing table.

bgp-igp-both-ribs—On both BGP and IGP destinations. Ingress routes are installed in the inet.0 and inet.3 routing tables. This option is used to support VPNs.

mpls-forwarding—On both BGP and IGP destinations. Use ingress routes for forwarding only, not for routing.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Configuring Traffic Engineering for LSPs*
- *Configuring MPLS on Provider Edge Switches Using IP Over MPLS (CLI Procedure)*

transit-lsp-association

Syntax

```
transit-lsp-association transit-association-lsp-group-name {
    from-1 address-of-associated-lsp-1;
    from-2 address-of-associated-lsp-2;
    lsp-name-1 name-of-associated-lsp-1;
    lsp-name-2 name-of-associated-lsp-2;
}
```

Hierarchy Level [edit protocols mpls]

Release Information

Statement introduced in Junos OS Release 12.1.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description Associate two label-swiched paths (LSPs) at a transit node to configure a path for sending and receiving GAL and G-Ach messages for MPLS-TP OAM.

Options

transit-association-lsp-group-name—Name of the transit association LSP group.

from-1 ***address-of-associated-lsp-1***—Address of the first associated LSP.

from-2 ***address-of-associated-lsp-2***—Address of the second associated LSP.

lsp-name-1 ***name-of-associated-lsp-1***—Name of the first associated LSP.

lsp-name-2 ***name-of-associated-lsp-1***—Name of the second associated LSP.

Required Privilege Level

routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Example: Configuring the MPLS Transport Profile for OAM*

te-class-matrix

Syntax

```
te-class-matrix {
  tenumber {
    priority priority;
    traffic-class {
      ctnumber priority priority;
    }
  }
}
```

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls diffserv-te],
[edit protocols mpls diffserv-te]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description Specify the traffic engineering class matrix for a multiclass LSP or a DiffServ-aware traffic engineering LSP.

Default The default traffic engineering class matrix is:

```
te-class-matrix {
  te0 traffic-class ct0 priority 7;
  te1 traffic-class ct1 priority 7;
  te2 traffic-class ct2 priority 7;
  te3 traffic-class ct3 priority 7;
  te4 traffic-class ct0 priority 0;
  te5 traffic-class ct1 priority 0;
  te6 traffic-class ct2 priority 0;
  te7 traffic-class ct3 priority 0;
}
```

If you define any of the traffic engineering classes, all the default values are dropped.

Options

ct*number*—Specify the number of the class type. It can be one of four values: **ct0**, **ct1**, **ct2**, or **ct3**.

priority *priority*—Specify the priority of the class type. It can be one of eight values from 0 through 7.

te*number*—Specify the number of the traffic engineering class. It can be one of eight values: **te0**, **te1**, **te2**, **te3**, **te4**, **te5**, **te6**, or **te7**. You must configure the traffic engineering classes in order, starting with **te0**.

traffic-class—Specify the traffic class for the traffic engineering class.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring Routers for DiffServ-Aware Traffic Engineering*

to

Syntax to *address*;

Hierarchy Level
[edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name*],
[edit logical-systems *logical-system-name* protocols mpls static-label-switched-path *lsp-name* bypass],
[edit logical-systems *logical-system-name* protocols mpls static-label-switched-path *lsp-name* ingress],
[edit protocols mpls label-switched-path *lsp-name*],
[edit protocols mpls static-label-switched-path *lsp-name* bypass],
[edit protocols mpls static-label-switched-path *lsp-name* ingress]

Release Information
Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 12.3X50 for the QFX Series.

Description Specify the egress router of a dynamic LSP.

Options ***address***—Address of the egress router.

Required Privilege Level
routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring the Ingress and Egress Router Addresses for LSPs*

traceoptions (Protocols MPLS)

Syntax

```
traceoptions {
  file filename <files number> <size size> <world-readable | no-world-readable>;
  flag flag;
}
```

Hierarchy Level

[edit logical-systems *logical-system-name* protocols mpls],
[edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name*],
[edit protocols mpls],
[edit protocols mpls label-switched-path *lsp-name*]

Release Information

Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description

Configure MPLS tracing options at the protocol level or for a label-switched path.

To specify more than one tracing operation, include multiple **flag** statements.

Default

The default MPLS protocol-level tracing options are inherited from the routing protocols **traceoptions** statement included at the **[edit routing-options]** hierarchy level.

Options

filename—Name of the file to receive the output of the tracing operation. All files are placed in the directory **/var/log**. We recommend that you place MPLS tracing output in the file **mpls-log**.

files *number*—(Optional) Maximum number of trace files. When a trace file named ***trace-file*** reaches its maximum size, it is renamed ***trace-file*.0**, then ***trace-file*.1**, and so on, until the maximum number of trace files is reached. Then the oldest trace file is overwritten.

Range: 2 through 1000

Default: 2 files

If you specify a maximum number of files, you must also include the **size** statement to specify the maximum file size.

flag—Tracing operation to perform. To specify more than one tracing operation, include multiple **flag** statements.

MPLS Tracing Flags

- **all**—Trace all operations
- **autobw-state**—Automatic bandwidth events.
- **connection**—All circuit cross-connect (CCC) activity
- **connection-detail**—Detailed CCC activity
- **cspf**—CSPF computations

- **cspf-link**—Links visited during CSPF computations
- **cspf-node**—Nodes visited during CSPF computations
- **error**—MPLS error packets
- **graceful-restart**—Trace MPLS graceful restart events
- **lsping**—Trace lsping packets and return codes
- **nsr-synchronization**—Trace NSR synchronization events
- **nsr-synchronization-detail**—Trace NSR synchronization events in detail
- **state**—All LSP state transitions
- **static**—Trace static label-switched path
- **timer**—Timer usage

no-world-readable—(Optional) Allow only certain users to read the log file.

size *size*—(Optional) Maximum size of each trace file, in kilobytes (KB), megabytes (MB), or gigabytes (GB). When a trace file named ***trace-file*** reaches this size, it is renamed ***trace-file*.0**. When the ***trace-file*** again reaches this size, ***trace-file*.0** is renamed ***trace-file*.1** and ***trace-file*** is renamed ***trace-file*.0**. This renaming scheme continues until the maximum number of trace files is reached. Then the oldest trace file is overwritten.

Syntax: ***x*k** to specify KB, ***x*m** to specify MB, or ***x*g** to specify GB

Range: 10 KB through the maximum file size supported on your system

Default: 1 MB

If you specify a maximum file size, you must also include the **files** statement to specify the maximum number of files.

world-readable—(Optional) Allow any user to read the log file.

Required Privilege Level

routing and trace—To view this statement in the configuration.
routing-control and trace-control—To add this statement to the configuration.

Related Documentation

- *Tracing MPLS and LSP Packets and Operations*

transit

Syntax

```
transit incoming-label {
  bandwidth bps;
  description string;
  link-protection bypass-name name;
  next-hop (address | interface-name | address/interface-name);
  node-protection bypass-name name next-next-label label;
  pop;
  stitch {
    bandwidth bps;
    description string;
    link-protection bypass-name name;
    next-hop (address | interface-name | address/interface-name);
    node-protection bypass-name name next-next-label label;
  }
  swap out-label;
}
```

Hierarchy Level

[edit logical-systems *logical-system-name* protocols mpls static-label-switched-path *lsp-name*],
[edit protocols mpls static-label-switched-path *lsp-name*]

Release Information

Statement introduced in Junos OS Release 10.1.
Statement introduced in Junos OS Release 12.3X50 for the QFX Series.
Statement updated to include switch option in Junos OS Release 14.1X53-D25

Description

Configure a transit static LSP.

The remaining statements are explained separately.

Options

incoming-label—Incoming label value.

Range: 1000000 through 1048575

Required Privilege Level

routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Configuring Static LSPs*
- *Using MPLS Stitching with BGP to Connect Virtual Machines*

Monitoring Commands for MPLS

- show mpls call-admission-control
- show mpls cspf
- show mpls diffserv-te
- show route forwarding-table
- show mpls interface
- show mpls lsp

- show mpls lsp autobandwidth
- show mpls path
- show mpls static-lsp

show mpls call-admission-control

List of Syntax
Syntax on page 147
Syntax (EX Series Switches) on page 147

Syntax
show mpls call-admission-control
<logical-system (all | *logical-system-name*)>
<*lsp-name*>

Syntax (EX Series Switches)
show mpls call-admission-control
<*lsp-name*>

Release Information
Command introduced before Junos OS Release 7.4.
Command introduced in Junos OS Release 9.5 for EX Series switches.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description
Display Multiprotocol Label Switching (MPLS) label-switched path (LSP) call admission control (CAC) information.

Options
none—Display CAC information for all LSPs.

logical-system (all | *logical-system-name*)—(Optional) Perform this operation on all logical systems or on a particular logical system.

lsp-name—(Optional) Display CAC information for the specified LSP only.

Additional Information
The available bandwidth on an LSP path at a particular class type is the total path bandwidth at that class type minus the total bandwidth reserved by any Layer 2 connection at that class type.

Required Privilege Level
view

List of Sample Output
show mpls call-admission-control on page 148

Output Fields
Table 11 on page 147 describes the output fields for the **show mpls call-admission-control** command. Output fields are listed in the approximate order in which they appear.

Table 11: show mpls call-admission-control Output Fields

Field Name	Field Description
Available bandwidth	Current available bandwidth on each LSP path. Depending on whether the LSP is an E-LSP or a regular LSP, either per-class bandwidth or a single bandwidth value (corresponding to best-effort bandwidth at **ct0**) is displayed. The available bandwidth on an LSP path at a particular class type is the total path bandwidth at that class type minus the total bandwidth reserved by some Layer 2 connections at that class type.
Layer2 connections	Different Layer 2 connections that had some bandwidth requirement and were admitted into an LSP path.

Table 11: show mpls call-admission-control Output Fields *(continued)*

Field Name	Field Description
LSP name	LSP pathname.
Neighbor address	Neighbor address from which CAC and bandwidth booking are configured for Layer 2 circuits.
Circuit	Interface name and circuit information.
Primary	LSP's primary standby path.
Standby	LSP's secondary standby path.
VC bandwidth	Bandwidth constraints associated with a Layer 2 circuit route.

Sample Output

show mpls call-admission-control

```
user@host# show mpls call-admission-control

LSP name: pro1-be
 *Primary
  Available bandwidth: 0bps

LSP name: pro1-be-1
 *Primary
  Available bandwidth: 60kbps

LSP name: pro1-be-gold
 *Primary
  Available bandwidth: <ct0 50kbps> <ct1 20kbps> <ct2 30kbps> <ct3 0bps>
    Layer2 connections:
    Neighbor address: 10.255.245.215, Circuit: so-0/3/0.0(vc 5)
    VC bandwidth: <ct0 50kbps> <ct1 40kbps> <ct2 40kbps>

LSP name: pro1-be-gold-2
 *Primary
  Available bandwidth: <ct0 0bps> <ct1 40kbps> <ct2 40kbps> <ct3 0bps>

LSP name: pro1-be-silver
 *Primary   prim1
  Available bandwidth: <ct0 10kbps> <ct1 20kbps> <ct2 0bps> <ct3 40kbps>
    Layer2 connections:
    Neighbor address: 10.255.245.215, Circuit: so-0/3/0.1(vc 3)
    VC bandwidth: <ct0 20kbps> <ct1 20kbps>
  Standby   sec1
  Available bandwidth: <ct0 10kbps> <ct1 10kbps> <ct2 20kbps> <ct3 0bps>
    Layer2 connections:
    Neighbor address: 10.255.245.215, Circuit: so-0/3/0.1(vc 3)
    VC bandwidth: <ct0 20kbps> <ct1 20kbps>
```

show mpls cspf

List of Syntax
Syntax on page 149
Syntax (EX Series Switches) on page 149

Syntax
show mpls cspf
<logical-system (all | *logical-system-name*)>

Syntax (EX Series Switches)
show mpls cspf

Release Information
Command introduced before Junos OS Release 7.4.
Command introduced in Junos OS Release 9.5 for EX Series switches.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description
Display Multiprotocol Label Switching (MPLS) Constrained Shortest Path First (CSPF) statistics.

Options
none—Display MPLS CSFP statistics.

logical-system (all | *logical-system-name*)—(Optional) Perform this operation on all logical systems or on a particular logical system.

Required Privilege Level
view

List of Sample Output
show mpls cspf on page 150

Output Fields
Table 12 on page 149 describes the output fields for the **show mpls cspf** command. Output fields are listed in the approximate order in which they appear.

Table 12: show mpls cspf Output Fields

Field Name	Field Description
Queue length	Number of LSPs queued for automatic path computation.
current	Current queue length.
maximum	Maximum queue length (high-water mark).
dequeued	Number of aborted computation attempts.
Paths	Counters for label-switched path computations.
total	Sum of the next four fields.
successful	Number of path computations that were successfully completed.

Table 12: show mpls cspf Output Fields *(continued)*

Field Name	Field Description
no route	Number of path computations that failed because the destination is unreachable.
Sys Error	Number of path computations that failed because of lack of memory.
CSPFs	Total number of CSPF computations. A single path might require multiple CSPF computations.
Time	Time, in seconds, required to perform the label-switched path computation.
Total	Total amount of time consumed by the CSPF path computation algorithm.
CSPFs	Total number of CSPF computations.
Avg per CSPF	Average amount of time required for each CSPF computation.
% of rpd	Percentage of routing process CPU used in the CSPF computation.

Sample Output

show mpls cspf

```
user@host> show mpls cspf
CSPF statistics
Queue length   current       maximum      dequeued
                     0             0             0
Paths            total    successful      no route     sys error         CSPFs
                     0             0             0             0             0
Time (secs)      total         CSPFs  avg per CSPF      % of rpd
              0.000000      0.000000      0.000000        0.0000
```

show mpls diffserv-te

List of Syntax
Syntax on page 151
Syntax (EX Series Switches) on page 151

Syntax
show mpls diffserve-te
<logical-system (all | *logical-system-name*)>

Syntax (EX Series Switches)
show mpls diffserve-te

Release Information
Command introduced before Junos OS Release 7.4.
Command introduced in Junos OS Release 9.5 for EX Series switches.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description
Display Multiprotocol Label Switching (MPLS) label-switched path (LSP) Differentiated Services (DiffServ) class and preemption priority information.

Options
none—Display DiffServ classes and priorities used by MPLS LSPs.

logical-system (all | *logical-system-name*)—(Optional) Perform this operation on all logical systems or on a particular logical system.

Required Privilege Level
view

List of Sample Output
show mpls diffserv-te on page 152

Output Fields
Table 13 on page 151 describes the output fields for the **show mpls diffserv-te** command. Output fields are listed in the approximate order in which they appear.

Table 13: show mpls diffserv-te Output Fields

Field Name	Field Description
Bandwidth model	Bandwidth constraint model supported. The maximum allocation model (MAM) for EXP-inferred LSPs (E-LSPs) is currently supported.
TE class	DiffServ traffic engineering class.
Traffic class	MPLS class type that corresponds to the DiffServ traffic engineering class: • **ct0**—Best effort • **ct1**—Assured forwarding • **ct2**—Expedited forwarding • **ct3**—Network control
Priority	MPLS preemption priority for this class type, a value from **0** through **7**. Interior gateway protocols (IGPs) distribute information about the available bandwidth for each traffic engineering class.

Sample Output

show mpls diffserv-te

```
user@host> show mpls diffserv-te
Bandwidth model: Maximum Allocation Model with support for E-LSPs.
TE class     Traffic class       Priority
te0          ct0                 3
te1          ct1                 2
```

show route forwarding-table

Syntax

show route forwarding-table
<detail | extensive | summary>
<ccc *ccc-interface-name*>
<*destination*>
<family *family-name*>
<label *label*>
<matching *ip_prefix*>
<multicast>
<vpn *vpn*>

Release Information

Command introduced in Junos OS Release 9.5 for EX Series switches.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description

Display the Routing Engine's forwarding table, including the network-layer prefixes and their next hops. This command is used to help verify that the routing protocol process has relayed the correction information to the forwarding table. The Routing Engine constructs and maintains one or more routing tables. From the routing tables, the Routing Engine derives a table of active routes, called the forwarding table.

Options

none—Display the routes in the forwarding table.

detail | extensive | summary—(Optional) Display the specified level of output.

ccc—(Optional) Display the specified circuit cross-connect interface name for entries to match.

destination—(Optional) Display the destination prefix.

family *family-name*—(Optional) Display routing table entries for the specified family: **ethernet-switching**, **inet**, **inet6**, **iso**, **mpls**, **vlan classification**.

label *label*—(Optional) Display route entries for the specified label name.

matching *ip_prefix*—(Optional) Display route entries for the specified IP prefix.

multicast—(Optional) Display route entries for multicast routes.

vpn *vpn*—(Optional) Display route entries for the specified VPN.

Required Privilege Level

view

Related Documentation

- *Example: Configuring MPLS on EX8200 and EX4500 Switches*
- *Configuring MPLS on EX8200 and EX4500 Provider Switches (CLI Procedure)*

List of Sample Output

show route forwarding-table on page 155
show route forwarding-table summary on page 156

show route forwarding-table extensive on page 156
show route forwarding-table ccc on page 158
show route forwarding-table family (MPLS) on page 158
show route forwarding-table family (IPv6) on page 159
show route forwarding-table label on page 159
show route forwarding-table matching on page 159
show route forwarding-table multicast on page 159

Output Fields Table 14 on page 154 lists the output fields for the **show route forwarding-table** command. Output fields are listed in the approximate order in which they appear. Field names might be abbreviated (as shown in parentheses) when no level of output is specified or when the **detail** keyword is used instead of the **extensive** keyword.

Table 14: show route forwarding-table Output Fields

Field Name	Field Description	Level of Output
Routing table	Name of the routing table (for example, **inet**, **inet6**, **mpls**).	All levels
Address family	Address family (for example, **IP**, **IPv6**, **ISO**, **MPLS**).	All levels
Destination	Destination of the route.	**detail, extensive**
Route Type (Type)	How the route was placed into the forwarding table. When the **detail** keyword is used, the route type might be abbreviated (as shown in parentheses): • **cloned** (**clon**)—(TCP or multicast only) Cloned route. • **destination** (**dest**)—Remote addresses directly reachable through an interface. • **destination down** (**iddn**)—Destination route for which the interface is unreachable. • **interface cloned** (**ifcl**)—Cloned route for which the interface is unreachable. • **route down** (**ifdn**)—Interface route for which the interface is unreachable. • **ignore** (**ignr**)—Ignore this route. • **interface** (**intf**)—Installed as a result of configuring an interface. • **permanent** (**perm**)—Routes installed by the kernel when the routing table is initialized. • **user**—Routes installed by the routing protocol process or as a result of the configuration.	All levels
Route reference (RtRef)	Number of routes to reference.	**detail, extensive**
Flags	Route type flags: • **none**—No flags are enabled. • **accounting**—Route has accounting enabled. • **cached**—Cache route. • **incoming-iface** ***interface-number*** —Check against incoming interface. • **prefix load balance**—Load balancing is enabled for this prefix. • **sent to PFE**—Route has been sent to the Packet Forwarding Engine. • **static**—Static route.	**extensive**

Table 14: show route forwarding-table Output Fields *(continued)*

Field Name	Field Description	Level of Output
Nexthop	IP address of the next hop to the destination.	**detail, extensive**
Next hop type (Type)	Next-hop type. When the **detail** keyword is used, the next-hop type might be abbreviated (as indicated in parentheses): • **broadcast (bcst)**—Broadcast. • **deny**—Deny. • **hold**—Next hop is waiting to be resolved into a unicast or multicast type. • **indexed (idxd)**—Indexed next hop. • **indirect (indr)**—Indirect next hop. • **local (locl)**—Local address on an interface. • **routed multicast (mcrt)**—Regular multicast next hop • **multicast (mcst)**—Wire multicast next hop (limited to the LAN). • **multicast discard (mdsc)**—Multicast discard. • **multicast group (mgrp)** —Multicast group member. • **receive (recv)**—Receive. • **reject (rjct)**—Discard. An ICMP unreachable message was sent. • **resolve (rslv)**—Resolving the next hop. • **unicast (ucst)**—Unicast. • **unilist (ulst)**—List of unicast next hops. A packet sent to this next hop goes to any next hop in the list.	**detail, extensive**
Index	Software index of the next hop that is used to route the traffic for a given prefix.	**detail, extensive** none
Route interface-index	Logical interface index from which the route is learned. For example, for interface routes, this is the logical interface index of the route itself. For static routes, this field is zero. For routes learned through routing protocols, this is the logical interface index from which the route is learned.	**extensive**
Reference (NhRef)	Number of routes that refer to this next hop.	none **detail, extensive**
Next-hop interface (Netif)	Interface used to reach the next hop.	none **detail, extensive**
Alternate forward nh index	Index number of the alternate next hop interface. Seen with **multicast** option only.	**extensive**
Next-hop L3 Interface	The next hop layer 3 interface. This option can be expressed as a VLAN name and is only seen with the **multicast** option.	**extensive**
Next-hop L2 Interfaces	The next hop layer 2 interfaces. Seen with **multicast** option only.	**extensive**

Sample Output

show route forwarding-table

```
user@switch> show route forwarding-table
```

```
Routing table: default.inet
Internet:
Destination        Type RtRef Next hop           Type Index NhRef Netif
default            user     2 0:12:f2:21:cf:0    ucst   333     5 me0.0
default            perm     0                    rjct    36     2
0.0.0.0/32         perm     0                    dscd    34     1
2.2.2.0/24         intf     0                    rslv  1309     1 ae0.0
2.2.2.0/32         dest     0 2.2.2.0            recv  1307     1 ae0.0
2.2.2.1/32         dest     0 0:21:59:cc:89:c0   ucst  1320     1 ae0.0
2.2.2.2/32         intf     0 2.2.2.2            locl  1308     2
2.2.2.2/32         dest     0 2.2.2.2            locl  1308     2
2.2.2.255/32       dest     0 2.2.2.255          bcst  1306     1 ae0.0
3.3.3.0/24         intf     0                    rslv  1313     1 ae1.0
3.3.3.0/32         dest     0 3.3.3.0            recv  1311     1 ae1.0
3.3.3.1/32         intf     0 3.3.3.1            locl  1312     2
3.3.3.1/32         dest     0 3.3.3.1            locl  1312     2
3.3.3.2/32         dest     0 0:21:59:cc:89:c1   ucst  1321    24 ae1.0
3.3.3.255/32       dest     0 3.3.3.255          bcst  1310     1 ae1.0
4.4.4.0/24         user     0 3.3.3.2            ucst  1321    24 ae1.0
8.8.8.8/32         user     0 3.3.3.2            ucst  1321    24 ae1.0
9.9.9.9/32         intf     0 9.9.9.9            locl  1280     1
10.10.10.10/32     user     0 3.3.3.2            ucst  1321    24 ae1.0
10.93.8.0/21       intf     0                    rslv   323     1 me0.0
10.93.8.0/32       dest     0 10.93.8.0          recv   321     1 me0.0
10.93.13.238/32    intf     0 10.93.13.238       locl   322     2
10.93.13.238/32    dest     0 10.93.13.238       locl   322     2
10.93.15.254/32    dest     0 0:12:f2:21:cf:0    ucst   333     5 me0.0
10.93.15.255/32    dest     0 10.93.15.255       bcst   320     1 me0.0
14.14.14.0/24      ifdn     0                    rslv  1319     1 ge-0/0/25.0
14.14.14.0/32      iddn     0 14.14.14.0         recv  1317     1 ge-0/0/25.0
14.14.14.2/32      user     0                    rjct    36     2
14.14.14.2/32      intf     0 14.14.14.2         locl  1318     2
14.14.14.2/32      iddn     0 14.14.14.2         locl  1318     2
14.14.14.255/32    iddn     0 14.14.14.255       bcst  1316     1 ge-0/0/25.0
224.0.0.0/4        perm     1                    mdsc    35     1
224.0.0.1/32       perm     0 224.0.0.1          mcst    31     3
224.0.0.5/32       user     1 224.0.0.5          mcst    31     3
255.255.255.255/32 perm     0                    bcst    32     1
```

show route forwarding-table summary

```
user@switch> show route forwarding-table summary

Routing table: default.inet
Internet:
         user:          6 routes
         perm:          5 routes
         intf:          8 routes
         dest:         12 routes
         ifdn:          1 routes
         iddn:          3 routes
```

show route forwarding-table extensive

```
user@switch> show route forwarding-table summary

Routing table: default.inet [Index 0]
Internet:

Destination:  default
```

```
  Route type: user
  Route reference: 2                    Route interface-index: 0
  Flags: sent to PFE, rt nh decoupled
  Nexthop: 0:12:f2:21:cf:0
  Next-hop type: unicast                Index: 333      Reference: 5
  Next-hop interface: me0.0

Destination:  default
  Route type: permanent
  Route reference: 0                    Route interface-index: 0
  Flags: none
  Next-hop type: reject                 Index: 36       Reference: 2

Destination:  0.0.0.0/32
  Route type: permanent
  Route reference: 0                    Route interface-index: 0
  Flags: sent to PFE
  Next-hop type: discard                Index: 34       Reference: 1

Destination:  2.2.2.0/24
  Route type: interface
  Route reference: 0                    Route interface-index: 66
  Flags: sent to PFE
  Next-hop type: resolve                Index: 1309     Reference: 1
  Next-hop interface: ae0.0

Destination:  2.2.2.0/32
  Route type: destination
  Route reference: 0                    Route interface-index: 66
  Flags: sent to PFE
  Nexthop: 2.2.2.0
  Next-hop type: receive                Index: 1307     Reference: 1
  Next-hop interface: ae0.0

Destination:  2.2.2.1/32
  Route type: destination
  Route reference: 0                    Route interface-index: 66
  Flags: sent to PFE
  Nexthop: 0:21:59:cc:89:c0
  Next-hop type: unicast                Index: 1320     Reference: 1
  Next-hop interface: ae0.0

Destination:  2.2.2.2/32
  Route type: interface
  Route reference: 0                    Route interface-index: 0
  Flags: sent to PFE
  Nexthop: 2.2.2.2
  Next-hop type: local                  Index: 1308     Reference: 2

Destination:  2.2.2.2/32
  Route type: destination
  Route reference: 0                    Route interface-index: 66
  Flags: none
  Nexthop: 2.2.2.2
  Next-hop type: local                  Index: 1308     Reference: 2

Destination:  2.2.2.255/32
  Route type: destination
  Route reference: 0                    Route interface-index: 66
  Flags: sent to PFE
  Nexthop: 2.2.2.255
```

```
  Next-hop type: broadcast             Index: 1306     Reference: 1
  Next-hop interface: ae0.0
```

show route forwarding-table ccc

```
user@switch> show route forwarding-table ccc ge-0/0/0.10
Routing table: default.mpls
MPLS:
Destination        Type RtRef Next hop           Type Index NhRef Netif
ge-0/0/0.10  (CCC) user     0 3.3.3.2           Push 300112  1343     2 ae1.0
```

show route forwarding-table family (MPLS)

```
user@switch> show route forwarding-table family mpls

Routing table: default.mpls
MPLS:
Destination        Type RtRef Next hop           Type Index NhRef Netif
default            perm     0                    dscd    50     1
0                  user     0                    recv    49     3
1                  user     0                    recv    49     3
2                  user     0                    recv    49     3
299776             user     0                   Pop    1334     2 ge-0/0/0.10
299792             user     0                   Pop    1339     2 ge-0/0/0.14
299808             user     0                   Pop    1341     2 ge-0/0/0.2
299824             user     0                   Pop    1344     2 ge-0/0/0.11
299840             user     0                   Pop    1345     2 ge-0/0/0.13
299856             user     0                   Pop    1346     2 ge-0/0/0.18
299872             user     0                   Pop    1347     2 ge-0/0/0.16
299888             user     0                   Pop    1348     2 ge-0/0/0.7
299904             user     0                   Pop    1349     2 ge-0/0/0.20
299920             user     0                   Pop    1350     2 ge-0/0/0.19
299936             user     0                   Pop    1351     2 ge-0/0/0.17
299952             user     0                   Pop    1352     2 ge-0/0/0.9
299968             user     0                   Pop    1353     2 ge-0/0/0.1
299984             user     0                   Pop    1354     2 ge-0/0/0.12
300000             user     0                   Pop    1355     2 ge-0/0/0.8
300016             user     0                   Pop    1356     2 ge-0/0/0.4
300032             user     0                   Pop    1357     2 ge-0/0/0.5
300048             user     0                   Pop    1358     2 ge-0/0/0.3
300064             user     0                   Pop    1359     2 ge-0/0/0.15
ge-0/0/0.1   (CCC) user     0 3.3.3.2           Push 300064  1340     2 ae1.0
ge-0/0/0.2   (CCC) user     0 3.3.3.2           Push 299872  1328     2 ae1.0
ge-0/0/0.3   (CCC) user     0 3.3.3.2           Push 299792  1323     2 ae1.0
ge-0/0/0.4   (CCC) user     0 3.3.3.2           Push 300016  1337     2 ae1.0
ge-0/0/0.5   (CCC) user     0 3.3.3.2           Push 299824  1325     2 ae1.0
ge-0/0/0.7   (CCC) user     0 3.3.3.2           Push 299920  1331     2 ae1.0
ge-0/0/0.8   (CCC) user     0 3.3.3.2           Push 299840  1326     2 ae1.0
ge-0/0/0.9   (CCC) user     0 3.3.3.2           Push 299888  1329     2 ae1.0
ge-0/0/0.10  (CCC) user     0 3.3.3.2           Push 300112  1343     2 ae1.0
ge-0/0/0.11  (CCC) user     0 3.3.3.2           Push 299776  1322     2 ae1.0
ge-0/0/0.12  (CCC) user     0 3.3.3.2           Push 299952  1333     2 ae1.0
ge-0/0/0.13  (CCC) user     0 3.3.3.2           Push 300096  1342     2 ae1.0
ge-0/0/0.14  (CCC) user     0 3.3.3.2           Push 299984  1335     2 ae1.0
ge-0/0/0.15  (CCC) user     0 3.3.3.2           Push 299936  1332     2 ae1.0
ge-0/0/0.16  (CCC) user     0 3.3.3.2           Push 299808  1324     2 ae1.0
ge-0/0/0.17  (CCC) user     0 3.3.3.2           Push 300000  1336     2 ae1.0
ge-0/0/0.18  (CCC) user     0 3.3.3.2           Push 300032  1338     2 ae1.0
ge-0/0/0.19  (CCC) user     0 3.3.3.2           Push 299904  1330     2 ae1.0
ge-0/0/0.20  (CCC) user     0 3.3.3.2           Push 299856  1327     2 ae1.0
```

show route forwarding-table family (IPv6)

```
user@switch> show route forwarding-table family inet6
Routing table: default.inet6
Internet6:
Destination        Type RtRef Next hop           Type Index NhRef Netif
default            perm     0                    rjct    44     1
::/128             perm     0                    dscd    42     1
ff00::/8           perm     0                    mdsc    43     1
ff02::1/128        perm     0 ff02::1            mcst    39     1

Routing table: default-switch.inet6
Internet6:
Destination        Type RtRef Next hop           Type Index NhRef Netif
default            perm     0                    rjct   530     1
::/128             perm     0                    dscd   528     1
2:1::3a00/312      user     0                    indr 131070     2
                                                 comp   572     1
2:1::3a82/320      user     0                    indr 131071     3
                                                 comp   573     1
2:1::3af0/320      user     0                    indr 131071     3
                                                 comp   573     1
2:1:0:ff00::/56    user     0                    mdsc   529     2
ff00::/8           perm     0                    mdsc   529     2
ff02::1/128        perm     0 ff02::1            mcst   526     1

Routing table: __master.anon__.inet6
Internet6:
Destination        Type RtRef Next hop           Type Index NhRef Netif
default            perm     0                    rjct   554     1
::/128             perm     0                    dscd   552     1
ff00::/8           perm     0                    mdsc   553     1
ff02::1/128        perm     0 ff02::1            mcst   550     1
```

show route forwarding-table label

```
user@switch> show route forwarding-table label 29976

Routing table: default.mpls
MPLS:
Destination        Type RtRef Next hop           Type Index NhRef Netif
299776             user     0                   Pop    1334     2 ge-0/0/0.10
```

show route forwarding-table matching

```
user@switch> show route forwarding-table matching 3

Routing table: default.inet
Internet:
```

show route forwarding-table multicast

```
user@switch> show route forwarding-table multicast

Routing table: default.inet
Internet:
Destination        Type RtRef Next hop           Type Index NhRef Netif
224.0.0.0/4        perm     1                    mdsc    35     1
224.0.0.1/32       perm     0 224.0.0.1          mcst    31     3
224.0.0.5/32       user     1 224.0.0.5          mcst    31     3
```

```
Routing table: __master.anon__.inet
Internet:
Destination        Type RtRef Next hop           Type Index NhRef Netif
224.0.0.0/4        perm     0                    mdsc  1289     1
224.0.0.1/32       perm     0 224.0.0.1          mcst  1285     1

Routing table: default.inet6
Internet6:
Destination        Type RtRef Next hop           Type Index NhRef Netif
ff00::/8           perm     0                    mdsc    43     1
ff02::1/128        perm     0 ff02::1            mcst    39     1
```

show mpls interface

List of Syntax
Syntax on page 161
Syntax (EX Series Switches) on page 161

Syntax
show mpls interface
<logical-system (all | *logical-system-name*)>

Syntax (EX Series Switches)
show mpls interface

Release Information
Command introduced before Junos OS Release 7.4.
Command introduced in Junos OS Release 9.5 for EX Series switches.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description
Display information about Multiprotocol Label Switching (MPLS)-enabled interfaces.

Options
none—Display information about MPLS-enabled interfaces.

logical-system (all | *logical-system-name*)—(Optional) Perform this operation on all logical systems or on a particular logical system.

Additional Information
MPLS is enabled on an interface when the interface is configured with both the **set protocol mpls interface *interface-name*** and **set interface *interface-name* unit 0 family mpls** statements.

Required Privilege Level
view

List of Sample Output
show mpls interface on page 162

Output Fields
Table 15 on page 161 describes the output fields for the **show mpls interface** command. Output fields are listed in the approximate order in which they appear.

Table 15: show mpls interface Output Fields

Field Name	Field Description
Interface	Name of the interface.
State	State of the interface: **Up** or **Dn** (down).
Administrative groups	Administratively assigned colors of the link.
Maximum labels	Maximum number of MPLS labels upon which MPLS can operate on a logical interface. This is configured using the **maximum-labels** statement at the **[edit logical-systems *logical-system-name* interfaces *interface-name* unit *logical-unit-number* family mpls]** or the **[edit interfaces *interface-name* unit *logical-unit-number* family mpls]** hierarchy levels.

Table 15: show mpls interface Output Fields *(continued)*

Field Name	Field Description
Static protection revert time	Time (in seconds) that a static LSP must wait before traffic reverts from the bypass path to the original path. This is configured using the **protection-revert-time** statement at the **[edit logical-systems *logical-system-name* protocols mpls interface *interface-name* static]** or the **[edit protocols mpls interface *interface-name* static]** hierarchy levels.
Always mark connection protection tlv	**Enabled** or **Disabled**: **Enabled** indicates that the **always-mark-connection-protection-tlv** statement is configured at the **[edit logical-systems *logical-system-name* protocols mpls interface *interface-name* static]** or the **[edit protocols mpls interface *interface-name* static]** hierarchy levels. When this statement is configured, it marks all OAM traffic transiting this interface in preparation for switching the traffic to an alternate path based on the OAM functionality. To switch traffic to the bypass LSP, the **switch-away-lsps** statement must be configured.
Switch away lsps	**Enabled** or **Disabled**: **Enabled** indicates that the **switch-away-lsps** statement is configured at the **[edit logical-systems *logical-system-name* protocols mpls interface *interface-name* static]** or the **[edit protocols mpls interface *interface-name* static]** hierarchy levels. This enables you to switch an LSP away from a network node using a bypass LSP. This feature can be used in maintenance of active networks when a network device needs to be replaced without interrupting traffic passing through the network. The LSPs can be either static or dynamic.

Sample Output

show mpls interface

```
user@host> show mpls interface

Interface: ge-0/2/1.57
  State: Up
  Administrative group: <none>
  Maximum labels: 5
  Static protection revert time: 5 seconds
  Always mark connection protection tlv: Disabled
  Switch away lsps : Disabled
```

show mpls lsp

List of Syntax
Syntax on page 163
Syntax (EX Series Switches) on page 163

Syntax

```
show mpls lsp
<brief | detail | extensive | terse>
<autobandwidth>
<bidirectional | unidirectional>
<bypass>
<count-active-routes>
<defaults>
<descriptions>
<down | up>
<externally-controlled>
<externally-provisioned>
<logical-system (all | logical-system-name)>
<lsp-type>
<name name>
<p2mp>
<statistics>
<transit>
```

Syntax (EX Series Switches)

```
show mpls lsp
<brief | detail | extensive | terse>
<bidirectional | unidirectional>
<bypass>
<descriptions>
<down | up>
<externally-controlled>
<externally-provisioned>
<lsp-type>
<name name>
<p2mp>
<statistics>
<transit>
```

Release Information
Command introduced before Junos OS Release 7.4.
defaults option added in Junos OS Release 8.5.
Command introduced in Junos OS Release 9.5 for EX Series switches.
autobandwidth option added in Junos OS Release 11.4.
externally-controlled option added in Junos OS Release 12.3.
externally-provisioned option added in Junos OS Release 13.3.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description
Display information about configured and active dynamic Multiprotocol Label Switching (MPLS) label-switched paths (LSPs).

Options
none—Display standard information about all configured and active dynamic MPLS LSPs.

brief | detail | extensive | terse—(Optional) Display the specified level of output. The extensive option displays the same information as the detail option, but covers the most recent 50 events.

autobandwidth—(Optional) Display automatic bandwidth information. This option is explained separately (see show mpls lsp autobandwidth).

bidirectional | unidirectional—(Optional) Display bidirectional or unidirectional LSP information, respectively.

bypass—(Optional) Display LSPs used for protecting other LSPs.

count-active-routes—(Optional) Display active routes for LSPs.

defaults—(Optional) Display the MPLS LSP default settings.

descriptions—(Optional) Display the MPLS label-switched path (LSP) descriptions. To view this information, you must configure the description statement at the **[edit protocol mpls lsp]** hierarchy level. Only LSPs with a description are displayed. This command is only valid for the ingress routing device, because the description is not propagated in RSVP messages.

down | up—(Optional) Display only LSPs that are inactive or active, respectively.

externally-controlled—(Optional) Display the LSPs that are under the control of an external Path Computation Element (PCE).

externally-provisioned—(Optional) Display the LSPs that are generated dynamically and provisioned by an external Path Computation Element (PCE).

logical-system (all | *logical-system-name*)—(Optional) Perform this operation on all logical systems or on a particular logical system.

lsp-type—(Optional) Display information about a particular LSP type:

- **bypass**—Sessions for bypass LSPs.
- **egress**—Sessions that terminate on this routing device.
- **ingress**—Sessions that originate from this routing device.
- **transit**—Sessions that pass through this routing device.

name *name*—(Optional) Display information about the specified LSP or group of LSPs.

p2mp—(Optional) Display information about point-to-multipoint LSPs.

statistics—(Optional) (Ingress and transit routers only) Display accounting information about LSPs. Statistics are not available for LSPs on the egress routing device, because the penultimate routing device in the LSP sets the label to 0. Also, as the packet arrives at the egress routing device, the hardware removes its MPLS header and the packet reverts to being an IPv4 packet. Therefore, it is counted as an IPv4 packet, not an MPLS packet.

NOTE: If a bypass LSP is configured for the primary static LSP, display cumulative statistics of packets traversing through the protected LSP and bypass LSP when traffic is re-optimized when the protected LSP link is restored. (Bypass LSPs are not supported on QFX Series switches.)

When used with the **bypass** option (**show mpls lsp bypass statistics**), display statistics for the traffic that flows only through the bypass LSP.

transit—(Optional) Display LSPs transiting this routing device.

Required Privilege Level view

Related Documentation
- *clear mpls lsp*
- show mpls lsp autobandwidth on page 179

List of Sample Output
show mpls lsp defaults on page 172
show mpls lsp descriptions on page 172
show mpls lsp detail on page 172
show mpls lsp extensive on page 173
show mpls lsp ingress extensive on page 174
show mpls lsp extensive (automatic bandwidth adjustment enabled) on page 175
show mpls lsp p2mp on page 176
show mpls lsp p2mp detail on page 176
show mpls lsp detail count-active-routes on page 177
show mpls lsp statistics extensive on page 177

Output Fields Table 16 on page 165 describes the output fields for the **show mpls lsp** command. Output fields are listed in the approximate order in which they appear.

Table 16: show mpls lsp Output Fields

Field Name	Field Description	Level of Output
Ingress LSP	Information about LSPs on the ingress routing device. Each session has one line of output.	All levels
Egress LSP	Information about the LSPs on the egress routing device. MPLS learns this information by querying RSVP, which holds all the transit and egress session information. Each session has one line of output.	All levels
Transit LSP	Number of LSPs on the transit routing devices and the state of these paths. MPLS learns this information by querying RSVP, which holds all the transit and egress session information.	All levels
P2MP name	Name of the point-to-multipoint LSP. Dynamically generated P2MP LSPs used for VPLS flooding use dynamically generated P2MP LSP names. The name uses the format ***identifier*:vpls:*router-id*:*routing-instance-name***. The ***identifier*** is automatically generated by Junos OS.	All levels

Table 16: show mpls lsp Output Fields *(continued)*

Field Name	Field Description	Level of Output
P2MP branch count	Number of destination LSPs the point-to-multipoint LSP is transmitting to.	All levels
P	An asterisk (*) under this heading indicates that the LSP is a primary path.	All levels
address	(**detail** and **extensive**) Destination (egress routing device) of the LSP.	**detail extensive**
To	Destination (egress routing device) of the session.	**brief**
From	Source (ingress routing device) of the session.	**brief detail**
State	State of the LSP handled by this RSVP session: **Up**, **Dn** (down), or **Restart**.	**brief detail**
Active Route	Number of active routes (prefixes) installed in the forwarding table. For ingress LSPs, the forwarding table is the primary IPv4 table (**inet.0**). For transit and egress RSVP sessions, the forwarding table is the primary MPLS table (**mpls.0**).	**detail extensive**
Rt	Number of active routes (prefixes) installed in the routing table. For ingress RSVP sessions, the routing table is the primary IPv4 table (**inet.0**). For transit and egress RSVP sessions, the routing table is the primary MPLS table (mpls.0).	**brief**
P	Path. An asterisk (*) underneath this column indicates that the LSP is a primary path.	**brief**
ActivePath	(Ingress LSP) Name of the active path: **Primary** or **Secondary**.	**detail extensive**
LSPname	Name of the LSP.	**brief detail**
Statistics	Displays the number of packets and the number of bytes transmitted over the LSP. These counters are reset to zero whenever the LSP path is optimized (for example, during an automatic bandwidth allocation).	**extensive**
Aggregate statistics	Displays the number of packets and the number of bytes transmitted over the LSP. These counters continue to iterate even if the LSP path is optimized. You can reset these counters to zero using the **clear mpls lsp statistics** command.	**extensive**
Packets	Displays the number of packets transmitted over the LSP.	**brief extensive**
Bytes	Displays the number of bytes transmitted over the LSP.	**brief extensive**
DiffServeInfo	Type of LSP: multiclass LSP **(multiclass diffServ-TE LSP)** or Differentiated-Services-aware traffic engineering LSP **(diffServ-TE LSP)**.	**detail**
LSPtype	Type of LSP: static **Static configured** or dynamic **Dynamic configured**. Also indicates if the LSP is a **Penultimate hop popping** LSP or an **Ultimate hop popping** LSP.	**detail extensive**
Bypass	(Bypass LSP) Destination address (egress routing device) for the bypass LSP.	All levels

Table 16: show mpls lsp Output Fields *(continued)*

Field Name	Field Description	Level of Output
LSPpath	Indicates whether the RSVP session is for the primary or secondary LSP path. **LSPpath** can be either **primary** or **secondary** and can be displayed on the ingress, egress, and transit routing devices.	**detail**
Bidir	(GMPLS) The LSP allows data to travel in both directions between GMPLS devices.	All levels
Bidirectional	(GMPLS) The LSP allows data to travel both ways between GMPLS devices.	All levels
FastReroute desired	Fast reroute has been requested by the ingress routing device.	**detail**
Link protection desired	Link protection has been requested by the ingress routing device.	**detail**
Node/Link protection desired	Link protection has been requested by the ingress routing device.	**detail extensive**
LoadBalance	(Ingress LSP) CSPF load-balancing rule that was configured to select the LSP's path among equal-cost paths: **Most-fill**, **Least-fill**, or **Random**.	**detail extensive**
Signal type	Signal type for GMPLS LSPs. The signal type determines the peak data rate for the LSP: **DS0**, **DS3**, **STS-1**, **STM-1**, or **STM-4**.	All levels
Encoding type	LSP encoding type: **Packet**, **Ethernet**, **PDH**, **SDH/SONET**, **Lambda**, or **Fiber**.	All levels
Switching type	Type of switching on the links needed for the LSP: **Fiber**, **Lamda**, **Packet**, **TDM**, or **PSC-1**.	All levels
GPID	Generalized Payload Identifier (identifier of the payload carried by an LSP): **HDLC**, **Ethernet**, **IPv4**, **PPP**, or **Unknown**.	All levels
Protection	Configured protection capability desired for the LSP: **Extra**, **Enhanced**, **none**, **One plus one**, **One to one**, or **Shared**.	All levels
Upstream label in	(Bidirectional LSPs) Incoming label for reverse direction traffic for this LSP.	All levels
Upstream label out	(Bidirectional LSPs) Outgoing label for reverse direction traffic for this LSP.	All levels
Suggested label received	(Bidirectional LSPs) Label the upstream node suggests to use in the Resv message that is sent.	All levels
Suggested label sent	(Bidirectional LSPs) Label the downstream node suggests to use in the Resv message that is returned.	All levels
Autobandwidth	(Ingress LSP) The LSP is performing autobandwidth allocation.	**detail extensive**
MinBW	(Ingress LSP) Configured minimum value of the LSP, in bps.	**detail extensive**

Table 16: show mpls lsp Output Fields *(continued)*

Field Name	Field Description	Level of Output
MaxBW	(Ingress LSP) Configured maximum value of the LSP, in bps.	**detail extensive**
Dynamic MinBW	(Ingress LSP) Displays the current dynamically specified minimum bandwidth allocation for the LSP, in bps.	**detail extensive**
Adjustment Timer	(Ingress LSP) Configured value for the **adjust-timer** statement, indicating the total amount of time allowed before bandwidth adjustment will take place, in seconds.	**detail extensive**
Adjustment Threshold	(Ingress LSP) Configured value for the **adjust-threshold** statement. Specifies how sensitive the automatic bandwidth adjustment for an LSP is to changes in bandwidth utilization.	**detail extensive**
Time for Next Adjustment	(Ingress LSP) Time in seconds until the next automatic bandwidth adjustment sample is taken.	**detail extensive**
Time of Last Adjustment	(Ingress LSP) Date and time since the last automatic bandwidth adjustment was completed.	**detail extensive**
Max AvgBW util	(Ingress LSP) Current value of the actual maximum average bandwidth utilization, in bps.	**detail extensive**
Overflow limit	(Ingress LSP) Configured value of the threshold overflow limit.	**detail extensive**
Overflow sample count	(Ingress LSP) Current value for the overflow sample count.	**detail extensive**
Bandwidth Adjustment in *nnn* second(s)	(Ingress LSP) Current value of the bandwidth adjustment timer, indicating the amount of time remaining until the bandwidth adjustment will take place, in seconds.	**detail extensive**
Underflow limit	(Ingress LSP) Configured value of the threshold underflow limit.	**detail extensive**
Underflow sample count	(Ingress LSP) Current value for the underflow sample count.	**detail extensive**
Underflow Max AvgBW	(Ingress LSP) The highest sample bandwidth among the underflow samples recorded currently. This is the signaling bandwidth if an adjustment occurs because of an underflow.	**detail extensive**
Active path indicator	(Ingress LSP) A value of * indicates that the path is active. The absence of * indicates that the path is not active. In the following example, “long” is the active path. ***Primary long** **Standby short**	**detail extensive**
Primary	(Ingress LSP) Name of the primary path.	**detail extensive**
Secondary	(Ingress LSP) Name of the secondary path.	**detail extensive**

Table 16: show mpls lsp Output Fields *(continued)*

Field Name	Field Description	Level of Output
Standby	(Ingress LSP) Name of the path in standby mode.	**detail extensive**
State	(Ingress LSP) State of the path: **Up** or **Dn** (down).	**detail extensive**
COS	(Ingress LSP) Class-of-service value.	**detail extensive**
Bandwidth per class	(Ingress LSP) Active bandwidth for the LSP path for each MPLS class type, in bps.	**detail extensive**
Priorities	(Ingress LSP) Configured value of the setup priority and the hold priority respecitively (the setup priority is displayed first), where 0 is the highest priority and 7 is the lowest priority. If you have not explicitly configured these values, the default values are displayed (7 for the setup priority and 0 for the hold priority).	**detail extensive**
OptimizeTimer	(Ingress LSP) Configured value of the optimize timer, indicating the total amount of time allowed before path reoptimization, in seconds.	**detail extensive**
SmartOptimizeTimer	(Ingress LSP) Configured value of the smart optimize timer, indicating the total amount of time allowed before path reoptimization, in seconds.	**detail extensive**
Reoptimization in xxx seconds	(Ingress LSP) Current value of the optimize timer, indicating the amount of time remaining until the path will be reoptimized, in seconds.	**detail extensive**
Computed ERO (S [L] denotes strict [loose] hops)	(Ingress LSP) Computed explicit route. A series of hops, each with an address followed by a hop indicator. The value of the hop indicator can be strict (**S**) or loose (**L**).	**detail extensive**
CSPF metric	(Ingress LSP) Constrained Shortest Path First metric for this path.	**detail extensive**

Table 16: show mpls lsp Output Fields *(continued)*

Field Name	Field Description	Level of Output
Received RRO	(Ingress LSP) Received record route. A series of hops, each with an address followed by a flag. (In most cases, the received record route is the same as the computed explicit route. If **Received RRO** is different from **Computed ERO**, there is a topology change in the network, and the route is taking a detour.) The following flags identify the protection capability and status of the downstream node: • **0x01**—Local protection available. The link downstream from this node is protected by a local repair mechanism. This flag can be set only if the Local protection flag was set in the **SESSION_ATTRIBUTE** object of the corresponding Path message. • **0x02**—Local protection in use. A local repair mechanism is in use to maintain this tunnel (usually because of an outage of the link it was routed over previously). • **0x03**—Combination of **0x01** and **0x02**. • **0x04**—Bandwidth protection. The downstream routing device has a backup path providing the same bandwidth guarantee as the protected LSP for the protected section. • **0x08**—Node protection. The downstream routing device has a backup path providing protection against link and node failure on the corresponding path section. If the downstream routing device can set up only a link-protection backup path, the **Local protection available** bit is set but the **Node protection** bit is cleared. • **0x09**—Detour is established. Combination of **0x01** and **0x08**. • **0x10**—Preemption pending. The preempting node sets this flag if a pending preemption is in progress for the traffic engine LSP. This flag indicates to the ingress legacy edge router (LER) of this LSP that it should be rerouted. • **0x20**—Node ID. Indicates that the address specified in the RRO's IPv4 or IPv6 sub-object is a node ID address, which refers to the router address or router ID. Nodes must use the same address consistently. • **0xb**—Detour is in use. Combination of **0x01**, **0x02**, and **0x08**.	**detail extensive**
Index number	(Ingress LSP) Log entry number of each LSP path event. The numbers are in chronological descending order, with a maximum of 50 index numbers displayed.	**extensive**
Date	(Ingress LSP) Date of the LSP event.	**extensive**
Time	(Ingress LSP) Time of the LSP event.	**extensive**
Event	(Ingress LSP) Description of the LSP event.	**extensive**
Created	(Ingress LSP) Date and time the LSP was created.	**extensive**
Resv style	(Bypass) RSVP reservation style. This field consists of two parts. The first is the number of active reservations. The second is the reservation style, which can be **FF** (fixed filter), **SE** (shared explicit), or **WF** (wildcard filter).	**brief detail extensive**
Labelin	Incoming label for this LSP.	**brief detail**
Labelout	Outgoing label for this LSP.	**brief detail**

Table 16: show mpls lsp Output Fields *(continued)*

Field Name	Field Description	Level of Output
LSPname	Name of the LSP.	**brief detail**
Time left	Number of seconds remaining in the lifetime of the reservation.	**detail**
Since	Date and time when the RSVP session was initiated.	**detail**
Tspec	Sender's traffic specification, which describes the sender's traffic parameters.	**detail**
Port number	Protocol ID and sender or receiver port used in this RSVP session.	**detail**
PATH rcvfrom	Address of the previous-hop (upstream) routing device or client, interface the neighbor used to reach this router, and number of packets received from the upstream neighbor.	**detail**
PATH sentto	Address of the next-hop (downstream) routing device or client, interface used to reach this neighbor, and number of packets sent to the downstream routing device.	**detail**
RESV rcvfrom	Address of the previous-hop (upstream) routing device or client, interface the neighbor used to reach this routing device, and number of packets received from the upstream neighbor. The output in this field, which is consistent with that in the **PATH rcvfrom** field, indicates that the RSVP negotiation is complete.	**detail**
Record route	Recorded route for the session, taken from the record route object.	**detail**
Soft preempt	Number of soft preemptions that occurred on a path and when the last soft preemption occurred. Only successful soft preemptions are counted (those that actually resulted in a new path being used).	**detail**
Soft preemption pending	Path is in the process of being soft preempted. This display is removed once the ingress router has calculated a new path.	**detail**
MPLS-TE LSP Defaults	Default settings for MPLS traffic engineered LSPs: • **LSP Holding Priority**—Determines the degree to which an LSP holds on to its session reservation after the LSP has been set up successfully. • **LSP Setup Priority**—Determines whether a new LSP that preempts an existing LSP can be established. • **Hop Limit**—Specifies the maximum number of routers the LSP can traverse (including the ingress and egress). • **Bandwidth**—Specifies the bandwidth in bits per second for the LSP. • **LSP Retry Timer**—Length of time in seconds that the ingress router waits between attempts to establish the primary path.	**defaults**

The XML tag name of the **bandwidth** tag under the **auto-bandwidth** tag has been updated to **maximum-average-bandwidth** . You can see the new tag when you issue the **show mpls lsp extensive** command with the **| display xml** pipe option. If you have any scripts that use the **bandwidth** tag, ensure that they are updated to **maximum-average-bandwidth**.

Sample Output

show mpls lsp defaults

```
user@host> show mpls lsp defaults
   MPLS-TE LSP Defaults
      LSP Holding Priority      0
      LSP Setup Priority        7
      Hop Limit                 255
      Bandwidth                 0
      LSP Retry Timer           30 seconds
```

show mpls lsp descriptions

```
user@host> show mpls lsp descriptions
Ingress LSP: 3 sessions
To              LSP name                                Description
10.0.0.195      to-sanjose                              to-sanjose-desc
10.0.0.195      to-sanjose-other-desc                   other-desc
Total 2 displayed, Up 2, Down 0
```

show mpls lsp detail

```
user@host> show mpls lsp detail
Ingress LSP: 1 sessions

192.168.0.4
  From: 192.168.0.5, State: Up, ActiveRoute: 0, LSPname: E-D
  ActivePath:  (primary)
  LSPtype: Static Configured, Penultimate hop popping
  LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
 *Primary                    State: Up
    Priorities: 7 0
    SmartOptimizeTimer: 180
    Computed ERO (S [L] denotes strict [loose] hops): (CSPF metric: 30)
 10.0.0.18 S 10.0.0.22 S
    Received RRO (ProtectionFlag 1=Available 2=InUse 4=B/W 8=Node 10=SoftPreempt
 20=Node-ID):
          10.0.0.18 10.0.0.22
Total 1 displayed, Up 1, Down 0

Egress LSP: 1 sessions

192.168.0.5
  From: 192.168.0.4, LSPstate: Up, ActiveRoute: 0
  LSPname: E-D, LSPpath: Primary
  Suggested label received: -, Suggested label sent: -
  Recovery label received: -, Recovery label sent: -
  Resv style: 1 FF, Label in: 3, Label out: -
  Time left:  157, Since: Wed Jul 18 17:55:12 2012
  Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
  Port number: sender 1 receiver 46128 protocol 0
  PATH rcvfrom: 10.0.0.18 (lt-1/2/0.17) 3 pkts
  Adspec: received MTU 1500
  PATH sentto: localclient
  RESV rcvfrom: localclient
  Record route: 10.0.0.22 10.0.0.18 <self>
Total 1 displayed, Up 1, Down 0
```

```
Transit LSP: 0 sessions
Total 0 displayed, Up 0, Down 0
```

show mpls lsp extensive

```
user@host> show mpls lsp extensive
Ingress LSP: 4 sessions

 1.1.1.1
   From: 3.3.3.3, State: Up, ActiveRoute: 0, LSPname: m120b-to-mx960
   ActivePath: DEFAULT (primary)
   FastReroute desired
   LSPtype: Static Configured, Penultimate hop popping
   LoadBalance: Random
   Encoding type: Packet, Switching type: Packet, GPID: IPv4
 *Primary   DEFAULT          State: Up
     Priorities: 7 0
     SmartOptimizeTimer: 180
     Computed ERO (S [L] denotes strict [loose] hops): (CSPF metric: 310)
 10.0.35.5 S 10.0.15.1 S
    Received RRO (ProtectionFlag 1=Available 2=InUse 4=B/W 8=Node 10=SoftPreempt
 20=Node-ID):
           10.0.34.4(flag=1) 10.0.14.1
    50 Sep 13 16:08:19.712 Record Route:  10.0.35.5(flag=1) 10.0.15.1
    49 Sep 13 16:08:16.720 Record Route:  10.0.34.4(flag=1) 10.0.14.1
    48 Sep 13 16:08:16.699 Fast-reroute Detour Up
    47 Sep 13 16:08:13.702 Record Route:  10.0.34.4 10.0.14.1
    46 Sep 13 16:08:13.702 Up
    45 Sep 13 16:08:13.672 Originate make-before-break call
    44 Sep 13 16:08:13.672 CSPF: computation result accepted  10.0.34.4 10.0.14.1

    43 Sep 13 16:08:13.672 Selected as active path
    42 Sep 13 16:08:13.672 Make-before-break: Switched to new instance
    41 Sep 13 16:08:01.685 Pending path switchover, skip CSPF run[3 times]
    40 Sep 13 16:06:33.910 Deselected as active
    39 Sep 13 16:06:33.910 Pending path switchover, skip CSPF run

    38 Sep 13 16:06:19.521 Record Route:  10.0.35.5 10.0.15.1
    37 Sep 13 16:06:19.518 ResvTear received
    36 Sep 13 16:06:19.518 Fast-reroute Detour Down
    35 Sep 13 16:06:16.676 Record Route:  10.0.35.5(flag=1) 10.0.15.1
    34 Sep 13 16:06:13.670 Record Route:  10.0.35.5 10.0.15.1
    33 Sep 13 16:06:13.670 Up
    32 Sep 13 16:06:13.569 Pending path switchover, skip CSPF run

    31 Sep 13 16:06:13.569 CSPF: link down/deleted:
10.0.34.3(3.3.3.3:79)(m120-b-re1.00/3.3.3.3)->0.0.0.0(0.0.0.0:0)(m120-b-re1.04/0.0.0.0)

    30 Sep 13 16:06:13.552 Pending path switchover, skip CSPF run

    29 Sep 13 16:06:13.552 CSPF: link down/deleted:
0.0.0.0(0.0.0.0:0)(m120-b-re1.04/0.0.0.0)->0.0.0.0(4.4.4.4:0)(m10i-a-re0.00/4.4.4.4)

    28 Sep 13 16:06:13.549 Originate make-before-break call
    27 Sep 13 16:06:13.549 CSPF: computation result accepted  10.0.35.5 10.0.15.1

    26 Sep 13 16:06:13.548 Tunnel local repaired
    25 Sep 13 16:06:13.546 Record Route:  10.0.23.2 10.0.12.1
    24 Sep 13 16:06:13.546 10.0.34.3: Tunnel local repaired
    23 Sep 13 16:06:13.546 10.0.34.3: Down
    22 Sep 13 16:03:46.842 Fast-reroute Detour Up
```

```
    21 Sep 13 16:03:42.730 Record Route:  10.0.34.4(flag=1) 10.0.14.1
    20 Sep 13 16:03:39.836 Selected as active path
    19 Sep 13 16:03:39.834 Record Route:  10.0.34.4 10.0.14.1
    18 Sep 13 16:03:39.834 Up
    17 Sep 13 16:03:39.698 Originate Call
    16 Sep 13 16:03:39.698 CSPF: computation result accepted  10.0.34.4 10.0.14.1

    15 Sep 13 16:03:39.697 Clear Call
    14 Sep 13 16:03:39.696 Deselected as active
    13 Sep 13 16:03:37.837 Record Route:  10.0.34.4 10.0.14.1
    12 Sep 13 16:03:32.829 Fast-reroute Detour Down
    11 Sep 13 16:02:15.493 Record Route:  10.0.34.4(flag=1) 10.0.14.1
    10 Sep 13 16:02:15.486 Fast-reroute Detour Up
     9 Sep 13 16:02:12.468 Record Route:  10.0.34.4 10.0.14.1
     8 Sep 13 16:02:07.460 Fast-reroute Detour Down
     7 Sep 13 15:57:46.741 Fast-reroute Detour Up
     6 Sep 13 15:57:40.768 Record Route:  10.0.34.4(flag=1) 10.0.14.1
     5 Sep 13 15:57:37.761 Selected as active path
     4 Sep 13 15:57:37.760 Record Route:  10.0.34.4 10.0.14.1
     3 Sep 13 15:57:37.760 Up
     2 Sep 13 15:57:37.733 Originate Call
     1 Sep 13 15:57:37.733 CSPF: computation result accepted  10.0.34.4 10.0.14.1

  Created: Fri Sep 13 15:57:38 2013
Total 1 displayed, Up 1, Down 0

Egress LSP: 4 sessions, 6 detours
Total 0 displayed, Up 0, Down 0

Transit LSP: 6 sessions, 1 detours

1.1.1.1
  From: 3.3.3.3, LSPstate: Up, ActiveRoute: 0
  LSPname: m120b-to-mx960, LSPpath: Primary
  Suggested label received: -, Suggested label sent: -
  Recovery label received: -, Recovery label sent: 302288
  Resv style: 1 FF, Label in: 300416, Label out: 302288
  Time left:  147, Since: Fri Sep 13 16:08:16 2013
  Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
  Port number: sender 4 receiver 13955 protocol 0
  Detour branch from 10.0.34.4, to skip 1.1.1.1, Up
    Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
    Adspec: received MTU 1500
    Path MTU: received 0
    PATH rcvfrom: 10.0.34.4 (ge-4/3/7.0) 7 pkts
    Adspec: received MTU 1500 sent MTU 1500
    PATH sentto: 10.0.35.5 (ge-3/1/0.0) 7 pkts
    RESV rcvfrom: 10.0.35.5 (ge-3/1/0.0) 7 pkts
    Explct route: 10.0.35.5 10.0.15.1
    Record route: 10.0.34.3 10.0.34.4 <self>10.0.35.5 10.0.15.1
 Label in: 300416, Label out: 302288
Total 1 displayed, Up 1, Down 0
```

show mpls lsp ingress extensive

```
user@host> show mpls lsp ingress extensive
Ingress LSP: 1 sessions

50.0.0.1
  From: 10.0.0.1, State: Up, ActiveRoute: 0, LSPname: test
  ActivePath:  (primary)
```

```
  LSPtype: Static Configured
  LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
 *Primary                   State: Up
    Priorities: 7 0
    OptimizeTimer: 300
    SmartOptimizeTimer: 180
    Reoptimization in 240 second(s).
    Computed ERO (S [L] denotes strict [loose] hops): (CSPF metric: 3)
 1.1.1.2 S 4.4.4.1 S 5.5.5.2 S
    Received RRO (ProtectionFlag 1=Available 2=InUse 4=B/W 8=Node 10=SoftPreempt
 20=Node-ID):
          1.1.1.2 4.4.4.1 5.5.5.2
   17 Aug  3 13:17:33.601 CSPF: computation result ignored, new path less avail
bw[3 times]
   16 Aug  3 13:02:51.283 CSPF: computation result ignored, new path no benefit[2
 times]
   15 Aug  3 12:54:36.678 Selected as active path
   14 Aug  3 12:54:36.676 Record Route:  1.1.1.2 4.4.4.1 5.5.5.2
   13 Aug  3 12:54:36.676 Up
   12 Aug  3 12:54:33.924 Deselected as active
   11 Aug  3 12:54:33.924 Originate Call
   10 Aug  3 12:54:33.923 Clear Call
    9 Aug  3 12:54:33.923 CSPF: computation result accepted  1.1.1.2 4.4.4.1
5.5.5.2
    8 Aug  3 12:54:33.922 2.2.2.2: No Route toward dest
    7 Aug  3 12:54:28.177 CSPF: computation result ignored, new path no benefit[4
 times]
    6 Aug  3 12:35:03.830 Selected as active path
    5 Aug  3 12:35:03.828 Record Route:  2.2.2.2 3.3.3.2
    4 Aug  3 12:35:03.827 Up
    3 Aug  3 12:35:03.814 Originate Call
    2 Aug  3 12:35:03.814 CSPF: computation result accepted  2.2.2.2 3.3.3.2
    1 Aug  3 12:34:34.921 CSPF failed: no route toward 50.0.0.1
  Created: Tue Aug  3 12:34:35 2010
Total 1 displayed, Up 1, Down 0
```

show mpls lsp extensive (automatic bandwidth adjustment enabled)

```
user@host> show mpls lsp extensive
Ingress LSP: 1 sessions

192.168.0.4
  From: 192.168.0.5, State: Up, ActiveRoute: 0, LSPname: E-D
  ActivePath:  (primary)
  Node/Link protection desired
  LSPtype: Static Configured, Penultimate hop popping
  LoadBalance: Random
  Autobandwidth
  MinBW: 300bps, MaxBW: 1000bps, Dynamic MinBW: 1000bps
  Adjustment Timer: 300 secs AdjustThreshold: 25%
  Max AvgBW util: 963.739bps, Bandwidth Adjustment in 0 second(s).
  Min BW Adjust Interval: 1000, MinBW Adjust Threshold (in %): 50
  Overflow limit: 0, Overflow sample count: 0
  Underflow limit: 0, Underflow sample count: 9, Underflow Max AvgBW: 614.421bps

  Encoding type: Packet, Switching type: Packet, GPID: IPv4
 *Primary                   State: Up
    Priorities: 7 0
    Bandwidth: 1000bps
    SmartOptimizeTimer: 180
```

```
    Computed ERO (S [L] denotes strict [loose] hops): (CSPF metric: 30)
 10.0.0.18 S 10.0.0.22 S
    Received RRO (ProtectionFlag 1=Available 2=InUse 4=B/W 8=Node 10=SoftPreempt
 20=Node-ID):
          192.168.0.6(flag=0x20) 10.0.0.18(Label=299792) 192.168.0.4(flag=0x20)
10.0.0.22(Label=3)
   12 Apr 30 10:25:17.024 Make-before-break: Switched to new instance
   11 Apr 30 10:25:16.023 Record Route:  192.168.0.6(flag=0x20)
10.0.0.18(Label=299792) 192.168.0.4(flag=0x20) 10.0.0.22(Label=3)
   10 Apr 30 10:25:16.023 Up
    9 Apr 30 10:25:16.023 Automatic Autobw adjustment succeeded: BW changes from
 300 bps to 1000 bps
    8 Apr 30 10:25:15.946 Originate make-before-break call
    7 Apr 30 10:25:15.946 CSPF: computation result accepted  10.0.0.18 10.0.0.22

    6 Apr 30 10:16:42.891 Selected as active path
    5 Apr 30 10:16:42.891 Record Route:  192.168.0.6(flag=0x20)
10.0.0.18(Label=299776) 192.168.0.4(flag=0x20) 10.0.0.22(Label=3)
    4 Apr 30 10:16:42.890 Up
    3 Apr 30 10:16:42.828 Originate Call
    2 Apr 30 10:16:42.828 CSPF: computation result accepted  10.0.0.18 10.0.0.22

    1 Apr 30 10:16:14.064 CSPF: could not determine self[2 times]
  Created: Tue Apr 30 10:15:16 2013
Total 1 displayed, Up 1, Down 0

Egress LSP: 0 sessions
Total 0 displayed, Up 0, Down 0

Transit LSP: 0 sessions
Total 0 displayed, Up 0, Down 0
```

show mpls lsp p2mp

```
user@host> show mpls lsp p2mp
Ingress LSP: 2 sessions
P2MP name: p2mp-lsp1, P2MP branch count: 1
To              From            State Rt P ActivePath       LSPname
10.255.245.51   10.255.245.50   Up     0 * path1            p2mp-branch-1
P2MP name: p2mp-lsp2, P2MP branch count: 1
To              From            State Rt P ActivePath       LSPname
10.255.245.51   10.255.245.50   Up     0 * path1            p2mp-st-br1
Total 2 displayed, Up 2, Down 0

Egress LSP: 0 sessions
Total 0 displayed, Up 0, Down 0

Transit LSP: 0 sessions
Total 0 displayed, Up 0, Down 0
```

show mpls lsp p2mp detail

```
user@host> show mpls lsp p2mp detail
Ingress LSP: 2 sessions
P2MP name: p2mp-lsp1, P2MP branch count: 1

10.255.245.51
  From: 10.255.245.50, State: Up, ActiveRoute: 0, LSPname: p2mp-branch-1
  ActivePath: path1 (primary)
  P2MP name: p2mp-lsp1
  LoadBalance: Random
```

```
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
 *Primary   path1            State: Up
    Computed ERO (S [L] denotes strict [loose] hops): (CSPF metric: 25)
 192.168.208.17 S
   Received RRO (ProtectionFlag 1=Available 2=InUse 4=B/W 8=Node 10=SoftPreempt):

          192.168.208.17
P2MP name: p2mp-lsp2, P2MP branch count: 1

10.255.245.51
  From: 10.255.245.50, State: Up, ActiveRoute: 0, LSPname: p2mp-st-br1
  ActivePath: path1 (primary)
  P2MP name: p2mp-lsp2
  LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
 *Primary   path1            State: Up
    Computed ERO (S [L] denotes strict [loose] hops): (CSPF metric: 25)
 192.168.208.17 S
   Received RRO (ProtectionFlag 1=Available 2=InUse 4=B/W 8=Node 10=SoftPreempt):

          192.168.208.17
Total 2 displayed, Up 2, Down 0
```

show mpls lsp detail count-active-routes

```
user@host> show mpls lsp detail count-active-routes
Ingress LSP: 1 sessions

213.119.192.2
  From: 156.154.162.128, State: Up, ActiveRoute: 1, LSPname: to-lahore
  ActivePath:  (primary)
  LSPtype: Static Configured
  LoadBalance: Random
  Autobandwidth
  MinBW: 5Mbps MaxBW: 250Mbps
  Adjustment Timer: 300 secs
  Max AvgBW util: 60.2599Mbps, Bandwidth Adjustment in 0 second(s).
  Overflow limit: 0, Overflow sample count: 0
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
 *Primary                    State: Up
    Priorities: 7 0
    Bandwidth: 5Mbps
    SmartOptimizeTimer: 180
    Computed ERO (S [L] denotes strict [loose] hops): (CSPF metric: 4)
 10.252.0.177 S
    Received RRO (ProtectionFlag 1=Available 2=InUse 4=B/W 8=Node 10=SoftPreempt
 20=Node-ID):
          10.252.0.177
Total 1 displayed, Up 1, Down 0

Egress LSP: 0 sessions
Total 0 displayed, Up 0, Down 0

Transit LSP: 0 sessions
Total 0 displayed, Up 0, Down 0
```

show mpls lsp statistics extensive

```
user@host> show mpls lsp statistics extensive
Ingress LSP: 1 sessions
```

```
192.168.0.4
  From: 192.168.0.5, State: Up, ActiveRoute: 0, LSPname: E-D
  Statistics: Packets 302, Bytes 28992
  Aggregate statistics: Packets 302, Bytes 28992
  ActivePath:  (primary)
  LSPtype: Static Configured, Penultimate hop popping
  LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
 *Primary                    State: Up
    Priorities: 7 0
    SmartOptimizeTimer: 180
    Computed ERO (S [L] denotes strict [loose] hops): (CSPF metric: 30)
 10.0.0.18 S 10.0.0.22 S
    Received RRO (ProtectionFlag 1=Available 2=InUse 4=B/W 8=Node 10=SoftPreempt
 20=Node-ID):
          10.0.0.18 10.0.0.22
    6 Oct  3 11:18:28.281 Selected as active path
    5 Oct  3 11:18:28.281 Record Route:  10.0.0.18 10.0.0.22
    4 Oct  3 11:18:28.280 Up
    3 Oct  3 11:18:27.995 Originate Call
    2 Oct  3 11:18:27.995 CSPF: computation result accepted  10.0.0.18 10.0.0.22

    1 Oct  3 11:17:59.118 CSPF failed: no route toward 192.168.0.4[2 times]
  Created: Wed Oct  3 11:17:01 2012
Total 1 displayed, Up 1, Down 0
```

show mpls lsp autobandwidth

Syntax
show mpls lsp autobandwidth
<brief | detail | extensive>
<logical-system (all | *logical-system-name*)>

Release Information
Command introduced in Junos OS Release 11.4.
Command introduced in Junos OS Release 13.2X51-D15 for the QFX Series.

Description
Display automatic bandwidth information for the LSP(s).

Options
brief | detail | extensive —(Optional) Display the specified level of output. The extensive option displays the same information as the detail option, but covers the most recent 50 events.

logical-system (all | *logical-system-name*)—(Optional) Perform this operation on all logical systems or on a particular logical system.

Required Privilege Level
view

Related Documentation
- show mpls lsp on page 163

List of Sample Output
show mpls lsp autobandwidth on page 180

Output Fields
Table 17 on page 179 describes the output fields for the **show mpls lsp autobandwidth** command. Output fields are listed in the approximate order in which they appear.

Table 17: show mpls lsp autobandwidth Output Fields

Field Name	Field Description	Level of Output
To	Destination (egress routing device) of the session.	All Levels
From	Source (ingress routing device) of the session.	All Levels
LSPname	Name of the LSP.	All Levels
Min BW	(Ingress LSP) Configured minimum value of the LSP, in bps.	**detail extensive**
Max BW	(Ingress LSP) Configured maximum value of the LSP, in bps.	**detail extensive**
Max AvgBW util	(Ingress LSP) Current value of the actual maximum average bandwidth utilization, in bps.	**detail extensive**
Overflow limit	(Ingress LSP) Configured value of the threshold overflow limit.	**detail extensive**
Overflow sample count	(Ingress LSP) Current value for the overflow sample count.	**detail extensive**
Underflow limit	(Ingress LSP) Configured value of the threshold underflow limit.	**detail extensive**

Table 17: show mpls lsp autobandwidth Output Fields *(continued)*

Field Name	Field Description	Level of Output
Underflow sample count	(Ingress LSP) Current value for the underflow sample count.	**detail extensive**
Adjustment Timer	(Ingress LSP) Configured value for the adjust-timer statement, indicating the total amount of time allowed before bandwidth adjustment will take place, in seconds.	**detail extensive**
Adjustment Threshold	(Ingress LSP) Configured value for the adjust-threshold statement. Specifies how sensitive the automatic bandwidth adjustment for an LSP is to changes in bandwidth utilization.	**detail extensive**
Time for Next Adjustment	(Ingress LSP) Time in seconds until the next automatic bandwidth adjustment sample is taken.	**detail extensive**
Time of Last Adjustment	(Ingress LSP) Date and time since the last automatic bandwidth adjustment was completed.	**detail extensive**
Last BW	Previous active bandwidth of the LSP.	**detail extensive**
Last Requested BW	Bandwidth requested in the previous automatic bandwidth adjustment.	**detail extensive**
Last Signaled BW	Bandwidth signaled in the previous automatic bandwidth adjustment.	**detail extensive**
Highest Watermark BW	Maximum bandwidth used by the LSP.	**detail extensive**
Total AutoBw Adjustments	Total number of attempts to adjust automatic bandwidth including failed and successful adjustments.	**detail extensive**
Successful Adjustments	Number of successful automatic bandwidth adjustments.	**detail extensive**
Failed Adjustments	Number of failed automatic bandwidth adjustments.	**detail extensive**

Sample Output

show mpls lsp autobandwidth

```
user@host> show mpls lsp autobandwidth extensive
To: 10.255.106.133,
From: 10.255.106.135, LSPname: r0-r1
Min BW: 100kbps, Max BW: 0bps, Max AvgBW util: 2.33249Mbps
Overflow limit: 0, Overflow sample count: 0
Underflow limit: 0, Underflow sample count: 0
Adjustment Timer: 300 sec, Adjustment Threshold: 0
Time for Next Adjustment: 23 sec, Time of Last Adjustment: Fri Jun  3 21:05:37
2011
Last BW: 100kbps, Last Requested BW: 2.2169Mbps, Last Signaled BW: 2.2169Mbps,
Highest Watermark BW: 2.33249Mbps
Total AutoBw Adjustments: 1, Successful Adjustments: 1, Failed Adjustments: 0
```

show mpls path

List of Syntax
Syntax on page 182
Syntax (EX Series Switches) on page 182

Syntax
show mpls path
<logical-system (all | *logical-system-name*)>
<*path-name*>

Syntax (EX Series Switches)
show mpls path
<*path-name*>

Release Information
Command introduced before Junos OS Release 7.4.
Command introduced in Junos OS Release 9.5 for EX Series switches.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description
Display dynamic Multiprotocol Label Switching (MPLS) label-switched paths (LSPs).

Options
none—Display standard information about all MPLS LSPs.

logical-system (all | *logical-system-name*)—(Optional) Perform this operation on all logical systems or on a particular logical system.

path-name—(Optional) Display information about the specified LSP only.

Required Privilege Level
view

List of Sample Output
show mpls path on page 182

Output Fields
Table 18 on page 182 describes the output fields for the **show mpls path** command. Output fields are listed in the approximate order in which they appear.

Table 18: show mpls path Output Fields

Field Name	Field Description
Path name	Information about ingress LSPs. Each path has one line of output.
Address	Addresses of the routing devices that form the LSP.
Strict/loose address	Whether the address is a configured as a strict or loose address.

Sample Output

show mpls path

```
user@host> show mpls path
Path name        Address          Strict/loose address
p1               123.456.55.6     Strict
```

```
                    123.456.1.6      Loose
p2                  191.456.1.4      Strict
```

show mpls static-lsp

Syntax

show mpls static-lsp
<brief | detail | extensive | terse>
<bypass>
<descriptions>
<down | up>
<ingress>
<logical-system (all | *logical-system-name*)>
<*lsp-type*>
<name *name*>
<statistics>
<transit>

Release Information

Command introduced in Junos OS Release 10.1.
Command updated in Junos OS Release 14.1X53-D25 to accommodate the stitching feature of MPLS.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description

Display information about configured and active static Multiprotocol Label Switching (MPLS) label-switched paths (LSPs).

Options

none—Display standard information about all configured and active static MPLS LSPs.

brief | detail | extensive | terse—(Optional) Display the specified level of output. The **extensive** option displays the same information as the **detail** option, but covers the most recent 50 events.

bypass—(Optional) Display LSPs used for protecting other static LSPs.

descriptions—(Optional) Display the MPLS static LSP descriptions. To view this information, you must configure the description statement at the **[edit protocols mpls static-label-switched-path *path-name* bypass]**, **[edit protocols mpls static-label-switched-path *path-name* ingress]**, or **[edit protocols mpls static-label-switched-path *path-name* transit *incoming-label*]** hierarchy levels. Only static LSPs with a description are displayed.

down | up—(Optional) Display only static LSPs that are inactive or active, respectively.

logical-system (all | *logical-system-name*)—(Optional) Perform this operation on all logical systems or on a particular logical system.

lsp-type—(Optional) Display information about a particular LSP type:

- **bypass**—Sessions for bypass LSPs.
- **ingress**—Sessions that originate from this routing device.
- **transit**—Sessions that pass through this routing device.

name *name*—(Optional) Display information about the specified static LSP or group of LSPs.

statistics—(Optional) Display accounting information about static LSPs.

transit—(Optional) Display static LSPs transiting this routing device.

Required Privilege Level view

List of Sample Output
show mpls static-lsp extensive on page 186
show mpls static-lsp statistics ingress on page 186
show mpls static-lsp (when MPLS stitching is used) on page 186

Output Fields Table 19 on page 185 describes the output fields for the **show mpls static-lsp** command. Output fields are listed in the approximate order in which they appear.

Table 19: show mpls static-lsp Output Fields

Field Name	Field Description	Level of Output
Ingress LSPs	Information about the static LSPs on the ingress routing device. Each session has one line of output.	All levels
Transit LSPs	Number of static LSPs on the transit routing devices and the state of these paths. MPLS learns this information by querying RSVP, which holds all the transit and egress session information.	All levels
Bypass LSPs	Information about the bypass LSPs configured on the routing device. Each session has one line of output.	All levels
LSPname	Name of the static LSP.	All levels
To	Destination (egress routing device) of the session.	All levels
State	State of the static LSP handled by this RSVP session: **Up**, **Dn** (down), or **Restart**.	All levels
Packets	Number of packet transiting the static LSP (**statistics** option only).	All levels
Bytes	Number of bytes transiting the static LSP (**statistics** option only).	All levels
Nexthop	IP address for the next-hop router for the static LSP.	**detail**, **extensive**
Bypass	(Bypass LSP) Destination address (egress routing device) for the bypass LSP.	All levels
Link protection desired	Link protection has been requested by the ingress routing device.	**detail**, **extensive**
LabelOperation	Label operation to perform: **Push**, **Pop**, **Swap**.	**detail**, **extensive**
Outgoing-label	Outgoing label to use for the MPLS packet in either push or swap label operations.	**detail**, **extensive**

Table 19: show mpls static-lsp Output Fields *(continued)*

Field Name	Field Description	Level of Output
Created	(Ingress LSP) Date and time the static LSP was created.	**extensive**
Bandwidth	Bandwidth configured for the static LSP.	**detail**, **extensive**
Resv style	(Bypass) RSVP reservation style. This field consists of two parts: the number of active reservations and the reservation style, which can be **FF** (fixed filter), **SE** (shared explicit), or **WF** (wildcard filter).	All levels

Sample Output

show mpls static-lsp extensive

```
user@host> show mpls static-lsp extensive
Ingress LSPs:
LSPname: alpha-to-beta, To: 192.168.14.1
  State: Dn
  Nexthop: 192.168.10.1
  LabelOperation: Push, Outgoing-label: 1000001
  Created: Thu Jan 14 16:44:43 2010
  Bandwidth: 0 bps
Total 1, displayed 1, Up 0, Down 1

Transit LSPs:
Total 0, displayed 0, Up 0, Down 0

Bypass LSPs:
Total 0, displayed 0, Up 0, Down 0
```

show mpls static-lsp statistics ingress

```
user@host> show mpls static-lsp statistics ingress
Ingress LSPs:
LSPname                    To              State     Packets            Bytes
alpha-to-beta              192.168.14.1    Dn             NA               NA
Total 1, displayed 1, Up 0, Down 1
```

show mpls static-lsp (when MPLS stitching is used)

The show mpls static-lsp command was extended in Junos release 14.1X53-D25 to accommodate the stitching feature of MPLS. This example shows the LSP state as 'InProgress' because the LSP is waiting for protocol next-hop resolution. For more information, see

```
user@host> show mpls static-lsp
Ingress LSPs:
Total 0, displayed 0, Up 0, Down 0
Transit LSPs: LSPname                          Incoming-label  State
to-165                                 1000000         InProgress
```

PART 2

RSVP

- Using RSVP on page 189
- Configuration Statements and Command Statements for RSVP on page 203

CHAPTER 3

Using RSVP

- Understanding MPLS Components on page 189
- RSVP Overview on page 192
- MTU Signaling in RSVP on page 193
- Tunneling LDP LSPs in RSVP LSPs on page 194
- Tunneling LDP LSPs in RSVP LSPs Overview on page 194
- Configuring MPLS on Provider Edge Switches on page 194
- Configuring MPLS on Provider Switches on page 198
- Verifying That MPLS Is Working Correctly on page 199

Understanding MPLS Components

MPLS devices include a number of components. While some components are required for all MPLS applications, others might not be, depending on the specific application.

This topic includes:

- Provider Edge Switches on page 189
- Provider Switch on page 190
- Components Required for All Switches in the MPLS Network on page 191

Provider Edge Switches

To implement MPLS on a network, you must configure two provider edge (PE) switches—an ingress PE switch and an egress PE switch. In addition, you must configure one or more provider switches as transit switches within the network to support the forwarding of MPLS packets.

The ingress PE switch (the entry point to the MPLS tunnel) receives a packet, analyzes it, and pushes an MPLS label onto it. This label places the packet in a forwarding equivalence class (FEC) and determines its handling and destination through the MPLS tunnel. The egress PE switch (the exit point from the MPLS tunnel) pops the MPLS label off the outgoing packet.

Within an MPLS tunnel, the network traffic is bidirectional. Therefore, each PE switch can be configured to be both an ingress switch and an egress switch, depending on the direction of the traffic.

The following MPLS components are configured on the PE switches but not on the provider switches:

- MPLS Protocol and Label-Switched Paths on page 190
- IP Over MPLS for Customer Edge Interfaces on page 190
- BGP Layer 3 VPN Configuration on page 190
- Routing Instances for Layer 3 VPN on page 190

MPLS Protocol and Label-Switched Paths

Each PE switch must be configured to support the MPLS protocol. You must also configure label-switched paths (LSPs) at the **[edit protocols mpls]** hierarchy level.

IP Over MPLS for Customer Edge Interfaces

You can configure the customer edge interfaces of the PE switches for IP over MPLS using a Layer 3 interface and a static route from the ingress PE switch to the egress PE switch. See "Configuring MPLS on Provider Edge Switches" on page 39.

BGP Layer 3 VPN Configuration

If you are implementing a Layer 3 virtual private network (VPN), you must configure the BGP routing protocol on the PE switches.

Routing Instances for Layer 3 VPN

If you are implementing a Layer 3 VPN, you must configure a routing instance. A routing instance is a collection of routing tables, interfaces, and routing protocol parameters. The set of interfaces belongs to the routing tables, and the routing protocol parameters control the information in the routing tables.

QFX Series and EX4600 devices support VPN routing and forwarding (VRF) routing instances for Layer 3 VPNs.

Each routing instance has a unique name and a corresponding IP unicast table. For example, if you configure a routing instance with the name **my-instance**, its corresponding IP unicast table will be **my-instance.inet.0**. All routes for **my-instance** are installed in **my-instance.inet.0**.

Provider Switch

You must configure one or more provider switches as transit switches within the network to support the forwarding of MPLS packets. You can add provider switches without changing the configuration of the PE switches.

A provider switch does not analyze packets. It refers to an MPLS label forwarding table and swaps one label for another. The new label determines the next hop along the MPLS tunnel. A provider switch cannot perform push or pop operations.

Components Required for All Switches in the MPLS Network

The following MPLS components are configured on both the PE switches and the provider switches:

- Interior Gateway Protocol on page 191
- MPLS Protocol on page 191
- RSVP on page 191
- Family mpls on page 192

Interior Gateway Protocol

MPLS works in coordination with OSPF as the interior gateway protocol (IGP). Therefore, you must configure OSPF as the IGP on the loopback interface and CE-facing interfaces of both the PE switches and the provider switches.

The CE-facing interfaces can be either Gigabit Ethernet or 10-Gigabit Ethernet interfaces, and they can be configured as either individual interfaces or as aggregated Ethernet interfaces.

NOTE: The CE-facing interfaces cannot be configured with VLAN tagging or a VLAN ID. When you configure them to belong to family mpls, they are removed from the default VLAN if they were members of that VLAN. They operate as an exclusive tunnel for MPLS traffic.

MPLS Protocol

You must enable the MPLS protocol on all switches that participate in the MPLS network and apply it to the core interfaces of both the PE and provider switches. You do not need to apply it to the loopback interface because the MPLS protocol uses the framework established by the RSVP signaling protocol to create LSPs. On the PE switches, the configuration of the MPLS protocol must also include the definition of an LSP.

RSVP

RSVP is a signaling protocol that allocates and distributes labels throughout an MPLS network. RSVP sets up unidirectional paths between the ingress PE switch and the egress PE switch. RSVP makes the LSPs dynamic; it can detect topology changes and outages and establish new LSPs to allow traffic to move around a failure.

You must enable RSVP and apply it to the loopback interface and the core interface of both the PE and provider switches. The path message contains the configured information about the resources required for the LSP to be established.

When the egress PE switch receives the path message, it sends a reservation message back to the ingress PE switch. This reservation message is passed along from switch to switch along the same path as the original path message. Once the ingress PE switch receives this reservation message, an RSVP path is established.

The established LSP stays active as long as the RSVP session remains active. RSVP continues activity through the transmissions and responses to RSVP path and reservation messages. If the messages stop for three minutes, the RSVP session terminates and the LSP is lost.

RSVP runs as a separate software process in Junos OS and is not in the packet-forwarding path.

Family mpls

You must configure the core interfaces used for MPLS traffic to belong to **family mpls**.

NOTE: **You can enable family mpls on either individual interfaces or on aggregated Ethernet interfaces. You cannot enable it on tagged VLAN interfaces.**

Related Documentation

- MPLS Feature Support on QFX Series and EX4600 Switches on page 17
- Understanding Using MPLS-Based Layer 3 VPNs on Switches on page 14
- Understanding CoS MPLS EXP Classifiers and Rewrite Rules on page 27
- Configuring MPLS on Provider Edge Switches on page 39
- Configuring MPLS on Provider Switches on page 42
- *Configuring Rewrite Rules for MPLS EXP Classifiers*
- *Configuring a Global MPLS EXP Classifier*
- *Configuring Ethernet over MPLS (L2 Circuit)*
- *Junos OS MPLS Applications Library for Routing Devices*
- *Junos OS VPNs Library for Routing Devices*

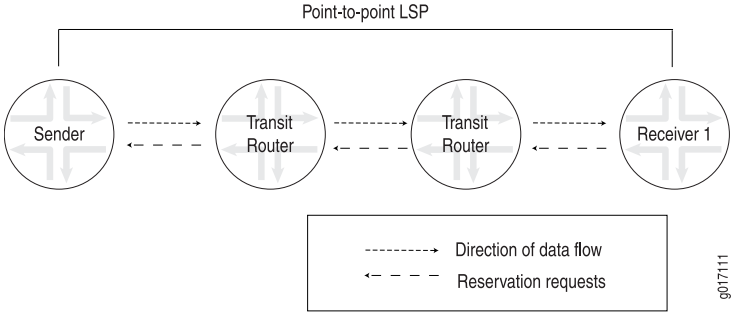
RSVP Overview

The RSVP protocol is used by routers to deliver quality-of-service (QoS) requests to all nodes along data flow path(s) and to establish and maintain state for the requested service. RSVP requests generally result in resource reservations in each node along the data path. RSVP has the following attributes:

- Makes resource reservations for unidirectional data flows.
- Allows the receiver of a data flow to initiate and maintain the resource reservation used for that flow, as shown in Figure 5 on page 37.
- Maintains a soft state in routers and hosts, providing graceful support for dynamic membership changes and automatic adaptation to routing changes.
- Depends upon present and future routing protocols, but is not a routing protocol itself.

- Provides several reservation models or styles to fit a variety of applications.
- Supports both IPv4 and IPv6. Note, you can configure the Junos OS to tunnel IPv6 over an MPLS-based IPv4 network. For more information, see the *Junos OS MPLS Applications Library for Routing Devices*.

Figure 8: RSVP Reservation Request and Data Flow



MTU Signaling in RSVP

The maximum transmission unit (MTU) is the largest size packet or frame, in bytes, that can be sent in a network. An MTU that is too large might cause retransmissions. Too small an MTU might cause the router to send and handle relatively more header overhead and acknowledgments. There are default values for MTUs associated with various protocols. You can also explicitly configure an MTU on an interface.

When an LSP is created across a set of links with different MTU sizes, the ingress router does not know what the smallest MTU is on the LSP path. By default, the MTU for an LSP is 1,500 bytes.

If this MTU is larger than the MTU of one of the intermediate links, traffic might be dropped, because MPLS packets cannot be fragmented. Also, the ingress router is not aware of this type of traffic loss, because the control plane for the LSP would still function normally.

To prevent this type of packet loss in MPLS LSPs, you can configure MTU signaling in RSVP. This feature is described in RFC 3209. Juniper Networks supports the Integrated Services object for MTU signaling in RSVP. The Integrated Services object is described in RFCs 2210 and 2215. MTU signaling in RSVP is disabled by default.

To avoid packet loss due to MTU mismatches, the ingress router needs to do the following:

- Signal the MTU on the RSVP LSP—To prevent packet loss from an MTU mismatch, the ingress router needs to know what the smallest MTU value is along the path taken by the LSP. Once this MTU value is obtained, the ingress router can assign it to the LSP.
- Fragment packets—Using the assigned MTU value, packets that exceed the size of the MTU can be fragmented into smaller packets on the ingress router before they are encapsulated in MPLS and sent over the RSVP-signaled LSP.

Once both MTU signaling and packet fragmentation have been enabled on an ingress router, any route resolving to an RSVP LSP on this router uses the signaled MTU value.

For information about how to configure this feature, see *Configuring MTU Signaling in RSVP*.

The following sections describe how MTU signaling in RSVP works:

- *How the Correct MTU Is Signaled in RSVP*
- *Determining an Outgoing MTU Value*
- *MTU Signaling in RSVP Limitations*

Tunneling LDP LSPs in RSVP LSPs

You can tunnel LDP LSPs over RSVP LSPs. The following sections describe how tunneling of LDP LSPs in RSVP LSPs works:

- Tunneling LDP LSPs in RSVP LSPs Overview on page 194

- *Label Operations*

Tunneling LDP LSPs in RSVP LSPs Overview

If you are using RSVP for traffic engineering, you can run LDP simultaneously to eliminate the distribution of external routes in the core. The LSPs established by LDP are tunneled through the LSPs established by RSVP. LDP effectively treats the traffic-engineered LSPs as single hops.

When you configure the router to run LDP across RSVP-established LSPs, LDP automatically establishes sessions with the router at the other end of the LSP. LDP control packets are routed hop-by-hop, rather than carried through the LSP. This routing allows you to use simplex (one-way) traffic-engineered LSPs. Traffic in the opposite direction flows through LDP-established LSPs that follow unicast routing rather than through traffic-engineered tunnels.

If you configure LDP over RSVP LSPs, you can still configure multiple OSPF areas and IS-IS levels in the traffic engineered core and in the surrounding LDP cloud.

Configuring MPLS on Provider Edge Switches

To implement MPLS, you must configure two provider edge (PE) switches—an ingress PE switch and an egress PE switch—and at least one provider switch. You can configure the customer edge (CE) interfaces on the PE switches of the MPLS network using IP over MPLS.

This topic describes how to configure an ingress PE switch and an egress PE switch using IP over MPLS:

1. Configuring the Ingress PE Switch on page 195
2. Configuring the Egress PE Switch on page 196

Configuring the Ingress PE Switch

To configure the ingress PE switch:

1. Configure an IP address for the loopback interface and the core interfaces:

```
[edit interfaces]
user@switch# set lo0 unit 0 family inet address 192.168.10.1/32
user@switch# set xe-0/0/5 unit 0 family inet address 10.1.5.1/24
user@switch# set xe-0/0/6 unit 0 family inet address 10.1.6.1/24
```

NOTE: You cannot use routed VLAN interfaces (RVIs) or Layer 3 subinterfaces as core interfaces.

2. Configure OSPF on the loopback interface and the core interfaces:

NOTE: You can use the switch address as an alternative to the loopback interface.

```
[edit protocols ospf]
user@switch# set area 0.0.0.0 interface lo0.0
user@switch# set area 0.0.0.0 interface xe-0/0/5.0
user@switch# set area 0.0.0.0 interface xe-0/0/6.0
```

3. Configure OSPF traffic engineering:

```
[edit protocols ospf]
user@switch# set traffic-engineering
```

4. Configure RSVP on the loopback interface and the core interfaces:

```
[edit protocols rsvp]
user@switch# set interface lo0.0
user@switch# set interface xe-0/0/5.0
user@switch# set interface xe-0/0/6.0
```

5. Configure MPLS traffic engineering.

```
[edit protocols mpls]
user@switch# set traffic-engineering
```

6. Configure MPLS on the core interfaces:

```
[edit protocols mpls]
user@switch# set interface xe-0/0/5.0
user@switch# set interface xe-0/0/6.0
```

7. Configure **family mpls** on the logical units of the core interfaces, thereby identifying the interfaces that will be used for forwarding MPLS packets:

```
[edit interfaces]
user@switch# set xe-0/0/5 unit 0 family mpls
user@switch# set xe-0/0/6 unit 0 family mpls
```

8. Configure a customer edge interface as a Layer 3 routed interface, specifying an IP address:

```
[edit interfaces]
user@switch# set xe-0/0/3 unit 0 family inet address 121.100.10.1/16
```

9. Configure this Layer 3 customer edge interface for the routing protocol:

```
[edit]
user@switch# set protocols ospf area 0.0.0 interface xe-0/0/3.0
```

10. Configure an LSP on the ingress PE switch (192.168.10.1) to send IP packets over MPLS to the egress PE switch (192.168.12.1):

```
[edit protocols mpls]
user@switch# set label-switched-path lsp_1 to 192.168.12.1
```

11. Disable constrained-path LSP computation for this LSP:

```
[edit protocols mpls]
user@switch# set label-switched-path lsp_1 no-cspf
```

12. Configure a static route from the ingress PE switch to the egress PE switch, thereby indicating to the routing protocol that the packets will be forwarded over the MPLS LSP that has been set up to that destination:

```
[edit routing-options]
user@switch# set static route 2.2.2.0/24 next-hop 192.168.10.1
user@switch# set static route 2.2.2.0/24 resolve
```

Configuring the Egress PE Switch

To configure the egress PE switch:

1. Configure an IP address for the loopback interface and the core interfaces:

```
[edit interfaces]
user@switch# set lo0 unit 0 family inet address 192.168.12.1/32
user@switch# set xe-0/0/5 unit 0 family inet address 10.1.20.1/24
user@switch# set xe-0/0/6 unit 0 family inet address 10.1.21.1/24
```

NOTE: You cannot use routed VLAN interfaces (RVIs) or Layer 3 subinterfaces as core interfaces.

2. Configure OSPF on the loopback interface and the core interfaces:

NOTE: You can use the switch address as an alternative to the loopback interface.

```
[edit protocols ospf]
user@switch# set area 0.0.0.0 interface lo0.0
user@switch# set area 0.0.0.0 interface xe-0/0/5.0
user@switch# set area 0.0.0.0 interface xe-0/0/6.0
```

3. Configure RSVP on the loopback interface and the core interfaces:

```
[edit protocols rsvp]
user@switch# set rsvp interface lo0.0
user@switch# set rsvp interface xe-0/0/5.0
user@switch# set rsvp interface xe-0/0/6.0
```

4. Configure MPLS on the core interfaces:

```
[edit protocols mpls]
user@switch# set interface xe-0/0/5.0
user@switch# set interface xe-0/0/6.0
```

5. Configure **family mpls** on the logical units of the core interfaces, thereby identifying the interfaces that will be used for forwarding MPLS packets:

```
[edit interfaces]
user@switch# set xe-0/0/5 unit 0 family mpls
user@switch# set xe-0/0/6 unit 0 family mpls
```

6. Configure a customer edge interface as a Layer 3 routed interface, specifying an IP address:

```
[edit interfaces]
user@switch# set xe-0/0/3 unit 0 family inet address 2.2.2.1/16
```

7. Configure this Layer 3 customer edge interface for the routing protocol:

```
[edit]
user@switch# set protocols ospf area 0.0.0 interface xe-0/0/3
```

8. Configure an LSP on the egress PE switch (192.168.12.1) to send IP packets over MPLS to the ingress PE switch (192.168.10.1):

```
[edit protocols mpls]
user@switch# set label-switched-path lsp_2 to 192.168.10.1
```

9. Disable constrained-path LSP computation for this LSP:

```
[edit protocols mpls]
user@switch# set label-switched-path lsp_2 no-cspf
```

10. Configure a static route from the ingress PE switch to the egress PE switch, thereby indicating to the routing protocol that the packets will be forwarded over the MPLS LSP that has been set up to that destination:

```
[edit routing-options]
user@switch#  set static route 121.121.121.0/24 next-hop 192.168.12.1
user@switch# set static route 121.121.121.0/24 resolve
```

Related Documentation

- MPLS Configuration Guidelines on page 15
- Configuring MPLS on Provider Switches on page 42
- MPLS Feature Support on QFX Series and EX4600 Switches on page 17
- Understanding MPLS Components on page 8
- Understanding CoS MPLS EXP Classifiers and Rewrite Rules on page 27

Configuring MPLS on Provider Switches

To implement MPLS, you must configure at least one provider switch as a transit switch for the MPLS packets.

MPLS requires the configuration of an interior gateway protocol (OSPF) and a signaling protocol (RSVP) on the core interfaces and the loopback interface of all the switches. This procedure includes the configuration of OSPF on the provider switch.

To configure the provider switch, complete the following tasks:

1. Configure OSPF on the loopback and core interfaces:

   NOTE: You can use the switch address as an alternative to the loopback interface.

   ```
   [edit protocols ospf]
   user@switch# set area 0.0.0.0 interface lo0.0
   user@switch# set area 0.0.0.0 interface xe-0/0/5.0
   user@switch# set area 0.0.0.0 interface xe-0/0/6.0
   user@switch# set area 0.0.0.0 interface ae0
   ```

   NOTE: You cannot use routed VLAN interfaces (RVIs) or Layer 3 subinterfaces as core interfaces.

2. Configure MPLS on the core interfaces:

   ```
   [edit protocols mpls]
   user@switch# set interface xe-0/0/5.0
   user@switch# set interface xe-0/0/6.0
   user@switch# set interface ae0
   ```

3. Configure RSVP on the loopback interface and the core interfaces:

   ```
   [edit protocols rsvp]
   user@switch# set interface lo0.0
   user@switch# set interface xe-0/0/5.0
   user@switch# set interface xe-0/0/6.0
   user@switch# set interface ae0
   ```

4. Configure an IP address for the loopback interface and the core interfaces:

   ```
   [edit interfaces]
   user@switch# set lo0 unit 0 family inet address 127.1.1.1/32
   user@switch# set xe-0/0/5 unit 0 family inet address 10.1.5.1/24
   user@switch# set xe-0/0/6 unit 0 family inet address 10.1.6.1/24
   user@switch# set ae0 unit 0 family inet address 10.1.9.2/24
   ```

5. Configure **family mpls** on the logical units of the core interfaces, thereby identifying the interfaces that will be used for forwarding MPLS packets:

   ```
   [edit interfaces]
   user@switch# set xe-0/0/5 unit 0 family mpls
   user@switch# set xe-0/0/6 unit 0 family mpls
   user@switch# set ae0 unit 0 family mpls
   ```

NOTE: You can configure **family mpls** on either individual interfaces or aggregated Ethernet interfaces. You cannot configure it on tagged VLAN interfaces.

Related Documentation

- Configuring MPLS on Provider Edge Switches on page 39
- MPLS Configuration Guidelines on page 15
- MPLS Feature Support on QFX Series and EX4600 Switches on page 17
- Understanding MPLS Components on page 8
- Understanding CoS MPLS EXP Classifiers and Rewrite Rules on page 27

Verifying That MPLS Is Working Correctly

To verify that MPLS is working correctly, perform the following tasks:

1. Verifying the Physical Layer on the Switches on page 199
2. Verifying the Routing Protocol on page 200
3. Verifying the Core Interfaces Being Used for the MPLS Traffic on page 200
4. Verifying RSVP on page 200

Verifying the Physical Layer on the Switches

Purpose Verify that the interfaces are up. Perform this verification task on each of the switches.

Action

```
user@switch> show interfaces xe-* terse

Interface               Admin Link Proto    Local                 Remote
xe-0/0/0                up    up
xe-0/0/0.0              up    up
xe-0/0/1.0              up    up
xe-0/0/2.0              up    up
xe-0/0/3.0              up    up   inet       2.2.2.1/16
xe-0/0/4.0              up    up
xe-0/0/5.0              up    up   inet      10.1.5.1/24
                                   mpls
xe-0/0/6.0              up    up   inet      10.1.6.1/24
                                   mpls
```

Meaning The **show interfaces terse** command displays status information about the 10-Gigabit Ethernet interfaces on the switch. This output verifies that the interfaces are **up**. The output for the protocol family (Proto column) of the core interfaces (xe-0/0/5.0 and xe-0/0/6.0), shows that these interfaces are configured as both **inet** and **mpls**. The **Local** column for the core interfaces shows the IP address configured for these interfaces.

Verifying the Routing Protocol

Purpose Verify the state of the configured routing protocol. You should perform this verification task on each of the switches. The state should be **Full**. If you have configured OSPF as the routing protocol, use the **show ospf neighbor** command to verify that the routing protocol is communicating with the switch neighbors.

Action

```
user@switch> show ospf neighbor

Address          Interface              State     ID               Pri  Dead
127.1.1.1        xe-0/0/5               Full      10.10.10.10      128    39
```

Meaning The **show ospf neighbor** command displays the status of the routing protocol that has been configured on this switch. The output shows that the state is **Full**, meaning that the routing protocol is operating correctly—that is, hello packets are being exchanged between directly connected neighbors. For additional information on checking and monitoring routing protocols, see the *Junos OS Routing Protocols and Policies Command Reference* .

Verifying the Core Interfaces Being Used for the MPLS Traffic

Purpose Verify that the state of the MPLS interface is **Up**. You should perform this verification task on each of the switches.

Action

```
user@switch> show mpls interface

Interface        State       Administrative groups
ge-0/0/5            Up          <none>
ge-0/0/6            Up          <none>
```

Meaning The **show mpls interface** command displays the status of the core interfaces that have been configured to belong to **family mpls**. This output shows that the interface configured to belong to **family mpls** is up.

Verifying RSVP

Purpose Verify the state of the RSVP session. You should perform this verification task on each of the switches.

```
user@switch> show rsvp session
```

Action

```
Ingress RSVP: 1 sessions
To              From            State   Rt Style Labelin Labelout LSPname
127.1.1.3       127.1.1.1         Up       0  1 FF       -   300064 lsp_to_pe2_ge1
Total 1 displayed, Up 1, Down 0

Egress RSVP: 1 sessions
To              From            State   Rt Style Labelin Labelout LSPname
127.1.1.1       127.1.1.3         Up       0  1 FF  299968        - lsp_to_pe1_ge1
Total 1 displayed, Up 1, Down 0

Transit RSVP: 0 sessions
Total 0 displayed, Up 0, Down 0
```

Meaning This output confirms that the RSVP sessions are up.

Related Documentation

- Configuring MPLS on Provider Edge Switches on page 39
- Configuring MPLS on Provider Switches on page 42

CHAPTER 4

Configuration Statements and Command Statements for RSVP

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Configuration Statements for RSVP

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admin-group

Syntax

```
admin-group {
  exclude [ group-names ];
  include-all [ group-names ];
  include-any [ group-names ];
}
```

Hierarchy Level

[edit logical-systems *logical-system-name* protocols rsvp interface *interface-name* link-protection],
[edit logical-systems *logical-system-name* protocols rsvp interface *interface-name* link-protection bypass *bypass-name*],
[edit protocols rsvp interface *interface-name* link-protection],
[edit protocols rsvp interface *interface-name* link-protection bypass *bypass-name*]

Release Information

Statement introduced in Junos OS Release 9.2.
Statement introduced for QFX switches in Junos OS Release13.2X51-D15
Statement introduced for QFX Virtual Chassis and Virtual Chassis Fabric in Junos OS Release 14.1X53-D30

Description

Enable you to configure administrative groups for bypass label-switched paths (LSPs). You can configure administrative groups either globally for all bypass LSPs traversing an interface or for just a specific bypass LSP.

Options

exclude *group-names*—Specify the administrative groups to exclude for a bypass LSP.

include-all *group-names*—Specify the administrative groups whose links the bypass LSP must traverse.

include-any *group-names*—Specify the administrative groups whose links the bypass LSP can traverse.

Required Privilege Level

routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Configuring Link Protection on Interfaces Used by LSPs*

authentication-key (Protocols RSVP)

Syntax authentication-key *key*;

Hierarchy Level [edit logical-systems *logical-system-name* protocols rsvp interface *interface-name*],
[edit logical-systems *logical-system-name* protocols rsvp peer-interface *peer-interface-name*],
[edit protocols rsvp interface *interface-name*],
[edit protocols rsvp peer-interface *peer-interface-name*]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced for QFX switches in Junos OS Release13.2X51-D15
Statement introduced for QFX Virtual Chassis and Virtual Chassis Fabric in Junos OS Release 14.1X53-D30

Description Authentication key (password). Neighboring routers use the password to verify the authenticity of packets sent from this interface or peer interface.

RSVP uses HMAC-MD5 authentication, which is defined in RFC 2104, *HMAC: Keyed-Hashing for Message Authentication*.

All routers that are connected to the same IP subnet must use the same authentication scheme and password.

Options ***key***—Authentication password. It can be 1 through 16 contiguous digits or letters. Separate decimal digits with periods. Separate hexadecimal digits with periods and precede the string with 0x. If you include spaces in the password, enclose the entire password in quotation marks (" ").

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring RSVP Interfaces*

aggregate (Protocols RSVP)

Syntax (aggregate | no-aggregate);

Hierarchy Level [edit logical-systems *logical-system-name* protocols rsvp interface *interface-name*],
[edit logical-systems *logical-system-name* protocols rsvp peer-interface *peer-interface-name*],
[edit protocols rsvp interface *interface-name*],
[edit protocols rsvp peer-interface *peer-interface-name*]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced for QFX switches in Junos OS Release13.2X51-D15
Statement introduced for QFX Virtual Chassis and Virtual Chassis Fabric in Junos OS Release 14.1X53-D30

Description Control the use of RSVP aggregate messages on an interface or peer interface:

- **aggregate**—Use RSVP aggregate messages.
- **no-aggregate**—Do not use RSVP aggregate messages.

  Aggregate messages can pack multiple RSVP messages into a single transmission, thereby reducing network overhead and enhancing efficiency. The number of supportable sessions and processing overhead are significantly improved when aggregation is enabled.

  Not all routers connected to a subnet need to support aggregation simultaneously. Each RSVP router negotiates its intention to use aggregate messages on a per-neighbor basis. Only when both routers agree are aggregate messages sent.

To have refresh reduction and reliable delivery, you must include the **aggregate** and **reliable** statements.

Default Aggregation is disabled.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Configuring RSVP Interfaces*
- reliable on page 235

bandwidth (Protocols RSVP)

Syntax bandwidth *bps*;

Hierarchy Level
[edit logical-systems *logical-system-name* protocols rsvp interface *interface-name*],
[edit logical-systems *logical-system-name* protocols rsvp interface *interface-name* link-protection],
[edit logical-systems *logical-system-name* protocols rsvp interface *interface-name* link-protection bypass *bypass-name*],
[edit protocols rsvp interface *interface-name*],
[edit protocols rsvp interface *interface-name* link-protection],
[edit protocols rsvp interface *interface-name* link-protection bypass *bypass-name*]

Release Information
Statement introduced before Junos OS Release 7.4.
Statement introduced for QFX switches in Junos OS Release13.2X51-D15
Statement introduced for QFX Virtual Chassis and Virtual Chassis Fabric in Junos OS Release 14.1X53-D30

Description For certain logical interfaces (such as Asynchronous Transfer Mode [ATM], Permanent Virtual Circuit [PVC], or Frame Relay), you cannot determine the correct bandwidth from the hardware. This statement enables you to specify the actual available bandwidth.

This statement also enables you to specify the bandwidth for a bypass label switched path (LSP). If you have configured multiple bypasses, this statement is mandatory and is applied to all of the bypass LSPs.

Default The hardware raw bandwidth is used.

Options *bps*—Bandwidth in bits per second. You can specify this as an integer value. If you do so, count your zeros carefully, or you can use the abbreviations **k** (for a thousand), **m** (for a million), or **g** (for a billion [also called a thousand million]).

Range: Any positive integer

Default: 0 (no bandwidth is reserved)

Required Privilege Level
routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring Link Protection on Interfaces Used by LSPs*
- *Configuring Link Protection on Interfaces Used by LSPs*
- *Configuring Link Protection on Interfaces Used by LSPs*

bypass (Signaled LSP)

Syntax

```
bypass bypass-name {
  bandwidth bps;
  description text;
  hop-limit number;
  no-cspf;
  path address <strict | loose>;
  priority setup-priority reservation-priority;
  to address;
}
```

Hierarchy Level

[edit logical-systems *logical-system-name* protocols rsvp interface *interface-name* link-protection],
[edit protocols rsvp interface *interface-name* link-protection]

Release Information

Statement introduced before Junos OS Release 7.4.
The **description** option was added in Junos OS Release 10.4.
Statement introduced for QFX switches in Junos OS Release13.2X51-D15
Statement introduced for QFX Virtual Chassis and Virtual Chassis Fabric in Junos OS Release 14.1X53-D30

Description

Enables you to configure specific bandwidth and path constraints for a bypass LSP. It is possible to individually configure multiple bypass LSPs. If you do not configure the bypass LSPs individually, they all share the same path and bandwidth constraints.

If you specify the **bandwidth**, **hop-limit**, and **path** statements for the bypass LSP, these values take precedence over the values configured at the **[edit protocols rsvp interface *interface-name* link-protection]** hierarchy level. The other attributes (**subscription**, **no-node-protection**, and **optimize-timer**) are inherited from the general constraints.

Options

bypass-name—(Required) Specify a name for the bypass LSP. The name can be up to 64 characters.

description—Provides a textual description of the bypass LSP. Enclose any descriptive text that includes spaces in quotation marks (" "). Any descriptive text you include is displayed in the output of the **show mpls lsp bypass detail** command and has no effect on the operation of the bypass LSP. The description text can be no more than 80 characters in length.

to *address*—(Required) Specify the address for the interface of the immediate next-hop node (for link protection) or the next-next-hop node (for node-link protection). The address specified determines whether this is a link protection bypass or a node-link protection bypass. On multiaccess networks (for example, a LAN), this address is also used to specify which next-hop node is being protected.

The remaining statements are explained separately.

Required Privilege Level

routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring Link Protection on Interfaces Used by LSPs*

class-of-service (Protocols RSVP)

Syntax class-of-service *cos-value*;

Hierarchy Level
[edit logical-systems *logical-system-name* protocols rsvp interface *interface-name* link-protection],
[edit logical-systems *logical-system-name* protocols rsvp interface *interface-name* link-protection bypass *bypass-name*],
[edit protocols rsvp interface *interface-name* link-protection],
[edit protocols rsvp interface *interface-name* link-protection bypass *bypass-name*]

Release Information
Statement introduced before Junos OS Release 7.4.
Statement introduced for QFX switches in Junos OS Release13.2X51-D15
Statement introduced for QFX Virtual Chassis and Virtual Chassis Fabric in Junos OS Release 14.1X53-D30

Description Class-of-service (CoS) value given to all packets in the bypass LSP. You can specify a single CoS value for all the bypass LSPs traversing an interface. You can also configure CoS values for specific bypass LSPs traversing an interface.

The CoS value might affect the scheduling or queuing algorithm of traffic traveling along an LSP.

Options ***cos-value***—CoS value. A higher value typically corresponds to a higher level of service.

Range: 0 through 7

Default: If you do not specify a CoS value, the IP precedence bits from the packet's IP header are used as the packet's CoS value.

Required Privilege Level
routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring Link Protection on Interfaces Used by LSPs*

disable (Protocols RSVP)

Syntax disable;

Hierarchy Level
[edit logical-systems *logical-system-name* protocols rsvp],
[edit logical-systems *logical-system-name* protocols rsvp graceful-restart],
[edit logical-systems *logical-system-name* protocols rsvp interface *interface-name*],
[edit logical-systems *logical-system-name* protocols rsvp interface *interface-name* link-protection],
[edit logical-systems *logical-system-name* protocols rsvp peer-interface *peer-interface-name*],
[edit protocols rsvp],
[edit protocols rsvp graceful-restart],
[edit protocols rsvp interface *interface-name*],
[edit protocols rsvp interface *interface-name* link-protection],
[edit protocols rsvp peer-interface *peer-interface-name*]

Release Information
Statement introduced before Junos OS Release 7.4.
Statement introduced for QFX switches in Junos OS Release13.2X51-D15
Statement introduced for QFX Virtual Chassis and Virtual Chassis Fabric in Junos OS Release 14.1X53-D30

Description Explicitly disable RSVP or RSVP graceful restart. Explicitly disable link protection on the specified interface.

Default RSVP is enabled on interfaces and peer interfaces configured with the RSVP **interface** statement. RSVP graceful restart is enabled on the router. Link protection is disabled.

Required Privilege Level
routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Minimum RSVP Configuration*
- *Configuring RSVP Graceful Restart*
- *Configuring Link Protection on Interfaces Used by LSPs*

graceful-deletion-timeout

Syntax graceful-deletion-timeout *seconds*;

Hierarchy Level [edit logical-systems *logical-system-name* protocols rsvp],
[edit protocols rsvp]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced for QFX switches in Junos OS Release13.2X51-D15
Statement introduced for QFX Virtual Chassis and Virtual Chassis Fabric in Junos OS Release 14.1X53-D30

Description Specify the time, in seconds, before completing graceful deletion of signaling.

Options ***seconds***—Time before completing graceful deletion of signaling.

Range: 1 through 300 seconds

Default: 30 seconds

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Gracefully Tearing Down GMPLS LSPs*

graceful-restart (Enabling Globally)

Syntax

```
graceful-restart {
    disable;
    helper-disable;
    maximum-helper-recovery-time seconds;
    maximum-helper-restart-time seconds;
    notify-duration seconds;
    recovery-time seconds;
    restart-duration seconds;
    stale-routes-time seconds;
}
```

Hierarchy Level

[edit logical-systems *logical-system-name* routing-options],
[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* routing-options],
[edit routing-options],
[edit routing-instances *routing-instance-name* routing-options]

Release Information

Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 9.0 for EX Series switches.
Statement introduced for QFX switches in Junos OS Release13.2X51-D15
Statement introduced for QFX Virtual Chassis and Virtual Chassis Fabric in Junos OS Release 14.1X53-D30
Statement introduced in Junos OS Release 14.1X53-D20 for the OCX Series.

Description

Configure graceful restart globally to enable the feature. You cannot enable graceful restart for specific protocols unless graceful restart is also enabled globally. You can, optionally, modify the global settings at the individual protocol level.

NOTE:

- For VPNs, the **graceful-restart** statement allows a router whose VPN control plane is undergoing a restart to continue to forward traffic while recovering its state from neighboring routers.
- For BGP, if you configure graceful restart after a BGP session has been established, the BGP session restarts and the peers negotiate graceful restart capabilities.
- LDP sessions flap when **graceful-restart** configurations change.

Default

Graceful restart is disabled by default.

Options

The remaining statements are explained separately.

Required Privilege Level

routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Enabling Graceful Restart*
- *Configuring Routing Protocols Graceful Restart*
- *Configuring Graceful Restart for MPLS-Related Protocols*
- *Configuring VPN Graceful Restart*
- *Configuring Logical System Graceful Restart*
- *Graceful Restart Configuration Statements*
- *Configuring Graceful Restart for QFabric Systems*

hello-acknowledgements

Syntax hello-acknowledgements;

Hierarchy Level [edit logical-systems *logical-systems-name* protocols rsvp],
[edit protocols rsvp]

Release Information Statement introduced in Junos OS Release 10.2.
Statement introduced for QFX switches in Junos OS Release13.2X51-D15
Statement introduced for QFX Virtual Chassis and Virtual Chassis Fabric in Junos OS Release 14.1X53-D30

Description Enable hello messages from nonsession neighbors to be acknowledged with a hello acknowledgment message. Once hello acknowledgments are enabled, the router continues to acknowledge hello messages from any nonsession RSVP neighbors unless the interface itself goes down or the configuration is changed by an administrator.

Default Hello acknowledgments are disabled.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Configuring Hello Acknowledgments for Nonsession RSVP Neighbors*

hello-interval (Protocols RSVP)

Syntax hello-interval *seconds*;

Hierarchy Level [edit logical-systems *logical-system-name* protocols rsvp interface *interface-name*],
[edit logical-systems *logical-system-name* protocols rsvp peer-interface *peer-interface-name*],
[edit protocols rsvp interface *interface-name*],
[edit protocols rsvp peer-interface *peer-interface-name*]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced for QFX switches in Junos OS Release13.2X51-D15
Statement introduced for QFX Virtual Chassis and Virtual Chassis Fabric in Junos OS Release 14.1X53-D30

Description Enable the sending of hello packets on the interface.

Options ***seconds***—Length of time between hello packets. A value of 0 disables the sending of hello packets on the interface.

Range: 1 through 60 seconds

Default: 9 seconds

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Configuring RSVP Interfaces*

helper-disable (Multiple Protocols)

Syntax helper-disable;

Hierarchy Level
[edit logical-systems *logical-system-name* protocols (isis | ldp | ospf | ospf3 | rsvp) graceful-restart],
[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols (ldp | ospf | ospf3) graceful-restart],
[edit protocols (isis | ldp | ospf | ospf3 | rsvp) graceful-restart],
[edit routing-instances *routing-instance-name* protocols (ldp | ospf | ospf3) graceful-restart]

Release Information
Statement introduced before Junos OS Release 7.4.
Statement introduced for QFX switches in Junos OS Release13.2X51-D15
Statement introduced for QFX Virtual Chassis and Virtual Chassis Fabric in Junos OS Release 14.1X53-D30

Description Disable helper mode for graceful restart. When helper mode is disabled, a router or switch cannot help a neighboring router that is attempting to restart.

Default Helper mode is enabled by default for these supported protocols: IS-IS, LDP, OSPF/OSPFv3, and RSVP.

Required Privilege Level
routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring Routing Protocols Graceful Restart*
- *Configuring Graceful Restart for MPLS-Related Protocols*

hop-limit

Syntax hop-limit *number*;

Hierarchy Level
[edit logical-systems *logical-system-name* protocols mpls],
[edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name*],
[edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name* fast-reroute],
[edit logical-systems *logical-system-name* protocols mpls label-switched-path *lsp-name* (primary | secondary) *path-name*],
[edit logical-systems *logical-system-name* protocols rsvp interface *interface-name* link-protection],
[edit logical-systems *logical-system-name* protocols rsvp interface *interface-name* link-protection bypass *bypass-name*],
[edit protocols mpls],
[edit protocols mpls label-switched-path *lsp-name*],
[edit protocols mpls label-switched-path *lsp-name* fast-reroute],
[edit protocols mpls label-switched-path *lsp-name* (primary | secondary) *path-name*],
[edit protocols rsvp interface *interface-name* link-protection],
[edit protocols rsvp interface *interface-name* link-protection bypass *bypass-name*]

Release Information
Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description Specify the maximum number of routers that an LSP can traverse. This limit can be applied to any of the following:

- LSPs—The configured hop limit includes the ingress and egress routers. You can specify a hop limit for an LSP and for both primary and secondary paths.
- Fast reroute detour—Specify the number of additional routers a fast reroute detour can traverse relative to the protected LSP. For example, if an LSP traverses 4 routers, any detour for the LSP can be no more than 10 router hops, including the ingress and egress routers.
- Link protection bypass—Specify the maximum number of routers that a link protection bypass can traverse.

Options *number*—Maximum number of hops.

Range: 2 through 255 (for an LSP or for a link protection bypass); 0 through 255 (for fast reroute)

Default: 255 (for an LSP or for a link protection bypass); 6 (for fast reroute)

Required Privilege Level
routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring Fast Reroute*
- *Limiting the Number of Hops in LSPs*

- *Configuring Link Protection on Interfaces Used by LSPs*

interface (Protocols RSVP)

Syntax

```
interface interface-name {
  disable;
  (aggregate | no-aggregate);
  authentication-key key;
  bandwidth bps;
  hello-interval seconds;
  link-protection {
    disable;
    admin-group {
      exclude [ group-names ];
      include-all [ group-names ];
      include-any [ group-names ];
    }
    bandwidth bps;
    bypass bypass-name {
      bandwidth bps {
        ct0 bps;
        ct1 bps;
        ct2 bps;
        ct3 bps;
      }
      description text;
      class-of-service cos-value;
      hop-limit number;
      no-cspf;
      path address <strict | loose>;
      priority setup-priority reservation-priority;
      to address;
    }
    class-of-service cos-value;
    hop-limit number;
    max-bypasses number;
    no-cspf;
    no-node-protection;
    optimize-timer seconds;
    path address <strict | loose>;
    priority setup-priority reservation-priority;
    subscription percentage;
  }
  (reliable | no-reliable);
  subscription percentage {
    ct0 percentage;
    ct1 percentage;
    ct2 percentage;
    ct3 percentage;
  }
  update-threshold threshold;
}
```

Hierarchy Level [edit logical-systems *logical-system-name* protocols rsvp],
[edit protocols rsvp]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced for QFX switches in Junos OS Release13.2X51-D15
Statement introduced for QFX Virtual Chassis and Virtual Chassis Fabric in Junos OS Release 14.1X53-D30

Description Enable RSVP on one or more router interfaces.

Default RSVP is disabled on all interfaces.

Options ***interface-name***—Name of an interface. To configure all interfaces, specify **all**. For details about specifying interfaces, see the *Junos OS Network Interfaces Library for Routing Devices*.

The remaining statements are explained separately.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Minimum RSVP Configuration*

keep-multiplier

Syntax keep-multiplier *number*;

Hierarchy Level [edit logical-systems *logical-system-name* protocols rsvp],
[edit protocols rsvp]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced for QFX switches in Junos OS Release13.2X51-D15
Statement introduced for QFX Virtual Chassis and Virtual Chassis Fabric in Junos OS Release 14.1X53-D30

Description Set the keep multiplier value.

Options ***number***—Multiplier value.

Range: 1 through 255

Default: 3

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring Timers for RSVP Refresh Messages*

link-protection (RSVP)

Syntax

```
link-protection {
  disable;
  admin-group {
    exclude [ group-names ];
    include-all [ group-names ];
    include-any [ group-names ];
  }
  bandwidth bps;
  bypass bypass-name {
    bandwidth bps {
      ct0 bps;
      ct1 bps;
      ct2 bps;
      ct3 bps;
    }
    description text;
    class-of-service cos-value;
    hop-limit number;
    no-cspf;
    path address <strict | loose>;
    priority setup-priority reservation-priority;
    to address;
  }
  class-of-service cos-value;
  hop-limit number;
  max-bypasses number;
  no-cspf;
  no-node-protection;
  optimize-timer seconds;
  path address <strict | loose>;
  priority setup-priority reservation-priority;
  subscription percentage;
}
```

Hierarchy Level [edit logical-systems *logical-system-name* protocols rsvp interface *interface-name*], [edit protocols rsvp interface *interface-name*]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 14.1X53-D10 for the QFX Series and for EX4600 switches.
Statement introduced for QFX Virtual Chassis and Virtual Chassis Fabric in Junos OS Release 14.1X53-D30

Description Enable link protection on the specified interface. Using link protection, you can configure a network to reroute traffic quickly around broken links. To fully enable link protection, you also need to configure the **link-protection** statement at the **[edit protocols mpls label-switched-path *lsp-name*]** hierarchy level. You can configure single or multiple bypasses for protected interface.

Default Link protection is disabled.

Options **no-node-protection**—Disable node-link protection on the RSVP interface. Link protection remains active. When this option is configured, the router can only initiate a next-hop bypass, not a next-next-hop bypass.

The remaining statements are explained separately.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring Link Protection on Interfaces Used by LSPs*
- *link-protection (Dynamic LSPs)*

load-balance (Protocols RSVP)

Syntax
```
load-balance {
  bandwidth;
}
```

Hierarchy Level [edit logical-systems *logical-system-name* protocols rsvp],
[edit protocols rsvp]

Release Information Statement introduced before Junos OS Release 7.4.

Description Load-balance traffic between RSVP LSPs.

Options **bandwidth**—Load-balance traffic between RSVP LSPs based on the bandwidth configured for each LSP.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring Load Balancing Across RSVP LSPs*

max-bypasses

Syntax max-bypasses *number*;

Hierarchy Level [edit logical-systems *logical-system-name* protocols rsvp interface *interface-name*], [edit protocols rsvp interface *interface-name*]

Release Information Statement introduced before Junos OS Release 7.4.
Range modified in Junos OS Release 9.3.
Statement introduced for QFX switches in Junos OS Release13.2X51-D15
Statement introduced for QFX Virtual Chassis and Virtual Chassis Fabric in Junos OS Release 14.1X53-D30

Description Specify the maximum number of dynamic bypass LSPs permitted for protecting this interface. When this option is configured, multiple bypasses for link protection are enabled. Call admission control (CAC) is also enabled. The limit on bypasses configured applies only to dynamically generated bypass LSPs. By default, this option is disabled and only one dynamic bypass LSP is enabled for each interface. If you configure **max-bypasses**, you must also configure the bandwidth statement.

Options *number*—Configure the maximum number of bypass LSPs. If you configure a value of 0, no dynamic bypass LSPs are allowed to be established for the interface. Only static bypass LSPs can be configured.

Range: 0 through 99

Default: 1

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Configuring Link Protection on Interfaces Used by LSPs*

maximum-helper-recovery-time

Syntax maximum-helper-recovery-time *seconds*;

Hierarchy Level [edit protocols rsvp graceful-restart],
[edit logical-systems *logical-system-name* protocols rsvp graceful-restart]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced for QFX switches in Junos OS Release13.2X51-D15
Statement introduced for QFX Virtual Chassis and Virtual Chassis Fabric in Junos OS Release 14.1X53-D30

Description Specify the length of time the router or switch retains the state of its Resource Reservation Protocol (RSVP) neighbors while they undergo a graceful restart.

Options ***seconds***—Legnth of time that the router retains the state of its Resource Reservation Protocol (RSVP) neighbors while they undergo a graceful restart.

Range: 1 through 3600

Default: 180

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Configuring Graceful Restart Options for RSVP, CCC, and TCC*
- maximum-helper-restart-time (RSVP) on page 225

maximum-helper-restart-time (RSVP)

Syntax maximum-helper-restart-time *seconds*;

Hierarchy Level [edit protocols rsvp graceful-restart],
[edit logical-systems *logical-system-name* protocols rsvp graceful-restart]

Release Information Statement introduced in Junos OS Release 8.3.
Statement introduced for QFX switches in Junos OS Release13.2X51-D15
Statement introduced for QFX Virtual Chassis and Virtual Chassis Fabric in Junos OS Release 14.1X53-D30

Description Specify the length of time the router or switch waits after it discovers that a neighboring router has gone down before it declares the neighbor down. This value is applied to all RSVP neighbor routers and should be based on the time that the slowest RSVP neighbor requires for restart.

Options ***seconds***—The time the router or switch waits after it discovers that a neighboring router has gone down before it declares the neighbor down.

Range: 1 through 1800

Default: 60

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Configuring Graceful Restart Options for RSVP, CCC, and TCC*
- maximum-helper-recovery-time on page 224

no-cspf (Protocols RSVP)

Syntax no-cspf;

Hierarchy Level
[edit logical-systems *logical-system-name* protocols rsvp interface *interface-name* link-protection],
[edit logical-systems *logical-system-name* protocols rsvp interface *interface-name* link-protection bypass *bypass-name*],
[edit protocols rsvp interface *interface-name* link-protection],
[edit protocols rsvp interface *interface-name* link-protection bypass *bypass-name*]

Release Information
Statement introduced in Junos OS Release 7.5.
Statement introduced for QFX switches in Junos OS Release 13.2X51-D15
Statement introduced for QFX Virtual Chassis and Virtual Chassis Fabric in Junos OS Release 14.1X53-D30

Description Disable CSPF computation on all bypass LSPs or on a specific bypass LSP. You need to disable CSPF for link protection to function properly on interarea paths.

Default CSPF is enabled.

Required Privilege Level
routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring Link Protection on Interfaces Used by LSPs*

no-interface-hello

Syntax no-interface-hello;

Hierarchy Level [edit logical-systems *logical-system-name* protocols rsvp],
[edit protocols rsvp]

Release Information Statement introduced in JUNOS Release 10.0.
Statement introduced for QFX switches in Junos OS Release13.2X51-D15
Statement introduced for QFX Virtual Chassis and Virtual Chassis Fabric in Junos OS Release 14.1X53-D30

Description Allows you to explicitly disable RSVP interface hellos globally on the router. This type of configuration might be necessary in networks where the Juniper Networks router has numerous RSVP connections with equipment from other vendors. However, if you disable RSVP interface hellos globally, you can also configure a hello interval on an RSVP interface using the hello-interval (Protocols RSVP) statement. This configuration disables RSVP interface hellos globally but enables RSVP interface hellos on the specified interface. This configuration might be necessary in a heterogeneous network where some devices support RSVP node ID hellos and other devices support RSVP interface hellos.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring RSVP Node ID Hellos*
- hello-interval (Protocols RSVP) on page 215

no-local-reversion

Syntax no-local-reversion;

Hierarchy Level [edit logical-systems *logical-system-name* protocols rsvp],
[edit protocols rsvp]

Release Information Statement introduced in Junos OS Release 10.4.
Statement introduced for QFX switches in Junos OS Release13.2X51-D15
Statement introduced for QFX Virtual Chassis and Virtual Chassis Fabric in Junos OS Release 14.1X53-D30

Description Disables RSVP local revertive mode as specified in RFC 4090, *Fast Reroute Extensions to RSVP-TE for LSP Tunnels*. RSVP local revertive mode is supported on all Juniper Networks routers running the Junos OS. It is the default behavior. If you include this statement, the Juniper Networks router uses global revertive mode instead. You might need to disable RSVP local revertive mode on Juniper Networks routers if your network includes equipment that does not support this mode.

The following information can also be found in RFC 4090. Refer to the full RFC for additional information. When an LSP fails, the connection can be repaired locally using a traffic protection mechanism such as fast reroute. To restore the LSP to a full working path, RFC 4090 specifies the following strategies:

- Local revertive mode—Upon detecting that the path is restored, the point of local repair (PLR) resignals each of the LSPs that were formerly routed over the restored path. Every LSP successfully resignaled along the restored path is switched back.
- Global revertive mode—The ingress router of each tunnel is responsible for reoptimizing the LSPs that used the failed path. There are several potential reoptimization triggers: RSVP error messages, inspection of OSPF LSAs or IS-IS LSPs, and timers. This re-optimization process can proceed as soon as the failure is detected. It is not tied to the restoration of the failed path.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

no-node-id-subobject

Syntax no-node-id-subobject;

Hierarchy Level [edit logical-systems *logical-system-name* protocols rsvp],
[edit protocols rsvp]

Release Information Statement introduced in Junos OS Release 9.4.
Statement introduced for QFX switches in Junos OS Release13.2X51-D15
Statement introduced for QFX Virtual Chassis and Virtual Chassis Fabric in Junos OS Release 14.1X53-D30

Description Disable the record route object (RRO) node ID subobject for compatibility with earlier versions of the Junos OS. To interoperate with other vendors' equipment, the Junos OS supports the RRO node ID subobject for use in inter-AS link and node protection configurations.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring Inter-AS Node and Link Protection*

no-p2mp-sublsp

Syntax no-p2mp-sublsp;

Hierarchy Level [edit logical-systems *logical-system-name* protocols rsvp],
[edit protocols rsvp]

Release Information Statement introduced in Junos OS Release 9.2.
Statement introduced for QFX switches in Junos OS Release13.2X51-D15
Statement introduced for QFX Virtual Chassis and Virtual Chassis Fabric in Junos OS Release 14.1X53-D30

Description Reject Resv messages that include the S2L_SUB_LSP object. By default, Resv messages that include the S2L_SUB_LSP object are accepted. However, in a network which includes Juniper Networks devices running both Junos OS Release 9.2 and later and Junos OS Release 9.1 and earlier, it is necessary to configure the **no-p2mp-sublsp** statement on devices running Junos OS Release 9.2 and later to ensure that point-to-multipoint LSPs function properly.

Default Resv messages that include the S2L_SUB_LSP object are accepted.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Preserving Point-to-Multipoint LSP Functioning with Different Junos OS Releases*

node-hello

Syntax node-hello;

Hierarchy Level [edit logical-systems *logical-system-name* protocols rsvp],
[edit protocols rsvp]

Release Information Statement introduced in JUNOS Release 10.0.
Statement introduced for QFX switches in Junos OS Release13.2X51-D15
Statement introduced for QFX Virtual Chassis and Virtual Chassis Fabric in Junos OS Release 14.1X53-D30

Description Enables node-ID based RSVP hellos globally on all of the RSVP interfaces on the router to allow Juniper Networks routers to interoperate with the equipment of other vendors. By default, the JUNOS Software uses interface-based RSVP hellos and node-ID based RSVP hellos are disabled. If you have not enabled RSVP node IDs on the router, the JUNOS software does not accept any node-ID hello packets.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Configuring RSVP Node ID Hellos*

optimize-timer (Protocols RSVP)

Syntax optimize-timer *seconds*;

Hierarchy Level [edit logical-systems *logical-system-name* protocols rsvp interface *interface-name* link-protection],
[edit protocols rsvp interface *interface-name* link-protection]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced for QFX switches in Junos OS Release13.2X51-D15
Statement introduced for QFX Virtual Chassis and Virtual Chassis Fabric in Junos OS Release 14.1X53-D30

Description Configure an optimize timer for a bypass LSP. The optimize timer initiates a periodic optimization process that reshuffles data LSPs among bypass LSPs to achieve the most efficient use of network resources. The optimization process attempts to either minimize the number of bypasses currently in use, minimize the total amount of bandwidth reserved for all bypasses, or both.

Options ***seconds***—Specify the number of seconds between optimizations.

Range: 0 through 65,535 seconds

Default: 0 (disabled)

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Configuring Link Protection on Interfaces Used by LSPs*

path (Protocols RSVP)

Syntax path *address* <strict | loose>;

Hierarchy Level
[edit logical-systems *logical-system-name* protocols rsvp interface *interface-name* link-protection],
[edit logical-systems *logical-system-name* protocols rsvp interface *interface-name* link-protection bypass *bypass-name*],
[edit protocols rsvp interface *interface-name* link-protection],
[edit protocols rsvp interface *interface-name* link-protection bypass *bypass-name*]

Release Information
Statement introduced before Junos OS Release 7.4.
Statement introduced for QFX switches in Junos OS Release13.2X51-D15
Statement introduced for QFX Virtual Chassis and Virtual Chassis Fabric in Junos OS Release 14.1X53-D30

Description Configure an explicit path (a sequence of strict or loose routes) to control where and how a bypass LSP is established. If multiple bypasses are configured, they all will use the same explicit path.

Default No path is configured. CSPF automatically calculates the path the bypass LSP takes.

Options

address—IP address of each transit router in the LSP. You must specify the address or hostname of each transit router, although you do not need to list each transit router if its type is **loose**. As an option, you can include the ingress and egress routers in the path. Specify the addresses in order, starting with the ingress router (optional) or the first transit router, and continuing sequentially along the path until reaching the egress router (optional) or the router immediately before the egress router.

Default: If you do not specify any routers explicitly, no routing limitations are imposed on the bypass LSP.

loose—(Optional) The next address in the **path** statement is loose. The LSP can traverse other routers before reaching this router.

Default: **strict**

strict—(Optional) The LSP must go to the next address specified in the **path** statement without traversing other nodes. This is the default.

Required Privilege Level
routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Configuring Link Protection on Interfaces Used by LSPs*

preemption

Syntax

```
preemption {
  (aggressive | disabled | normal);
  soft-preemption {
    cleanup-timer seconds;
  }
}
```

Hierarchy Level [edit logical-systems *logical-system-name* protocols rsvp],
[edit protocols rsvp]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced for QFX switches in Junos OS Release13.2X51-D15
Statement introduced for QFX Virtual Chassis and Virtual Chassis Fabric in Junos OS Release 14.1X53-D30

Description Control RSVP session preemption.

Default normal

Options

aggressive—Preempt RSVP sessions whenever bandwidth is insufficient to handle all sessions. A session is preempted whenever bandwidth is lowered or a new higher-priority session is established.

disabled—Do not preempt RSVP sessions.

normal—Preempt RSVP sessions to accommodate new higher-priority sessions when bandwidth is insufficient to handle all sessions.

The remaining statements are explained separately.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Preempting RSVP Sessions*

priority (Protocols RSVP)

Syntax priority *setup-priority reservation-priority*;

Hierarchy Level
[edit logical-systems *logical-system-name* protocols rsvp interface *interface-name* link-protection],
[edit logical-systems *logical-system-name* protocols rsvp interface *interface-name* link-protection bypass *bypass-name*],
[edit protocols rsvp interface *interface-name* link-protection],
[edit protocols rsvp interface *interface-name* link-protection bypass *bypass-name*],

Release Information
Statement introduced before Junos OS Release 7.4.
Statement introduced for QFX switches in Junos OS Release13.2X51-D15
Statement introduced for QFX Virtual Chassis and Virtual Chassis Fabric in Junos OS Release 14.1X53-D30

Description Configure the setup priority and reservation priority for a bypass LSP. If insufficient link bandwidth is available during session establishment, the setup priority is compared with other setup priorities for established sessions on the link to determine whether some of them should be preempted to accommodate the new session. The session with the lower-hold priority is preempted.

Options
reservation-priority—Reservation priority, used to keep a reservation after it has been set up. A smaller number has a higher priority. The priority must be greater than or equal to the setup priority to prevent preemption loops.

Range: 0 through 7, where 0 is the highest and 7 is the lowest priority.

Default: 0 (Once the session is set up, no other session can preempt it.)

setup-priority—Setup priority.

Range: 0 through 7, where 0 is the highest and 7 is the lowest priority.

Default: 7 (The session cannot preempt any existing sessions.)

Required Privilege Level
routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring Link Protection on Interfaces Used by LSPs*
- *Configuring Priority and Preemption for LSPs*

refresh-time

Syntax refresh-time *seconds*;

Hierarchy Level [edit logical-systems *logical-system-name* protocols rsvp],
[edit protocols rsvp]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced for QFX switches in Junos OS Release13.2X51-D15
Statement introduced for QFX Virtual Chassis and Virtual Chassis Fabric in Junos OS Release 14.1X53-D30

Description Set the refresh time.

Options *seconds*—Refresh time.

Range: 1 through 65,535

Default: 30 seconds

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring Timers for RSVP Refresh Messages*

reliable

Syntax (reliable | no-reliable);

Hierarchy Level [edit logical-systems *logical-system-name* protocols rsvp interface *interface-name*],
[edit logical-systems *logical-system-name* protocols rsvp peer-interface *peer-interface-name*],
[edit protocols rsvp interface *interface-name*],
[edit protocols rsvp peer-interface *peer-interface-name*]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced for QFX switches in Junos OS Release13.2X51-D15
Statement introduced for QFX Virtual Chassis and Virtual Chassis Fabric in Junos OS Release 14.1X53-D30

Description Enable reliable message delivery on the interface.

In order to have refresh reduction and reliable delivery, you must include the **aggregate** and **reliable** statements.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- *Configuring RSVP Interfaces*
- aggregate on page 207

setup-protection

Syntax setup-protection;

Hierarchy Level [edit logical-systems *logical-system-name* protocols rsvp],
[edit protocols rsvp]

Description The facility-backup fast reroute mechanism can provide setup protection for LSPs which are in the process of being signaled. Both point-to-point LSPs and point-to-multipoint LSPs are supported. You should configure the **setup-protection** statement on each of the routers along the LSP path on which you want to enable LSP setup protection. You should also configure IGP traffic engineering on all of the routers on the LSP path.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Configuring RSVP Setup Protection*

subscription

Syntax

```
subscription percentage {
  ct0 percentage;
  ct1 percentage;
  ct2 percentage;
  ct3 percentage;
}
```

Hierarchy Level

[edit logical-systems *logical-system-name* protocols rsvp interface *interface-name*],
[edit logical-systems *logical-system-name* protocols rsvp interface *interface-name* link-protection],
[edit protocols rsvp interface *interface-name*],
[edit protocols rsvp interface *interface-name* link-protection]

Release Information

Statement introduced before Junos OS Release 7.4.
Statement introduced for QFX switches in Junos OS Release13.2X51-D15
Statement introduced for QFX Virtual Chassis and Virtual Chassis Fabric in Junos OS Release 14.1X53-D30

Description

Configure the amount of bandwidth subscribed to a class type (when you have enabled Differentiated Services) or bypass LSP (when you have enabled link protection). **subscription** is the percentage of the link bandwidth that can be used for the RSVP reservation process.

Options

ct*number percentage*—Percentage of the class-type bandwidth allowed for reservations. If you specify a value greater than 100, you are oversubscribing the class type. You can specify bandwidth subscriptions for class types 0 through 3. This option is not available for bypass LSPs.

Range: 0 through 65,000

Default: 100 percent

percentage—Percentage of the class-type or bypass LSP bandwidth allowed for reservations. If you specify a value greater than 100, you are oversubscribing the class type or bypass LSP.

Range: 0 through 65,000

Default: 100 percent

Required Privilege Level

routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Configuring the Bandwidth Subscription Percentage for LSPs*
- *Configuring Link Protection on Interfaces Used by LSPs*

soft-preemption (Protocols RSVP)

Syntax

```
soft-preemption {
  cleanup-timer seconds;
}
```

Hierarchy Level [edit logical-systems *logical-system-name* protocols rsvp preemption],
[edit protocols rsvp preemption]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced for QFX switches in Junos OS Release13.2X51-D15
Statement introduced for QFX Virtual Chassis and Virtual Chassis Fabric in Junos OS Release 14.1X53-D30

Description Enable soft preemption to attempt to establish a new path for a preempted LSP before tearing it down.

Options **cleanup-timer**—A value of 0 disables soft preemption.

Range: 0 through 180 seconds

Default: 30 seconds

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Configuring MPLS Soft Preemption*

traceoptions (Protocols RSVP)

Syntax

```
traceoptions {
  file filename <files number> <size size> <world-readable | no-world-readable>;
  flag flag <flag-modifier> <disable>;
}
```

Hierarchy Level [edit logical-systems *logical-system-name* protocols rsvp],
[edit protocols rsvp]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced for QFX switches in Junos OS Release13.2X51-D15
Statement introduced for QFX Virtual Chassis and Virtual Chassis Fabric in Junos OS Release 14.1X53-D30

Description Enable RSVP-level trace options.

Default The default RSVP-level trace options are those inherited from the routing protocols **traceoptions** statement included at the **[edit routing-options]** hierarchy level.

Options

disable—(Optional) Disable the tracing operation. You can use this option to disable a single operation when you have defined a broad group of tracing operations, such as **all**.

filename—Name of the file to receive the output of the tracing operation. Enclose the name within quotation marks. All files are placed in the directory **/var/log**. We recommend that you place RSVP tracing output in the file **rsvp-log**.

files *number*—(Optional) Maximum number of trace files. When a trace file named ***trace-file*** reaches its maximum size, it is renamed ***trace-file*.0**, then ***trace-file*.1**, and so on, until the maximum number of trace files is reached. Then the oldest trace file is overwritten.

Range: 2 through 1000

Default: 2 files

If you specify a maximum number of files, you must also include the **size** statement to specify the maximum file size.

flag—Tracing operation to perform. To specify more than one tracing operation, include multiple **flag** statements.

- **all**—All tracing operations
- **error**—All detected error conditions
- **event**—RSVP-related events
- **lmp**—RSVP-LMP interactions
- **packets**—All RSVP packets
- **path**—All path messages

- **pathtear**—PathTear messages
- **resv**—Resv messages
- **resvtear**—ResvTear messages
- **route**—Routing information
- **state**—Session state transitions, including when RSVP-signaled LSPs come up and go down.

flag-modifier—(Optional) Modifier for the tracing flag. You can specify one or more of these modifiers:

- **detail**—Provide detailed trace information
- **receive**—Packets being received
- **send**—Packets being transmitted

no-world-readable—(Optional) Enable only certain users to read the log file.

size *size*—(Optional) Maximum size of each trace file, in kilobytes (KB), megabytes (MB), or gigabytes (GB). When a trace file named ***trace-file*** reaches this size, it is renamed ***trace-file*.0**. When the ***trace-file*** again reaches this size, ***trace-file*.0** is renamed ***trace-file*.1** and ***trace-file*** is renamed ***trace-file*.0**. This renaming scheme continues until the maximum number of trace files is reached. Then the oldest trace file is overwritten.

Syntax: ***x*k** to specify KB, ***x*m** to specify MB, or ***x*g** to specify GB

Range: 10 KB through the maximum file size supported on your system

Default: 1 MB

If you specify a maximum file size, you must also include the **files** statement to specify the maximum number of files.

world-readable—(Optional) Enable any user to read the log file.

Required Privilege Level

routing and trace—To view this statement in the configuration.
routing-control and trace-control—To add this statement to the configuration.

Related Documentation

- *Tracing RSVP Protocol Traffic*

tunnel-services (RSVP)

Syntax

```
tunnel-services {
  devices device-names;
}
```

Hierarchy Level [edit logical-systems *logical-system-name* protocols rsvp], [edit protocols rsvp]

Release Information Statement introduced in Junos OS Release 8.1.
Statement introduced for QFX switches in Junos OS Release13.2X51-D15
Statement introduced for QFX Virtual Chassis and Virtual Chassis Fabric in Junos OS Release 14.1X53-D30

Description Enable ultimate-hop popping on point-to-multipoint LSPs. The Junos OS selects one of the available virtual tunnel (VT) interfaces to de-encapsulate the egress traffic. By default, the selection process is performed automatically.

Default Ultimate-hop popping is disabled.

Options devices *device-names*—Specify which VT interfaces are used to handle the RSVP traffic.

Range: 0 to 8 devices

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Enabling Ultimate-Hop Popping on Point-to-Multipoint LSPs*

update-threshold

Syntax update-threshold *threshold*;

Hierarchy Level [edit logical-systems *logical-system-name* protocols rsvp interface *interface-name*], [edit protocols rsvp interface *interface-name*]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced for QFX switches in Junos OS Release 13.2X51-D15
Statement introduced for QFX Virtual Chassis and Virtual Chassis Fabric in Junos OS Release 14.1X53-D30

Description Adjust the threshold at which a change in bandwidth triggers an interior gateway protocol (IGP) update.

Options ***threshold***—Specify the percentage change in bandwidth to trigger an IGP update.

Range: 1 through 20 percent

Default: 10 percent

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- *Configuring RSVP Interfaces*

Monitoring Commands for RSVP

- clear rsvp session
- clear rsvp statistics
- ping mpls rsvp
- show rsvp interface
- show rsvp neighbor
- show rsvp session
- show rsvp statistics
- show rsvp version
- traceroute mpls rsvp

clear rsvp session

List of Syntax
Syntax on page 243
Syntax (EX and QFX Series Switches) on page 243

Syntax

clear rsvp session
<connection-destination *address*>
<connection-source *address*>
<gracefully>
<logical-system (all | *logical-system-name*)>
<lsp-id *identifier*>
<name *name*>
<optimize-fast-reroute>
<tunnel-id *identifier*>

Syntax (EX and QFX Series Switches)

clear rsvp session
<connection-destination *address*>
<connection-source *address*>
<gracefully>
<lsp-id *identifier*>
<name *name*>
<optimize-fast-reroute>
<tunnel-id *identifier*>

Release Information

Command introduced before Junos OS Release 7.4.
Command introduced in Junos OS Release 9.5 for EX Series switches.
Command introduced in Junos OS Release 13.2X51-D15 for the QFX Series.

Description

Reset and restart Resource Reservation Protocol (RSVP) sessions.

Options

none—Reset and restart all RSVP sessions for which this routing device is the ingress, transit, or egress routing device.

connection-source *address*—(Optional) Source address for GMPLS and MPLS LSPs from the RSVP sender template.

connection-destination *address*—(Optional) Destination address for GMPLS and MPLS LSPs from the RSVP sender template.

gracefully—(Optional) Gracefully reset an RSVP session for a nonpacket LSP in two passes. In the first pass, the Admin-Status object is signaled along the path to the other endpoint of the RSVP session. In the second pass, the path used by the RSVP session is torn down. This option can only be used on the ingress or egress routing device of the RSVP session and is only valid for nonpacket LSPs.

logical-system (all | *logical-system-name*)—(Optional) Perform this operation on all logical systems or on a particular logical system.

lsp-id *identifier*—(Optional) LSP identifier (source port) for the RSVP sender template.

name *name*—(Optional) Reset and restart the specified RSVP session.

optimize-fast-reroute—(Optional) Begin fast reroute optimization.

tunnel-id *identifier*—(Optional) Tunnel identifier (destination port) for the RSVP session.

Required Privilege Level clear

Related Documentation
- *clear mpls lsp*
- show rsvp session on page 261

List of Sample Output clear rsvp session on page 244

Output Fields When you enter this command, you are provided feedback on the status of your request.

Sample Output

clear rsvp session

```
user@host> clear rsvp session
```

clear rsvp statistics

List of Syntax
Syntax on page 245
Syntax (EX Series Switches) on page 245

Syntax
clear rsvp statistics
<logical-system (all | *logical-system-name*)>

Syntax (EX Series Switches)
clear rsvp statistics

Release Information
Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 9.5 for EX Series switches.
Statement introduced for QFX switches in Junos OS Release 13.2X51-D15
Statement introduced for QFX Virtual Chassis and Virtual Chassis Fabric in Junos OS Release 14.1X53-D30

Description
Clear Resource Reservation Protocol (RSVP) packet and error statistics.

Options
none—Clear RSVP packet and error statistics.

logical-system (all | *logical-system-name*)—(Optional) Perform this operation on all logical systems or on a particular logical system.

Required Privilege Level
clear

Related Documentation
- show rsvp statistics on page 270

List of Sample Output
clear rsvp statistics on page 245

Output Fields
When you enter this command, you are provided feedback on the status of your request.

Sample Output

clear rsvp statistics

```
user@host> clear rsvp statistics
```

ping mpls rsvp

Syntax

ping mpls rsvp
<*lsp-name*>
<count *count*>
<destination *address*>
<detail>
<dynamic-bypass>
<egress *egress-address*>
<exp *forwarding-class*>
<interface *interface-name*>
<logical-system (all | *logical-system-name*)>
<manual-bypass>
<multipoint>
<size *bytes*>
<source *source-address*>
<standby *standby-path-name*>
<sweep>

Release Information

Command introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.
The **egress** and **multipoint** options were introduced in Junos OS Release 9.2.
The **size** and **sweep** options were introduced in Junos OS Release 9.6.
The **dynamic-bypass** and **manual-bypass** options were introduced in Junos OS Release 10.2.

Description

Check the operability of MPLS RSVP-signaled label-switched path (LSP) connections. Type Ctrl+c to interrupt a **ping mpls** command.

Options

count ***count***—(Optional) Number of ping requests to send. If **count** is not specified, five ping requests are sent. The range of values is **1** through **1,000,000**. The default value is **5**.

destination ***address***—(Optional) Specify an address other than the default (**127.0.0.1/32**) for the ping echo requests. The address can be anything within the **127/8** subnet.

detail—(Optional) Display detailed information about the echo requests sent and received.

NOTE: When using the **detail** option, the reported time is based on the system time configured on the local and remote routers. Differences in these system times can result in inaccurate one way ping trip times being reported.

In practice, it is difficult to synchronize the system times of independent Juniper Networks routers with sufficient accuracy to provide a meaningful time value for the **detail** option (even when synchronized using NTP).

dynamic-bypass—(Optional) Ping dynamically generated bypass LSPs, used for protecting other LSPs.

egress ***egress-address***—(Optional) Only the specified egress router or switch responds to the ping request.

exp ***forwarding-class***—(Optional) Value of the forwarding class for the MPLS ping packets.

interface—(Optional) Specify the name of the interface protected by the manual bypass LSP. This option is only available when you have also used the **manual-bypass** option.

logical-system (all | ***logical-system-name*****)**—(Optional) Perform this operation on all logical systems or on the specified logical system.

lsp-name—Ping an RSVP-signaled LSP using an LSP name.

manual-bypass—(Optional) Ping manually configured bypass LSPs, used for protecting other LSPs. For this option, you must also specify the interface protected by the manual bypass LSP using the **interface** option.

multipoint—(Optional) Send ping requests to each of the egress routers or switches participating in a point-to-multipoint LSP. You can also include the **egress** option to ping a specific egress router or switch participating in a point-to-multipoint LSP.

size ***bytes***—(Optional) Size of the LSP ping request packet (**100** through **65468** bytes). Packets are 4-byte aligned. For example, if you enter a size of 101, 102, 103, or 104, the router or switch uses a size value of 104 bytes. If you enter a packet size that is smaller than the minimum size, an error message is displayed reminding you of the 100-byte minimum.

source ***source-address***—(Optional) IP address of the outgoing interface. This address is sent in the IP source address field of the ping request. If this option is not specified, the default address is usually the loopback interface.

standby ***standby-path-name***—(Optional) Name of the standby path.

sweep —(Optional) Automatically determine the size of the maximum transmission unit (MTU).

Additional Information

If the LSP changes, the label and interface information displayed when you issued the **ping** command continues to be used. You must configure MPLS at the **[edit protocols mpls]** hierarchy level on the remote router or switch to ping an LSP terminating there. You must configure MPLS even if you intend to ping only LDP forwarding equivalence classes (FECs).

In asymmetric MTU scenarios, the echo response may be dropped. For example, if the MTU from System A to System B is 1000 bytes, the MTU from System B to System A is 500 bytes, and the ping request packet size is 1000 bytes, the echo response is dropped because the PAD TLV is included in the echo response, making it too large.

Required Privilege Level

network

List of Sample Output

ping mpls rsvp (Echo Reply Received) on page 248
ping mpls rsvp (Echo Reply with Error Code) on page 248
ping mpls rsvp detail on page 248
ping mpls rsvp multipoint egress detail count on page 248
ping mpls rsvp multipoint detail count on page 248
ping mpls rsvp destination detail count size on page 249
ping mpls rsvp destination detail sweep size on page 249

Output Fields

When you enter this command, you are provided feedback on the status of your request. An exclamation point (**!**) indicates that an echo reply was received. A period (**.**) indicates that an echo reply was not received within the timeout period. An **x** indicates that an echo reply was received with an error code. Packets with an error code are not counted in the received packets count. They are accounted for separately.

Sample Output

ping mpls rsvp (Echo Reply Received)

```
user@host> ping mpls rsvp test1
!!!!!--- lsping statistics ---5 packets transmitted, 5 packets received, 0% packet
 loss
```

ping mpls rsvp (Echo Reply with Error Code)

```
user@host> ping mpls rsvp test2
!!xxx--- lsping statistics ---5 packets transmitted, 2 packets received, 60%
packet loss3 packets received with error status, not counted as received.
```

ping mpls rsvp detail

```
user@host> ping mpls rsvp to-green detail
Request for seq 1, to interface 67, labels <100095, 0, 0>
Reply for seq 1, return code: Egress-ok
Request for seq 2, to interface 67, labels <100095, 0, 0>
Reply for seq 2, return code: Egress-ok
```

ping mpls rsvp multipoint egress detail count

```
user@host>ping mpls rsvp sample-lsp multipoint egress 192.168.1.3 detail count 1
Request for seq 1, to interface 70, label 299952
Request for seq 1, to interface 70, no label stack.
Request for seq 1, to interface 67, no label stack.

Reply for seq 1, egress 192.168.1.3, return code: Egress-ok, time: 0.242 ms
 Local transmit time: 1205310695s 215737us
 Remote receive time: 1205310695s 215979us

--- lsping, egress 192.168.1.3 statistics ---
1 packets transmitted, 1 packets received, 0% packet loss
```

ping mpls rsvp multipoint detail count

```
user@host>ping mpls rsvp sample-lsp multipoint detail count 1
Request for seq 1, to interface 70, label 299952
Request for seq 1, to interface 70, no label stack.
Request for seq 1, to interface 67, no label stack.

Reply for seq 1, return code: Unknown TLV, time: 9.877 ms
 Local transmit time: 1205310615s 347317us
```

```
 Remote receive time: 1205310615s 357194us
Reply for seq 1, egress 192.168.1.3, return code: Egress-ok, time: 0.351 ms
 Local transmit time: 1205310615s 347262us
 Remote receive time: 1205310615s 347613us
Reply for seq 1, egress 192.168.1.13, return code: Egress-ok, time: 0.301 ms
 Local transmit time: 1205310615s 347167us
 Remote receive time: 1205310615s 347468us
Timeout for seq 1, egress 192.168.1.1
Timeout for seq 1, egress 192.168.1.4
Timeout for seq 1, egress 192.168.1.14

--- lsping, egress 192.168.1.1 statistics ---
1 packets transmitted, 0 packets received, 100% packet loss

--- lsping, egress 192.168.1.3 statistics ---
1 packets transmitted, 1 packets received, 0% packet loss

--- lsping, egress 192.168.1.4 statistics ---
1 packets transmitted, 0 packets received, 100% packet loss

--- lsping, egress 192.168.1.13 statistics ---
1 packets transmitted, 1 packets received, 0% packet loss

--- lsping, egress 192.168.1.14 statistics ---
1 packets transmitted, 0 packets received, 100% packet loss
```

ping mpls rsvp destination detail count size

```
user@host>ping mpls rsvp chaser-access destination 192.168.0.1 detail count 1 size 4468

Request for seq 1, to interface 88, label 299984, packet size 4468
Reply for seq 1, return code: Egress-ok, time: 44.804 ms
        Local transmit time: 2009-03-30 22:05:02 CEST 408.629 ms
        Remote receive time: 2009-03-30 22:05:02 CEST 453.433 ms

--- lsping statistics ---
1 packets transmitted, 1 packets received, 0% packet loss
```

ping mpls rsvp destination detail sweep size

```
user@router>  ping mpls rsvp chaser-access destination 192.168.0.1 detail sweep size 4500
Request for seq 1, to interface 86, no label stack., packet size 100
Reply for seq 1, return code: Egress-ok, time: -39.264 ms
        Local transmit time: 2009-04-24 14:05:40 CEST 541.423 ms
        Remote receive time: 2009-04-24 14:05:40 CEST 502.159 ms
Request for seq 2, to interface 86, no label stack., packet size 2300
Reply for seq 2, return code: Egress-ok, time: -38.179 ms
        Local transmit time: 2009-04-24 14:05:41 CEST 544.240 ms
        Remote receive time: 2009-04-24 14:05:41 CEST 506.061 ms
Request for seq 3, to interface 86, no label stack., packet size 4500
Timeout for seq 3
Request for seq 4, to interface 86, no label stack., packet size 3400
Reply for seq 4, return code: Egress-ok, time: -37.545 ms
        Local transmit time: 2009-04-24 14:05:45 CEST 549.953 ms
        Remote receive time: 2009-04-24 14:05:45 CEST 512.408 ms
Request for seq 5, to interface 86, no label stack., packet size 3952
Reply for seq 5, return code: Egress-ok, time: -37.176 ms
        Local transmit time: 2009-04-24 14:05:46 CEST 555.881 ms
        Remote receive time: 2009-04-24 14:05:46 CEST 518.705 ms
Request for seq 6, to interface 86, no label stack., packet size 4228
Reply for seq 6, return code: Egress-ok, time: -36.962 ms
```

```
        Local transmit time: 2009-04-24 14:05:47 CEST 561.809 ms
        Remote receive time: 2009-04-24 14:05:47 CEST 524.847 ms
Request for seq 7, to interface 86, no label stack., packet size 4368
Reply for seq 7, return code: Egress-ok, time: -36.922 ms
        Local transmit time: 2009-04-24 14:05:48 CEST 568.738 ms
        Remote receive time: 2009-04-24 14:05:48 CEST 531.816 ms
Request for seq 8, to interface 86, no label stack., packet size 4440
Reply for seq 8, return code: Egress-ok, time: -36.855 ms
        Local transmit time: 2009-04-24 14:05:49 CEST 575.669 ms
        Remote receive time: 2009-04-24 14:05:49 CEST 538.814 ms
Request for seq 9, to interface 86, no label stack., packet size 4476
Timeout for seq 9
Request for seq 10, to interface 86, no label stack., packet size 4460
Reply for seq 10, return code: Egress-ok, time: -36.906 ms
        Local transmit time: 2009-04-24 14:05:53 CEST 584.382 ms
        Remote receive time: 2009-04-24 14:05:53 CEST 547.476 ms
Request for seq 11, to interface 86, no label stack., packet size 4480
Timeout for seq 11
Request for seq 12, to interface 86, no label stack., packet size 4472
Timeout for seq 12
Request for seq 13, to interface 86, no label stack., packet size 4468
Reply for seq 13, return code: Egress-ok, time: -36.943 ms
        Local transmit time: 2009-04-24 14:06:00 CEST 594.884 ms
        Remote receive time: 2009-04-24 14:06:00 CEST 557.941 ms
Request for seq 14, to interface 86, no label stack., packet size 4476
Timeout for seq 14
Request for seq 15, to interface 86, no label stack., packet size 4472
Timeout for seq 15

--- lsp ping sweep result---
Maximum Transmission Unit (MTU) is 4468 bytes
```

show rsvp interface

List of Syntax
Syntax on page 251
Syntax (EX Series Switches) on page 251

Syntax
show rsvp interface
<brief | detail | extensive>
<link-management>
<logical-system (all | *logical-system-name*)>

Syntax (EX Series Switches)
show rsvp interface
<brief | detail | extensive>
<link-management>

Release Information
Command introduced before Junos OS Release 7.4.
Command introduced in Junos OS Release 9.5 for EX Series switches.
Statement introduced for QFX switches in Junos OS Release 13.2X51-D15
Statement introduced for QFX Virtual Chassis and Virtual Chassis Fabric in Junos OS Release 14.1X53-D30

Description
Display the status of Resource Reservation Protocol (RSVP)-enabled interfaces and packet statistics.

Options
none—Display standard information about the status of RSVP-enabled interfaces and packet statistics.

brief | detail | extensive | link-management—(Optional) Display the specified level of output.

link-management—(Optional) Use the link-management option to display the control peers and corresponding TE-link information created by the Link Management Protocol (LMP).

logical-system (all | *logical-system-name*)—(Optional) Perform this operation on all logical systems or on a particular logical system.

Required Privilege Level
view

List of Sample Output
show rsvp interface brief on page 254
show rsvp interface detail on page 254
show rsvp interface extensive on page 254
show rsvp interface link-management on page 255

Output Fields
Table 20 on page 252 lists the output fields for the **show rsvp interface** command. Output fields are listed in the approximate order in which they appear.

Table 20: show rsvp interface Output Fields

Field Name	Field Description	Level of Output
RSVP interface	Number of interfaces on which RSVP is active. Each interface has one line of output.	All levels
Interface	Name of the interface.	All levels
Index	Index of the interface.	**detail**
State	State of the interface. • **Disabled**—No traffic engineering information is displayed. • **Down**—Interface is not operational. • **Enabled**—Displays traffic engineering information. • **Up**—Interface is operational.	All levels
NoAuthentication	Interface does not support RSVP authentication.	**detail**
NoAggregate	Interface does not support refresh reduction.	**detail**
NoReliable	Interface does not support refresh reduction message ID extension.	**detail**
NoLinkProtection	Interface does not support link protection.	**detail**
HelloInterval	Frequency at which RSVP hellos are sent on this interface (in seconds).	**detail**
Address	IP address of the local interface.	**detail**
Active control channel	Next-hop link address to transmit messages.	None specified
TElink	Traffic-engineered links that are managed by the peer they are associated with.	None specified
Active resv	Number of reservations that are actively reserving bandwidth on the interface.	All levels
PreemptionCnt	Number of times an RSVP session was preempted on this interface.	**detail**
Update threshold	Percentage change in reserved bandwidth to trigger an IGP update.	**detail**
Subscription	User-configured subscription factor.	All levels
bc ***number***	Bandwidth allocated for the specified bandwidth constraint.	**extensive**
ct ***number***	Bandwidth allocated for the specified class type.	**extensive**
Static BW	Total interface bandwidth, in bps.	All levels
Available BW	Amount of bandwidth that RSVP is allowed to reserve, in bps. It is equal to (static bandwidth * subscription factor).	al levels

Table 20: show rsvp interface Output Fields *(continued)*

Field Name	Field Description	Level of Output
Reserved BW	Currently reserved bandwidth, in bps.	All levels
SoftPreemptionCnt	Number of times a soft preemption occurred on this interface. This number is not included in the **PreemptionCnt** value.	**detail**
Overbooked BW	Currently overbooked bandwidth, in bps, by class type (**ct0** through **ct3**).	**detail**
Highwater mark	Highest bandwidth that has ever been reserved on this interface, in bps.	**brief**
PacketType	Type of RSVP packet.	**detail**
Total Sent	Total number of packets sent.	**detail**
Total Received	Total number of packets received since RSVP was enabled.	**detail**
Last 5 seconds Sent	Number of packets sent in the last 5 seconds.	**detail**
Last 5 seconds Received	Number of packets received in the last 5 seconds.	**detail**
Path	Statistics about Path messages, which are sent from the RSVP sender along the data paths and store path state information in each node along the path.	**detail**
PathErr	Statistics about PathErr messages, which are advisory messages that are sent upstream to the sender.	**detail**
PathTear	Statistics about PathTear messages, which remove path states and dependent reservation states in any routers along a path.	**detail**
Resv	Statistics about Resv messages, which are sent from the RSVP receiver along the data paths and store reservation state information in each node along the path.	**detail**
ResvErr	Statistics about ResvErr messages, which are advisory messages that are sent when an attempt to establish a reservation fails.	**detail**
ResvTear	Statistics about ResvTear messages, which remove reservation states along a path.	**detail**
Hello	Number of RSVP hello packets that have been sent to and received from the neighbor.	**detail**
Ack	Acknowledge message for refresh reductions.	**detail**
Srefresh	Summary refresh messages.	**detail**
EndtoEnd RSVP	Statistics for the number of end-to-end RSVP messages sent.	**detail**
Queue	CoS transmit queue number and its associated forwarding class designation.	**extensive**

Table 20: show rsvp interface Output Fields *(continued)*

Field Name	Field Description	Level of Output
TxRate	Configured bandwidth in Mbps and configured bandwidth as a percentage of the specified queue.	**extensive**
Priority	Weight of the queue relative to other configured queues, in percentage.	**extensive**
queue-priority-value	**Low**, **High**, **None**, or **Exact**. **None** indicates no rate limiting. **Exact** indicates the queue transmits at the configured rate only.	**extensive**

Sample Output

show rsvp interface brief

```
user@host> show rsvp interface brief
RSVP interface: 1 active
                  Active Subscr- Static      Available   Reserved    Highwater
Interface   State resv   iption  BW          BW          BW          mark
de0.0     Up         1    23%    10Mbps      989.992kbps 1.31Mbps    1.31Mbps
```

show rsvp interface detail

```
user@host> show rsvp interface detail
so-0/1/1.0  Index 6, State: Ena/Up
  NoAuthentication, NoAggregate, NoReliable, NoLinkProtection
  HelloInterval 3(second)
  Address 192.168.207.29, 10.255.245.194
  ActiveResv 0, PreemptionCnt 0, Update threshold 10%
  Subscription 100%, StaticBW 155.52Mbps, AvailableBW 155.52Mbps
ReservedBW [0] 155Mbps[1] 0bps[2] 0bps[3] 0bps[4] 0bps[5] 0bps[6] 0bps[7] 0bps
SoftPreemptionCnt1
OverbookedBW [0] 0bps[1] 0bps[2] 0bps[3] 0bps[4] 155Mbps[5] 0bps[6] 0bps[7] 0bps
PacketType              Total                 Last 5 seconds
                    Sent      Received        Sent      Received
  Path                16             0           1             0
  PathErr              0             0           0             0
  PathTear             1             0           0             0
  Resv                 0            11           0             1
  ResvErr              0             0           0             0
  ResvTear             0             0           0             0
  Hello               66            67           1             1
  Ack                  0             0           0             0
  Srefresh             0             0           0             0
  EndtoEnd RSVP        0             0           0             0
...
```

show rsvp interface extensive

```
user@host> show rsvp interface extensive
so-1/0/0.0 Index 72, State Ena/Up
  NoAuthentication, NoAggregate, NoReliable, NoLinkProtection
  HelloInterval 9(second)
  Address 192.168.213.22, 10.255.240.175
  ActiveResv 1, PreemptionCnt 0, Update threshold 10%
  Subscription 100%,
  bc0 = (ct0+ct1+ct2+ct3), StaticBW 622.08Mbps
  bc1 = (ct1+ct2+ct3), StaticBW 466.56Mbps
```

```
  bc2 = (ct2+ct3), StaticBW 311.04Mbps
  bc3 = ct3, StaticBW 155.52Mbps
  ct0: StaticBW 155.52Mbps, AvailableBW 522.08Mbps
  ReservedBW [0] 0bps[1] 0bps[2] 0bps[3] 0bps[4] 0bps[5] 0bps[6] 0bps[7] 0bps
  ct1: StaticBW 155.52Mbps, AvailableBW 366.56Mbps
  ReservedBW [0] 100Mbps[1] 0bps[2] 0bps[3] 0bps[4] 0bps[5] 0bps[6] 0bps[7] 0bps

  ct2: StaticBW 155.52Mbps, AvailableBW 311.04Mbps
  ReservedBW [0] 0bps[1] 0bps[2] 0bps[3] 0bps[4] 0bps[5] 0bps[6] 0bps[7] 0bps
  ct3: StaticBW 155.52Mbps, AvailableBW 155.52Mbps
  ReservedBW [0] 0bps[1] 0bps[2] 0bps[3] 0bps[4] 0bps[5] 0bps[6] 0bps[7] 0bps
  Queue          TxRate             Priority Exact
    0            155.52Mbps         25%      Low
    1            155.52Mbps         25%      Low
    2            155.52Mbps         25%      Low
    3            155.52Mbps         25%      Low
```

show rsvp interface link-management

```
user@host> show rsvp interface link-management
RSVP interface: 2 active
PEER-C  State: Up
Active Control Channel: so-0/1/0.0

  TElink: TElnk1, Link ID: 37811
  ActiveResv 0, PreemptionCnt 0
  StaticBW 155.52Mbps, ReservedBW: 0bps, AvailableBW: 155.52Mbps

  TElink: TElnk2, Link ID: 37808
  ActiveResv 1, PreemptionCnt 0
  StaticBW 155.52Mbps, ReservedBW: 0bps, AvailableBW: 155.52Mbps

PEER-B  State: Up
Active Control Channel: so-1/0/0.0

  TElink: TElnkAB1, Link ID: 1598
  ActiveResv 0, PreemptionCnt 0
  StaticBW 622.08Mbps, ReservedBW: 0bps, AvailableBW: 622.08Mbps

  TElink: TElnkAB2, Link ID: 1597
  ActiveResv 0, PreemptionCnt 0
  StaticBW 622.08Mbps, ReservedBW: 0bps, AvailableBW: 622.08Mbps
```

show rsvp neighbor

List of Syntax
Syntax on page 256
Syntax (EX Series Switches) on page 256

Syntax
show rsvp neighbor
<brief | detail>
<logical-system (all | *logical-system-name*)>

Syntax (EX Series Switches)
show rsvp neighbor
<brief | detail>

Release Information
Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 9.5 for EX Series switches.
Statement introduced for QFX switches in Junos OS Release 13.2X51-D15
Statement introduced for QFX Virtual Chassis and Virtual Chassis Fabric in Junos OS Release 14.1X53-D30

Description
Display Resource Reservation Protocol (RSVP) neighbors that were discovered dynamically during the exchange of RSVP packets.

Options
none—Display standard information about RSVP neighbors.

brief | detail—(Optional) Display the specified level of output.

logical-system (all | *logical-system-name*)—(Optional) Perform this operation on all logical systems or on a particular logical system.

Required Privilege Level
view

List of Sample Output
show rsvp neighbor on page 260
show rsvp neighbor detail on page 260

Output Fields
Table 21 on page 256 lists the output fields for the **show rsvp neighbor** command. Output fields are listed in the approximate order in which they appear.

Table 21: show rsvp neighbor Output Fields

Field Name	Field Description	Level of Output
RSVP neighbor	Number of neighbors that the routing device has learned of. Each neighbor has one line of output.	All levels
via	Name of the interface where the neighbor has been detected. In the case of generalized MPLS (GMPLS) LSPs, the name of the peer where the neighbor has been detected.	**detail**
Address	Address of a learned neighbor.	All levels
Idle	Length of time the neighbor has been idle, in seconds.	All levels

Table 21: show rsvp neighbor Output Fields *(continued)*

Field Name	Field Description	Level of Output
Up/Dn	Number of neighbor up or down transitions detected by RSVP hello packets. If the up count is 1 greater than the down count, the neighbor is currently up. Otherwise, the neighbor is down. Neighbors that do not support RSVP hello packets, such as routers running Junos OS Release 3.2 or earlier, are not reported as up or down.	All levels
Up cnt and Down cnt	Number of neighbor up or down transitions detected by RSVP hello packets. If the up count is 1 greater than the down count, the neighbor is currently up. Otherwise, the neighbor is down. Neighbors that do not support RSVP hello packets, such as routers running Junos OS Release 3.2 or earlier, are not reported as up or down.	**detail**

status	State of the RSVP neighbor:
	• **Up**—Routing device can detect RSVP Hello messages from the neighbor.
	• **Down**—Routing device has received one of the following indications:
	  ◦ Communication failure from the neighbor.
	  ◦ Communication from IGP that the neighbor is unavailable.
	  ◦ Change in the sequence numbers in the RSVP Hello messages sent by the neighbor.
	• **Restarting**—RSVP neighbor is unavailable and might be restarting. The neighbor remains in this state until it has restarted or is declared dead. This state is possible only when graceful restart is enabled.
	• **Restarted**—RSVP neighbor has restarted and is undergoing state recovery (graceful restart) procedures.
	• **Dead**—Routing device has lost all communication with the RSVP neighbor. Any RSVP sessions with that neighbor are torn down.
		detail

LastChange	Time elapsed since the neighbor state changed either from up to down or from down to up. The format is ***hh*:*mm*:*ss***.	All levels
Last changed time	Time elapsed since the neighbor state changed either from up to down or from down to up.	**detail**
HelloInt	Frequency at which RSVP hellos are sent on this interface (in seconds).	All levels
HelloTx/Rx	Number of hello packets sent to and received from the neighbor.	All levels
Hello	Number of RSVP hello packets that have been sent to and received from the neighbor.	**detail**
Message received	Number of Path and Resv messages that this routing device has received from the neighbor.	**detail**
Remote Instance	Identification provided by the remote routing device during Hello message exchange.	**detail**
Local Instance	Identification sent to the remote routing device during Hello message exchange.	**detail**

Table 21: show rsvp neighbor Output Fields *(continued)*

Field Name	Field Description	Level of Output
Refresh reduction	Measure of processing overhead requests of refresh messages. Refresh reduction extensions improve routing device performance by reducing the process overhead, thus increasing the number of LSPs a routing device can support. **Refresh reduction** can have the following values: • **operational**—All four RSVP refresh reduction extensions—message ack, bundling, summary refresh, and staged refresh timer—are functional between the two neighboring routing devices. For a detailed explanation of these extensions, see RFC 2961. • **incomplete**—Some RSVP refresh reduction extensions are functional between the two neighboring routing devices. • **no operational**—Either the refresh reduction feature has been turned off, or the remote routing device cannot support the refresh reduction extensions.	**detail**
Remote end	Neighboring routing device's status with regard to refresh reduction: • **enabled**—Remote routing device has requested refresh reduction during RSVP message exchanges. • **disabled**—Remote routing device does not require refresh reduction.	**detail**
Ack-extension	An RSVP refresh reduction extension: • **enabled**—Both local and remote routing devices support the ack-extension (RFC 2961). • **disabled**—Remote routing device does not support the ack-extension.	**detail**
Link protection	Status of the MPLS fast reroute mechanism that protects traffic from link failure: • **enabled**—Link protection feature has been turned on, protecting the neighbor with a bypass LSP. • **disabled**—No link protection feature has been enabled for this neighbor.	**detail**
LSP name	Name of the bypass LSP.	**detail**
Bypass LSP	Status of the bypass LSP. It can have the following values: • **does not exist**—Bypass LSP is not available. • **connecting**—Routing device is in the process of establishing a bypass LSP, and the LSP is not available for link protection at the moment. • **operational**—Bypass LSP is up and running. • **down**—Bypass LSP has gone down, with the most probable cause a node or a link failure on the bypass path.	**detail**
Backup routes	Number of user LSPs (or routes) that are being protected by a bypass LSP (before link failure).	**detail**
Backup LSPs	Number of LSPs that have been temporarily established to maintain traffic by refreshing the downstream LSPs during link failure (not a one-to-one correspondence).	**detail**
Bypass explicit route	Explicit route object's (ERO) path that is taken by the bypass LSP.	**detail**

Table 21: show rsvp neighbor Output Fields *(continued)*

Field Name	Field Description	Level of Output
Restart time	Length of time a neighbor waits to receive a Hello from the restarting node before declaring the node dead and deleting the states (in milliseconds).	**detail**
Recovery time	Length of time during which the restarting node attempts to recover its lost states with help from its neighbors (in milliseconds). Recovery time is advertised by the restarting node to its neighbors, and applies to nodal faults. The restarting node considers its graceful restart complete after this time has elapsed.	**detail**

Sample Output

show rsvp neighbor

```
user@host> show rsvp neighbor
RSVP neighbor: 2 learned
Address            Idle Up/Dn LastChange HelloInt HelloTx/Rx
192.168.207.203       0  3/2       13:01        3   366/349
192.168.207.207       0  1/0       22:49        3   448/448
```

show rsvp neighbor detail

```
user@host> show rsvp neighbor detail
RSVP neighbor: 2 learned
Address: 192.168.207.203   via: ecstasyl status: Up
   Last changed time: 28:47, Idle: 0 sec, Up cnt: 3, Down cnt: 2
   Message received: 632
   Hello: sent 673, received 656, interval 3 sec
   Remote instance: 0x6432838a, Local instance: 0x74b72e36
   Refresh reduction:  operational
     Remote end: enabled,  Ack-extension: enabled
   Link protection:  enabled
     LSP name: Bypass_to_192.168.207.203
     Bypass LSP: operational,  Backup routes: 1,  Backup LSPs: 0
     Bypass explicit route: 192.168.207.207 192.168.207.224
  Restart time: 60000 msec, Recovery time: 0 msec
```

show rsvp session

List of Syntax
Syntax on page 261
Syntax (EX and QFX Series Switches) on page 261

Syntax

show rsvp session
<brief | detail | extensive | terse>
<bidirectional | unidirectional>
<bypass>
<down | up>
<externally-provisioned>
<interface *interface-name*>
<logical-system (all | *logical-system-name*)>
<*lsp-type*>
<name *session-name*>
<p2mp>
<*session-type*>
<statistics>
<te-link *te-link*>

Syntax (EX and QFX Series Switches)

show rsvp session
<brief | detail | extensive | terse>
<bidirectional | unidirectional>
<bypass>
<down | up>
<externally-provisioned>
<interface *interface-name*>
<*lsp-type*>
<name *session-name*>
<p2mp>
<*session-type*>
<statistics>
<te-link *te-link*>

Release Information

Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 9.5 for EX Series switches.
externally-provisioned option added in Junos OS Release 13.3.
Statement introduced for QFX switches in Junos OS Release 13.2X51-D15
Statement introduced for QFX Virtual Chassis and Virtual Chassis Fabric in Junos OS Release 14.1X53-D30

Description

Display information about Resource Reservation Protocol (RSVP) sessions.

Options

none—Display standard information about all RSVP sessions.

brief | detail | extensive | terse—(Optional) Display the specified level of output.

bidirectional | unidirectional—(Optional) Display information about bidirectional or unidirectional RSVP sessions only, respectively.

bypass—(Optional) Display RSVP sessions for bypass LSPs.

down | up—(Optional) Display only LSPs that are inactive or active, respectively.

externally-provisioned—(Optional) Display the LSPs that are generated dynamically and provisioned by an external Path Computation Element (PCE).

interface *interface-name*—(Optional) Display RSVP sessions for the specified interface only.

logical-system (all | *logical-system-name*)—(Optional) Perform this operation on all logical systems or on a particular logical system.

lsp-type—(Optional) Display information about RSVP sessions with regard to LSPs:

- **bypass**—Sessions used for bypass LSPs.
- **lsp**—Sessions used to set up LSPs.
- **nolsp**—Sessions not used to set up LSPs.

name *session-name*—(Optional) Display information about the named session.

p2mp—(Optional) Display point-to-multipoint information.

session-type—(Optional) Display information about a particular session type:

- **egress**—Sessions that terminate on this routing device.
- **ingress**—Sessions that originate from this routing device.
- **transit**—Sessions that transit through this routing device.

statistics—(Optional) Display packet statistics.

te-link *te-link*—(Optional) Display sessions with reservations on the specified TE link.

Required Privilege Level view

Related Documentation

- clear rsvp session on page 243

List of Sample Output

show rsvp session on page 266
show rsvp session statistics on page 266
show rsvp session detail on page 267
show rsvp session detail (Path MTU Output Field) on page 267
show rsvp session detail (GMPLS) on page 267
show rsvp session extensive on page 268
show rsvp session p2mp (Ingress Router) on page 268
show rsvp session p2mp (Transit Router) on page 269

Output Fields Table 22 on page 263 describes the output fields for the **show rsvp session** command. Output fields are listed in the approximate order in which they appear.

Table 22: show rsvp session Output Fields

Field Name	Field Description	Level of Output
Ingress RSVP	Information about ingress RSVP sessions.	**detail**
Ingress RSVP	Information about ingress RSVP sessions. Each session has one line of output.	All levels
Egress RSVP	Information about egress RSVP sessions.	All levels
Transit RSVP	Information about the transit RSVP sessions.	All levels
P2MP name	(Appears only when the **p2mp** option is specified). Name of the point-to-multipoint LSP path.	All levels
P2MP branch count	(Appears only when the **p2mp** option is specified). Number of LSPs receiving packets from the point-to-multipoint LSP.	All levels
To	Destination (egress routing device) of the session.	All levels
From	Source (ingress routing device) of the session.	All levels
State	State of the path: **Up**, **Down**, or **AdminDn**. **AdminDn** indicates that the LSP is being taken down gracefully.	All levels
Address	Destination (egress routing device) of the LSP.	**detail**
From	Source (ingress routing device) of the session.	**detail**
LSPstate	State of the LSP that is being handled by this RSVP session. It can be either **Up**, **Dn** (down), or **AdminDn**. **AdminDn** indicates that the LSP is being taken down gracefully.	**brief detail**
Rt	Number of active routes (prefixes) that have been installed in the routing table. For ingress RSVP sessions, the routing table is the primary IPv4 table (**inet.0**). For transit and egress RSVP sessions, the routing table is the primary MPLS table **mpls.0**).	**brief**
Active Route	Number of active routes (prefixes) that have been installed in the forwarding table. For ingress RSVP sessions, the forwarding table is the primary IPv4 table (**inet.0**). For transit and egress RSVP sessions, the forwarding table is the primary MPLS table (**mpls.0**).	**detail**
LSPname	Name of the LSP.	**brief detail**
LSPpath	Indicates whether the RSVP session is for the primary or secondary LSP path. **LSPpath** can be either **primary** or **secondary** and can be displayed on the ingress, egress, and transit routing devices. **LSPpath** can also indicate when a graceful LSP deletion has been triggered.	**detail**
Bypass	(Egress routing device) Destination address for the bypass LSP.	**detail**

Table 22: show rsvp session Output Fields *(continued)*

Field Name	Field Description	Level of Output
Bidir	(When LSP is bidirectional) LSP will allow data to travel in both directions between GMPLS devices.	**detail**
Bidirectional	(When LSP is bidirectional) LSP will allow data to travel both ways between GMPLS devices.	**detail**
Upstream label in	(When LSP is bidirectional) Incoming label for reverse direction traffic for this LSP.	**detail**
Upstream label out	(When LSP is bidirectional) Outgoing label for reverse direction traffic for this LSP.	**detail**
Recovery label received	(When LSP is bidirectional) Label the upstream node suggests for use in the Resv message that is sent.	**detail**
Recovery label sent	(When LSP is bidirectional) Label the downstream node suggests for use in its Resv messages that is returned.	**detail**
Suggested label received	(When LSP is bidirectional) Label the upstream node suggests for use in the Resv message that is sent.	**detail**
Suggested label sent	(When LSP is bidirectional) Label the downstream node suggests for use in its Resv message that is returned.	**detail**
Resv style or **Style**	RSVP reservation style. This field consists of two parts. The first is the number of active reservations. The second is the reservation style, which can be **FF** (fixed filter), **SE** (shared explicit), or **WF** (wildcard filter).	**brief detail**
Label in	Incoming label for this LSP.	**brief detail**
Label out	Outgoing label for this LSP.	**brief detail**
Time left	Number of seconds remaining in the lifetime of the reservation.	**brief detail**
Since	Date and time when the RSVP session was initiated.	**detail**
Tspec	Sender's traffic specification, which describes the sender's traffic parameters.	**detail**
DiffServ info	Indicates whether the LSP is a multiclass LSP (**multiclass diffServ-TE LSP**) or a Differentiated-Services-aware traffic engineering LSP (**diffServ-TE LSP**).	**detail**
bandwidth	Bandwidth for each class type (**ct0**, **ct1**, **ct2**, or **ct3**).	**detail**
Port number	Protocol ID and sender/receiver port used in this RSVP session.	**detail**
Attrib flags	**Non-PHP** indicates that ultimate hop popping has been requested by the LSP using this RSVP session	extensive

Table 22: show rsvp session Output Fields *(continued)*

Field Name	Field Description	Level of Output
FastReroute desired	Fast reroute has been requested by the ingress routing device.	**detail**
Soft preemption desired	Soft preemption has been requested by the ingress routing device.	**detail**
FastReroute desired	(Data [not a bypass or backup] LSP when the protection scheme has been requested) Fast reroute (one-to-one backup) has been requested by the ingress routing device.	**detail extensive**
Link protection desired	(Data [not a bypass or backup] LSP when the protection scheme has been requested) Link protection (many-to-one backup) has been requested by the ingress routing device.	**detail extensive**
Node/Link protection desired	(Data [not a bypass or backup] LSP when the protection scheme has been requested) Node and link protection (many-to-one backup) has been requested by the ingress routing device.	**detail extensive**
Type	LSP type: • **Link protected LSP**—LSP has been protected by link protection at the outgoing interface. The name of the bypass used is also listed here (**extensive**). • **Node/Link protected LSP**—LSP has been protected by node and link protection at the outgoing interface. The name of the bypass used is also listed here (**extensive**). • **Protection down**—LSP is not currently protected. • **Bypass LSP**—LSP that is used to protected one or more user LSPs in case of link failure. • **Backup LSP at Point-of-Local-Repair (PLR)**—LSP that has been temporarily established to protected a user LSP at the ingress of a failed link. • **Backup LSP at Merge Point (MP)**—LSP that has been temporarily established to protected a user LSP at the egress of a failed link.	**detail extensive**
New bypass	New bypass (the bypass name is also displayed) has been activated to protect the LSP.	**extensive**
Link protection up, using *bypass-name*	Link protection (the bypass name is also displayed) has been activated for the LSP.	**extensive**
Creating backup LSP, link down	A **link down** event occurred, and traffic is being switched over to the bypass LSP.	**extensive**
Deleting backup LSP, protected LSP restored	Link has come back up and the LSP has been restored. Because the backup LSP is no longer needed, it is deleted.	**extensive**
Path mtu	Displays the value of the path MTU received from the network (through signaling) and the value used for forwarding. This value is only displayed on ingress routing devices with the **allow-fragmentation** statement configured at the **[edit protocols mpls path-mtu]** hierarchy level. If there is a detour LSP, the path MTU for the detour is also displayed.	**detail**

Table 22: show rsvp session Output Fields *(continued)*

Field Name	Field Description	Level of Output
PATH rcvfrom	Address of the previous-hop (upstream) routing device or client, interface the neighbor used to reach this routing device, and number of packets received from the upstream neighbor.	**detail**
Adspec	MTU signaled from the ingress routing device to the egress routing device by means of the adspec object.	**detail**
PATH sentto	Address of the next-hop (downstream) routing device or client, interface used to reach this neighbor (or peer-name in the GMPLS LSP case), and number of packets sent to the downstream routing device.	**detail**
Explct route	Explicit route for the session. Normally this value will be the same as that of record route. Differences indicate that path rerouting has occurred, typically during fast reroute.	**detail**
Record route	Recorded route for the session, taken from the record route object. Normally this value will be the same as that of explct route. Differences indicate that path rerouting has occurred, typically during fast reroute.	**detail**

Sample Output

show rsvp session

```
user@host> show rsvp session
Ingress RSVP: 1 sessions
To              From            State   Rt Style Labelin Labelout LSPname
10.255.245.214  10.255.245.212  AdminDn  0  1 FF       -    22293 LSP Bidir
Total 1 displayed, Up 1, Down 0

Egress RSVP: 2 sessions
To              From            State Rt Style Labelin Labelout LSPname
10.255.245.194  10.255.245.195  Up     0  1 FF   39811        - Gpro3-ba Bidir
10.255.245.194  10.255.245.195  Up     0  1 FF       3        - pro3-ba
Total 2 displayed, Up 2, Down 0

Transit RSVP: 1 sessions
To              From            State Rt Style Labelin Labelout LSPname
10.255.245.198  10.255.245.197  Up     0  1 SE  100000        3 pro3-de
Total 1 displayed, Up 1, Down 0
```

show rsvp session statistics

```
user@host> show rsvp session statistics
Ingress RSVP: 2 sessions
To              From           State   Packets      Bytes    LSPname
10.255.245.24   10.255.245.22     Up         0          0     pro3-bd
10.255.245.24   10.255.245.22     Up     44868    2333136  pro3-bd-2
Total 2 displayed, Up 2, Down 0
Egress RSVP: 2 sessions
To              From           State   Packets      Bytes    LSPname
10.255.245.22   10.255.245.24     Up         0          0    pro3-db
10.255.245.22   10.255.245.24     Up         0          0  pro3-db-2
Total 2 displayed, Up 2, Down 0
```

```
Transit RSVP: 0 sessions
Total 0 displayed, Up 0, Down 0
```

show rsvp session detail

```
user@host> show rsvp session detail
Ingress RSVP: 1 sessions
1.1.1.1
  From: 2.2.2.2, LSPstate: Up, ActiveRoute: 0
  LSPname: to-a, LSPpath: Primary
  Suggested label received: -, Suggested label sent: -
  Recovery label received: -, Recovery label sent: 3
  Resv style: 1 FF, Label in: -, Label out: 3
  Time left:    -, Since: Fri Mar 26 18:42:42 2004
  Tspec: rate 300kbps size 300kbps peak Infbps m 20 M 1500
  DiffServ info: diffServ-TE LSP, bandwidth: <ct1 300kbps>
  Port number: sender 1 receiver 15876 protocol 0
  PATH rcvfrom: localclient
  Adspec: sent MTU 1500
  PATH sentto: 192.168.37.16 (t1-0/2/1.0) 1 pkt
```

show rsvp session detail (Path MTU Output Field)

```
user@host> show rsvp session detail
Ingress RSVP: 1 sessions
10.255.245.3
  From: 10.255.245.5, LSPstate: Up, ActiveRoute: 3
  LSPname: to-c, LSPpath: Primary
  Suggested label received: -, Suggested label sent: -
  Recovery label received: -, Recovery label sent: 100432
  Resv style: 1 FF, Label in: -, Label out: 100432
  Time left:    -, Since: Mon Aug 16 17:54:40 2006
  Tspec: rate 0bps size 0bps peak Infbps m 20 M 9192
  Port number: sender 1 receiver 57843 protocol 0
  FastReroute desired
  PATH rcvfrom: localclient
  Adspec: sent MTU 4470
  Path mtu: received 4470, using 4458 for forwarding
  PATH sentto: 192.168.37.89 (so-0/2/3.0) 11 pkts
  RESV rcvfrom: 192.168.37.89 (so-0/2/3.0) 10 pkts
  Explct route: 192.168.37.89
  Record route: <self> 192.168.37.89 192.168.37.87
    Detour is Up
    Detour Tspec: rate 0bps size 0bps peak Infbps m 20 M 9192
    Detour adspec: sent MTU 1512
    Path mtu: received 1512, using 1500 for forwarding
```

show rsvp session detail (GMPLS)

```
user@host> show rsvp session detail
Ingress RSVP: 1 sessions
192.168.4.1
  From: 192.168.1.1, LSPstate: Dn, ActiveRoute: 0
  LSPname: gmpls-r1-to-r3, LSPpath: Primary
  Bidirectional, Upstream label in: 21253, Upstream label out: -
  Suggested label received: -, Suggested label sent: 21253
  Recovery label received: -, Recovery label sent: -
  Resv style: 0 -, Label in: -, Label out: -
  Time left:    -, Since: Mon Aug 16 17:54:40 2006
  Tspec: rate 0bps size 0bps peak 155.52Mbps m 20 M 1500
  Port number: sender 2 receiver 46115 protocol 0
  PATH rcvfrom: localclient
```

```
  Adspec: sent MTU 1500
  PATH MTU: received 0
  PATH sentto: 10.35.1.5 (so-0/2/3.0) 11 pkts
  Explct route: 100.100.100.100 93.93.93.93
  Record route: <self> 100.100.100.100 93.93.93.93
  Total 1 displayed, Up 0, Down 1
  Egress RSVP: 0 sessions
  Total 0 displayed, Up 0, Down 0
  Transit RSVP: 0 sessions
  Total 0 displayed, Up 0, Down 0
```

show rsvp session extensive

```
user@host> show rsvp session extensive
Ingress RSVP: 1 sessions

192.168.0.4
  From: 192.168.0.5, LSPstate: Up, ActiveRoute: 0
  LSPname: E-D, LSPpath: Primary
  LSPtype: Static Configured
  Suggested label received: -, Suggested label sent: -
  Recovery label received: -, Recovery label sent: 299808
  Resv style: 1 FF, Label in: -, Label out: 299808
  Time left:    -, Since: Thu Sep 20 15:54:20 2012
  Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
  Port number: sender 2 receiver 61576 protocol 0
  Attrib flags: Non-PHP
  PATH rcvfrom: localclient
  Adspec: sent MTU 1500
  Path MTU: received 1500
  PATH sentto: 10.0.0.18 (lt-1/2/0.17) 41 pkts
  RESV rcvfrom: 10.0.0.18 (lt-1/2/0.17) 40 pkts
  Explct route: 10.0.0.18 10.0.0.22
  Record route: <self> 10.0.0.18 10.0.0.22
Total 1 displayed, Up 1, Down 0

Egress RSVP: 1 sessions

192.168.0.5
  From: 192.168.0.4, LSPstate: Up, ActiveRoute: 0
  LSPname: E-D, LSPpath: Primary
  Suggested label received: -, Suggested label sent: -
  Recovery label received: -, Recovery label sent: -
  Resv style: 1 FF, Label in: 3, Label out: -
  Time left:  140, Since: Thu Sep 20 15:52:10 2012
  Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
  Port number: sender 1 receiver 49601 protocol 0
  PATH rcvfrom: 10.0.0.18 (lt-1/2/0.17) 44 pkts
  Adspec: received MTU 1500
  PATH sentto: localclient
  RESV rcvfrom: localclient
  Record route: 10.0.0.22 10.0.0.18 <self>
Total 1 displayed, Up 1, Down 0

Transit RSVP: 0 sessions
Total 0 displayed, Up 0, Down 0
```

show rsvp session p2mp (Ingress Router)

```
user@host> show rsvp session p2mp
```

```
Ingress RSVP: 3 sessions
P2MP name: test, P2MP branch count: 1
To              From            State   Rt Style Labelin Labelout LSPname
10.255.10.95    10.255.10.2     Up       0  1 SE    -           3 to-pe1
P2MP name: test2, P2MP branch count: 2
To              From            State   Rt Style Labelin Labelout LSPname
10.255.10.23    10.255.10.2     Up       0  1 SE    -      299776 to-pe3
10.255.10.16    10.255.10.2     Up       0  1 SE    -      299776 to-pe4
Total 3 displayed, Up 3, Down 0

Egress RSVP: 0 sessions
Total 0 displayed, Up 0, Down 0

Transit RSVP: 0 sessions
Total 0 displayed, Up 0, Down 0
```

show rsvp session p2mp (Transit Router)

```
user@host> show rsvp session p2mp
Ingress RSVP: 1 sessions
P2MP name: test, P2MP branch count: 1
To              From            State   Rt Style Labelin  Labelout LSPname
10.255.10.23    10.255.10.95    Up       0  1 SE    -       299792 to-pe2
Total 1 displayed, Up 1, Down 0

Egress RSVP: 1 sessions
P2MP name: test, P2MP branch count: 1
To              From            State   Rt Style Labelin Labelout  LSPname
10.255.10.95    10.255.10.2     Up       0  1 SE    3        -     to-pe1
Total 1 displayed, Up 1, Down 0

Transit RSVP: 2 sessions
P2MP name: test2, P2MP branch count: 2
To              From            State   Rt Style Labelin Labelout  LSPname
10.255.10.23    10.255.10.2     Up       0  1 SE  299776   299808  to-pe3
10.255.10.16    10.255.10.2     Up       0  1 SE  299776   299856  to-pe4
Total 2 displayed, Up 2, Down 0
```

show rsvp statistics

List of Syntax
Syntax on page 270
Syntax (EX Series Switches) on page 270

Syntax
show rsvp statistics
<logical-system (all | *logical-system-name*)>

Syntax (EX Series Switches)
show rsvp statistics

Release Information
Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 9.5 for EX Series switches.
Statement introduced for QFX switches in Junos OS Release 13.2X51-D15
Statement introduced for QFX Virtual Chassis and Virtual Chassis Fabric in Junos OS Release 14.1X53-D30

Description
Display Resource Reservation Protocol (RSVP) packet and error statistics.

Options
none—Display RSVP packet and error statistics.

logical-system (all |*logical-system-name*)—(Optional) Perform this operation on all logical systems or on a particular logical system.

Required Privilege Level
view

Related Documentation
- clear rsvp statistics on page 245

List of Sample Output
show rsvp statistics on page 273

Output Fields
Table 23 on page 270 describes the output fields for the **show rsvp statistics** command. Output fields are listed in the approximate order in which they appear.

Table 23: show rsvp statistics Output Fields

Field Name	Field Description
Packet Type	Statistics about different RSVP messages.
Total Sent	Total number of packets sent since RSVP was enabled.
Total Received	Total number of packets received since RSVP was enabled.
Last 5 seconds Sent	Total number of packets sent in the last 5 seconds.
Last 5 seconds Received	Number of packets received in the last 5 seconds.
Path	Statistics about Path messages, which are sent from the RSVP sender along the data paths and which store path state information in each node along the path.

Table 23: show rsvp statistics Output Fields *(continued)*

Field Name	Field Description
PathErr	Statistics about PathErr messages, which are advisory messages that are sent upstream to the sender.
PathTear	Statistics about PathTear messages, which remove path states and dependent reservation states in any routing devices along a path.
Resv FF	Statistics about fixed-filter reservation style messages, which consist of distinct reservations among explicit senders.
Resv WF	Statistics about wildcard-filter reservation style messages, which consist of shared reservations among wildcard senders.
Res SE	Statistics about shared-explicit reservation style messages, which consist of shared reservations among explicit senders.
ResvErr	Statistics about ResvErr messages, which are advisory messages that are sent when an attempt to establish a reservation fails.
ResvTear	Statistics about ResvTear messages, which remove reservation states along a path.
ResvConf	Statistics about ResvConfirm messages, which are responses to confirm a reservation request.
Ack	Acknowledge message for refresh reductions.
SRefresh	Summary refresh messages.
Hello	Number of RSVP hello packets that have been sent to and received from the neighbor.
EndtoEnd RSVP	Statistics for the number of End-to-end RSVP messages.
Errors	Statistics about errored RSVP packets.
Rcv pkt bad length	The packet was not processed because its length is inappropriate.
Rcv pkt unknown type	The packet is not one of the well-known RSVP types, as defined in RFC 2205, *Resource ReSerVation Protocol (RSVP)*.
Rcv pkt bad version	The packet is not an RSVP version 1 packet.
Rcv pkt auth fail	The packet failed authentication checks.
Rcv pkt bad checksum	The RSVP checksum check failed.
Rcv pkt bad format	General packet processing failed because the packet was badly formed.
Memory allocation fail	An internal resource failure occurred.
No path information	A reservation was received, but no sender is active.

Table 23: show rsvp statistics Output Fields *(continued)*

Field Name	Field Description
Resv style conflict	The same session contains inconsistent reservation styles.
Port conflict	There were inconsistent port numbers for the same session.
Resv no interface	An interface for the receive reservation packets cannot be located.
PathErr to client	Number of PathErr packets delivered to the local client.
ResvErr to client	Number of ResvErr packets delivered to the local client.
Path timeout	Number of times the sender timed out because the path was removed.
Resv timeout	Number of times the receiver timed out because the reservation was removed.
Message out-of-order	Records the number of RSVP incoming messages that are considered out of order. This is detected from the message ID object's sequence number.
Unknown ack msg	A neighboring routing device replies with an ACK object that contains an unknown message ID. This can indicate a message ID handshake problem. For example, a router receives an ACK for message IDs 1, 2, and 3. However, it only has state for message IDs 1 and 3. The router increments the unknown ack counter by 1.
Recv nack	If a neighboring router receives an unknown message ID in an RSVP refresh message, the router sends a Resv nack message back to the sender. This can happen if that neighbor has been rebooted. For this case, the router sends a regular RSVP refresh message to recover the state and start the message-ID handshake process again.
Recv duplicated msg-id	Number of times the same message ID is used by two different RSVP messages. This duplication is usually caused when a neighboring routing device restarts.
No TE-link to recv Hop	Counter of packets discarded because a TE link was not found.
Rcv pkt disabled interface	Number of RSVP packets received on an interface that is not enabled for RSVP.
Transmit buffer full	Number of times the buffer for assembling an outgoing RSVP message was not large enough.
Transmit failure	Number of times the RSVP task failed to send out a packet.
Receive failure	Number of times the RSVP task failed to read an incoming packet.
P2MP RESV discarded by appl	Number of Resv messages discarded because the MPLS label is not valid for the P2MP LSP application.
Rate limit	Number of RSVP packets dropped due to rate limiting.
Err msg loop detected	Number of RSVP error messages that have looped back to their originator. This is detected by checking the error node address in the ERROR_SPEC object.

Sample Output

show rsvp statistics

```
user@host> show rsvp statistics
   PacketType              Total                 Last 5 seconds
                     Sent      Received        Sent      Received
   Path               355           408           0             0
   PathErr              2            13           0             0
   PathTear           101           139           0             0
   Resv FF              0             0           0             0
   Resv WF              0             0           0             0
   Resv SE            419           225           0             0
   ResvErr              0             0           0             0
   ResvTear             0            13           0             0
   ResvConf             0             0           0             0
   Ack                682          1414           0             0
   SRefresh        395198        236030           5             2
   Hello           578809        578221           4             4
   EndtoEnd RSVP        0             0           0             0

   Errors                          Total           Last 5 seconds
   Rcv pkt bad length                0                       0
   Rcv pkt unknown type              0                       0
   Rcv pkt bad version               0                       0
   Rcv pkt auth fail                 0                       0
   Rcv pkt bad checksum              0                       0
   Rcv pkt bad format                0                       0
   Memory allocation fail            0                       0
   No path information              10                       0
   Resv style conflict               0                       0
   Port conflict                     0                       0
   Resv no interface                 0                       0
   PathErr to client                38                       0
   ResvErr to client                 0                       0
   Path timeout                      8                       0
   Resv timeout                     57                       0
   Message out-of-order              0                       0
   Unknown ack msg                2978                       0
   Recv nack                        86                       0
   Recv duplicated msg-id            5                       0
   No TE-link to recv Hop            0                       0
   Rcv pkt disabled interface        0                       0
   Transmit buffer full              0                       0
   Transmit failure                  0                       0
   Receive failure                   0                       0
   P2MP RESV discarded by appl       0                       0
   Rate limit                      306                       0
   Err msg loop detected             0                       0
```

show rsvp version

List of Syntax
Syntax on page 274
Syntax (EX Series Switches) on page 274

Syntax
show rsvp version
<logical-system (all | *logical-system-name*)>

Syntax (EX Series Switches)
show rsvp version

Release Information
Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 9.5 for EX Series switches.
Statement introduced for QFX switches in Junos OS Release 13.2X51-D15
Statement introduced for QFX Virtual Chassis and Virtual Chassis Fabric in Junos OS Release 14.1X53-D30

Description
Display information about the Resource Reservation Protocol (RSVP) protocol settings, such as the version of the RSVP software, the refresh timer and keep multiplier, and local RSVP graceful restart capabilities on a routing device.

Options
none—Display RSVP protocol settings.

logical-system (all |*logical-system-name*)—(Optional) Perform this operation on all logical systems or on a particular logical system.

Required Privilege Level
view

List of Sample Output
show rsvp version on page 276

Output Fields
Table 24 on page 274 describes the output fields for the **show rsvp version** command. Output fields are listed in the approximate order in which they appear.

Table 24: show rsvp version Output Fields

Field Name	Field Description
Resource ReSerVation Protocol, version	RSVP software version.
RSVP protocol	Status of RSVP: **Enabled** or **Disabled**.
R(refresh timer)	Configured time interval used to generate periodic RSVP messages.
K(keep multiplier)	Number of RSVP messages that can be lost before an RSVP state is declared stale.
Preemption	Currently configured preemption capability: **Aggressive**, **Disabled**, or **Normal**. The default is **Normal**.
Soft-preemption cleanup	Time, in seconds, that an LSP is kept after it has been soft preempted. This is a global property of the RSVP protocol.

Table 24: show rsvp version Output Fields *(continued)*

Field Name	Field Description
Graceful deleting timeout	Currently configured value for the **graceful-deletion-timeout** statement. The router that initiates the graceful deletion procedure for an RSVP session waits for the graceful deletion timeout interval to ensure that all routers along the path (especially the ingress and egress routers) have prepared for the LSP to be taken down.
NSR Mode	Status of the nonstop active routing feature for RSVP on the restarting device: **Disabled**, **Enabled/Master**, or **Enabled/Standby**.
NSR State	State of the nonstop active routing feature for RSVP on the restarting device. Possible values are: • **Idle** • **TE-link sync complete** • **Neighbor sync complete** • **Path state sync complete** • **Resv state sync complete** • **Bypass sync complete** • **Init sync complete**
Setup protection	Status of point-to-point and point-to-multipoint LSP setup protection configuration on the device: **Enabled** or **Disabled**
Graceful restart	Status of the graceful restart feature for RSVP on the restarting routing device: **Enabled** or **Disabled**.
Restart helper mode	Status of the helper mode feature: **Enabled** or **Disabled**. When this feature is enabled, the restarting routing device can help the neighbor with its RSVP restart procedures.
Maximum helper restart time	Number of milliseconds (ms) configured for the maximum helper restart time. The maximum helper restart time is the length of time the routing device waits before declaring that an RSVP neighbor attempting to restart gracefully is down.
Maximum helper recovery time	Number of milliseconds configured for the maximum helper recovery time. The maximum helper recovery time is the amount of time the routing device maintains the state of an RSVP neighbor attempting to restart gracefully.
Restart time	Number of milliseconds that a neighbor waits to receive a Hello message from the restarting node before declaring the node dead and deleting the states.
Recovery time	Number of milliseconds during which the restarting node attempts to recover its lost states with help from its neighbors. Recovery time is advertised by the restarting node to its neighbors, and applies to nodal faults. The restarting node considers its graceful restart complete after this time has elapsed.
P2p transit LSP nexthop mode	Point-to-point transit LSP nexthop mode on PTX Series devices. The possible values are **Chained** or **Unchained**
P2mp transit LSP nexthop mode	Point-to-multipoint transit LSP nexthop mode on PTX Series devices. The possible values are **Chained** or **Unchained**

Sample Output

show rsvp version

```
user@host> show rsvp version
Resource ReSerVation Protocol, version 1. rfc2205
   RSVP protocol:                Enabled
   R(refresh timer):             30 seconds
   K(keep multiplier):           3
   Preemption:                   Normal
   Soft-preemption cleanup:      30 seconds
   Graceful deletion timeout:    30 seconds
   NSR mode:                     Enabled/Master
   NSR state:                    Init sync complete
   Setup protection:             Disabled
   Graceful restart:             Disabled
   Restart helper mode:          Enabled
   Maximum helper restart time:  20000 msec
   Maximum helper recovery time: 180000 msec
   Restart time:                 0 msec
   P2p transit LSP nexthop mode: Unchained
   P2mp transit LSP nexthop mode: Unchained
```

traceroute mpls rsvp

Syntax

traceroute mpls <rsvp> *lsp-name*
<detail>
<egress>
<exp>
<logical-system>
<multipoint>
<no-resolve>
<retries>
<source *source-address*>
<ttl>

Release Information

Command introduced in Junos OS Release 9.2.
egress, **multipoint**, and **ttl** options added in Junos OS Release 11.2.
Statement introduced in Junos OS Release 13.2X51-D15 for the QFX Series.
Statement introduced in Junos OS Release 14.1X53-D30 for QFX Virtual Chassis and Virtual Chassis Fabric.

Description

Trace route to a remote host for an MPLS LSP signaled by RSVP. Use **traceroute mpls rsvp** as a debugging tool to locate MPLS label-switched path (LSP) forwarding issues in a network. (Currently supported for IPv4 packets only.)

Options

lsp-name—Specify the name of the LSP to be traced.

detail—(Optional) Display detailed output.

egress—(Optional) Request that a specific point-to-multipoint egress node reply to the trace route. The trace route would follow the associated sub-LSP to the egress node.

exp—(Optional) Specify the class of service to use when sending probes. The range of values is 0 through 7. The default value is 7.

logical-system—(Optional) Specify the name of the logical system for the traceroute attempt.

multipoint—(Optional) Perform a trace route on a point-to-multipoint LSP.

no-resolve—(Optional) Specify not to resolve the hostname that corresponds to the IP address.

retries—(Optional) Specify the number of times to resend probe. The range of values is 1 through 9. The default value is 3.

source *source-address*—(Optional) Specify the source address of the outgoing traceroute packets.

ttl—(Optional) Specify the number of hops to follow before forcing the trace route to quit.

Required Privilege Level

network

List of Sample Output

traceroute mpls rsvp on page 279
traceroute mpls rsvp detail on page 279
traceroute mpls rsvp multipoint (branch node for sub-LSPs) on page 280
traceroute mpls rsvp multipoint (single-hop sub-LSPs) on page 280

Output Fields

Table 25 on page 278 describes the output fields for the **traceroute mpls rsvp *lsp-name*** and **traceroute mpls rsvp *lsp-name* detail** commands. Output fields are listed in the approximate order in which they appear.

Table 25: traceroute mpls rsvp Output Fields

Field Name	Field Description	Level of Output
Probe options	Probe options specified in the **traceroute mpls rsvp *lsp-name*** command.	all levels
ttl	Time-to-live value of the labeled packet.	none specified
Label	MPLS label used to forward the packets along the LSP.	none specified
Protocol	Signaling protocol used. For this command, it is RSVP-TE.	none specified
Address	Address of the next hop.	none specified
Previous Hop	Address of the previous hop. Previous hop address of the first hop is null.	none specified
Probe status	Forwarding status from the first hop to the last-hop label-switching router (egress point in the label-switched paths). Displays **Success** if the trace to a hop is successful or **Egress** if the trace has reached the last router on the path.	none specified
Hop	Address of the hops in the label-switched path from the first hop to the last hop. Depth indicates the level of the hop.	**detail**
Parent	Address of the previous hop. Parent value for the first hop is null.	**detail**
Return Code	Return code for reporting the result of processing the echo request by the receiver.	**detail**
Sender timestamp	Displays the timestamp when the MPLS echo request is sent to the next hop.	**detail**
Receiver timestamp	Timestamp when the echo request from the previous hop is received and acknowledged with an echo response by the next hop.	**detail**
Response time	Time for the echo request to reach the receiver.	**detail**

Table 25: traceroute mpls rsvp Output Fields *(continued)*

Field Name	Field Description	Level of Output
MTU	Size of the largest packet that includes the label stack forwarded to the next hop.	**detail**
Multipath type	Labels or addresses used by the specified multipath type. If multipaths are not used, the value is none.	**detail**
Label stack	Label stack used to forward the packet.	**detail**
Path	Displays the sub-lsp path number for this traceroute, the interface used, and the destination address.	all levels

Sample Output

traceroute mpls rsvp

```
user@host> traceroute mpls rsvp lsp-chicago-atlanta

     Probe options: retries 3, exp 7

     ttl    Label  Protocol    Address          Previous Hop     Probe Status
       1   299792  RSVP-TE        192.168.1.2      (null)           Success
       2   299803  RSVP-TE        192.168.2.3      192.168.1.2      Success
       3        3  RSVP-TE        192.168.3.4      192.168.2.3      Egress

     Path 1 via ge-0/0/0.1 destination 127.0.0.64
```

traceroute mpls rsvp detail

```
user@host> traceroute mpls rsvp lsp-chicago-atlanta detail
Probe options: retries 3, exp 7

   Hop 192.168.1.2 Depth 1
     Probe status: Success
     Parent: (null)
     Return code: Label-switched at stack-depth 1
     Sender timestamp: 2008-04-17 09:35:27 EDT 400.88 msec
     Receiver timestamp: 2008-04-17 09:35:27 EDT 427.87 msec
     Response time: 26.99 msec
     MTU: Unknown
     Multipath type: IP bitmask
       Address Range 1: 127.0.0.64 ~ 127.0.0.127
     Label Stack:
       Label 1 Value 299792 Protocol RSVP-TE

Hop 192.168.2.3 Depth 2
     Probe status: Success
     Parent: 192.168.1.2
     Return code: Upstream interface index unknown label-switched at stack-depth
 1
     Sender timestamp: 2008-04-17 09:35:27 EDT 522.13 msec
     Receiver timestamp: 2008-04-17 09:35:27 EDT 548.69 msec
     Response time: 26.55 msec
     MTU: 1518
     Multipath type: IP bitmask
```

```
      Address Range 1: 127.0.0.64 ~ 127.0.0.127
    Label Stack:
      Label 1 Value 299803 Protocol RSVP-TE
```

traceroute mpls rsvp multipoint (branch node for sub-LSPs)

The following traceroute output is for a point-to-multipoint LSP where the penultimate node is a branch node for the sub-LSPs.

```
user@host> traceroute mpls rsvp multipoint p2mplsp
  Probe options: retries 3, exp 7

  ttl    Label  Protocol    Address          Previous Hop     Probe Status
    1   300000  RSVP-TE     81.1.2.2         (null)           Success
    2   299968  RSVP-TE     81.2.3.3         81.1.2.2         Success
    3   299952  RSVP-TE     81.3.4.4         81.2.3.3         Success
    4   299920  RSVP-TE     81.4.6.6         81.3.4.4         Egress

  Path 1 via lt-1/2/0.102 destination 127.0.0.64

  ttl    Label  Protocol    Address          Previous Hop     Probe Status
    4   299920  RSVP-TE     81.4.5.5         81.3.4.4         Egress

  Path 2 via lt-1/2/0.102 destination 127.0.0.64
```

traceroute mpls rsvp multipoint (single-hop sub-LSPs)

The following traceroute output is for a point-to-multipoint LSP with multiple single-hop sub-LSPs.

```
user@host> traceroute mpls rsvp multipoint p2mplsp
  Probe options: retries 3, exp 7

   ttl    Label  Protocol    Address          Previous Hop     Probe Status
     1        0  RSVP-TE     81.1.2.2         (null)           Egress

   Path 1 via lt-1/2/0.102 destination 127.0.0.64

   ttl    Label  Protocol    Address          Previous Hop     Probe Status
     1        0  RSVP-TE     81.1.8.8         (null)           Egress

   Path 2 via lt-1/2/0.108 destination 127.0.0.64

   ttl    Label  Protocol    Address          Previous Hop     Probe Status
     1        0  RSVP-TE     81.1.9.9         (null)           Egress

   Path 3 via lt-1/2/0.109 destination 127.0.0.64
```