



Junos[®] OS

PCEP Feature Guide for Routing Devices

Release

14.1



Published: 2014-05-14

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Junos[®] OS PCEP Feature Guide for Routing Devices

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Table of Contents

	About the Documentation	ix
	Documentation and Release Notes	ix
	Supported Platforms	ix
	Using the Examples in This Manual	ix
	Merging a Full Example	x
	Merging a Snippet	x
	Documentation Conventions	xi
	Documentation Feedback	xiii
	Requesting Technical Support	xiii
	Self-Help Online Tools and Resources	xiii
	Opening a Case with JTAC	xiv
Part 1	Overview	
Chapter 1	Introduction to PCEP	3
	PCEP Overview	3
Part 2	Configuration	
Chapter 2	PCEP Configuration	7
	Example: Configuring Path Computation Element Protocol for MPLS	
	RSVP-TE	7
	Support of Path Computation Element Protocol for RSVP-TE Overview	7
	Understanding MPLS RSVP-TE	7
	Current MPLS RSVP-TE Limitations	9
	Use of an External Path Computing Entity	10
	Components of External Path Computing	11
	Interaction Between a PCE and a PCC Using PCEP	13
	LSP Behavior with External Computing	14
	Configuration Statements Supported for External Computing	16
	PCE-Controlled LSP Protection	16
	Auto-Bandwidth and PCE-Controlled LSP	16
	Impact of Client-Side PCE Implementation on Network	
	Performance	17
	Example: Configuring the Path Computation Element Protocol for MPLS	
	RSVP-TE	17
Chapter 3	PCEP Configuration Statements	31
	[edit protocols pcep] Hierarchy Level	31
	pcep	33
	delegation-cleanup-timeout	34
	delegation-priority	34

	destination-ipv4-address	35
	destination-port	35
	lsp-external-controller	36
	max-unknown-messages	36
	message-rate-limit	37
	pce	38
	pce-group (PCE)	38
	pce-group (Protocols PCEP)	39
	pce-type	40
	traceoptions (PCE)	41
	traceoptions (Protocols PCEP)	43
	update-rate-limit	44
Part 3	Administration	
Chapter 4	PCEP Operational Commands	47
	clear path-computation-client statistics	48
	request path-computation-client active-pce	49
	show path-computation-client active-pce	50
	show path-computation-client statistics	54
Part 4	Index	
	Index	61

List of Figures

Part 1	Overview	
Chapter 1	Introduction to PCEP	3
	Figure 1: PCEP Session	3
Part 2	Configuration	
Chapter 2	PCEP Configuration	7
	Figure 2: Example MPLS Traffic Engineering	10
	Figure 3: PCC and RSVP-TE	13
	Figure 4: Example PCE for MPLS RSVP-TE	14
	Figure 5: Configuring PCEP for MPLS RSVP-TE	19

List of Tables

	About the Documentation	ix
	Table 1: Notice Icons	xi
	Table 2: Text and Syntax Conventions	xii
Part 2	Configuration	
Chapter 2	PCEP Configuration	7
	Table 3: Applicability of MPLS and Existing LSP Configurations to a PCE-Controlled LSP	16
Part 3	Administration	
Chapter 4	PCEP Operational Commands	47
	Table 4: show path-computation-client active-pce Output Fields	50
	Table 5: show path-computation-client statistics Output Fields	54

About the Documentation

- Documentation and Release Notes on page ix
- Supported Platforms on page ix
- Using the Examples in This Manual on page ix
- Documentation Conventions on page xi
- Documentation Feedback on page xiii
- Requesting Technical Support on page xiii

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/>.

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Supported Platforms

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

- MX Series
- T Series
- M 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.xml;
    }
  }
}
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.xml; }
```

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 the *CLI User Guide*.

Documentation Conventions

Table 1 on page xi 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 xii 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
Fixed-width text like this	Represents output that appears on the terminal screen.	user@host> show chassis alarms No alarms currently active
<i>Italic text like this</i>	<ul style="list-style-type: none"> Introduces or emphasizes important new terms. Identifies guide names. Identifies RFC and Internet draft titles. 	<ul style="list-style-type: none"> A policy <i>term</i> is a named structure that defines match conditions and actions. <i>Junos OS CLI User Guide</i> RFC 1997, <i>BGP Communities Attribute</i>
<i>Italic text like this</i>	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 <i>domain-name</i>
Text like this	Represents names of configuration statements, commands, files, and directories; configuration hierarchy levels; or labels on routing platform components.	<ul style="list-style-type: none"> 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]
Indentation and braces ({ })	Identifies a level in the configuration hierarchy.	[edit] routing-options { static { route default { nexthop <i>address</i> ; retain; } } }
;(semicolon)	Identifies a leaf statement at a configuration hierarchy level.	

GUI Conventions

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

Convention	Description	Examples
Bold text like this	Represents graphical user interface (GUI) items you click or select.	<ul style="list-style-type: none"> In the Logical Interfaces box, select All Interfaces. To cancel the configuration, click Cancel.
> (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 send your comments to techpubs-comments@juniper.net, or fill out the documentation feedback form at <https://www.juniper.net/cgi-bin/docbugreport/>. If you are using e-mail, be sure to include the following information with your comments:

- Document or topic name
- URL or page number
- Software release version (if applicable)

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Technical product support is available through the Juniper Networks Technical Assistance Center (JTAC). If you are a customer with an active J-Care or JNASC 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/>.
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- 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

Overview

- [Introduction to PCEP on page 3](#)

CHAPTER 1

Introduction to PCEP

- [PCEP Overview on page 3](#)

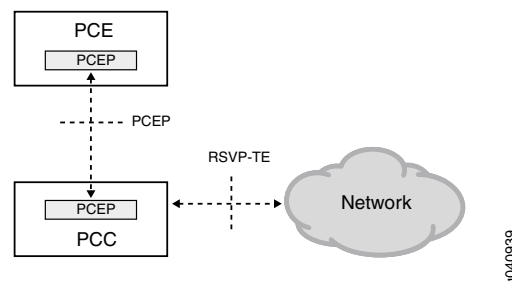
PCEP Overview

A Path Computation Element (PCE) is an entity (component, application, or network node) that is capable of computing a network path or route based on a network graph and applying computational constraints. A Path Computation Client (PCC) is any client application requesting a path computation to be performed by a PCE. The Path Computation Element Protocol (PCEP) enables communications between a PCC and a PCE, or between two PCEs (defined in RFC 5440).

PCEP is a TCP-based protocol defined by the IETF PCE Working Group, and defines a set of messages and objects used to manage PCEP sessions and to request and send paths for multidomain traffic engineered LSPs (TE LSPs). It provides a mechanism for a PCE to perform path computation for a PCC's external LSPs. The PCEP interactions include LSP status reports sent by the PCC to the PCE, and PCE updates for the external LSPs.

[Figure 1 on page 3](#) illustrates the role of PCEP in the client-side implementation of a stateful PCE architecture in an MPLS RSVP-TE enabled network.

Figure 1: PCEP Session



A TCP-based PCEP session connects a PCC to an external PCE. The PCC initiates the PCEP session and stays connected to the PCE for the duration of the PCEP session. During the PCEP session, the PCC requests LSP parameters from the stateful PCE. On

receiving one or more LSP parameters from the PCE, the PCC re-signals the TE LSP. When the PCEP session is terminated, the underlying TCP connection is closed immediately, and the PCC attempts to re-establish the PCEP session.

Thus, the PCEP functions include:

- LSP tunnel state synchronization between a PCC and a stateful PCE—When an active stateful PCE connection is detected, a PCC tries to delegate all LSPs to this PCE in a procedure called LSP state synchronization. PCEP enables synchronization of the PCC LSP state to the PCE.
- Delegation of control over LSP tunnels to a stateful PCE—An active stateful PCE controls one or more LSP attributes for computing paths, such as bandwidth, path (ERO), and priority (setup and hold). PCEP enables such delegation of LSPs for path computation.
- Stateful PCE control of timing and sequence of path computations within and across PCEP sessions—An active stateful PCE modifies one or more LSP attributes, such as bandwidth, path (ERO), and priority (setup and hold). PCEP communicates these new LSP attributes from the PCE to the PCC, after which the PCC re-signals the LSP in the specified path.

**Related
Documentation**

- [Example: Configuring Path Computation Element Protocol for MPLS RSVP-TE on page 7](#)
- [PCEP Hierarchy Level on page 31](#)

PART 2

Configuration

- [PCEP Configuration on page 7](#)
- [PCEP Configuration Statements on page 31](#)

CHAPTER 2

PCEP Configuration

- [Example: Configuring Path Computation Element Protocol for MPLS RSVP-TE on page 7](#)

Example: Configuring Path Computation Element Protocol for MPLS RSVP-TE

- [Support of Path Computation Element Protocol for RSVP-TE Overview on page 7](#)
- [Example: Configuring the Path Computation Element Protocol for MPLS RSVP-TE on page 17](#)

Support of Path Computation Element Protocol for RSVP-TE Overview

- [Understanding MPLS RSVP-TE on page 7](#)
- [Current MPLS RSVP-TE Limitations on page 9](#)
- [Use of an External Path Computing Entity on page 10](#)
- [Components of External Path Computing on page 11](#)
- [Interaction Between a PCE and a PCC Using PCEP on page 13](#)
- [LSP Behavior with External Computing on page 14](#)
- [Configuration Statements Supported for External Computing on page 16](#)
- [PCE-Controlled LSP Protection on page 16](#)
- [Auto-Bandwidth and PCE-Controlled LSP on page 16](#)
- [Impact of Client-Side PCE Implementation on Network Performance on page 17](#)

Understanding MPLS RSVP-TE

Traffic engineering (TE) deals with performance optimization of operational networks, mainly mapping traffic flows onto an existing physical topology. Traffic engineering provides the ability to move traffic flow away from the shortest path selected by the interior gateway protocol (IGP) and onto a potentially less congested physical path across a network.

For traffic engineering in large dense networks, MPLS capabilities can be implemented, because they potentially provide most of the functionality available from an overlay model, in an integrated manner, and at a lower cost than the currently competing alternatives. The primary reason for implementing MPLS traffic engineering is to control paths along which traffic flows through a network. The main advantage of implementing

MPLS traffic engineering is that it provides a combination of ATM's traffic engineering capabilities along with the class-of-service (CoS) differentiation of IP.

In an MPLS network, data plane information is forwarded using label switching. A packet arriving on a provider edge (PE) router from the customer edge (CE) router is applied labels and forwarded to the egress PE router. The labels are removed at the egress router and forwarded out to the appropriate destination as an IP packet. The label switch routers (LSRs) in the MPLS domain use label distribution protocols to communicate the meaning of labels used to forward traffic between and through the LSRs. RSVP-TE is one such label distribution protocol that enables an LSR peer to learn about the other peer's label mappings.

When both MPLS and RSVP are enabled on a router, MPLS becomes a client of RSVP. The primary purpose of the Junos OS RSVP software is to support dynamic signaling within label-switched paths (LSPs). RSVP reserves resources, such as for IP unicast and multicast flows, and requests quality-of-service (QoS) parameters for applications. The protocol was extended in MPLS traffic engineering to enable RSVP to set up LSPs that can be used for traffic engineering in MPLS networks.

When MPLS and RSVP are combined, labels are associated with RSVP flows. Once an LSP is established, the traffic through the path is defined by the label applied at the ingress node of the LSP. The mapping of label to traffic is accomplished using different criteria. The set of packets that are assigned the same label value by a specific node belong to the same forwarding equivalence class (FEC), and effectively define the RSVP flow. When traffic is mapped onto an LSP in this way, the LSP is called an LSP tunnel.

LSP tunnels are a way to establish unidirectional label-switched paths. RSVP-TE builds on the RSVP core protocol by defining new objects and modifying existing objects used in the PATH and RESV objects for LSP establishment. The new objects—LABEL-REQUEST object (LRO), RECORD-ROUTE object (RRO), LABEL object, and EXPLICIT-ROUTE object (ERO)—are optional with respect to the RSVP protocol, except for the LRO and LABEL objects, which are both mandatory for establishing LSP tunnels.

In general, RSVP-TE establishes a label-switched path that ensures frame delivery from ingress to egress router. However, with the new traffic engineering capabilities, the following functions are supported in an MPLS domain:

- Possibility to establish a label-switched path using either a full or partial explicit route (RFC 3209).
- Constraint-based LSP establishment over links that fulfill requirements, such as bandwidth and link properties.
- End-point control, which is associated with establishing and managing LSP tunnels at the ingress and egress routers.
- Link management, which manages link resources to do resource-aware routing of TE LSPs and to program MPLS labels.
- MPLS fast reroute (FRR), which manages the LSPs that need protection and assigns backup tunnel information to these LSPs.

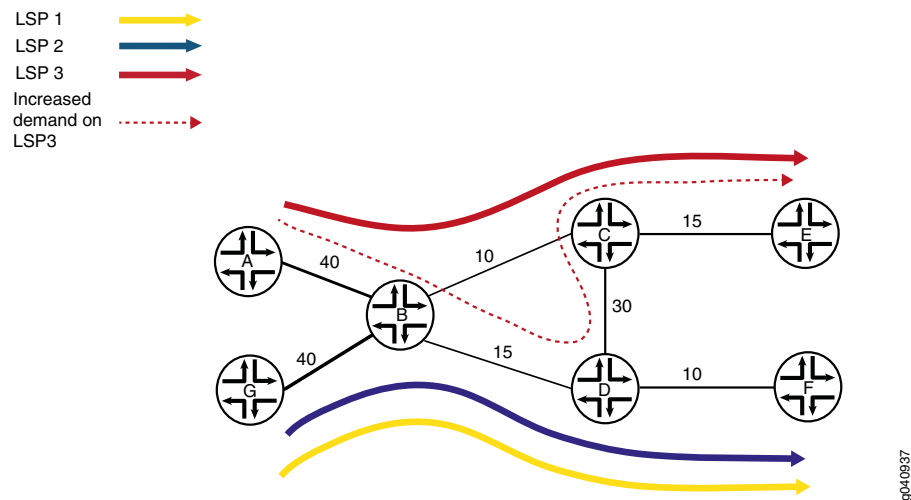
Current MPLS RSVP-TE Limitations

Although the RSVP extensions for traffic engineering enable better network utilization and meet requirements of classes of traffic, today's MPLS RSVP-TE protocol suite has several issues inherent to its distributed nature. This causes a number of issues during contention for bisection capacity, especially within an LSP priority class where a subset of LSP shares common setup and hold priority values. The limitations of RSVP-TE include:

- Lack of visibility of individual per-LSP, per-device bandwidth demands—The ingress routers in an MPLS RSVP-TE network establish LSPs without having a global view of the bandwidth demand on the network. Information about network resource utilization is only available as total reserved capacity by traffic class on a per interface basis. Individual LSP state is available locally on each label edge router (LER) for its own LSPs only. As a result, a number of issues related to demand pattern arise, particularly within a common setup and hold priority.
- Asynchronous and independent nature of RSVP signaling—In RSVP-TE, the constraints for path establishment are controlled by an administrator. As such, bandwidth reserved for an LSP tunnel is set by the administrator and does not automatically imply any limit on the traffic sent over the tunnel. Therefore, bandwidth available on a traffic engineering link is the bandwidth configured for the link excluding the sum of all reservations made on the link. Thus, the unsignaled demands on an LSP tunnel lead to service degradation of the LSP requiring excess bandwidth, as well as the other LSPs that comply with the bandwidth requirements of the traffic engineering link.
- LSPs established based on dynamic or explicit path options in the order of preference—The ingress routers in an MPLS RSVP-TE network establish LSPs for demands based on the order of arrival. Because the ingress routers do not have a global view of the bandwidth demand on the network, using the order of preference to establish LSPs can cause traffic to be dropped or LSPs from not being established at all when there is an excess of bandwidth demand.

As an example, [Figure 2 on page 10](#) is configured with MPLS RSVP-TE, in which A and G are the label edge routers (LERs). These ingress routers establish LSPs independently based on the order of demands and have no knowledge or control over each other's LSPs. Routers B, C, and D are intermediate or transit routers that connect to the egress routers E and F.

Figure 2: Example MPLS Traffic Engineering



The ingress routers establish LSPs based on the order in which the demands arrive. If Router G receives two demands of capacity 5 each for G-F, then G signals two LSPs – LSP1 and LSP2 – through G-B-D-F. In the same way, when Router A receives the third demand of capacity 10 for A-E, then it signals an LSP, LSP3, through A-B-C-E. However, if the demand on the A-E LSP increases from 10 to 15, Router A cannot signal LSP3 using the same (A-B-C-E) path, because the B-C link has a lower capacity.

Router A should have signaled the increased demand on LSP3 using the A-B-D-C-E path. Since, LSP1 and LSP2 have utilized the B-D link based on the order of demands received, LSP3 is not signaled.

Thus, although adequate max-flow bandwidth is available for all the LSPs, LSP3 is subject to potentially prolonged service degradation. This is due to Router A's lack of global demand visibility and the lack of systemic coordination in demand placement by the ingress routers A and G.

Use of an External Path Computing Entity

As a solution to the current limitations found in the MPLS RSVP-TE path computation, an external path computing entity with a global view of per-LSP, per-device demand in the network independent of available capacity is required.

Currently, only online and real-time constraint-based routing path computation is provided in an MPLS RSVP-TE network. Each router performs constraint-based routing calculations independent of the other routers in the network. These calculations are based on currently available topology information—information that is usually recent, but not completely accurate. LSP placements are locally optimized, based on current network status. The MPLS RSVP-TE tunnels are set up using the CLI. An operator configures the TE LSP, which is then signaled by the ingress router.

In addition to the existing traffic engineering capabilities, the MPLS RSVP-TE functionality is extended to include an external path computing entity, called the Path Computation Element (PCE). The PCE computes path for the TE LSPs of ingress routers that have been configured for external control. The ingress router that connects to a PCE is called a Path Computation Client (PCC). The PCC is configured with the Path Computation Client Protocol (PCEP) to facilitate external path computing by a PCE.

For more information, see [“Components of External Path Computing” on page 11](#).

To enable external path computing for a PCC's TE LSPs, include the `lsp-external-controller pccd` statement at the `[edit mpls]` and `[edit mpls lsp lsp-name]` hierarchy levels.

Components of External Path Computing

The components that make up an external path computing system are:

- [Path Computation Element on page 11](#)
- [Path Computation Client on page 12](#)
- [Path Computation Element Protocol on page 12](#)

Path Computation Element

A Path Computation Element (PCE) can be any entity (component, application, or network node) that is capable of computing a network path or route based on a network graph and applying computational constraints. However, a PCE can compute path for only those TE LSPs of a PCC that have been configured for external control.

A PCE can either be stateful or stateless.

- **Stateful PCE**—A stateful PCE maintains strict synchronization between the PCE and network states (in terms of topology and resource information), along with the set of computed paths and reserved resources in use in the network. In other words, a stateful PCE utilizes information from the traffic engineering database as well as information about existing paths (for example, TE LSPs) in the network when processing new requests from the PCC.

A stateful PCE is of two types:

- **Passive stateful PCE**—Maintains synchronization with the PCC and learns the PCC LSP states to better optimize path calculations, but does not have control over them.
- **Active stateful PCE**—Actively modifies the PCC LSPs, in addition to learning about the PCC LSP states.



NOTE: In a redundant configuration with main and backup active stateful PCEs, the backup active stateful PCE cannot modify the attributes of delegated LSPs until it becomes the main PCE at the time of a failover. There is no preempting of PCEs in the case of a switchover. The main PCE is backed by a backup PCE, and when the main PCE goes down, the backup PCE assumes the role of the main PCE and remains as the main PCE even though the previously main PCE comes up again.

A stateful PCE provides the following functions:

- Offers offline LSP path computation.
- Triggers LSP re-route when there is a need to re-optimize the network.
- Changes LSP bandwidth when there is an increase in bandwidth demand from an application.
- Modifies other LSP attributes on the router, such as ERO, setup priority, and hold priority.

A PCE has a global view of the bandwidth demand in the network and maintains a traffic engineered database to perform path computations. It performs statistics collection from all the routers in the MPLS domain using SNMP and NETCONF. This provides a mechanism for offline control of PCC's TE LSPs. Although an offline LSP path computation system can be embedded in a network controller, the PCE acts like a full-fledged network controller that provides control over the PCC's TE LSPs, in addition to computing paths.

Although a stateful PCE allows for optimal path computation and increased path computation success, it requires reliable state synchronization mechanisms, with potentially significant control plane overhead and the maintenance of a large amount of data in terms of states, as in the case of a full mesh of TE LSPs.

- Stateless PCE—A stateless PCE does not remember any computed path, and each set of requests is processed independently of each other (RFC 5440).

Path Computation Client

A Path Computation Client (PCC) is any client application requesting a path computation to be performed by a PCE.

A PCC can connect to a maximum of 10 PCEs at one time. The PCC to PCE connection can be a configured static route or a TCP connection that establishes reachability. The PCC assigns each connected PCE a priority number. It sends a message to all the connected PCEs with information about its current LSPs, in a process called LSP state synchronization. For the TE LSPs that have external control enabled, the PCC delegates those LSPs to the main PCE. The PCC elects as the main PCE a PCE with the lowest priority number, or the PCE that it connects to first in the absence of priority number.

The PCC re-signals an LSP based on the computed path it receives from a PCE. When the PCEP session with the main PCE is terminated, the PCC elects a new main PCE, and all delegated LSPs to the previously main PCE are delegated to the newly available main PCE.

Path Computation Element Protocol

Path Computation Element Protocol (PCEP) is used for communication between PCC and PCE (as well as between two PCEs) (RFC 5440). PCEP is a TCP-based protocol defined by the IETF PCE Working Group, and defines a set of messages and objects used to manage PCEP sessions and to request and send paths for multidomain TE LSPs. The PCEP interactions include PCC messages as well as notifications of specific states related

to the use of a PCE in the context of MPLS RSVP-TE. When PCEP is used for PCE-to-PCE communication, the requesting PCE assumes the role of a PCC.

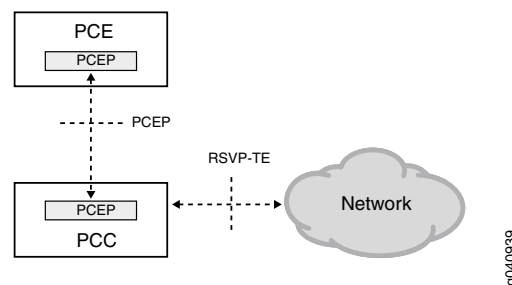
Thus, the PCEP functions include:

- LSP tunnel state synchronization between PCC and a stateful PCE.
- Delegation of control over LSP tunnels to a stateful PCE.

Interaction Between a PCE and a PCC Using PCEP

Figure 3 on page 13 illustrates the relationship between a PCE, PCC, and the role of PCEP in the context of MPLS RSVP-TE.

Figure 3: PCC and RSVP-TE



The PCE to PCC communication is enabled by the TCP-based PCEP. The PCC initiates the PCEP session and stays connected to a PCE for the duration of the PCEP session.

Once the PCEP session is established, the PCC performs the following tasks:

1. LSP state synchronization—The PCC sends information about all the LSPs (local and external) to all connected PCEs. For external LSPs, the PCC sends information about any configuration change, RRO change, state change, and so on, to the PCE.
2. LSP delegation—The PCC then delegates the external LSPs to one PCE, which is the main active stateful PCE. It is only the main PCE that can set parameters for the external LSP. The parameters that the main PCE modifies include bandwidth, path (ERO), and priority (setup and hold). The parameters specified in the local configuration are overridden by the parameters that are set by the main PCE.



NOTE: When the PCEP session with the main PCE is terminated, the PCC elects a new main PCE, and all delegated LSPs to the previously main PCE are delegated to the newly available main PCE.

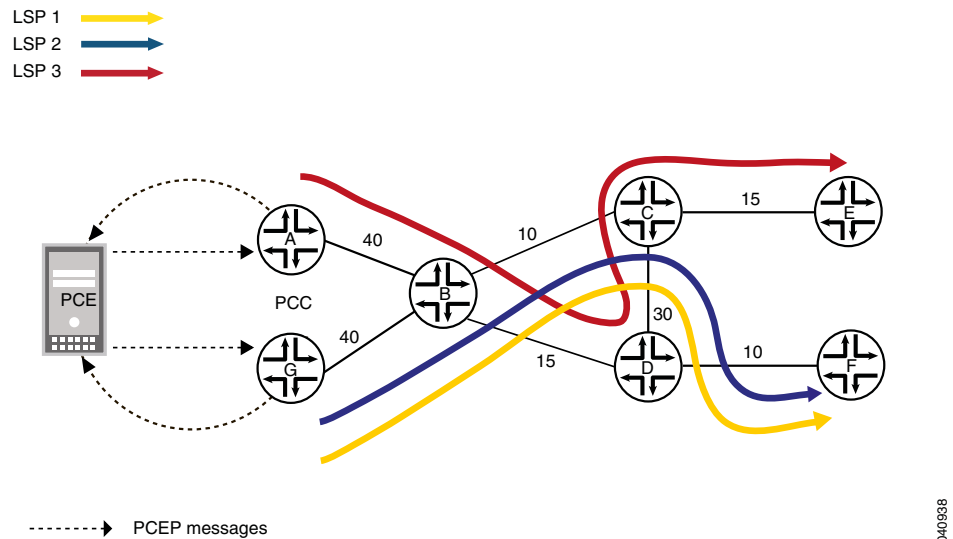
3. LSP signaling—On receiving one or more LSP parameters from the main active stateful PCE, the PCC re-signals the TE LSP based on the PCE provided path. If the PCC fails to set up the LSP, it notifies the PCE of the setup failure and waits for the main PCE to provide new parameters for that LSP, and then re-signals it.

When the PCE specifies a path that is incomplete or has loose hops where only the path end-points are specified, the PCC does not perform local constraint-based routing to find out the complete set of hops. Instead, the PCC provides RSVP with the PCE provided path, as it is, for signaling, and the path gets set up using IGP hop by hop routing.

Considering the topology used in [Figure 2 on page 10](#), [Figure 4 on page 14](#) illustrates the partial client-side PCE implementation in the MPLS RSVP-TE enabled network. The ingress routers A and G are the PCCs that are configured to connect to the external stateful PCE through a TCP connection.

The PCE has a global view of the bandwidth demand in the network and performs external path computations after looking up the traffic engineering database. The active stateful PCE then modifies one or more LSP attributes and sends an update to the PCC. The PCC uses the parameters it receives from the PCE to re-signal the LSP.

Figure 4: Example PCE for MPLS RSVP-TE



This way, the stateful PCE provides a cooperative operation of distributed functionality used to address specific challenges of a shortest interdomain constrained path computation. It eliminates congestion scenarios in which traffic streams are inefficiently mapped onto available resources causing over utilization of some subsets of network resources, while other resources remain under utilized.

LSP Behavior with External Computing

- [LSP Types on page 15](#)
- [LSP Control Mode on page 15](#)

LSP Types

In a client-side PCE implementation, there are two types of TE LSPs:

- CLI-controlled LSPs—The LSPs that do not have the ***lsp-external-controller pccd*** statement configured are called CLI-controlled LSPs. Although these LSPs are under local control, the PCC updates the connected PCEs with information about the CLI-controlled LSPs during the initial LSP synchronization process. After the initial LSP synchronization, the PCC informs the PCE of any new and deleted LSPs as well.
- PCE-controlled LSPs—The LSPs that have the ***lsp-external-controller pccd*** statement configured are called PCE-controlled LSPs. The PCC delegates the PCE-controlled LSPs to the main PCE for external path computation.

The PCC informs the PCE about the configured parameters of a PCE-controlled LSP, such as bandwidth, ERO, and priorities. It also informs the PCE about the actual values used for these parameters to set up the LSP including the RRO, when available.

The PCC sends such LSP status reports to the PCE only when a re-configuration has occurred or when there is a change in the ERO, RRO, or status of the PCE-controlled LSPs under external control.

There are two types of parameters that come from the CLI configuration of an LSP for a PCE:

- Parameters that are not overridden by a PCE, and that are applied immediately.
- Parameters that are overridden by a PCE. These parameters include bandwidth, path, and priority (setup and hold values). When the control mode switches from external to local, the CLI configured values for these parameters are applied at the next opportunity to re-signal the LSP. The values are not applied immediately.

The CLI-controlled LSPs coexist with the PCE-controlled LSPs on a PCC.

LSP Control Mode

In a client-side PCE implementation, there are two types of control modes for a PCC-controlled LSP:

- External—By default, all PCE-controlled LSPs are under external control. When an LSP is under external control, the PCC uses the PCE-provided parameters to set up the LSP.
- Local—A PCE-controlled LSP can come under local control. When the LSP switches from external control to local control, path computation is done using the CLI-configured parameters and constraint-based routing. Such a switchover happens only when there is a trigger to re-signal the LSP. Until then, the PCC uses the PCE-provided parameters to signal the PCE-controlled LSP, although the LSP remains under local control.

A PCE-controlled LSP switches to local control from its default external control mode in cases such as no connectivity to a PCE or when a PCE returns delegation of LSPs back to the PCC.

For more information about CLI-controlled LSPs and PCE-controlled LSPs, see “[LSP Types](#)” on page 15.

Configuration Statements Supported for External Computing

Table 3 on page 16 lists the MPLS and existing LSP configuration statements that apply to a PCE-controlled LSP.

Table 3: Applicability of MPLS and Existing LSP Configurations to a PCE-Controlled LSP

Support for PCE-Controlled LSP	Applicable LSP Configuration Statements	Applicable MPLS Configuration Statements
These configuration statements can be configured along with the PCE configuration. However, they take effect only when the local configuration is in use. During PCE control, these configuration statements remain inactive.	<ul style="list-style-type: none"> • admin-group • auto-bandwidth • hop-limit • least-fill • most-fill • random 	<ul style="list-style-type: none"> • admin-group • admin-groups • admin-group-extended • hop-limit • no-cspf • smart-optimize-timer
<p>These configuration statements can be configured along with the PCE configuration, but are overridden by the PCE-controlled LSP attributes. However, when the local configuration is in use, the configured values for these configuration statements are applied.</p> <p>NOTE: Changes to the local configuration using the CLI while the LSP is under the control of a stateful PCE does not have any effect on the LSP. These changes come into effect only when the local configuration is applied.</p>	<ul style="list-style-type: none"> • bandwidth • primary • priority 	<ul style="list-style-type: none"> • priority
These configuration statements cannot be configured along with the PCE configuration.	<ul style="list-style-type: none"> • p2mp • template 	<ul style="list-style-type: none"> • p2mp-lsp-next-hop

The rest of the LSP configuration statements are applicable in the same way as for existing LSPs. On configuring any of the above configuration statements for a PCE-controlled LSP, an mpls log message is generated to indicate when the configured parameters take effect.

PCE-Controlled LSP Protection

The protection paths, including fast reroute and bypass LSPs, are locally computed by the PCC using constraint-based routing. A stateful PCE specifies the primary path (ERO) only. A PCE can also trigger a non-standby secondary path, even if the local configuration does not have a non-standby secondary path for LSP protection.

Auto-Bandwidth and PCE-Controlled LSP

The auto-bandwidth option does not apply to PCE-controlled LSPs, although LSPs under the control of auto-bandwidth and constraint-based routing can coexist with

PCE-controlled LSPs. The statistics collection for auto-bandwidth takes effect only when the control mode of a PCE-controlled LSP changes from external to local. This can happen in cases such as no connectivity to a PCE or when a PCE returns delegation of LSPs back to the PCC.

Impact of Client-Side PCE Implementation on Network Performance

The maintenance of a stateful database can be non-trivial. In a single centralized PCE environment, a stateful PCE simply needs to remember all the TE LSPs that the PCE has computed, the TE LSPs that were actually set up (if this can be known), and when the TE LSPs were torn down. However, these requirements cause substantial control protocol overhead in terms of state, network usage and processing, and optimizing links globally across the network. Thus, the concerns of a stateful PCE implementation include:

- Any reliable synchronization mechanism results in significant control plane overhead. PCEs might synchronize state by communicating with each other, but when TE LSPs are set up using distributed computation performed among several PCEs, the problems of synchronization and race condition avoidance become larger and more complex.
- Out-of-band traffic engineering database synchronization can be complex with multiple PCEs set up in a distributed PCE computation model, and can be prone to race conditions, scalability concerns, and so on.
- Path calculations incorporating total network state is highly complex, even if the PCE has detailed information on all paths, priorities, and layers.

In spite of the above concerns, the partial client-side implementation of the stateful PCE is extremely effective in large traffic engineering systems. It provides rapid convergence and significant benefits in terms of optimal resource usage, by providing the requirement for global visibility of a TE LSP state and for ordered control of path reservations across devices within the system being controlled.

Example: Configuring the Path Computation Element Protocol for MPLS RSVP-TE

This example shows how to enable external path computing by a Path Computation Element (PCE) for traffic engineered label-switched paths (TE LSPs) on a Path Computation Client (PCC). It also shows how to configure the Path Computation Element Protocol (PCEP) on the PCC to enable PCE to PCC communication.

- [Requirements on page 17](#)
- [Overview on page 18](#)
- [Configuration on page 20](#)
- [Verification on page 25](#)

Requirements

This example uses the following hardware and software components:

- Three routers that can be a combination of M Series Multiservice Edge Routers, MX Series 3D Universal Edge Routers, or T Series Core Routers, one of which is configured as a PCC.
- A TCP connection to an external stateful PCE from the PCC.

- Junos OS Release 12.3 or later running on the PCC along with the JSDN add-on package.



NOTE: The JSDN add-on package is required to be installed along with the core Junos OS installation package.

Before you begin:

1. Configure the device interfaces.
2. Configure MPLS and RSVP-TE.
3. Configure IS-IS or any other IGP protocol.

Overview

Starting with Junos OS Release 12.3, the MPLS RSVP-TE functionality is extended to provide a partial client-side implementation of the stateful PCE architecture (draft-ietf-pce-stateful-pce) on a PCC.

To enable external path computing by a PCE, include the **`lsp-external-controller`** statement on the PCC at the **`[edit mpls]`** and **`[edit mpls lsp lsp-name]`** hierarchy levels.

`lsp-external-controller` *pccd*;

An LSP configured with the **`lsp-external-controller`** statement is referred to as a PCE-controlled LSP and is under the external control of a PCE by default. An active stateful PCE can override the parameters set from the CLI, such as bandwidth, path (ERO), and priority, for such PCE-controlled LSPs of the PCC.

To enable PCE to PCC communication, configure PCEP on the PCC at the **`[edit protocols]`** hierarchy level.

`pcep { ... }`

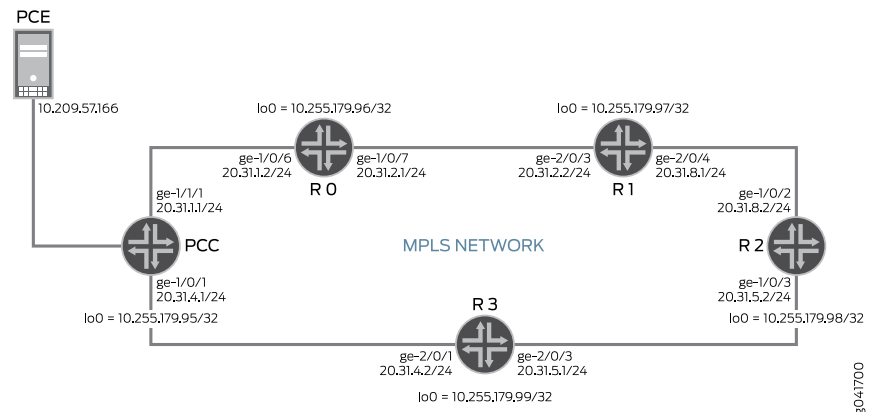
When configuring PCEP on a PCC, be aware of the following considerations:

- The JSDN add-on package is required to be installed along with the core Junos OS installation package.
- Junos OS Release 12.3 supports only stateful PCEs.
- A PCC can connect to a maximum of 10 stateful PCEs. At any given point in time, there can be only one main PCE (the PCE with the lowest priority value, or the PCE that connects to the PCC first in the absence of a PCE priority) to which the PCC delegates LSPs for path computation.
- For Junos OS Release 12.3, the PCC always initiates the PCEP sessions. PCEP sessions initiated by remote PCEs are not accepted by the PCC.
- Existing LSP features, such as LSP protection and make-before-break, work for PCE-controlled LSPs.

- The auto-bandwidth option is turned off for PCE-controlled LSPs, although LSPs under the control of auto-bandwidth and constraint-based routing can coexist with PCE-controlled LSPs.
- PCE-controlled LSPs can be referred to by other CLI configurations, such as `lsp-nexthop` to routes, forwarding adjacencies, CCC connections, and logical tunnels.
- PCE-controlled LSPs do not support GRES.
- PCE-controlled LSPs under logical-systems are not supported.
- PCE-controlled LSPs cannot be point-to-multipoint LSPs.
- Bidirectional LSPs are not supported.
- PCE-controlled LSPs cannot have secondary paths without a primary path.
- PCE-controlled LSPs depend on external path computation, which impacts overall setup time, reroutes, and make-before-break features.
- Setup time and convergence time (reroute, MBB) for existing LSPs is the same as in previous releases, in the absence of PCE-controlled LSPs. However, a small impact is seen in the presence of PCE-controlled LSPs.
- ERO computation time is expected to be significantly higher than local-CSPF.

Topology

Figure 5: Configuring PCEP for MPLS RSVP-TE



In this example, PCC is the ingress router that connects to the external active stateful PCE.

The external LSPs of Router PCC are computed as follows:

1. Router PCC receives the LSP tunnel configuration that was set up using the CLI. Assuming that the received configuration is enabled with external path computing, Router PCC becomes aware that some of the LSP attributes – bandwidth, path, and priority – are under the control of the stateful PCE and delegates the LSP to the PCE.

In this example, the external LSP is called **PCC-to-R2** and it is being set up from Router PCC to Router R2. The CLI-configured ERO for **PCC-to-R2** is PCC-R0-R1-R2. The bandwidth for **PCC-to-R2** is 10m, and both the setup and hold priority values are 4.
2. Router PCC tries to retrieve the PCE-controlled LSP attributes. To do this, Router PCC sends out a PCRpt message to the stateful PCE stating that the LSP has been configured. The PCRpt message communicates the status of the LSP and contains the local configuration parameters of the LSP.
3. The stateful PCE modifies one or more of the delegated LSP attributes and sends the new LSP parameters to Router PCC through the PCUpd message.
4. On receiving the new LSP parameters, Router PCC sets up a new LSP and re-signals it using the PCE-provided path.

In this example, the PCE-provided ERO for **PCC-to-R2** is PCC-R3-R2. The bandwidth for **PCC-to-R2** is 8m, and both the setup and hold priority values are 3.
5. Router PCC sends a PCRpt with the new RRO to the stateful PCE.

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.

```
PCC set interfaces ge-1/0/1 unit 0 family inet address 20.31.4.1/24
set interfaces ge-1/0/1 unit 0 family iso
set interfaces ge-1/0/1 unit 0 family mpls
set interfaces ge-1/1/1 unit 0 family inet address 20.31.1.1/24
set interfaces ge-1/1/1 unit 0 family iso
set interfaces ge-1/1/1 unit 0 family mpls
set interfaces lo0 unit 0 family inet address 10.255.179.95/32
set protocols rsvp interface all
set protocols rsvp interface fxp0.0 disable
set protocols mpls lsp-external-controller pccd
set protocols mpls label-switched-path PCC-to-R2 to 10.255.179.98
set protocols mpls label-switched-path PCC-to-R2 bandwidth 10m
set protocols mpls label-switched-path PCC-to-R2 priority 4 4
set protocols mpls label-switched-path PCC-to-R2 primary to-R2-path
set protocols mpls label-switched-path PCC-to-R2 lsp-external-controller pccd
set protocols mpls path to-R2-path 20.31.1.2 strict
set protocols mpls path to-R2-path 20.31.2.2 strict
set protocols mpls interface all
set protocols mpls interface fxp0.0 disable
set protocols isis level 1 disable
set protocols isis interface all
set protocols isis interface fxp0.0 disable
```

```

set protocols isis interface lo0.0
set protocols pcep pce pce1 destination-ipv4-address 10.209.57.166
set protocols pcep pce pce1 destination-port 4189
set protocols pcep pce pce1 pce-type active
set protocols pcep pce pce1 pce-type stateful

R0  set interfaces ge-1/0/6 unit 0 family inet address 20.31.1.2/24
    set interfaces ge-1/0/6 unit 0 family iso
    set interfaces ge-1/0/6 unit 0 family mpls
    set interfaces ge-1/0/7 unit 0 family inet address 20.31.2.1/24
    set interfaces ge-1/0/7 unit 0 family iso
    set interfaces ge-1/0/7 unit 0 family mpls
    set interfaces lo0 unit 0 family inet address 10.255.179.96/32
    set protocols rsvp interface all
    set protocols rsvp interface fxp0.0 disable
    set protocols mpls interface all
    set protocols mpls interface fxp0.0 disable
    set protocols isis level 1 disable
    set protocols isis interface all
    set protocols isis interface fxp0.0 disable
    set protocols isis interface lo0.0

R1  set system ports console log-out-on-disconnect
    set interfaces ge-2/0/3 unit 0 family inet address 20.31.2.2/24
    set interfaces ge-2/0/3 unit 0 family iso
    set interfaces ge-2/0/3 unit 0 family mpls
    set interfaces ge-2/0/4 unit 0 family inet address 20.31.8.1/24
    set interfaces ge-2/0/4 unit 0 family iso
    set interfaces ge-2/0/4 unit 0 family mpls
    set interfaces lo0 unit 0 family inet address 10.255.179.97/32
    set protocols rsvp interface all
    set protocols rsvp interface fxp0.0 disable
    set protocols mpls interface all
    set protocols mpls interface fxp0.0 disable
    set protocols isis level 1 disable
    set protocols isis interface all
    set protocols isis interface fxp0.0 disable
    set protocols isis interface lo0.0

R2  set interfaces ge-1/0/2 unit 0 family inet address 20.31.8.2/24
    set interfaces ge-1/0/2 unit 0 family iso
    set interfaces ge-1/0/2 unit 0 family mpls
    set interfaces ge-1/0/3 unit 0 family inet address 20.31.5.2/24
    set interfaces ge-1/0/3 unit 0 family iso
    set interfaces ge-1/0/3 unit 0 family mpls
    set interfaces lo0 unit 0 family inet address 10.255.179.98/32
    set protocols rsvp interface all
    set protocols rsvp interface fxp0.0 disable
    set protocols mpls interface all
    set protocols mpls interface fxp0.0 disable
    set protocols isis level 1 disable
    set protocols isis interface all
    set protocols isis interface fxp0.0 disable
    set protocols isis interface lo0.0

```

```

R3    set interfaces ge-2/0/1 unit 0 family inet address 20.31.4.2/24
      set interfaces ge-2/0/1 unit 0 family iso
      set interfaces ge-2/0/1 unit 0 family mpls
      set interfaces ge-2/0/3 unit 0 family inet address 20.31.5.1/24
      set interfaces ge-2/0/3 unit 0 family iso
      set interfaces ge-2/0/3 unit 0 family mpls
      set interfaces lo0 unit 0 family inet address 10.255.179.99/32
      set protocols rsvp interface all
      set protocols rsvp interface fxp0.0 disable
      set protocols mpls interface all
      set protocols mpls interface fxp0.0 disable
      set protocols isis level 1 disable
      set protocols isis interface all
      set protocols isis interface fxp0.0 disable
      set protocols isis interface lo0.0

```

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*.

To configure Router PCC:



NOTE: Repeat this procedure for every Juniper Networks ingress router in the MPLS domain, after modifying the appropriate interface names, addresses, and any other parameters for each router.

1. Configure the interfaces.

To enable MPLS, include the protocol family on the interface so that the interface does not discard incoming MPLS traffic.

[edit interfaces]

```

user@PCC# set ge-1/0/1 unit 0 family inet address 20.31.4.1/24
user@PCC# set ge-1/0/1 unit 0 family iso
user@PCC# set ge-1/0/1 unit 0 family mpls

```

```

user@PCC# set ge-1/1/1 unit 0 family inet address 20.31.1.1/24
user@PCC# set ge-1/1/1 unit 0 family iso
user@PCC# set ge-1/1/1 unit 0 family mpls

```

```

user@PCC# set lo0 unit 0 family inet address 10.255.179.95/32

```

2. Enable RSVP on all interfaces of Router PCC, excluding the management interface.

[edit protocols]

```

user@PCC# set rsvp interface all
user@PCC# set rsvp interface fxp0.0 disable

```

3. Configure the label-switched path (LSP) from Router PCC to Router R2 and enable external control of LSPs by the PCE.

[edit protocols]

```

user@PCC# set mpls lsp-external-controller pccd

```

```

user@PCC# set mpls label-switched-path PCC-to-R2 to 10.255.179.98/32
user@PCC# set mpls label-switched-path PCC-to-R2 bandwidth 10m
user@PCC# set protocols mpls label-switched-path PCC-to-R2 priority 4 4
user@PCC# set protocols mpls label-switched-path PCC-to-R2 primary to-R2-path
user@PCC# set protocols mpls label-switched-path PCC-to-R2
lsp-external-controller pccd

```

4. Configure the LSP from Router PCC to Router R2, which has local control and is overridden by the PCE-provided LSP parameters.

```

[edit protocols]
user@PCC# set mpls path to-R2-path 20.31.1.2/30 strict
user@PCC# set mpls path to-R2-path 20.31.2.2/30 strict

```

5. Enable MPLS on all interfaces of Router PCC, excluding the management interface.

```

[edit protocols]
user@PCC# set mpls interface all
user@PCC# set mpls interface fxp0.0 disable

```

6. Configure IS-IS on all interfaces of Router PCC, excluding the management interface.

```

[edit protocols]
user@PCC# set isis level 1 disable
user@PCC# set isis interface all
user@PCC# set isis interface fxp0.0 disable
user@PCC# set isis interface lo0.0

```

7. Define the PCE that Router PCC connects to, and configure the IP address of the PCE.

```

[edit protocols]
user@PCC# set pcep pce pce1 destination-ipv4-address 10.209.57.166

```

8. Configure the destination port for Router PCC that connects to a PCE using the TCP-based PCEP.

```

[edit protocols]
user@PCC# set pcep pce pce1 destination-port 4189

```

9. Configure the PCE type.

```

[edit protocols]
user@PCC# set pcep pce pce1 pce-type active
user@PCC# set pcep pce pce1 pce-type stateful

```

Results

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

```

user@PCC# show interfaces
ge-1/0/1 {
  unit 0 {
    family inet {
      address 20.31.4.1/24;
    }
    family iso;
  }
}

```

```
        family mpls;
    }
}
ge-1/1/1 {
    unit 0 {
        family inet {
            address 20.31.1.1/24;
        }
        family iso;
        family mpls;
    }
}
lo0 {
    unit 0 {
        family inet {
            address 10.255.179.95/32;
        }
    }
}

user@PCC# show protocols
rsvp {
    interface all;
    interface fxp0.0 {
        disable;
    }
}
mpls {
    lsp-external-controller pccd;
    label-switched-path PCC-to-R2 {
        to 10.255.179.98;
        bandwidth 10m;
        priority 4 4;
        primary to-R2-path;
        lsp-external-controller pccd;
    }
    path to-R2-path {
        20.31.1.2 strict;
        20.31.2.2 strict;
    }
    interface all;
    interface fxp0.0 {
        disable;
    }
}
isis {
    level 1 disable;
    interface all;
    interface fxp0.0 {
        disable;
    }
    interface lo0.0;
}
pcep {
    pce pce1 {
        destination-ipv4-address 10.209.57.166;
```

```

        destination-port 4189;
        pce-type active stateful;
    }
}

```

If you are done configuring the device, enter **commit** from configuration mode.

Verification

Confirm that the configuration is working properly.

- [Verifying the PCEP Session Status on page 25](#)
- [Verifying the PCE-Controlled LSP Status When LSP Control Is External on page 26](#)
- [Verifying the PCE-Controlled LSP Status When LSP Control Is Local on page 27](#)

Verifying the PCEP Session Status

Purpose Verify the PCEP session status between the PCE and Router PCC when the PCE status is up.

Action From operational mode, run the **show path-computation-client active-pce** command.

```
user@PCC> show path-computation-client active-pce
```

```
PCE pce1
```

```
General
```

```

IP address           : 10.209.57.166
Priority              : 0
PCE status           : PCE_STATE_UP
Session type         : PCE_TYPE_STATEFULACTIVE
PCE-mastership       : main

```

```
Counters
```

PCReqs	Total: 0	last 5min: 0	last hour: 0
PCReps	Total: 0	last 5min: 0	last hour: 0
PCRpts	Total: 5	last 5min: 5	last hour: 5
PCUpdates	Total: 1	last 5min: 1	last hour: 1

```
Timers
```

Local	Keepalive timer:	30 [s]	Dead timer:	120 [s]
Remote	Keepalive timer:	30 [s]	Dead timer:	120 [s]

```
Errors
```

```

PCErr-recv
PCErr-sent
PCE-PCC-NTFS
PCC-PCE-NTFS

```

Meaning The output displays information about the current active stateful PCE that Router PCC is connected to. The **PCE status** output field indicates the current status of the PCEP session between the PCE and Router PCC.

For **pce1**, the status of the PCEP session is **PCE_STATE_UP**, which indicates that the PCEP session has been established between the PCEP peers.

The statistics of **PCRpts** indicate the number of messages sent by Router PCC to the PCE to report the current status of LSPs. The **PCUpdates** statistics indicate the number of messages received by Router PCC from the PCE. The **PCUpdates** messages include the PCE modified parameters for the PCE-controlled LSPs.

Verifying the PCE-Controlled LSP Status When LSP Control Is External

Purpose Verify the status of the PCE-controlled LSP from Router PCC to Router R2 when the LSP is under external control.

Action From operational mode, run the **show mpls lsp name PCC-to-R2 extensive** command.

```

user@PCC> show mpls lsp name PCC-to-R2 extensive
Ingress LSP: 1 sessions

10.255.179.98
  From: 10.255.183.59, State: Up, ActiveRoute: 0, LSPname: PCC-to-R2
  ActivePath: to-R2-path (primary)
  LSPtype: Externally controlled, Penultimate hop popping
  LSP Control Status: Externally controlled
    LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
  *Primary to-R2-path State: Up
    Priorities: 3 3
    Bandwidth: 8Mbps
    SmartOptimizeTimer: 180
    No computed ERO.
  Received RRO (ProtectionFlag 1=Available 2=InUse 4=B/W 8=Node 10=SoftPreempt
  20=Node-ID):
    20.31.4.2 20.31.5.2
  21 Mar 11 05:00:56.736 EXTCTRL LSP: Sent Path computation request and LSP
  status
  20 Mar 11 05:00:56.736 EXTCTRL_LSP: Computation request/lsp status contains:
  bandwidth 10000000 priority - setup 4 hold 4 hops: 20.31.1.2 20.31.2.2
  19 Mar 11 05:00:56.735 Selected as active path
  18 Mar 11 05:00:56.734 EXTCTRL LSP: Sent Path computation request and LSP
  status
  17 Mar 11 05:00:56.734 EXTCTRL_LSP: Computation request/lsp status contains:
  bandwidth 10000000 priority - setup 4 hold 4 hops: 20.31.1.2 20.31.2.2
  16 Mar 11 05:00:56.734 Record Route: 20.31.4.2 20.31.5.2
  15 Mar 11 05:00:56.734 Up
  14 Mar 11 05:00:56.713 EXTCTRL LSP: Sent Path computation request and LSP
  status
  13 Mar 11 05:00:56.713 EXTCTRL_LSP: Computation request/lsp status contains:
  bandwidth 10000000 priority - setup 4 hold 4 hops: 20.31.1.2 20.31.2.2
  12 Mar 11 05:00:56.712 Originate Call
  11 Mar 11 05:00:56.712 EXTCTRL_LSP: Received setup parameters : 20.31.4.2
  20.31.5.2
  10 Mar 11 05:00:49.283 EXTCTRL LSP: Sent Path computation request and LSP
  status
  9 Mar 11 05:00:49.283 EXTCTRL_LSP: Computation request/lsp status contains:
  bandwidth 10000000 priority - setup 4 hold 4 hops: 20.31.1.2 20.31.2.2
  8 Mar 11 05:00:20.581 EXTCTRL_LSP: Computation request/lsp status contains:
  bandwidth 10000000 priority - setup 4 hold 4 hops: 20.31.1.2 20.31.2.2
  7 Mar 11 05:00:20.581 EXTCTRL LSP: Sent Path computation request and LSP

```



```

status
  6 Mar 11 05:00:20.581 EXTCTRL_LSP: Computation request/lsp status contains:
    bandwidth 10000000 priority - setup 4 hold 4 hops: 20.31.1.2 20.31.2.2
  5 Mar 11 05:00:20.580 EXTCTRL_LSP: Control status became external
  4 Mar 11 05:00:03.716 EXTCTRL_LSP: Control status became local
  3 Mar 11 05:00:03.714 EXTCTRL LSP: Sent Path computation request and LSP
status
  2 Mar 11 05:00:03.714 EXTCTRL_LSP: Computation request/lsp status contains:
    bandwidth 10000000 priority - setup 4 hold 4 hops: 20.31.1.2 20.31.2.2
  1 Mar 11 05:00:00.279 EXTCTRL LSP: Awaiting external controller connection
  Created: Mon Mar 11 05:00:00 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

```

Meaning In the output, the **LSptype** and **LSP Control Status** output fields show that the LSP is externally controlled. The output also shows a log of the PCEP messages sent between Router PCC and the PCE.

The PCEP session between the PCE and Router PCC is up, and Router PCC receives the following PCE-controlled LSP parameters:

- ERO (path)—20.31.4.2 and 20.31.5.2
- Bandwidth—8Mbps
- Priorities—3 3 (setup and hold values)

Verifying the PCE-Controlled LSP Status When LSP Control Is Local

Purpose Verify the status of the PCE-controlled LSP from Router PCC to Router R2 when the LSP control becomes local.

Action From operational mode, run the **show mpls lsp name PCC-to-R2 extensive** command.

```

user@PCC> show mpls lsp name PCC-to-R2 extensive
Ingress LSP: 1 sessions

10.255.179.98
  From: 10.255.183.59, State: Up, ActiveRoute: 0, LSPname: PCC-to-R2
  ActivePath: to-R2-path (primary)
  LSptype: Externally controlled, Penultimate hop popping
  LSP Control Status: Locally controlled
  LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
  *Primary to-R2-path State: Up
    Priorities: 4 4 (ActualPriorities 3 3)
    Bandwidth: 10Mbps (ActualBandwidth: 8Mbps)
    SmartOptimizeTimer: 180
    No computed ERO.
  Received RRO (ProtectionFlag 1=Available 2=InUse 4=B/W 8=Node 10=SoftPreempt
  20=Node-ID):
    20.31.4.2 20.31.5.2
  22 Mar 11 05:02:09.618 EXTCTRL_LSP: Control status became local
  21 Mar 11 05:00:56.736 EXTCTRL LSP: Sent Path computation request and LSP

```

```

status
  20 Mar 11 05:00:56.736 EXTCTRL_LSP: Computation request/lsp status contains:
    bandwidth 10000000 priority - setup 4 hold 4 hops: 20.31.1.2 20.31.2.2
  19 Mar 11 05:00:56.735 Selected as active path
  18 Mar 11 05:00:56.734 EXTCTRL LSP: Sent Path computation request and LSP
status
  17 Mar 11 05:00:56.734 EXTCTRL_LSP: Computation request/lsp status contains:
    bandwidth 10000000 priority - setup 4 hold 4 hops: 20.31.1.2 20.31.2.2
  16 Mar 11 05:00:56.734 Record Route: 20.31.4.2 20.31.5.2
  15 Mar 11 05:00:56.734 Up
  14 Mar 11 05:00:56.713 EXTCTRL LSP: Sent Path computation request and LSP
status
  13 Mar 11 05:00:56.713 EXTCTRL_LSP: Computation request/lsp status contains:
    bandwidth 10000000 priority - setup 4 hold 4 hops: 20.31.1.2 20.31.2.2
  12 Mar 11 05:00:56.712 Originate Call
  11 Mar 11 05:00:56.712 EXTCTRL_LSP: Received setup parameters : 20.31.4.2
20.31.5.2
  10 Mar 11 05:00:49.283 EXTCTRL LSP: Sent Path computation request and LSP
status
  9 Mar 11 05:00:49.283 EXTCTRL_LSP: Computation request/lsp status contains:
    bandwidth 10000000 priority - setup 4 hold 4 hops: 20.31.1.2 20.31.2.2
  8 Mar 11 05:00:20.581 EXTCTRL_LSP: Computation request/lsp status contains:
    bandwidth 10000000 priority - setup 4 hold 4 hops: 20.31.1.2 20.31.2.2
  7 Mar 11 05:00:20.581 EXTCTRL LSP: Sent Path computation request and LSP
status
  6 Mar 11 05:00:20.581 EXTCTRL_LSP: Computation request/lsp status contains:
    bandwidth 10000000 priority - setup 4 hold 4 hops: 20.31.1.2 20.31.2.2
  5 Mar 11 05:00:20.580 EXTCTRL_LSP: Control status became external
  4 Mar 11 05:00:03.716 EXTCTRL_LSP: Control status became local
  3 Mar 11 05:00:03.714 EXTCTRL LSP: Sent Path computation request and LSP
status
  2 Mar 11 05:00:03.714 EXTCTRL_LSP: Computation request/lsp status contains:
    bandwidth 10000000 priority - setup 4 hold 4 hops: 20.31.1.2 20.31.2.2
  1 Mar 11 05:00:00.279 EXTCTRL LSP: Awaiting external controller connection
    Created: Mon Mar 11 05:00:00 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

```

Meaning In the output, the **LSPControlStatus** output field shows that the LSP is under local control. Although the PCE-controlled LSP is under local control, Router PCC continues to use the PCE-provided parameters, until the next opportunity to re-signal the LSP.

The output now displays the LSP parameters that were configured using the CLI along with the PCE-provided parameters used to establish the LSP as the actual values in use.

- Bandwidth—10Mbps (ActualBandwidth: 8Mbps)
- Priorities—4 4 (ActualPriorities 3 3)

On the trigger to re-signal the LSP, Router PCC uses the local configuration parameters to establish the PCE-controlled LSP.

```

user@PCC> show mpls lsp name PCC-to-R2 extensive externally-controlled
Ingress LSP: 1 sessions

```

```

10.255.179.98
  From: 10.255.183.59, State: Up, ActiveRoute: 0, LSPname: PCC-to-R2
  ActivePath: to-R2-path (primary)
  LSPTYPE: Externally controlled, Penultimate hop popping
  LSP Control Status: Locally controlled
  LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
  *Primary to-R2-path State: Up
  Priorities: 4 4
  Bandwidth: 10Mbps
  SmartOptimizeTimer: 180
  Computed ERO (S [L] denotes strict [loose] hops): (CSPF metric: 30)
20.31.1.2 S 20.31.2.2 S 20.31.8.2 S
  Received RRO (ProtectionFlag 1=Available 2=InUse 4=B/W 8=Node 10=SoftPreempt
20=Node-ID):
    20.31.1.2 20.31.2.2 20.31.8.2
  28 Mar 11 05:02:51.787 Record Route: 20.31.1.2 20.31.2.2 20.31.8.2
  27 Mar 11 05:02:51.787 Up
  26 Mar 11 05:02:51.697 EXTCTRL_LSP: Applying local parameters with this
signalling attempt
  25 Mar 11 05:02:51.697 Originate Call
  24 Mar 11 05:02:51.696 Clear Call
  23 Mar 11 05:02:51.696 CSPF: computation result accepted 20.31.1.2 20.31.2.2
20.31.8.2
  22 Mar 11 05:02:09.618 EXTCTRL_LSP: Control status became local
  21 Mar 11 05:00:56.736 EXTCTRL LSP: Sent Path computation request and LSP
status
  20 Mar 11 05:00:56.736 EXTCTRL_LSP: Computation request/lsp status contains:
bandwidth 10000000 priority - setup 4 hold 4 hops: 20.31.1.2 20.31.2.2
  19 Mar 11 05:00:56.735 Selected as active path
  18 Mar 11 05:00:56.734 EXTCTRL LSP: Sent Path computation request and LSP
status
  17 Mar 11 05:00:56.734 EXTCTRL_LSP: Computation request/lsp status contains:
bandwidth 10000000 priority - setup 4 hold 4 hops: 20.31.1.2 20.31.2.2
  16 Mar 11 05:00:56.734 Record Route: 20.31.4.2 20.31.5.2
  15 Mar 11 05:00:56.734 Up
  14 Mar 11 05:00:56.713 EXTCTRL LSP: Sent Path computation request and LSP
status
  13 Mar 11 05:00:56.713 EXTCTRL_LSP: Computation request/lsp status contains:
bandwidth 10000000 priority - setup 4 hold 4 hops: 20.31.1.2 20.31.2.2
  12 Mar 11 05:00:56.712 Originate Call
  11 Mar 11 05:00:56.712 EXTCTRL_LSP: Received setup parameters : 20.31.4.2
20.31.5.2
  10 Mar 11 05:00:49.283 EXTCTRL LSP: Sent Path computation request and LSP
status
  9 Mar 11 05:00:49.283 EXTCTRL_LSP: Computation request/lsp status contains:
bandwidth 10000000 priority - setup 4 hold 4 hops: 20.31.1.2 20.31.2.2
  8 Mar 11 05:00:20.581 EXTCTRL_LSP: Computation request/lsp status contains:
bandwidth 10000000 priority - setup 4 hold 4 hops: 20.31.1.2 20.31.2.2
  7 Mar 11 05:00:20.581 EXTCTRL LSP: Sent Path computation request and LSP
status
  6 Mar 11 05:00:20.581 EXTCTRL_LSP: Computation request/lsp status contains:
bandwidth 10000000 priority - setup 4 hold 4 hops: 20.31.1.2 20.31.2.2
  5 Mar 11 05:00:20.580 EXTCTRL_LSP: Control status became external
  4 Mar 11 05:00:03.716 EXTCTRL_LSP: Control status became local
  3 Mar 11 05:00:03.714 EXTCTRL LSP: Sent Path computation request and LSP
status
  2 Mar 11 05:00:03.714 EXTCTRL_LSP: Computation request/lsp status contains:
bandwidth 10000000 priority - setup 4 hold 4 hops: 20.31.1.2 20.31.2.2
  1 Mar 11 05:00:00.279 EXTCTRL LSP: Awaiting external controller connection
Created: Mon Mar 11 05:00:00 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

The **Computed ERO** is 20.31.1.2, 20.31.2.2, and 20.31.8.2. The PCE-controlled LSP is established using the local configuration parameters.

CHAPTER 3

PCEP Configuration Statements

- [\[edit protocols pcep\] Hierarchy Level on page 31](#)
- [pcep on page 33](#)
- [delegation-cleanup-timeout on page 34](#)
- [delegation-priority on page 34](#)
- [destination-ipv4-address on page 35](#)
- [destination-port on page 35](#)
- [lsp-external-controller on page 36](#)
- [max-unknown-messages on page 36](#)
- [message-rate-limit on page 37](#)
- [pce on page 38](#)
- [pce-group \(PCE\) on page 38](#)
- [pce-group \(Protocols PCEP\) on page 39](#)
- [pce-type on page 40](#)
- [traceoptions \(PCE\) on page 41](#)
- [traceoptions \(Protocols PCEP\) on page 43](#)
- [update-rate-limit on page 44](#)

[\[edit protocols pcep\] Hierarchy Level](#)

```
pcep {  
  message-rate-limit messages-per-minute;  
  pce pce-id {  
    delegation-cleanup-timeout seconds;  
    delegation-priority priority-number;  
    destination-ipv4-address ipv4-address;  
    destination-port port-number;  
    max-unknown-messages messages-per-minute;  
    pce-group pce-group-name;  
    pce-type {  
      active stateful;  
    }  
    traceoptions {  
      file filename <files number> <size size> <world-readable | no-world-readable>;  
      flag (all | pcep);  
    }  
  }  
}
```

```
        no-remote-trace;
    }
}
pce-group pce-group-id {
    delegation-cleanup-timeout seconds;
    max-unknown-messages messages-per-minute;
    pce-type {
        active stateful;
    }
    traceoptions {
        file filename <files number> <size size> <world-readable | no-world-readable>;
        flag (all | pcep);
        no-remote-trace;
    }
}
traceoptions {
    file filename <files number> <size size> <world-readable | no-world-readable>;
    flag flag;
    no-remote-trace;
}
update-rate-limit updates-per-minute;
}
```

pcep

Syntax	<pre> pcep { message-rate-limit <i>messages-per-minute</i>; pce <i>pce-id</i> { delegation-cleanup-timeout <i>seconds</i>; delegation-priority <i>priority-number</i>; destination-ipv4-address <i>ipv4-address</i>; destination-port <i>port-number</i>; max-unknown-messages <i>messages-per-minute</i>; pce-group <i>pce-group-name</i>; pce-type { active stateful; } traceoptions { file <i>filename</i> <files <i>number</i>> <size <i>size</i>> <world-readable no-world-readable>; flag (all pcep); no-remote-trace; } } pce-group <i>pce-group-id</i> { delegation-cleanup-timeout <i>seconds</i>; max-unknown-messages <i>messages-per-minute</i>; pce-type { active stateful; } traceoptions { file <i>filename</i> <files <i>number</i>> <size <i>size</i>> <world-readable no-world-readable>; flag (all pcep); no-remote-trace; } } traceoptions { file <i>filename</i> <files <i>number</i>> <size <i>size</i>> <world-readable no-world-readable>; flag <i>flag</i>; no-remote-trace; } update-rate-limit <i>updates-per-minute</i>; } </pre>
Hierarchy Level	[edit protocols]
Release Information	Statement introduced in Junos OS Release 12.3.
Description	<p>Configure the Path Computation Client (PCC) parameters.</p> <p>The remaining statements are explained separately.</p>
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>
Related Documentation	<ul style="list-style-type: none"> • Example: Configuring Path Computation Element Protocol for MPLS RSVP-TE on page 7

delegation-cleanup-timeout

Syntax	<code>delegation-cleanup-timeout seconds;</code>
Hierarchy Level	<code>[edit protocols pcep pce pce-id]</code>
Release Information	Statement introduced in Junos OS Release 12.3.
Description	Specify the amount of time (in seconds) that a Path Computation Client (PCC) must wait before returning control of all LSPs to the routing protocol process after a PCEP session with the main active stateful Path Computation Element (PCE) is disconnected.
Options	seconds —Time (in seconds) that a PCC must wait before returning control of all LSPs to the routing protocol process after a PCEP session with the main active stateful PCE is disconnected. Range: 0 through 600 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	<ul style="list-style-type: none">• pce on page 38

delegation-priority

Syntax	<code>delegation-priority priority-number;</code>
Hierarchy Level	<code>[edit protocols pcep pce pce-id]</code>
Release Information	Statement introduced in Junos OS Release 12.3.
Description	Specify the priority number of the active stateful Path Computation Element (PCE). This value is used by the Path Computation Client (PCC) to elect a PCE to delegate LSPs. No two PCEs can have the same delegation-priority value. The PCC elects the PCE with a lower priority as the main active stateful PCE to delegate LSPs.
Options	priority-number —Priority number of the active stateful PCE. Range: 1 through 65535 Default: 0 (no priority is set)
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Documentation	<ul style="list-style-type: none">• pce on page 38

destination-ipv4-address

Syntax	<code>destination-ipv4-address <i>ipv4-address</i>;</code>
Hierarchy Level	<code>[edit protocols pcep pce <i>pce-id</i>]</code>
Release Information	Statement introduced in Junos OS Release 12.3.
Description	Specify the IPv4 address of the Path Computation Element (PCE) to which the Path Computation Client (PCC) should connect.
Options	<i>ipv4-address</i> —IPv4 address of the PCE.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Documentation	<ul style="list-style-type: none">• pce on page 38

destination-port

Syntax	<code>destination-port <i>port-number</i>;</code>
Hierarchy Level	<code>[edit protocols pcep pce <i>pce-id</i>]</code>
Release Information	Statement introduced in Junos OS Release 12.3.
Description	Specify the TCP port number of the Path Computation Element (PCE) to which the Path Computation Client (PCC) should connect.
Options	<i>port-number</i> —Destination TCP port number. Range: 1 through 65535 Default: 4189
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Documentation	<ul style="list-style-type: none">• pce on page 38

`lsp-external-controller`

Syntax	<code>lsp-external-controller</code> <i>lsp-external-controller</i> ;
Hierarchy Level	[edit protocols mpls], [edit protocols mpls label-switched-path <i>lsp-name</i>]
Release Information	Statement introduced in Junos OS Release 12.3.
Description	Configure an external path computing entity.
Options	<i>lsp-external-controller</i> —Name of the external path computing entity. Values: <i>pccd</i>
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Documentation	• pcep on page 33

`max-unknown-messages`

Syntax	<code>max-unknown-messages</code> <i>messages-per-minute</i> ;
Hierarchy Level	[edit protocols pcep pce <i>pce-id</i>]
Release Information	Statement introduced in Junos OS Release 12.3.
Description	Specify the number of unknown messages per minute that the Path Computation Client (PCC) can receive at maximum after which the PCEP session is closed.
Options	<i>messages-per-minute</i> —Number of unknown messages per minute that the PCC can receive at maximum after which the PCEP session is closed. Recommended value is 5. If the number of unknown messages received by the PCC is greater than or equal to the maximum number, the PCEP session is closed. Range: 1 through 16384 Default: 0 (disabled or no limit)
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Documentation	• pce on page 38

message-rate-limit

Syntax	<code>message-rate-limit <i>messages-per-minute</i>;</code>
Hierarchy Level	[edit protocols pcep]
Release Information	Statement introduced in Junos OS Release 12.3.
Description	Specify the number of messages per minute that the Path Computation Client (PCC) can receive at maximum.
Options	<p><i>messages-per-minute</i>—Number of messages per minute that the PCC can receive at maximum.</p> <p>Range: 1 through 16384</p> <p>Default: 0 (disabled or no limit)</p>
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>
Related Documentation	<ul style="list-style-type: none">• pcep on page 33

pce

```
Syntax  pce pce-id {
        delegation-cleanup-timeout seconds;
        delegation-priority priority-number;
        destination-ipv4-address ipv4-address;
        destination-port port-number;
        max-unknown-messages messages-per-minute;
        pce-group pce-group-name;
        pce-type {
            active stateful;
        }
        traceoptions {
            file filename <files number> <size size> <world-readable | no-world-readable>;
            flag (all | pcep);
            no-remote-trace;
        }
    }
```

Hierarchy Level [edit protocols pcep]

Release Information Statement introduced in Junos OS Release 12.3.

Description Configure per path computation element (PCE) parameters.

Options *pce-id*—IP address of the PCE.

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

Related Documentation • [pcep on page 33](#)

pce-group (PCE)

```
Syntax  pce-group pce-group-name;
```

Hierarchy Level [edit protocols pcep pce pce-id]

Release Information Statement introduced in Junos OS Release 12.3.

Description Specify the Path Computation Element (PCE) group to which the configured PCE belongs.

Options *pce-group-name*—Name of the PCE group.

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

Related Documentation • [pce on page 38](#)

pce-group (Protocols PCEP)

Syntax `pce-group pce-group-id {
 delegation-cleanup-timeout seconds;
 max-unknown-messages messages-per-minute;
 pce-type {
 active stateful;
 }
 traceoptions {
 file filename <files number> <size size> <world-readable | no-world-readable>;
 flag (all | pcep);
 no-remote-trace;
 }
 }`

Hierarchy Level [edit protocols pcep]

Release Information Statement introduced in Junos OS Release 12.3.

Description Configure the Path Computation Element (PCE) group parameters. A maximum of 10 PCE groups can be configured at any given point in time. The remaining statements are explained separately.



NOTE: A PCE group can include PCEs that are either only stateful or only active stateful. A combination of stateful PCEs and active stateful PCEs in one PCE group is not supported.

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

Related Documentation • [pcep on page 33](#)

pce-type

Syntax	<pre>pce-type { active stateful; }</pre>
Hierarchy Level	[edit protocols pcep pce <i>pce-id</i>]
Release Information	Statement introduced in Junos OS Release 12.3.
Description	<p>Configure the path computation element (PCE) type:</p> <ul style="list-style-type: none">• active—Uses LSP state information learned from PCCs to optimize path computations, and actively updates LSP parameters in those PCCs that delegated control over their LSPs to the PCE.• stateful—Uses LSP state information learned from PCCs to optimize path computations, but does not actively update the LSP state. A PCC maintains synchronization with the PCE.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>
Related Documentation	<ul style="list-style-type: none">• pce on page 38

traceoptions (PCE)

Syntax	<pre> traceoptions { file <i>filename</i> <files <i>number</i>> <size <i>size</i>> <world-readable no-world-readable>; flag (all pcep); no-remote-trace; } </pre>
Hierarchy Level	[edit protocols pcep pce <i>pce-id</i>]
Description	Configure the Path Computation Element Protocol (PCEP) tracing options.
Options	<p><i>filename</i>—Name of the file to receive the output of the tracing operation. All files are placed in the directory <i>/var/log</i>.</p> <p><i>files number</i>—(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.</p> <p>Range: 2 through 1000 files</p> <p>Default: 2 files. If you specify a maximum number of files, you must also include the size statement to specify the maximum file size.</p> <p><i>flag</i>—Area of path computation client process (pccd) to enable debugging output.</p> <ul style="list-style-type: none"> all—Trace all areas of PCD code. pcep—Trace Path Computation Element Protocol (PCEP) operations. <p><i>no-remote-trace</i>—(Optional) Disable remote tracing options.</p> <p><i>no-world-readable</i>—(Optional) Allow only certain users to read the log file.</p> <p><i>size size</i>—(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.</p> <p>Syntax: <i>xk</i> to specify KB, <i>xm</i> to specify MB, or <i>xg</i> to specify GB.</p> <p>Range: 10 KB through the maximum file size supported on your system.</p> <p>Default: 1 MB. If you specify a maximum file size, you must also include the files statement to specify the maximum number of files.</p> <p><i>world-readable</i>—(Optional) Allow any user to read the log file.</p>
Required Privilege	routing and trace—To view this statement in the configuration.
Level	routing-control and trace-control—To add this statement to the configuration.

Related • [pce on page 38](#)
Documentation

traceoptions (Protocols PCEP)

Syntax	<pre> traceoptions { file <i>filename</i> <files <i>number</i>> <size <i>size</i>> <world-readable no-world-readable>; flag <i>flag</i>; no-remote-trace; } </pre>
Hierarchy Level	[edit protocols pcep]
Description	Configure the Path Computation Element Protocol (PCEP) tracing options.
Options	<p><i>filename</i>—Name of the file to receive the output of the tracing operation. All files are placed in the directory <i>/var/log</i>.</p> <p><i>files number</i>—(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.</p> <p>Range: 2 through 1000 files</p> <p>Default: 2 files. If you specify a maximum number of files, you must also include the size statement to specify the maximum file size.</p> <p><i>flag</i>—Area of path computation client process (pccd) to enable debugging output.</p> <p>PCEP Tracing Flags</p> <ul style="list-style-type: none"> • <i>all</i>—Trace all areas of PCCD code • <i>pccd-config</i>—All configuration parsing operations • <i>pccd-core</i>—PCCD core operations • <i>pccd-functions</i>—PCCD function entries and outs • <i>pccd-main</i>—PCCD main module • <i>pccd-rpd</i>—PCCD communication with RPD • <i>pccd-ui</i>—PCCD user interface handling <p><i>no-remote-trace</i>—(Optional) Disable remote tracing options.</p> <p><i>no-world-readable</i>—(Optional) Allow only certain users to read the log file.</p> <p><i>size size</i>—(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.</p> <p>Syntax: <i>xk</i> to specify KB, <i>xm</i> to specify MB, or <i>xg</i> to specify GB.</p> <p>Range: 10 KB through the maximum file size supported on your system.</p>

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

- [pcep on page 33](#)

update-rate-limit

Syntax `update-rate-limit updates-per-minute;`

Hierarchy Level [edit protocols pcep]

Release Information Statement introduced in Junos OS Release 12.3.

Description Specify the number of updates per minute that the Path Computation Client (PCC) can receive at maximum. Updates above this limit are ignored by the PCC.

Options ***updates-per-minute***—Number of updates per minute that the PCC can receive at maximum.
Range: 1 through 16384
Default: 0 (disabled or no limit)

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

Related Documentation

- [pcep on page 33](#)

PART 3

Administration

- [PCEP Operational Commands on page 47](#)

CHAPTER 4

PCEP Operational Commands

- `clear path-computation-client statistics`
- `request path-computation-client active-pce`
- `show path-computation-client active-pce`
- `show path-computation-client statistics`

clear path-computation-client statistics

Syntax	clear path-computation-client statistics < <i>pce-id</i> all>
Release Information	Command introduced in Junos OS Release 12.3.
Description	Clear Path Computation Element (PCE) statistics.
Options	<i>pce-id</i> —(Optional) Clear statistics of the specified PCE. all—(Optional) Clear statistics of all available PCEs configured on the path computation client (PCC).
Required Privilege Level	clear
Related Documentation	<ul style="list-style-type: none">• show path-computation-client statistics on page 54
List of Sample Output	clear path-computation-client statistics pce-id on page 48 clear path-computation-client statistics all on page 48
Output Fields	When you enter this command, you are not provided feedback on the status of your request.

Sample Output

clear path-computation-client statistics pce-id

```
user@host> clear path-computation-client statistics pce1
```

clear path-computation-client statistics all

```
user@host> clear path-computation-client statistics all
```

[request path-computation-client active-pce](#)

Syntax	<code>request path-computation-client active-pce <i>pce-id</i></code>
Release Information	Command introduced in Junos OS Release 12.3.
Description	Request a new active Path Computation Element (PCE).
Options	<i>pce-id</i> —Unique user defined ID for this PCE.
Required Privilege Level	request
Related Documentation	<ul style="list-style-type: none">• show path-computation-client active-pce on page 50
List of Sample Output	request path-computation-client active-pce pce-id on page 49

Sample Output

[request path-computation-client active-pce pce-id](#)

```
user@host> request path-computation-client active-pce pce1
```

show path-computation-client active-pce

Syntax	show path-computation-client active-pce <brief detail>
Release Information	Command introduced in Junos OS Release 12.3.
Description	Displays information about the current active Path Computation Element (PCE).
Options	none —Display brief information about the current active PCE. brief detail —(Optional) Display the specific level of output.
Required Privilege Level	view
Related Documentation	<ul style="list-style-type: none"> request path-computation-client active-pce on page 49
List of Sample Output	show path-computation-client active-pce on page 52 show path-computation-client active-pce detail on page 52
Output Fields	Table 4 on page 50 describes the output fields for the show path-computation-client active-pce command. Output fields are listed in the approximate order in which they appear.

Table 4: show path-computation-client active-pce Output Fields

Field Name	Field Description	Level of Output
IP address	IP address of the current active PCE.	All levels
Priority	Active PCE priority.	All levels
PCE status	Active PCE state: <ul style="list-style-type: none"> PCE_STATE_NEW—Initial PCEP session state. PCE_STATE_RECONNECT—Trying to re-establish TCP connection with the PCEP peer. PCE_STATE_CONNECTING—Establishing TCP connection with the PCEP peer. PCE_STATE_CONNECTED—TCP connection established with the PCEP peer. PCE_STATE_SYNC—Open messages exchanged with the PCEP peer and entering SYNC state. PCE_STATE_UP—PCEP session established. 	All levels
Session type	Active PCE type: <ul style="list-style-type: none"> PCE_TYPE_STATELESS—Does not learn LSP state information from PCC. PCE_TYPE_STATEFUL—Uses LSP state information learned from PCCs to optimize path computations, but does not actively update LSP state. A PCC maintains synchronization with the PCE. PCE_TYPE_STATEFULACTIVE—Uses LSP state information learned from PCCs to optimize path computations, and actively updates LSP parameters in those PCCs that delegate control of their LSPs to the PCE. 	All levels

Table 4: show path-computation-client active-pce Output Fields (*continued*)

Field Name	Field Description	Level of Output
PCE-mastership	PCE mastership state: <ul style="list-style-type: none"> main—Current active PCE. backup—Backup PCE. 	All levels
PCRpts	Number of PC report (PCRpt) messages sent by PCC to a stateful PCE to report current state of LSP(s).	All levels
PCUpdates	Number of PC update (PCUpd) messages sent by a PCE to a PCC to update LSP parameters.	All levels
Local Keepalive timer	Keepalive timer used by or for the PCC.	All levels
Local Dead timer	Dead timer used by or for the PCC.	All levels
Remote Keepalive timer	Keepalive timer used by or for the PCE.	All levels
Remote Dead timer	Dead timer used by or for the PCE.	All levels
PCErr-recv	Information about type, value, and number of PC Error messages received.	All levels
Max unknown messages	Maximum number of unknown messages received for a PCEP session. Recommended value is 5. If the number of unknown messages received by a PCC or PCE is greater than or equal to the maximum number, the PCEP session is closed.	detail
Keepalives received	Number of Keepalive messages received by a PCC from a PCE.	detail
Keepalives sent	Number of Keepalive messages sent by a PCC to a PCE.	detail
Dead timer	Dead timer used by the current active PCE.	detail
Elapsed as main current	Time (in seconds) the PCE is in the main mastership state.	detail
Elapsed as main total	Time (in seconds) the PCE became main from the last PCCD restart.	detail
Unknown msgs/min rate	Number of unknown messages received per minute.	detail
Session failures	Number of PCEP session failures with the PCE.	detail
Delegation timeout in	Time (in seconds) left for LSP delegation to timeout.	detail
Delegation failures	Number of LSP delegation failures.	detail

Table 4: show path-computation-client active-pce Output Fields (*continued*)

Field Name	Field Description	Level of Output
Connection down	Time (in seconds) since the PCEP session is down.	detail
PCErr-sent	Information about type, value, and number of PC Error messages sent.	All levels

Sample Output

show path-computation-client active-pce

```

user@host> show path-computation-client active-pce
PCE pce1
General
  IP address           : 10.209.57.166
  Priority              : 2
  PCE status           : PCE_STATE_NEW
  Session type         : PCE_TYPE_STATEFULACTIVE
  PCE-mastership       : main

Counters
  PCReqs               Total: 0          last 5min: 0          last hour: 0
  PCReps               Total: 0          last 5min: 0          last hour: 0
  PCRpts               Total: 0          last 5min: 0          last hour: 0
  PCUpdates            Total: 0          last 5min: 0          last hour: 0

Timers
  Local                Keepalive timer: 0 [s]   Dead timer: 0 [s]
  Remote               Keepalive timer: 0 [s]   Dead timer: 0 [s]

Errors
  PCErr-recv
  PCErr-sent
    Type: 19           Value: 3          Count: 1
  PCE-PCC-NTFS
  PCC-PCE-NTFS

```

show path-computation-client active-pce detail

```

user@host> show path-computation-client active-pce detail
PCE pce1
General
  IP address           : 172.22.25.223
  Priority              : 1
  PCE status           : PCE_STATE_RECONNECT
  Session type         : PCE_TYPE_STATEFULACTIVE
  PCE-mastership       : main
  Max unknown messages : 5
  Keepalives received  : 0
  Keepalives sent      : 0
  Dead timer           : 0 [s]
  Elapsed as main current : 1 [s]

```

```

Elapsed as main total : 2542 [s]
Unknown msgs/min rate : 0
Session failures      : 575
Delegation timeout in : 14 [s]
Delegation failures   : 21928
Connection down       : 16 [s]

```

Counters

```

PCReqs          Total: 0          last 5min: 0          last hour: 0

PCReps          Total: 0          last 5min: 0          last hour: 0

PCRpts          Total: 31512       last 5min: 7243       last hour:
7243
PCUpdates       Total: 80          last 5min: 40          last hour:
40

```

Timers

```

Local           Keepalive timer: 30 [s]  Dead timer: 120 [s]

Remote          Keepalive timer: 30 [s]  Dead timer: 120 [s]

```

Errors

```

PCErr-recv
PCErr-sent
Type: 1          Value: 2          Count: 12

PCE-PCC-NTFS
PCC-PCE-NTFS

```

show path-computation-client statistics

Syntax	show path-computation-client statistics <brief detail> <all>
Release Information	Command introduced in Junos OS Release 12.3.
Description	Display statistics about the Path Computation Element (PCE).
Options	<p>none—Display statistics about the primary PCE.</p> <p>brief detail—(Optional) Display the specific level of output.</p> <p>all—(Optional) Display the statistics about all PCEs configured on the PCC.</p>
Required Privilege Level	view
Related Documentation	<ul style="list-style-type: none"> • clear path-computation-client statistics on page 48
List of Sample Output	show path-computation-client statistics all on page 56 show path-computation-client statistics detail on page 57
Output Fields	Table 5 on page 54 describes the output fields for the show path-computation-client statistics command. Output fields are listed in the approximate order in which they appear.

Table 5: show path-computation-client statistics Output Fields

Field Name	Field Description	Level of Output
IP address	IP address of the PCE.	All levels
Priority	PCE priority.	All levels
PCE status	PCE state: <ul style="list-style-type: none"> • PCE_STATE_NEW— Initial PCEP session state. • PCE_STATE_RECONNECT—Trying to re-establish TCP connection with the PCEP peer. • PCE_STATE_CONNECTING—Establishing TCP connection with the PCEP peer. • PCE_STATE_CONNECTED—TCP connection established with the PCEP peer. • PCE_STATE_SYNC—Open messages exchanged with the PCEP peer and entering SYNC state. • PCE_STATE_UP—PCEP session established. 	All levels

Table 5: show path-computation-client statistics Output Fields (*continued*)

Field Name	Field Description	Level of Output
Session type	Active PCE type: <ul style="list-style-type: none"> • PCE_TYPE_STATELESS—Does not learn LSP state information from PCC. • PCE_TYPE_STATEFUL—Uses LSP state information learned from PCCs to optimize path computations, but does not actively update LSP state. A PCC maintains synchronization with the PCE. • PCE_TYPE_STATEFULACTIVE—Uses LSP state information learned from PCCs to optimize path computations, and actively updates LSP parameters in those PCCs that delegate control of their LSPs to the PCE. 	All levels
PCE-mastership	PCE mastership state: <ul style="list-style-type: none"> • main • primary • backup 	All levels
PCRpts	Number of PC report (PCRpt) messages sent by PCC to a stateful PCE to report current state of LSP(s).	All levels
PCUpdates	Number of PC update (PCUpd) messages sent by a PCE to a PCC to update LSP parameters.	All levels
Local Keepalive timer	Keepalive timer used by or for the PCC.	All levels
Local Dead timer	Dead timer used by or for the PCC.	All levels
Remote Keepalive timer	Keepalive timer used by or for the PCE.	All levels
Remote Dead timer	Dead timer used by or for the PCE.	All levels
PCErr-recv	Information about type, value, and number of PC Error messages received.	All levels
PCErr-sent	Information about type, value, and number of PC Error messages sent.	All levels
Max unknown messages	Maximum number of unknown messages received for a PCEP session. Recommended value is 5. If the number of unknown messages received by a PCC or PCE is greater than or equal to the maximum number, the PCEP session is closed.	detail

Table 5: show path-computation-client statistics Output Fields (*continued*)

Field Name	Field Description	Level of Output
Keepalives received	Number of Keepalive messages received by a PCC from a PCE.	detail
Keepalives sent	Number of Keepalive messages sent by a PCC to a PCE.	detail
Elapsed as main current	Time (in seconds) the PCE is in the main mastership state.	detail
Elapsed as main total	Time (in seconds) the PCE became main from the last PCCD restart.	detail
Unknown msgs/min rate	Number of unknown messages received per minute.	detail
Session failures	Number of PCEP session failures with the PCE.	detail
Delegation timeout in	Time (in seconds) left for LSP delegation to timeout.	detail
Delegation failures	Number of LSP delegation failures.	detail
Connection down	Time (in seconds) since the PCEP session is down.	detail

Sample Output

show path-computation-client statistics all

```

user@host> show path-computation-client statistics all
PCE pce1

General
  IP address       : 10.209.57.166
  Priority          : 2
  PCE status       : PCE_STATE_NEW
  Session type     : PCE_TYPE_STATEFULACTIVE
  PCE-mastership   : main

Counters
  PCReqs           Total: 0          last 5min: 0          last hour: 0
  PCReps           Total: 0          last 5min: 0          last hour: 0
  PCRpts           Total: 0          last 5min: 0          last hour: 0
  PCUpdates        Total: 0          last 5min: 0          last hour: 0

Timers
  Local            Keepalive timer: 0 [s]   Dead timer: 0 [s]
  Remote           Keepalive timer: 0 [s]   Dead timer: 0 [s]

```

```

Errors
  PCErr-recv
  PCErr-sent
  PCE-PCC-NTFS
  PCC-PCE-NTFS

PCE pce2

General
  IP address           : 10.31.32.1
  Priority              : 10
  PCE status           : PCE_STATE_NEW
  Session type         : PCE_TYPE_STATEFULACTIVE
  PCE-mastership       : backup

Counters
  PCReqs               Total: 0          last 5min: 0          last hour: 0
  PCReps               Total: 0          last 5min: 0          last hour: 0
  PCRpts               Total: 0          last 5min: 0          last hour: 0
  PCUpdates            Total: 0          last 5min: 0          last hour: 0

Timers
  Local                Keepalive timer: 0 [s]  Dead timer: 0 [s]
  Remote               Keepalive timer: 0 [s]  Dead timer: 0 [s]

Errors
  PCErr-recv
  PCErr-sent
  PCE-PCC-NTFS
  PCC-PCE-NTFS

```

show path-computation-client statistics detail

```

user@host> show path-computation-client statistics detail
PCE pce1
General
  IP address           : 10.209.57.166
  Priority              : 2
  PCE status           : PCE_STATE_NEW
  Session type         : PCE_TYPE_STATEFULACTIVE
  PCE-mastership       : main
  Max unknown messages : 5
  Keepalives received  : 0
  Keepalives sent      : 0
  Dead timer           : 0 [s]
  Elapsed as main current : 294 [s]
  Elapsed as main total : 294 [s]
  Unknown msgs/min rate : 0
  Session failures     : 0
  Replies timedout     : 0
  Delegation timeout in : 26 [s]
  Delegation failures  : 0
  Connection down      : 4 [s]

Counters

```

PCReqs	Total: 0	last 5min: 0	last hour: 0
PCReps	Total: 0	last 5min: 0	last hour: 0
PCRpts	Total: 0	last 5min: 0	last hour: 0
PCUpdates	Total: 0	last 5min: 0	last hour: 0

Timers

Local	Keepalive timer:	0 [s]	Dead timer:	0 [s]
Remote	Keepalive timer:	0 [s]	Dead timer:	0 [s]

Errors

- PCErr-recv
- PCErr-sent
- PCE-PCC-NTFS
- PCC-PCE-NTFS

PART 4

Index

- [Index on page 61](#)

Index

Symbols

#, comments in configuration statements.....	xii
(), in syntax descriptions.....	xii
< >, in syntax descriptions.....	xii
[], in configuration statements.....	xii
{ }, in configuration statements.....	xii
(pipe), in syntax descriptions.....	xii

A

auto-bandwidth	
PCE-controlled LSP.....	16

B

braces, in configuration statements.....	xii
brackets	
angle, in syntax descriptions.....	xii
square, in configuration statements.....	xii

C

clear path-computation-client statistics	
command.....	48
CLI-controlled LSP.....	15
comments, in configuration statements.....	xii
conventions	
text and syntax.....	xi
curly braces, in configuration statements.....	xii
customer support.....	xiii
contacting JTAC.....	xiii

D

documentation	
comments on.....	xiii

E

external control.....	15
external path computation	
PCE.....	7

F

font conventions.....	xi
-----------------------	----

L

local control.....	15
LSP	
behavior.....	14
control mode.....	15
types.....	15
LSP configuration	
support for PCE-controlled LSP.....	16
LSP protection	
PCE-controlled LSP.....	16

M

manuals	
comments on.....	xiii
MPLS configuration	
support for PCE-controlled LSP.....	16
MPLS RSVP-TE	
understanding.....	7

P

parentheses, in syntax descriptions.....	xii
path computation	
PCE.....	3
<i>See also</i> PCC	
Path Computation Client.....	12
Path Computation Element.....	11
Path Computation Element Protocol.....	12
PCC.....	12
active pce.....	50
active-PCE	
request.....	49
statistics.....	54
clear.....	48
PCE.....	11
external path computing.....	17
impact on network performance.....	17
path computation.....	7
PCE and PCC interaction.....	13
PCE-controlled LSP.....	15
auto-bandwidth.....	16
LSP protection.....	16
PCEP.....	3, 7, 12
for MPLS RSVP-TE.....	7
functions.....	12
pcep	
configuring.....	17
for MPLS RSVP-TE.....	17
PCEP session.....	13

pcep statement	
PCEP	
complete hierarchy under.....	31

R

request path-computation-client active-pce	
command.....	49
RSVP-TE	
addressing current limitations.....	10
current limitations.....	9
RSVP extension.....	7

S

show path-computation-client active-pce	
command.....	50
show path-computation-client statistics	
command.....	54
stateful PCE	
active.....	11
functions.....	11
passive.....	11
stateless PCE.....	11
support, technical See technical support	
syntax conventions.....	xi

T

technical support	
contacting JTAC.....	xiii
traffic engineering.....	3