Junos® OS

CCC and TCC Feature Guide for Routing Devices

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13.2

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

YEAR 2000 NOTICE

Juniper Networks hardware and software products are Year 2000 compliant. Junos OS has no known time-related limitations through the year 2038. However, the NTP application is known to have some difficulty in the year 2036.

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About the Documentation

Documentation and Release Notes

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

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

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Supported Platforms

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

- MX Series
- T Series
- M Series
- PTX Series

Using the Examples in This Manual

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

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

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

Merging a Full Example

To merge a full example, follow these steps:

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

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

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

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

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

Merging a Snippet

To merge a snippet, follow these steps:

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

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

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


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

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

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

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

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

Table 2 on page xi 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`

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

<table>
<tr><th>Convention</th><th>Description</th><th>Examples</th></tr>
<tr><td>Italic text like this</td><td>Introduces or emphasizes important new terms.
Identifies book names.
Identifies RFC and Internet draft titles.</td><td>A policy term is a named structure that defines match conditions and actions.
Junos OS System Basics Configuration Guide
RFC 1997, BGP Communities Attribute</td></tr>
<tr><td>Italic text like this</td><td>Represents variables (options for which you substitute a value) in commands or configuration statements.</td><td>Configure the machine's domain name:

[edit]
root@# set system domain-name domain-name</td></tr>
<tr><td>Text like this</td><td>Represents names of configuration statements, commands, files, and directories; configuration hierarchy levels; or labels on routing platform components.</td><td>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.</td></tr>
<tr><td>< > (angle brackets)</td><td>Enclose optional keywords or variables.</td><td>stub <default-metric <i>metric</i>>;</td></tr>
<tr><td>| (pipe symbol)</td><td>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.</td><td>broadcast | multicast

(string1 | string2 | string3)</td></tr>
<tr><td># (pound sign)</td><td>Indicates a comment specified on the same line as the configuration statement to which it applies.</td><td>rsvp { # Required for dynamic MPLS only</td></tr>
<tr><td>[ ] (square brackets)</td><td>Enclose a variable for which you can substitute one or more values.</td><td>community name members [community-ids]</td></tr>
<tr><td>Indention and braces ({ })</td><td>Identify a level in the configuration hierarchy.</td><td rowspan="2">[edit]
routing-options {
  static {
    route default {
      nexthop address;
      retain;
    }
  }
}</td></tr>
<tr><td>; (semicolon)</td><td>Identifies a leaf statement at a configuration hierarchy level.</td></tr>
<tr><td colspan="3">GUI Conventions</td></tr>
<tr><td>Bold text like this</td><td>Represents graphical user interface (GUI) items you click or select.</td><td>In the Logical Interfaces box, select All Interfaces.
To cancel the configuration, click Cancel.</td></tr>
<tr><td>> (bold right angle bracket)</td><td>Separates levels in a hierarchy of menu selections.</td><td>In the configuration editor hierarchy, select Protocols>Ospf.</td></tr>
</table>

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)

Requesting Technical Support

Technical product support is available through the Juniper Networks Technical Assistance Center (JTAC). If you are a customer with an active J-Care or 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/.
- JTAC hours of operation—The JTAC centers have resources available 24 hours a day, 7 days a week, 365 days a year.

Self-Help Online Tools and Resources

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

- Find CSC offerings: http://www.juniper.net/customers/support/
- Search for known bugs: http://www2.juniper.net/kb/
- Find product documentation: http://www.juniper.net/techpubs/
- Find solutions and answer questions using our Knowledge Base: http://kb.juniper.net/
- Download the latest versions of software and review release notes: http://www.juniper.net/customers/csc/software/
- Search technical bulletins for relevant hardware and software notifications: https://www.juniper.net/alerts/

- 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

CHAPTER 1

Introduction to CCC and TCC

CCC Overview

Circuit cross-connect (CCC) allows you to configure transparent connections between two circuits, where a circuit can be a Frame Relay data-link connection identifier (DLCI), an Asynchronous Transfer Mode (ATM) virtual circuit (VC), a Point-to-Point Protocol (PPP) interface, a Cisco High-Level Data Link Control (HDLC) interface, or an MPLS label-switched path (LSP). Using CCC, packets from the source circuit are delivered to the destination circuit with, at most, the Layer 2 address being changed. No other processing—such as header checksums, time-to-live (TTL) decrementing, or protocol processing—is done.

CCC circuits fall into two categories: logical interfaces, which include DLCIs, VCs, virtual local area network (VLAN) IDs, PPP and Cisco HDLC interfaces, and LSPs. The two circuit categories provide three types of cross-connect:

- Layer 2 switching—Cross-connects between logical interfaces provide what is essentially Layer 2 switching. The interfaces that you connect must be of the same type.
- MPLS tunneling—Cross-connects between interfaces and LSPs allow you to connect two distant interface circuits of the same type by creating MPLS tunnels that use LSPs as the conduit.
- LSP stitching—Cross-connects between LSPs provide a way to “stitch” together two label-switched paths, including paths that fall in two different traffic engineering database areas.

For Layer 2 switching and MPLS tunneling, the cross-connect is bidirectional, so packets received on the first interface are transmitted out the second interface, and those received on the second interface are transmitted out the first. For LSP stitching, the cross-connect is unidirectional.

You can police (control) the amount of traffic flowing over CCC circuits. For more information, see the *Junos OS VPNs Library for Routing Devices*.

It is also possible to use the **ping** command to check the integrity of CCC LSPs. See *Pinging CCC LSPs* for more information.

Transmitting Nonstandard BPDUs

CCC protocol (and Layer 2 Circuit and Layer 2 VPN) configurations can transmit nonstandard bridge protocol data units (BPDUs) generated by other vendors' equipment. This is the default behavior on all supported PICs and requires no additional configuration.

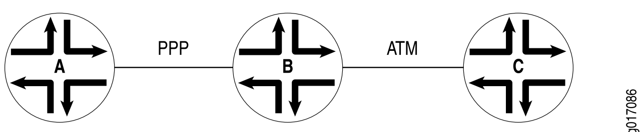
The following PICs are supported on M320 and T Series routers:

- 1-port Gigabit Ethernet PIC
- 2-port Gigabit Ethernet PIC
- 4-port Gigabit Ethernet PIC
- 10-port Gigabit Ethernet PIC

TCC Overview

Translational cross-connect (TCC) is a switching concept that enables you to establish interconnections between a variety of Layer 2 protocols or circuits. It is similar to CCC. However, whereas CCC requires the same Layer 2 encapsulations on each side of a Juniper Networks router (such as PPP-to-PPP or Frame Relay-to-Frame Relay), TCC enables you to connect different types of Layer 2 protocols interchangeably. When you use TCC, combinations such as PPP-to-ATM (see Figure 1 on page 4) and Ethernet-to-Frame Relay connections are possible.

Figure 1: TCC Example



The Layer 2 circuits and encapsulation types that can be interconnected by TCC are:

- Ethernet
- Extended VLANs
- PPP
- HDLC
- ATM
- Frame Relay

TCC works by removing the Layer 2 header when frames enter the router and adding a different Layer 2 header on the frames before they leave the router. In Figure 1 on page 4, the PPP encapsulation is stripped from the frames arriving at Router B, and the ATM encapsulation is added before the frames are sent to Router C.

Note that all control traffic is terminated at the interconnecting router (Router B). Examples of traffic controllers include the Link Control Protocol (LCP) and the Network Control Protocol (NCP) for PPP, keepalives for HDLC, and Local Management Interface (LMI) for Frame Relay.

TCC functionality is different from standard Layer 2 switching. TCC only swaps Layer 2 headers. No other processing, such as header checksums, TTL decrementing, or protocol handling is performed. TCC is supported for IPv4 only.

Address Resolution Protocol (APR) packet policing on TCC Ethernet interfaces is effective for releases 10.4 and onwards.

You can configure TCC for interface switching and for Layer 2 VPNs. For more information about using TCC for virtual private networks (VPNs), see the *Junos OS VPNs Library for Routing Devices*.

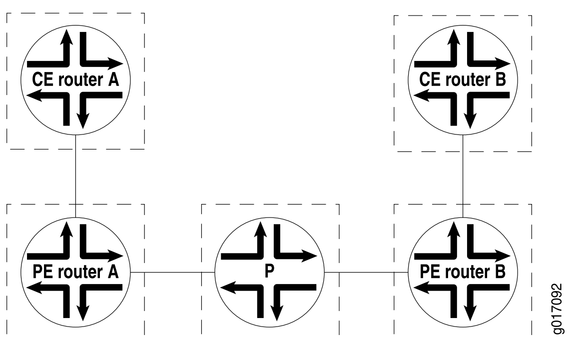
CCC and TCC Graceful Restart

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

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

Figure 2 on page 5 illustrates how graceful restart might work on a CCC connection between two CE routers.

Figure 2: Remote Interface Switch Connecting Two CE Routers Using CCC



PE Router A is the ingress for the transmit LSP from PE Router A to PE Router B and the egress for the receive LSP from PE Router B to PE Router A. With RSVP graceful restart enabled on all the PE and P routers, the following occurs when PE router A restarts:

- PE Router A preserves the forwarding state associated with the CCC routes (those from CCC to MPLS and from MPLS to CCC).

- Traffic flows without disruption from CE router to CE router.
- After the restart, PE Router A preserves the label for the LSP for which PE Router A is the egress (the receive LSP, for example). The transmit LSP from PE Router A to PE Router B can derive new label mappings, but should not cause any traffic disruption.

PART 2

Configuration

CHAPTER 2

CCC and TCC Configuration Guidelines

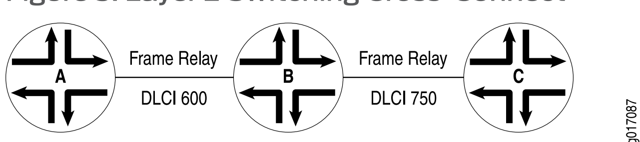
Configuring Layer 2 Switching Cross-Connects Using CCC

Layer 2 switching cross-connects join logical interfaces to form what is essentially Layer 2 switching. The interfaces that you connect must be of the same type.

Figure 3 on page 9 illustrates a Layer 2 switching cross-connect. In this topology, Router A and Router C have Frame Relay connections to Router B, which is a Juniper Networks router. Circuit cross-connect (CCC) allows you to configure Router B to act as a Frame Relay (Layer 2) switch.

To configure Router B to act as a Frame Relay switch, you configure a circuit from Router A to Router C that passes through Router B, effectively configuring Router B as a Frame Relay switch with respect to these routers. This configuration allows Router B to transparently switch packets (frames) between Router A and Router C without regard to the packets' contents or the Layer 3 protocols. The only processing that Router B performs is to translate DLCI 600 to 750.

Figure 3: Layer 2 Switching Cross-Connect



If the Router A–to–Router B and Router B–to–Router C circuits were PPP, for example, the Link Control Protocol and Network Control Protocol exchanges occur between Router A and Router C. These messages are handled transparently by Router B, allowing Router A and Router C to use various PPP options (such as header or address compression and authentication) that Router B might not support. Similarly, Router A and Router C exchange keepalives, providing circuit-to-circuit connectivity status.

You can configure Layer 2 switching cross-connects on PPP, Cisco HDLC, Frame Relay, Ethernet, and ATM circuits. In a single cross-connect, only like interfaces can be connected.

To configure Layer 2 switching cross-connects, you must configure the following on the router that is acting as the switch (Router B in Figure 3 on page 9):

Configuring the CCC Encapsulation for Layer 2 Switching Cross-Connects

To configure Layer 2 switching cross-connects, configure the CCC encapsulation on the router that is acting as the switch (Router B in Figure 3 on page 9).

NOTE: **You cannot configure families on CCC interfaces; that is, you cannot include the family statement at the [edit interfaces *interface-name* unit *logical-unit-number*] hierarchy level.**

For instructions for configuring the encapsulation for Layer 2 switching cross-connects, see the following sections:

Configuring ATM Encapsulation for Layer 2 Switching Cross-Connects

For ATM circuits, specify the encapsulation when configuring the virtual circuit (VC). Configure each VC as a circuit or a regular logical interface by including the following statements:

```
at-fpc/pic/port {
  atm-options {
    vpi vpi-identifier maximum-vcs maximum-vcs;
  }
  unit logical-unit-number {
    encapsulation encapsulation-type;
    point-to-point; # Default interface type
    vci vpi-identifier.vci-identifier;
```

```
    }
}
```

You can include these statements at the following hierarchy levels:

- **[edit interfaces]**
- **[edit logical-systems *logical-system-name* interfaces]**

Configuring Ethernet Encapsulation for Layer 2 Switching Cross-Connects

For Ethernet circuits, specify **ethernet-ccc** in the **encapsulation** statement. This statement configures the entire physical device. For these circuits to work, you must also configure a logical interface (unit 0).

Ethernet interfaces with standard Tag Protocol Identifier (TPID) tagging can use Ethernet CCC encapsulation. On M Series Multiservice Edge Routers, except the M320, one-port Gigabit Ethernet, two-port Gigabit Ethernet, four-port Gigabit Ethernet, and four-port Fast Ethernet PICs can use Ethernet CCC encapsulation. On T Series Core Routers and M320 routers, one-port Gigabit Ethernet and two-port Gigabit Ethernet PICs installed in FPC2 can use Ethernet CCC encapsulation. When you use this encapsulation type, you can configure the **ccc** family only.

```
fe-fpc/pic/port {
    encapsulation ethernet-ccc;
    unit 0;
}
```

You can include these statements at the following hierarchy levels:

- **[edit interfaces]**
- **[edit logical-systems *logical-system-name* interfaces]**

Configuring Ethernet VLAN Encapsulation for Layer 2 Switching Cross-Connects

An Ethernet virtual LAN (VLAN) circuit can be configured using either the **vlan-ccc** or **extended-vlan-ccc** encapsulation. If you configure the **extended-vlan-ccc** encapsulation on the physical interface, you cannot configure the **inet** family on the logical interfaces. Only the **ccc** family is allowed. If you configure the **vlan-ccc** encapsulation on the physical interface, both the **inet** and **ccc** families are supported on the logical interfaces. Ethernet interfaces in VLAN mode can have multiple logical interfaces.

For encapsulation type **vlan-ccc**, VLAN IDs from 512 through 4094 are reserved for CCC VLANs. For the **extended-vlan-ccc** encapsulation type, all VLAN IDs 1 and higher are valid. VLAN ID 0 is reserved for tagging the priority of frames.

NOTE: Some vendors use the proprietary TPIDs 0x9100 and 0x9901 to encapsulate a VLAN-tagged packet into a VLAN-CCC tunnel to interconnect a geographically separated metro Ethernet network. By configuring the **extended-vlan-ccc** encapsulation type, a Juniper Networks router can accept all three TPIDs (0x8100, 0x9100, and 0x9901).

Configure an Ethernet VLAN circuit with the **vlan-ccc** encapsulation as follows:

```
interfaces {
  type-fpc/pic/port {
    vlan-tagging;
    encapsulation vlan-ccc;
    unit logical-unit-number {
      encapsulation vlan-ccc;
      vlan-id vlan-id;
    }
  }
}
```

You can configure these statements at the following hierarchy levels:

- **[edit interfaces]**
- **[edit logical-systems *logical-system-name* interfaces]**

Configure an Ethernet VLAN circuit with the **extended-vlan-ccc** encapsulation statement as follows:

```
interfaces {
  type-fpc/pic/port {
    vlan-tagging;
    encapsulation extended-vlan-ccc;
    unit logical-unit-number {
      vlan-id vlan-id;
      family ccc;
    }
  }
}
```

You can configure these statements at the following hierarchy levels:

- **[edit interfaces]**
- **[edit logical-systems *logical-system-name* interfaces]**

Whether you configure the encapsulation as **vlan-ccc** or **extended-vlan-ccc**, you must enable VLAN tagging by including the **vlan-tagging** statement.

Configuring Aggregated Ethernet Encapsulation for Layer 2 Switching Cross-Connects

You can configure aggregated Ethernet interfaces for CCC connections and for Layer 2 virtual private networks (VPNs).

Aggregated Ethernet interfaces configured with VLAN tagging can be configured with multiple logical interfaces. The only encapsulation available for aggregated Ethernet logical interfaces is **vlan-ccc**. When you configure the **vlan-id** statement, you are limited to VLAN IDs 512 through 4094.

Aggregated Ethernet interfaces configured without VLAN tagging can be configured only with the **ethernet-ccc** encapsulation. All untagged Ethernet packets received are forwarded based on the CCC parameters.

To configure aggregated Ethernet interfaces for CCC connections, include the **ae0** statement at the **[edit interfaces]** hierarchy level:

```
[edit interfaces]
ae0 {
  encapsulation (ethernet-ccc | extended-vlan-ccc | vlan-ccc);
  vlan-tagging;
  aggregated-ether-options {
    minimum-links links;
    link-speed speed;
  }
  unit logical-unit-number {
    encapsulation vlan-ccc;
    vlan-id identifier;
    family ccc;
  }
}
```

Be aware of the following limitations when configuring CCC connections over aggregated Ethernet interfaces:

- If you configured load balancing between child links, be aware that a different hash key is used to distribute packets among the child links. Standard aggregated interfaces have family inet configured. An IP version 4 (IPv4) hash key (based on the Layer 3 information) is used to distribute packets among the child links. A CCC connection over an aggregated Ethernet interface has family ccc configured instead. Instead of an IPv4 hash key, an MPLS hash key (based on the destination media access control [MAC] address) is used to distributed packets among the child links.
- The extended-vlan-ccc encapsulation is not supported on the 12-port Fast Ethernet PIC and the 48-port Fast Ethernet PIC.
- The Junos OS does not support the Link Aggregation Control Protocol (LACP) when an aggregated interface is configured as a VLAN (with vlan-ccc encapsulation). LACP can be configured only when the aggregated interface is configured with the ethernet-ccc encapsulation.

For more information about how to configure aggregated Ethernet interfaces, see the *Junos OS Network Interfaces Library for Routing Devices*.

Configuring Frame Relay Encapsulation for Layer 2 Switching Cross-Connects

For Frame Relay circuits, specify the encapsulation when configuring the DLCI. Configure each DLCI as a circuit or a regular logical interface. The DLCI for regular interfaces must be from 1 through 511. For CCC interfaces, it must be from 512 through 4094.

```
interfaces {
  type-fpc/pic/port {
    unit logical-unit-number {
      dlci dlci-identifier;
      encapsulation encapsulation-type;
      point-to-point; # Default interface type
    }
  }
}
```

You can configure these statements at the following hierarchy levels:

- **[edit interfaces]**
- **[edit logical-systems *logical-system-name* interfaces]**

Configuring PPP and Cisco HDLC Encapsulation for Layer 2 Switching Cross-Connects

For PPP and Cisco HDLC circuits, specify the encapsulation in the **encapsulation** statement. This statement configures the entire physical device. For these circuits to work, you must configure a logical interface (unit 0).

```
interfaces type-fpc/pic/port {
  encapsulation encapsulation-type;
  unit 0;
}
```

You can configure these statements at the following hierarchy levels:

- **[edit interfaces *type-fpc/pic/port*]**
- **[edit logical-systems *logical-system-name* interfaces *type-fpc/pic/port*]**

Configuring the CCC Connection for Layer 2 Switching Cross-Connects

To configure Layer 2 switching cross-connects, define the connection between the two circuits by including the **interface-switch** statement. You configure this connection on the router that is acting as the switch (Router B in Figure 3 on page 9). The connection joins the interface that comes from the circuit's source to the interface that leads to the circuit's destination. When you specify the interface names, include the logical portion of the name, which corresponds to the logical unit number. The cross-connect is bidirectional, so packets received on the first interface are transmitted out the second interface, and those received on the second interface are transmitted out the first.

```
interface-switch connection-name {
  interface interface-name.unit-number;
  interface interface-name.unit-number;
}
```

You can include this statement at the following hierarchy levels:

- **[edit protocols connections]**
- **[edit logical-systems *logical-system-name* protocols connections]**

Configuring MPLS for Layer 2 Switching Cross-Connects

For Layer 2 switching cross-connects to work, you must enable MPLS on the router by including at least the following statements. This minimum configuration enables MPLS on a logical interface for the switching cross-connect.

Include the **family mpls** statement:

```
family mpls;
```


You can configure this statement at the following hierarchy levels:

- **[edit interfaces *interface-name* unit *logical-unit-number*]**
- **[edit logical-systems *logical-system-name* interfaces *interface-name* unit *logical-unit-number*]**

You can then specify this logical interface in the MPLS protocol configuration:

```
mpls {
  interface interface-name; # Required to enable MPLS on the interface
}
```

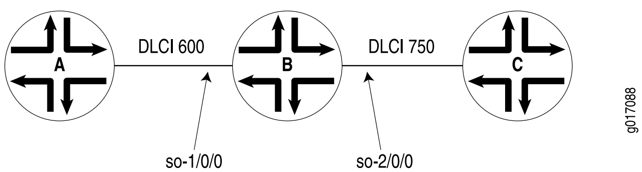
You can configure these statements at the following hierarchy levels:

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

Example: Configuring a Layer 2 Switching Cross-Connect

Configure a full-duplex Layer 2 switching cross-connect between Router A and Router C, using a Juniper Networks router, Router B, as the virtual switch. See the topology in Figure 4 on page 15 and Figure 5 on page 16.

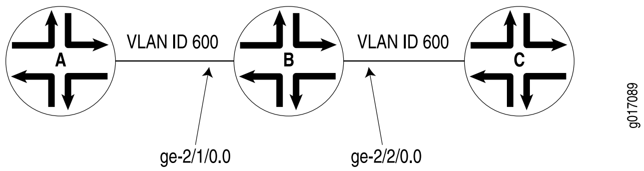
Figure 4: Topology of a Frame Relay Layer 2 Switching Cross-Connect




```
[edit]
interfaces {
  so-1/0/0 {
    encapsulation frame-relay-ccc;
    unit 1 {
      point-to-point;
      encapsulation frame-relay-ccc;
      dlci 600;
    }
  }
  so-2/0/0 {
    encapsulation frame-relay-ccc;
    unit 2 {
      point-to-point;
      encapsulation frame-relay-ccc;
      dlci 750;
    }
  }
}
protocols {
  connections {
    interface-switch router-a-to-router-c {
      interface so-1/0/0.1;
```

```
        interface so-2/0/0.2;
      }
    }
    mpls {
      interface all;
    }
  }
```

Figure 5: Sample Topology of a VLAN Layer 2 Switching Cross-Connect

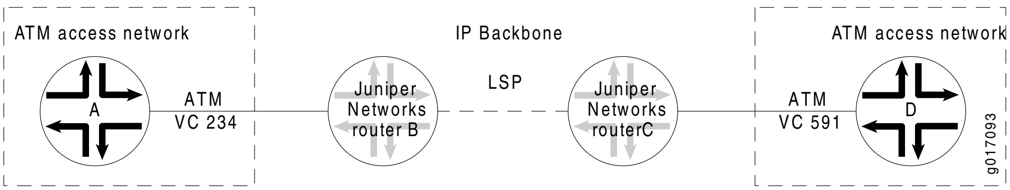



```
[edit]
interfaces {
  ge-2/1/0 {
    vlan-tagging;
    encapsulation vlan-ccc;
    unit 0 {
      encapsulation vlan-ccc;
      vlan-id 600;
    }
  }
  ge-2/2/0 {
    vlan-tagging;
    encapsulation vlan-ccc;
    unit 0 {
      encapsulation vlan-ccc;
      vlan-id 600;
    }
    unit 1 {
      family inet {
        vlan-id 1;
        address 10.9.200.1/24;
      }
    }
  }
}
protocols {
  mpls {
    interface all;
  }
  connections {
    interface-switch layer2-sw {
      interface ge-2/1/0.0;
      interface ge-2/2/0.0;
    }
  }
}
```


Configuring MPLS LSP Tunnel Cross-Connects Using CCC

MPLS tunnel cross-connects between interfaces and LSPs allow you to connect two distant interface circuits of the same type by creating MPLS tunnels that use LSPs as the conduit. The topology in Figure 6 on page 17 illustrates an MPLS LSP tunnel cross-connect. In this topology, two separate networks, in this case ATM access networks, are connected through an IP backbone. CCC allows you to establish an LSP tunnel between the two domains. With LSP tunneling, you tunnel the ATM traffic from one network across a SONET backbone to the second network by using an MPLS LSP.

Figure 6: MPLS Tunnel Cross-Connect



When traffic from Router A (VC 234) reaches Router B, it is encapsulated and placed into an LSP, which is sent through the backbone to Router C. At Router C, the label is removed, and the packets are placed onto the ATM permanent virtual circuit (PVC) (VC 591) and sent to Router D. Similarly, traffic from Router D (VC 591) is sent over an LSP to Router B, then placed on VC 234 to Router A.

You can configure LSP tunnel cross-connect on PPP, Cisco HDLC, Frame Relay, and ATM circuits. In a single cross-connect, only like interfaces can be connected.

When you use MPLS tunnel cross-connects to support IS-IS, you must ensure that the LSP's maximum transmission unit (MTU) can, at a minimum, accommodate a 1492-octet IS-IS protocol data unit (PDU) in addition to the link-level overhead associated with the technology being connected.

For the tunnel cross-connects to work, the IS-IS frame size on the edge routers (Routers A and D in Figure 7 on page 20) must be smaller than the LSP's MTU.

NOTE: **Frame size values do not include the frame check sequence (FCS) or delimiting flags.**

To determine the LSP MTU required to support IS-IS, use the following calculation:

IS-IS MTU (minimum 1492, default 1497) + frame overhead + 4 (MPLS shim header) = Minimum LSP MTU

The framing overhead varies based on the encapsulation being used. The following lists the IS-IS encapsulation overhead values for various encapsulations:

- ATM
  - AAL5 multiplex—8 bytes (RFC 1483)

  - VC multiplex—0 bytes
- Frame Relay
  - Multiprotocol—2 bytes (RFCs 1490 and 2427)
  - VC multiplex—0 bytes
- HDLC—4 bytes
- PPP—4 bytes
- VLAN—21 bytes (802.3/LLC)

For IS-IS to work over VLAN-CCC, the LSP's MTU must be at least 1513 bytes (or 1518 for 1497-byte PDUs). If you increase the size of a Fast Ethernet MTU above the default of 1500 bytes, you might need to explicitly configure jumbo frames on intervening equipment.

To modify the MTU, include the **mtu** statement when configuring the logical interface family at the **[edit interfaces *interface-name* unit *logical-unit-number* encapsulation *family*]** hierarchy level. For more information about setting the MTU, see the *Junos OS Network Interfaces Library for Routing Devices*.

To configure an LSP tunnel cross-connect, you must configure the following on the interdomain router (Router B in Figure 7 on page 20):

- Configuring the CCC Encapsulation for LSP Tunnel Cross-Connects on page 18
- Configuring the CCC Connection for LSP Tunnel Cross-Connects on page 19
- Example: Configuring an LSP Tunnel Cross-Connect on page 20

Configuring the CCC Encapsulation for LSP Tunnel Cross-Connects

To configure LSP tunnel cross-connects, you must configure the CCC encapsulation on the ingress and egress routers (Router B and Router C, respectively, in Figure 7 on page 20).

NOTE: **You cannot configure families on CCC interfaces; that is, you cannot include the family statement at the [edit interfaces *interface-name* unit *logical-unit-number*] hierarchy level.**

For PPP or Cisco HDLC circuits, include the **encapsulation** statement to configure the entire physical device. For these circuits to work, you must configure logical unit 0 on the interface.

```
type-fpc/pic/port {
  encapsulation (ppp-ccc | cisco-hdlc-ccc);
  unit 0;
}
```

You can include these statements at the following hierarchy levels:

- **[edit interfaces]**
- **[edit logical-systems *logical-system-name* interfaces]**

For ATM circuits, specify the encapsulation when configuring the VC by including the following statements. For each VC, you configure whether it is a circuit or a regular logical interface.

```
at-fpc/pic/port {
  atm-options {
    vpi vpi-identifier maximum-vcs maximum-vcs;
  }
  unit logical-unit-number {
    point-to-point; # Default interface type
    encapsulation atm-ccc-vc-mux;
    vci vpi-identifier.vci-identifier;
  }
}
```

You can include these statements at the following hierarchy levels:

- **[edit interfaces]**
- **[edit logical-systems *logical-system-name* interfaces]**

For Frame Relay circuits, include the following statements to specify the encapsulation when configuring the DLCI. For each DLCI, you configure whether it is a circuit or a regular logical interface. The DLCI for regular interfaces must be in the range 1 through 511. For CCC interfaces, it must be in the range 512 through 1022.

```
type-fpc/pic/port {
  encapsulation frame-relay-ccc;
  unit logical-unit-number {
    point-to-point; # default interface type
    encapsulation frame-relay-ccc;
    dlci dlci-identifier;
  }
}
```

You can include these statements at the following hierarchy levels:

- **[edit interfaces]**
- **[edit logical-systems *logical-system-name* interfaces]**

For more information about the **encapsulation** statement, see the *Junos OS Network Interfaces Library for Routing Devices*.

Configuring the CCC Connection for LSP Tunnel Cross-Connects

To configure LSP tunnel cross-connects, include the **remote-interface-switch** statement to define the connection between the two circuits on the ingress and egress routers (Router B and Router C, respectively, in Figure 7 on page 20). The connection joins the interface or LSP that comes from the circuit's source to the interface or LSP that leads to the circuit's destination. When you specify the interface name, include the logical portion of the name, which corresponds to the logical unit number. For the cross-connect to be bidirectional, you must configure cross-connects on two routers.

```
remote-interface-switch connection-name {
  interface interface-name.unit-number;
```



```
    transmit-lsp label-switched-path;
    receive-lsp label-switched-path;
}
```

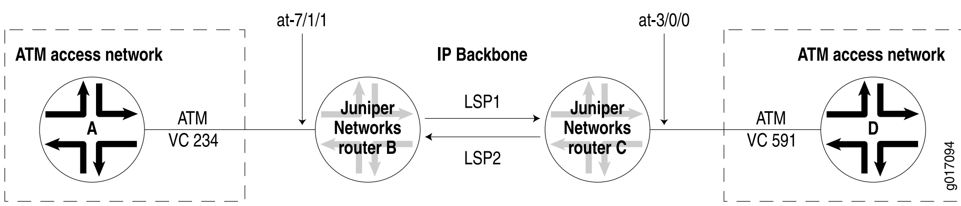
You can include these statements at the following hierarchy levels:

- **[edit protocols connections]**
- **[edit logical-systems *logical-system-name* protocols connections]**

Example: Configuring an LSP Tunnel Cross-Connect

Configure a full-duplex MPLS LSP tunnel cross-connect from Router A to Router D, passing through Router B and Router C. See the topology in Figure 7 on page 20.

Figure 7: Example Topology of MPLS LSP Tunnel Cross-Connect



On Router B:

```
[edit]
interfaces {
    at-7/1/1 {
        atm-options {
            vpi 1 maximum-vcs 600;
        }
        unit 1 {
            point-to-point; # default interface type
            encapsulation atm-ccc-vc-mux;
            vci 1.234;
        }
    }
}
protocols {
    connections {
        remote-interface-switch router-b-to-router-c {
            interface at-7/1/1.1;
            transmit-lsp lsp1;
            receive-lsp lsp2;
        }
    }
}
```

On Router C:

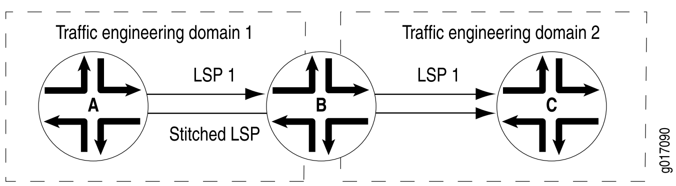
```
[edit]
interfaces {
    at-3/0/0 {
        atm-options {
            vpi 2 maximum-vcs 600;
        }
```

```
        unit 2 {
            point-to-point; # default interface type
            encapsulation atm-ccc-vc-mux;
            vci 2.591;
        }
    }
}
protocols {
    connections {
        remote-interface-switch router-b-to-router-c {
            interface at-3/0/0.2;
            transmit-lsp lsp2;
            receive-lsp lsp1;
        }
    }
}
```

Configuring LSP Stitching Cross-Connects Using CCC

LSP stitching cross-connects "stitch" together LSPs to join two LSPs. For example, they stitch together LSPs that fall in two different traffic engineering database areas. The topology in Figure 8 on page 21 illustrates an LSP stitching cross-connect. In this topology, the network is divided into two traffic engineering domains. CCC allows you to establish an LSP between the two domains by stitching together LSPs from the two domains. For LSP stitching to work, the LSPs must be dynamic LSPs, not static.

Figure 8: LSP Stitching Cross-Connect



Without LSP stitching, a packet traveling from Router A to Router C is encapsulated on Router A (the ingress router for the first LSP), de-encapsulated on Router B (the egress router), and then reencapsulated on Router B (the ingress router for the second LSP). With LSP stitching, you connect LSP1 and LSP2 into a single, stitched LSP, which means that the packet is encapsulated once (on Router A) and de-encapsulated once (on Router C).

You can use LSP stitching to create a seamless LSP for LSPs carrying any kind of traffic.

NOTE: **You cannot configure an LSP stitching cross-connect over an LSP on which you have also configured ultimate-hop popping.**

To configure LSP stitching cross-connects, configure the two LSPs that you are stitching together on the two ingress routers. Then on the interdomain router (Router B in Figure 8 on page 21), you define the connection between the two LSPs. The connection joins the LSP that comes from the connection's source to the LSP that leads to the connection's destination.

```
protocols {
  connections {
    lsp-switch connection-name {
      transmit-lsp label-switched-path;
      receive-lsp label-switched-path;
    }
  }
}
```

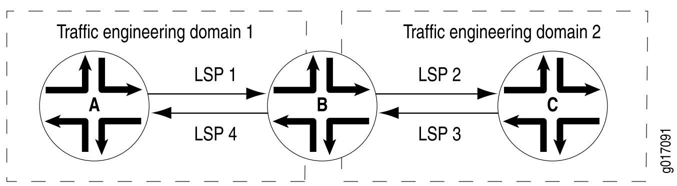
You can configure these statements at the following hierarchy levels:

- **[edit protocols connections]**
- **[edit logical-systems *logical-system-name* protocols connections]**

Example: Configuring an LSP Stitching Cross-Connect

Configure a full-duplex LSP stitching cross-connect between Router A and Router C. To do this, you configure Router B, which is the interdomain router. See the topology in Figure 9 on page 22.

Figure 9: Example Topology of LSP Stitching Cross-Connect




```
[edit]
protocols {
  connections interface-switch {
    lsp-switch router-a-to-router-c {
      transmit-lsp lsp2;
      receive-lsp lsp1;
    }
  }
  connections {
    lsp-switch router-c-to-router-a {
      receive-lsp lsp3;
      transmit-lsp lsp4;
    }
  }
}
```

Related Documentation

Configuring TCC

This section describes how to configure translational cross-connect (TCC). Extensive examples on how to configure TCC for interface switching and for Layer 2.5 VPNs are available in the *Junos OS Feature Guides*.

To configure TCC, you must perform the following tasks on the router that is acting as the switch:

- Configuring the Encapsulation for Layer 2 Switching TCCs on page 23
- Configuring the Connection for Layer 2 Switching TCCs on page 26
- Configuring MPLS for Layer 2 Switching TCCs on page 27

Configuring the Encapsulation for Layer 2 Switching TCCs

To configure a Layer 2 switching TCC, specify the TCC encapsulation on the desired interfaces of the router that is acting as the switch.

NOTE: You cannot configure standard protocol families on TCC or CCC interfaces. Only the CCC family is allowed on CCC interfaces, and only the TCC family is allowed on TCC interfaces.

For Ethernet circuits and Ethernet extended VLAN circuits, you must also configure the Address Resolution Protocol (ARP). See "Configuring ARP for Ethernet and Ethernet Extended VLAN Encapsulations" on page 26.

- Configuring PPP and Cisco HDLC Encapsulation for Layer 2 Switching TCCs on page 23
- Configuring ATM Encapsulation for Layer 2 Switching TCCs on page 23
- Configuring Frame Relay Encapsulation for Layer 2 Switching TCCs on page 24
- Configuring Ethernet Encapsulation for Layer 2 Switching TCCs on page 24
- Configuring Ethernet Extended VLAN Encapsulation for Layer 2 Switching TCCs on page 25
- Configuring ARP for Ethernet and Ethernet Extended VLAN Encapsulations on page 26

Configuring PPP and Cisco HDLC Encapsulation for Layer 2 Switching TCCs

For PPP and Cisco HDLC circuits, configure the encapsulation type for the entire physical device by specifying the appropriate value for the **encapsulation** statement. For these circuits to work, you must also configure the logical interface **unit 0**.

```
encapsulation (ppp-tcc | cisco-hdlc-tcc);
unit 0{...}
```

You can include these statements at the following hierarchy levels:

- **[edit interfaces *interface-name*]**
- **[edit logical-systems *logical-system-name* interfaces *interface-name*]**

Configuring ATM Encapsulation for Layer 2 Switching TCCs

For ATM circuits, configure the encapsulation type by specifying the appropriate value for the **encapsulation** statement in the virtual circuit (VC) configuration. Specify whether each VC is a circuit or a regular logical interface.

```
atm-options {
```



```
    vpi vpi-identifier maximum-vcs maximum-vcs;
  }
  unit logical-unit-number {
    encapsulation (atm-tcc-vc-mux | atm-tcc-snap);
    point-to-point;
    vci vpi-identifier.vci-identifier;
  }
```

You can include these statements at the following hierarchy levels:

- **[edit interfaces at-*fpc/pic/port*]**
- **[edit logical-systems *logical-system-name* interfaces at-*fpc/pic/port*]**

Configuring Frame Relay Encapsulation for Layer 2 Switching TCCs

For Frame Relay circuits, configure the encapsulation type by specifying the value **frame-relay-tcc** for the **encapsulation** statement when configuring the data-link connection identifier (DLCI). You configure each DLCI as a circuit or a regular logical interface. The DLCI for regular interfaces must be in the range from 1 through 511, but for TCC and CCC interfaces it must be in the range from 512 through 1022.

```
  encapsulation frame-relay-tcc;
  unit logical-unit-number {
    dlci dlci-identifier;
    encapsulation frame-relay-tcc;
    point-to-point;
  }
```

You can include these statements at the following hierarchy levels:

- **[edit interfaces *interface-name*]**
- **[edit logical-systems *logical-system-name* interfaces *interface-name*]**

Configuring Ethernet Encapsulation for Layer 2 Switching TCCs

For Ethernet TCC circuits, configuring the encapsulation type for the entire physical device by specifying the value **ethernet-tcc** for the **encapsulation** statement.

You must also specify static values for a remote address and a proxy address at the **[edit interfaces *interface-name* unit *unit-number* family tcc]** or **[edit logical-systems *logical-system-name* interfaces *interface-name* unit *unit-number* family tcc]** hierarchy level.

The remote address is associated with the TCC switching router's Ethernet neighbor; in the **remote** statement you must specify both the IP address and the media access control (MAC) address of the Ethernet neighbor. The proxy address is associated with the TCC router's other neighbor connected by the unlike link; in the **proxy** statement you must specify the IP address of the non-Ethernet neighbor.

You can configure Ethernet TCC encapsulation for the interfaces on 1-port Gigabit Ethernet, 2-port Gigabit Ethernet, 4-port Fast Ethernet, and 4-port Gigabit Ethernet PICs.

```
  encapsulation ethernet-tcc;
  unit logical-unit-number {
```



```
    family tcc {
      proxy {
        inet-address ip-address;
      }
      remote {
        inet-address ip-address;
        mac-address mac-address;
      }
    }
  }
```

You can include these statements at the following hierarchy levels:

- **[edit interfaces (fe | ge)-*fpc/pic/port*]**
- **[edit logical-systems *logical-system-name* interfaces (fe | ge)-*fpc/pic/port*]**

NOTE: For Ethernet circuits, you must also configure the Address Resolution Protocol (ARP). See "Configuring ARP for Ethernet and Ethernet Extended VLAN Encapsulations" on page 26.

Configuring Ethernet Extended VLAN Encapsulation for Layer 2 Switching TCCs

For Ethernet extended VLAN circuits, configure the encapsulation type for the entire physical device by specifying the value **extended-vlan-tcc** for the **encapsulation** statement.

You must also enable VLAN tagging. Ethernet interfaces in VLAN mode can have multiple logical interfaces. With encapsulation type **extended-vlan-tcc**, all VLAN IDs from 0 through 4094 are valid, up to a maximum of 1024 VLANs. As with Ethernet circuits, you must also specify a proxy address and a remote address at the **[edit interfaces *interface-name* unit *logical-unit-number* family tcc]** or **[edit logical-systems *logical-system-name* interfaces *interface-name* unit *unit-number* family tcc]** hierarchy level (see "Configuring Ethernet Encapsulation for Layer 2 Switching TCCs" on page 24).

```
encapsulation extended-vlan-tcc;
vlan-tagging;
unit logical-unit-number {
  vlan-id identifier;
  family tcc;
  proxy {
    inet-address ip-address;
  }
  remote {
    inet-address ip-address;
    mac-address mac-address;
  }
}
```

You can configure these statements at the following hierarchy levels:

- **[edit interfaces *interface-name*]**
- **[edit logical-systems *logical-system-name* interfaces *interface-name*]**

NOTE: For Ethernet extended VLAN circuits, you must also configure the Address Resolution Protocol (ARP). See "Configuring ARP for Ethernet and Ethernet Extended VLAN Encapsulations" on page 26.

Configuring ARP for Ethernet and Ethernet Extended VLAN Encapsulations

For Ethernet and Ethernet extended VLAN circuits with TCC encapsulation, you must also configure ARP. Because TCC simply removes one Layer 2 header and adds another, the default form of dynamic ARP is not supported; you must configure static ARP.

Because remote and proxy addresses are specified on the router performing TCC switching, you must apply the static ARP statement to the Ethernet-type interfaces of the routers that connect to the TCC-switched router. The **arp** statement must specify the IP address and the MAC address of the remotely connected neighbor by use of the unlike Layer 2 protocol on the far side of the TCC switching router.

```
arp ip-address mac mac-address;
```

You can include this statement at the following hierarchy levels:

- **[edit interfaces *interface-name* unit *logical-unit-number* family inet address *ip-address*]**
- **[edit logical-systems *logical-system-name* interfaces *interface-name* unit *logical-unit-number* family inet address *ip-address*]**

Configuring the Connection for Layer 2 Switching TCCs

You must configure the connection between the two circuits of the Layer 2 switching TCC on the router acting as the switch. The connection joins the interface coming from the circuit's source to the interface leading to the circuit's destination. When you specify the interface names, include the logical portion of the name, which corresponds to the logical unit number. The cross-connect is bidirectional, so packets received on the first interface are transmitted from the second interface, and those received on the second interface are transmitted from the first.

To configure a connection for a local interface switch, include the following statements:

```
interface-switch connection-name {
  interface interface-name.unit-number;
}
lsp-switch connection-name {
  transmit-lsp lsp-number;
  receive-lsp lsp-number;
}
```

You can include these statements at the following hierarchy levels:

- **[edit protocols connections]**
- **[edit logical-systems *logical-system-name* protocols connections]**

To configure a connection for a remote interface switch, include the following statements:


```
remote-interface-switch connection-name {
   interface interface-name.unit-number;
   interface interface-name.unit-number;
   transmit-lsp lsp-number;
   receive-lsp lsp-number;
}
```

You can include these statements at the following hierarchy levels:

- **[edit protocols connections]**
- **[edit logical-systems *logical-system-name* protocols connections]**

Configuring MPLS for Layer 2 Switching TCCs

For a Layer 2 switching TCC to work, you must enable MPLS on the router by including at least the following statements. This minimum configuration enables MPLS on a logical interface for the switching cross-connect.

Include the **family mpls** statement:

```
family mpls;
```

You can configure this statement at the following hierarchy levels:

- **[edit interfaces *interface-name* unit *logical-unit-number*]**
- **[edit logical-systems *logical-system-name* interfaces *interface-name* unit *logical-unit-number*]**

You can then specify this logical interface in the MPLS protocol configuration:

```
mpls {
   interface interface-name; # Required to enable MPLS on the interface
}
```

You can configure these statements at the following hierarchy levels:

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

NOTE: MPLS LSP link protection does not support TCC.

Configuring CCC and TCC Graceful Restart

To enable CCC and TCC graceful restart, include the **graceful-restart** statement:

```
graceful-restart;
```

You can include this statement at the following hierarchy levels:

- **[edit routing-options]**
- **[edit logical-systems *logical-system-name* routing-options]**

The **graceful-restart** statement enables graceful restart for all protocols supporting this feature on the router. For more information about graceful restart, see the *Junos OS Routing Protocols Library for Routing Devices*.

CCC and TCC graceful restart depend on RSVP graceful restart. If you disable RSVP graceful restart, CCC and TCC graceful restart will not work. For more information about RSVP graceful restart, see *RSVP Graceful Restart* and *Configuring RSVP Graceful Restart*.

Configuring CCC Switching for Point-to-Multipoint LSPs

You can configure circuit cross-connect (CCC) between two circuits to switch traffic from interfaces to point-to-multipoint LSPs. This feature is useful for handling multicast or broadcast traffic (for example, a digital video stream).

To configure CCC switching for point-to-multipoint LSPs, you do the following:

- On the ingress provider edge (PE) router, you configure CCC to switch traffic from an incoming interface to a point-to-multipoint LSP.
- On the egress PE, you configure CCC to switch traffic from an incoming point-to-multipoint LSP to an outgoing interface.

The CCC connection for point-to-multipoint LSPs is unidirectional.

For more information about point-to-multipoint LSPs, see *Point-to-Multipoint LSPs Overview*.

To configure a CCC connection for a point-to-multipoint LSP, complete the steps in the following sections:

- Configuring the Point-to-Multipoint LSP Switch on Ingress PE Routers on page 28
- Configuring Local Receivers on a Point-to-Multipoint CCC LSP Switch on Ingress PE Routers on page 29
- Configuring the Point-to-Multipoint LSP Switch on Egress PE Routers on page 29

Configuring the Point-to-Multipoint LSP Switch on Ingress PE Routers

To configure the ingress PE router with a CCC switch for a point-to-multipoint LSP, include the **p2mp-transmit-switch** statement:

```
p2mp-transmit-switch switch-name {
  input-interface input-interface-name.unit-number;
  transmit-p2mp-lsp transmitting-lsp;
}
```

You can include the **p2mp-transmit-switch** statement at the following hierarchy levels:

- **[edit protocols connections]**
- **[edit logical-systems *logical-system-name* protocols connections]**

switch-name specifies the name of the ingress CCC switch.

input-interface ***input-interface-name.unit-number*** specifies the name of the ingress interface.

transmit-p2mp-lsp ***transmitting-lsp*** specifies the name of the transmitting point-to-multipoint LSP.

Configuring Local Receivers on a Point-to-Multipoint CCC LSP Switch on Ingress PE Routers

In addition to configuring an incoming CCC interface to a point-to-multipoint LSP on an ingress PE router, you can also configure CCC to switch traffic on an incoming CCC interface to one or more outgoing CCC interfaces by configuring output interfaces as local receivers.

To configure output interfaces, include the **output-interface** statement at the **[edit protocols connections p2mp-transmit-switch *p2mp-transmit-switch-name*]** hierarchy level.

```
[edit protocols connections]
p2mp-transmit-switch pc-ccc {
  input-interface fe-1/3/1.0;
  transmit-p2mp-lsp myp2mp;
  output-interface [fe-1/3/2.0 fe-1/3/3.0];
}
```

You can configure one or more output interfaces as local receivers on the ingress PE router using this statement.

Use the **show connections p2mp-transmit-switch (extensive | history | status)**, **show route ccc <*interface-name*> (detail | extensive)**, and **show route forwarding-table ccc <*interface-name*> (detail | extensive)** commands to view details of the local receiving interfaces on the ingress PE router.

Configuring the Point-to-Multipoint LSP Switch on Egress PE Routers

To configure the CCC switch for a point-to-multipoint LSP on the egress PE router, include the **p2mp-receive-switch** statement.

```
p2mp-receive-switch switch-name {
  output-interface [ output-interface-name.unit-number ];
  receive-p2mp-lsp receptive-lsp;
}
```

You can include this statement at the following hierarchy levels:

- **[edit protocols connections]**
- **[edit logical-systems *logical-system-name* protocols connections]**

switch-name specifies the name of the egress CCC switch.

output-interface [*output-interface-name.unit-number*] specifies the name of one or more egress interfaces.

receive-p2mp-lsp ***receptive-lsp*** specifies the name of the receptive point-to-multipoint LSP.

CHAPTER 3

CCC and TCC Configuration Statements

connections (Circuits)

Syntax

```
connections {
  interface-switch connection-name {
    interface interface-name.unit-number;
  }
  lsp-switch connection-name {
    transmit-lsp label-switched-path;
    receive-lsp label-switched-path;
  }
  p2mp-receive-switch {
    output-interface [ interface-name.unit-number ];
    receive-p2mp-lsp receiving-point-to-multipoint-lsp;
  }
  p2mp-transmit-switch {
    input-interface interface-name.unit-number;
    transmit-p2mp-lsp transmitting-point-to-multipoint-lsp;
  }
  remote-interface-switch connection-name {
    interface interface-name.unit-number;
    receive-lsp label-switched-path;
    transmit-lsp label-switched-path;
  }
}
```

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

Release Information Statement introduced before Junos OS Release 7.4.

Description Define the connection between two circuits in a CCC connection.

Options The statements are explained separately.

NOTE: **The edit logical-systems hierarchy is not available on QFabric systems.**

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

Related Documentation

- Configuring Layer 2 Switching Cross-Connects Using CCC on page 9
- Configuring MPLS LSP Tunnel Cross-Connects Using CCC on page 17
- Configuring LSP Stitching Cross-Connects Using CCC on page 21
- Configuring TCC on page 22
- Configuring CCC Switching for Point-to-Multipoint LSPs on page 28

encapsulation (Logical Interface)

Syntax

encapsulation (atm-ccc-cell-relay | atm-ccc-vc-mux | atm-cisco-nlpid | atm-mlppp-llc | atm-nlpid | atm-ppp-llc | atm-ppp-vc-mux | atm-snap | atm-tcc-snap | atm-tcc-vc-mux | atm-vc-mux | ether-over-atm-llc | ether-vpls-over-atm-llc | ether-vpls-over-fr | ether-vpls-over-ppp | ethernet | ethernet-ccc | ethernet-vpls | ethernet-vpls-fr | frame-relay-ccc | frame-relay-ether-type | frame-relay-ether-type-tcc | frame-relay-ppp | frame-relay-tcc | gre-fragmentation | multilink-frame-relay-end-to-end | multilink-ppp | ppp-over-ether | ppp-over-ether-over-atm-llc | vlan-bridge | vlan-ccc | vlan-vci-ccc | vlan-tcc | vlan-vpls);

Hierarchy Level

[edit interfaces *interface-name* unit *logical-unit-number*],
[edit logical-systems *logical-system-name* interfaces *interface-name* unit *logical-unit-number*],
[edit interfaces rlsq *number* unit *logical-unit-number*]

Release Information

Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 12.1X48 for PTX Series Packet Transport Routers (**vlan-ccc** and **vlan-tcc** options only).
Statement introduced in Junos OS Release 12.2 for the ACX Series Universal Access Routers. Only the **atm-ccc-cell-relay** and **atm-ccc-vc-mux** options are supported on ACX Series routers.

Description

Configure a logical link-layer encapsulation type.

Options

atm-ccc-cell-relay—Use ATM cell-relay encapsulation.

atm-ccc-vc-mux—Use ATM virtual circuit (VC) multiplex encapsulation on CCC circuits. When you use this encapsulation type, you can configure the **ccc** family only.

atm-cisco-nlpid—Use Cisco ATM network layer protocol identifier (NLPID) encapsulation. When you use this encapsulation type, you can configure the **inet** family only.

atm-mlppp-llc—For ATM2 IQ interfaces only, use Multilink Point-to-Point (MLPPP) over AAL5 LLC. For this encapsulation type, your router must be equipped with a Link Services or Voice Services PIC. MLPPP over ATM encapsulation is not supported on ATM2 IQ OC48 interfaces.

atm-nlpid—Use ATM NLPID encapsulation. When you use this encapsulation type, you can configure the **inet** family only.

atm-ppp-llc—(ATM2 IQ interfaces and MX Series routers with MPC/MIC interfaces using the ATM MIC with SFP only) Use PPP over AAL5 LLC encapsulation.

atm-ppp-vc-mux—(ATM2 IQ interfaces and MX Series routers with MPC/MIC interfaces using the ATM MIC with SFP only) Use PPP over ATM AAL5 multiplex encapsulation.

atm-snap—(All interfaces including MX Series routers with MPC/MIC interfaces using the ATM MIC with SFP) Use ATM subnetwork attachment point (SNAP) encapsulation.

atm-tcc-snap—Use ATM SNAP encapsulation on translational cross-connect (TCC) circuits.

atm-tcc-vc-mux—Use ATM VC multiplex encapsulation on TCC circuits. When you use this encapsulation type, you can configure the **tcc** family only.

atm-vc-mux—(All interfaces including MX Series routers with MPC/MIC interfaces using the ATM MIC with SFP) Use ATM VC multiplex encapsulation. When you use this encapsulation type, you can configure the **inet** family only.

ether-over-atm-llc—(All IP interfaces including MX Series routers with MPC/MIC interfaces using the ATM MIC with SFP) For interfaces that carry IP traffic, use Ethernet over ATM LLC encapsulation. When you use this encapsulation type, you cannot configure multipoint interfaces.

ether-vpls-over-atm-llc—For ATM2 IQ interfaces only, use the Ethernet virtual private LAN service (VPLS) over ATM LLC encapsulation to bridge Ethernet interfaces and ATM interfaces over a VPLS routing instance (as described in RFC 2684, *Multiprotocol Encapsulation over ATM Adaptation Layer 5*). Packets from the ATM interfaces are converted to standard ENET2/802.3 encapsulated Ethernet frames with the frame check sequence (FCS) field removed.

ether-vpls-over-fr—For E1, T1, E3, T3, and SONET interfaces only, use the Ethernet virtual private LAN service (VPLS) over Frame Relay encapsulation to support Bridged Ethernet over Frame Relay encapsulated TDM interfaces for VPLS applications, per RFC 2427, *Multiprotocol Interconnect over Frame Relay*.

NOTE: **The SONET/SDH OC3/STM1 (Multi-Rate) MIC with SFP, the Channelized SONET/SDH OC3/STM1 (Multi-Rate) MIC with SFP, and the DS3/E3 MIC do not support Ethernet over Frame Relay encapsulation.**

ether-vpls-over-ppp—For E1, T1, E3, T3, and SONET interfaces only, use the Ethernet virtual private LAN service (VPLS) over Point-to-Point Protocol (PPP) encapsulation to support Bridged Ethernet over PPP-encapsulated TDM interfaces for VPLS applications.

ethernet—Use Ethernet II encapsulation (as described in RFC 894, *A Standard for the Transmission of IP Datagrams over Ethernet Networks*).

ethernet-ccc—Use Ethernet CCC encapsulation on Ethernet interfaces.

ethernet-vpls—Use Ethernet VPLS encapsulation on Ethernet interfaces that have VPLS enabled and that must accept packets carrying standard Tag Protocol ID (TPID) values.

NOTE: **The built-in Gigabit Ethernet PIC on an M7i router does not support extended VLAN VPLS encapsulation.**

ethernet-vpls-fr—Use in a VPLS setup when a CE device is connected to a PE device over a time-division multiplexing (TDM) link. This encapsulation type enables the PE device to terminate the outer layer 2 Frame Relay connection, use the 802.1p bits inside the inner Ethernet header to classify the packets, look at the MAC address from the Ethernet header, and use the MAC address to forward the packet into a given VPLS instance.

frame-relay-ccc—Use Frame Relay encapsulation on CCC circuits. When you use this encapsulation type, you can configure the **ccc** family only.

frame-relay-ether-type—Use Frame Relay ether type encapsulation for compatibility with Cisco Frame Relay. The physical interface must be configured with flexible-frame-relay encapsulation.

frame-relay-ether-type-tcc—Use Frame Relay ether type TCC for Cisco-compatible Frame Relay on TCC circuits to connect different media. The physical interface must be configured with flexible-frame-relay encapsulation.

frame-relay-ppp—Use PPP over Frame Relay circuits. When you use this encapsulation type, you can configure the **ppp** family only. J Series routers do not support frame-relay-ppp encapsulation.

frame-relay-tcc—Use Frame Relay encapsulation on TCC circuits for connecting different media. When you use this encapsulation type, you can configure the **tcc** family only.

gre-fragmentation—For adaptive services interfaces only, use GRE fragmentation encapsulation to enable fragmentation of IPv4 packets in GRE tunnels. This encapsulation clears the do not fragment (DF) bit in the packet header. If the packet's size exceeds the tunnel's maximum transmission unit (MTU) value, the packet is fragmented before encapsulation.

multilink-frame-relay-end-to-end—Use MLFR FRF.15 encapsulation. This encapsulation is used only on multilink, link services, and voice services interfaces and their constituent T1 or E1 interfaces, and is supported on LSQ and redundant LSQ interfaces.

multilink-ppp—Use MLPPP encapsulation. This encapsulation is used only on multilink, link services, and voice services interfaces and their constituent T1 or E1 interfaces.

ppp-over-ether—For underlying Ethernet interfaces on J Series routers, use PPP over Ethernet encapsulation. When you use this encapsulation type, you cannot configure the interface address. Instead, configure the interface address on the PPP interface. You also use PPP over Ethernet encapsulation to configure an underlying Ethernet interface for a dynamic PPPoE logical interface on M120 and M320 routers with Intelligent Queuing 2 (IQ2) PICs, and on MX Series routers with MPCs.

ppp-over-ether-over-atm-llc—(J Series routers and MX Series routers with MPCs using the ATM MIC with SFP only) For underlying ATM interfaces, use PPP over Ethernet over ATM LLC encapsulation. When you use this encapsulation type, you cannot configure the interface address. Instead, configure the interface address on the PPP interface.

vlan-bridge—Use Ethernet VLAN bridge encapsulation on Ethernet interfaces that have IEEE 802.1Q tagging, flexible-ethernet-services, and bridging enabled and that must accept packets carrying TPID 0x8100 or a user-defined TPID.

vlan-ccc—Use Ethernet virtual LAN (VLAN) encapsulation on CCC circuits. When you use this encapsulation type, you can configure the **ccc** family only.

vlan-vci-ccc—Use ATM-to-Ethernet interworking encapsulation on CCC circuits. When you use this encapsulation type, you can configure the **ccc** family only.

vlan-tcc—Use Ethernet VLAN encapsulation on TCC circuits. When you use this encapsulation type, you can configure the **tcc** family only.

vlan-vpls—Use Ethernet VLAN encapsulation on VPLS circuits.

Required Privilege Level

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

Related Documentation

- Configuring Layer 2 Switching Cross-Connects Using CCC on page 9
- Configuring the Encapsulation for Layer 2 Switching TCCs on page 23

- *Configuring Interface Encapsulation on Logical Interfaces*

- Configuring the CCC Encapsulation for LSP Tunnel Cross-Connects on page 18

- *Circuit and Translational Cross-Connects Overview*
- *Identifying the Access Concentrator*
- *Configuring ATM Interface Encapsulation*
- *Configuring VLAN Encapsulation*
- *Configuring Extended VLAN Encapsulation*
- *Configuring ISDN Logical Interface Properties*
- *Configuring ATM-to-Ethernet Interworking*
- *Configuring Interface Encapsulation on PTX Series Packet Transport Routers*
- *Configuring CCC Encapsulation for Layer 2 VPNs*
- *Configuring TCC Encapsulation for Layer 2 VPNs and Layer 2 Circuits*
- *Configuring ATM for Subscriber Access*
- *Junos OS Services Interfaces Library for Routing Devices*
- *CoS on ATM IMA Pseudowire Interfaces Overview*
- *Configuring Policing on an ATM IMA Pseudowire*

encapsulation (Physical Interface)

Syntax encapsulation (atm-ccc-cell-relay | atm-pvc | cisco-hdlc | cisco-hdlc-ccc | cisco-hdlc-tcc | ethernet-bridge | ethernet-ccc | ethernet-over-atm | ethernet-tcc | ethernet-vpls | ethernet-vpls-fr | ether-vpls-over-atm-llc | ethernet-vpls-ppp |extended-frame-relay-ccc | extended-frame-relay-ether-type-tcc | extended-frame-relay-tcc | extended-vlan-bridge | extended-vlan-ccc | extended-vlan-tcc | extended-vlan-vpls | flexible-ethernet-services | flexible-frame-relay | frame-relay | frame-relay-ccc | frame-relay-ether-type | frame-relay-ether-type-tcc | frame-relay-port-ccc | frame-relay-tcc | generic-services | multilink-frame-relay-uni-nni | ppp | ppp-ccc | ppp-tcc | vlan-ccc | vlan-vci-ccc | vlan-vpls);

Hierarchy Level [edit interfaces *interface-name*],
[edit interfaces rlsq *number*:*number*]

Release Information Statement introduced before Junos OS Release 7.4.
Statement introduced in Junos OS Release 11.1 for EX Series switches.
Statement introduced in Junos OS Release 12.1X48 for PTX Series Packet Transport Routers (**flexible-ethernet-services**, **ethernet-ccc**, and **ethernet-tcc** options only).

Description Specify the physical link-layer encapsulation type. Not all encapsulation types are supported on the switches. See the switch CLI.

Default **ppp**—Use serial PPP encapsulation.

Options **atm-ccc-cell-relay**—Use ATM cell-relay encapsulation.

atm-pvc—Use ATM PVC encapsulation.

cisco-hdlc—Use Cisco-compatible High-Level Data Link Control (HDLC) framing.

cisco-hdlc-ccc—Use Cisco-compatible HDLC framing on CCC circuits.

cisco-hdlc-tcc—Use Cisco-compatible HDLC framing on TCC circuits for connecting different media.

ethernet-bridge—Use Ethernet bridge encapsulation on Ethernet interfaces that have bridging enabled and that must accept all packets.

ethernet-ccc—Use Ethernet CCC encapsulation on Ethernet interfaces that must accept packets carrying standard Tag Protocol ID (TPID) values. For 8-port, 12-port, and 48-port Fast Ethernet PICs, CCC is not supported.

ethernet-over-atm—For interfaces that carry IPv4 traffic, use Ethernet over ATM encapsulation. When you use this encapsulation type, you cannot configure multipoint interfaces. As defined in RFC 2684, *Multiprotocol Encapsulation over ATM Adaptation Layer 5*, this encapsulation type allows ATM interfaces to connect to devices that support only bridge protocol data units (BPDUs). Junos OS does not completely support bridging, but accepts BPDU packets as a default gateway. If you use the router as an edge device, then the router acts as a default gateway. It accepts Ethernet LLC/SNAP frames with IP or ARP in the payload, and drops the rest. For packets destined to the Ethernet LAN, a route lookup is done using the destination

IP address. If the route lookup yields a full address match, the packet is encapsulated with an LLC/SNAP and MAC header, and the packet is forwarded to the ATM interface.

ethernet-tcc—For interfaces that carry IPv4 traffic, use Ethernet TCC encapsulation on interfaces that must accept packets carrying standard TPID values. For 8-port, 12-port, and 48-port Fast Ethernet PICs, TCC is not supported.

ethernet-vpls—Use Ethernet VPLS encapsulation on Ethernet interfaces that have VPLS enabled and that must accept packets carrying standard TPID values. On M Series routers, except the M320 router, the 4-port Fast Ethernet TX PIC and the 1-port, 2-port, and 4-port, 4-slot Gigabit Ethernet PICs can use the Ethernet VPLS encapsulation type.

ethernet-vpls-fr—Use in a VPLS setup when a CE device is connected to a PE device over a time division multiplexing (TDM) link. This encapsulation type enables the PE device to terminate the outer layer 2 Frame Relay connection, use the 802.1p bits inside the inner Ethernet header to classify the packets, look at the MAC address from the Ethernet header, and use the MAC address to forward the packet into a given VPLS instance.

ethernet-vpls-ppp—Use in a VPLS setup when a CE device is connected to a PE device over a time division multiplexing (TDM) link. This encapsulation type enables the PE device to terminate the outer layer 2 PPP connection, use the 802.1p bits inside the inner Ethernet header to classify the packets, look at the MAC address from the Ethernet header, and use it to forward the packet into a given VPLS instance.

ether-vpls-over-atm-llc—For ATM intelligent queuing (IQ) interfaces only, use the Ethernet virtual private LAN service (VPLS) over ATM LLC encapsulation to bridge Ethernet interfaces and ATM interfaces over a VPLS routing instance (as described in RFC 2684, *Multiprotocol Encapsulation over ATM Adaptation Layer 5*). Packets from the ATM interfaces are converted to standard ENET2/802.3 encapsulated Ethernet frames with the frame check sequence (FCS) field removed.

extended-frame-relay-ccc—Use Frame Relay encapsulation on CCC circuits. This encapsulation type allows you to dedicate DLCIs 1 through 1022 to CCC.

extended-frame-relay-ether-type-tcc—Use extended Frame Relay ether type TCC for Cisco-compatible Frame Relay for DLCIs 1 through 1022. This encapsulation type is used for circuits with different media on either side of the connection.

extended-frame-relay-tcc—Use Frame Relay encapsulation on TCC circuits to connect different media. This encapsulation type allows you to dedicate DLCIs 1 through 1022 to TCC.

extended-vlan-bridge—Use extended VLAN bridge encapsulation on Ethernet interfaces that have IEEE 802.1Q VLAN tagging and bridging enabled and that must accept packets carrying TPID 0x8100 or a user-defined TPID.

extended-vlan-ccc—Use extended VLAN encapsulation on CCC circuits with Gigabit Ethernet and 4-port Fast Ethernet interfaces that must accept packets carrying 802.1Q values. For 8-port, 12-port, and 48-port Fast Ethernet PICs, extended VLAN CCC is not supported. For 4-port Gigabit Ethernet PICs, extended VLAN CCC is not supported.

extended-vlan-tcc—For interfaces that carry IPv4 traffic, use extended VLAN encapsulation on TCC circuits with Gigabit Ethernet interfaces on which you want to use 802.1Q tagging. For 4-port Gigabit Ethernet PICs, extended VLAN TCC is not supported.

extended-vlan-vpls—Use extended VLAN VPLS encapsulation on Ethernet interfaces that have VLAN 802.1Q tagging and VPLS enabled and that must accept packets carrying TPIDs 0x8100, 0x9100, and 0x9901. On M Series routers, except the M320 router, the 4-port Fast Ethernet TX PIC and the 1-port, 2-port, and 4-port, 4-slot Gigabit Ethernet PICs can use the Ethernet VPLS encapsulation type.

NOTE: **The built-in Gigabit Ethernet PIC on an M7i router does not support extended VLAN VPLS encapsulation.**

flexible-ethernet-services—For Gigabit Ethernet IQ interfaces and Gigabit Ethernet PICs with small form-factor pluggable transceivers (SFPs) (except the 10-port Gigabit Ethernet PIC and the built-in Gigabit Ethernet port on the M7i router), use flexible Ethernet services encapsulation when you want to configure multiple per-unit Ethernet encapsulations. Aggregated Ethernet bundles can use this encapsulation type. This encapsulation type allows you to configure any combination of route, TCC, CCC, Layer 2 virtual private networks (VPNs), and VPLS encapsulations on a single physical port. If you configure flexible Ethernet services encapsulation on the physical interface, VLAN IDs from 1 through 511 are no longer reserved for normal VLANs.

flexible-frame-relay—For IQ interfaces only, use flexible Frame Relay encapsulation when you want to configure multiple per-unit Frame Relay encapsulations. This encapsulation type allows you to configure any combination of TCC, CCC, and standard Frame Relay encapsulations on a single physical port. Also, each logical interface can have any DLCI value from 1 through 1022.

frame-relay—Use Frame Relay encapsulation.

frame-relay-ccc—Use Frame Relay encapsulation on CCC circuits.

frame-relay-ether-type—Use Frame Relay ether type encapsulation for compatibility with the Cisco Frame Relay.

frame-relay-ether-type-tcc—Use Frame Relay ether type TCC for Cisco-compatible Frame Relay on TCC circuits to connect different media.

frame-relay-port-ccc—Use Frame Relay port CCC encapsulation to transparently carry all the DLCIs between two customer edge (CE) routers without explicitly configuring each DLCI on the two provider edge (PE) routers with Frame Relay transport. When you use this encapsulation type, you can configure the **ccc** family only.

frame-relay-tcc—Use Frame Relay encapsulation on TCC circuits to connect different media.

generic-services—Use generic services encapsulation for services with a hierarchical scheduler.

multilink-frame-relay-uni-nni—Use MLFR UNI NNI encapsulation. This encapsulation is used on link services, voice services interfaces functioning as FRF.16 bundles, and their constituent T1 or E1 interfaces, and is supported on LSQ and redundant LSQ interfaces.

ppp—Use serial PPP encapsulation.

ppp-ccc—Use serial PPP encapsulation on CCC circuits. When you use this encapsulation type, you can configure the **ccc** family only.

ppp-tcc—Use serial PPP encapsulation on TCC circuits for connecting different media. When you use this encapsulation type, you can configure the **tcc** family only.

vlan-ccc—Use Ethernet VLAN encapsulation on CCC circuits.

vlan-vci-ccc—Use ATM-to-Ethernet interworking encapsulation on CCC circuits. When you use this encapsulation type, you can configure the **ccc** family only. All logical interfaces configured on the Ethernet interface must also have the encapsulation type set to **vlan-vci-ccc**.

vlan-vpls—Use VLAN VPLS encapsulation on Ethernet interfaces with VLAN tagging and VPLS enabled. Interfaces with VLAN VPLS encapsulation accept packets carrying standard TPID values only. On M Series routers, except the M320 router, the 4-port Fast Ethernet TX PIC and the 1-port, 2-port, and 4-port, 4-slot Gigabit Ethernet PICs can use the Ethernet VPLS encapsulation type.

NOTE: Label-switched interfaces (LSIs) do not support VLAN VPLS encapsulation. Therefore, you can only use VLAN VPLS encapsulation on a PE-router-to-CE-router interface and not a core-facing interface.

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

Related Documentation

- *Configuring Interface Encapsulation on Physical Interfaces*
- *Configuring CCC Encapsulation for Layer 2 VPNs*
- Configuring Layer 2 Switching Cross-Connects Using CCC on page 9
- *Configuring TCC Encapsulation for Layer 2 VPNs and Layer 2 Circuits*
- *Configuring ATM Interface Encapsulation*
- *Configuring ATM-to-Ethernet Interworking*
- *Configuring VLAN Encapsulation*
- *Configuring Extended VLAN Encapsulation*
- *Configuring Encapsulation for Layer 2 Wholesale VLAN Interfaces*
- *Configuring Interfaces for Layer 2 Circuits*
- *Configuring Interface Encapsulation on PTX Series Packet Transport Routers*
- *Configuring an MPLS-Based Layer 2 VPN (CLI Procedure)*
- Configuring MPLS LSP Tunnel Cross-Connects Using CCC on page 17
- Configuring TCC on page 22
- *Configuring VPLS Interface Encapsulation*
- *Configuring Interfaces for VPLS Routing*
- *Defining the Encapsulation for Switching Cross-Connects*
- *Understanding Encapsulation on an Interface*

interface-switch

Syntax

```
interface-switch connection-name {
  interface interface-name.unit-number;
}
```

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

Release Information Statement introduced before Junos OS Release 7.4.

Description Configure Layer 2 switching cross-connects. The cross-connect is bidirectional, so packets received on the first interface are transmitted out the second interface, and those received on the second interface are transmitted out the first.

For Layer 2 switching cross-connects to work, you must also configure MPLS.

Options ***connection-name***—Connection name.

interface *interface-name.unit-number*—Interface name. Include the logical portion of the name, which corresponds to the logical unit number.

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

Related Documentation

- Configuring the CCC Connection for Layer 2 Switching Cross-Connects on page 14
- *Defining the Connection for Switching Cross-Connects*
- *Junos OS MPLS Applications Library for Routing Devices*

output-interface (CCC)

Syntax output-interface [*interface-name 1 interface-name n*];

Hierarchy Level [edit protocols connections p2mp-transmit-switch *p2mp-transmit-switch-name*]

Release Information Statement introduced in Junos OS Release 12.3.

Description Specify one or more output interfaces to switch traffic on an incoming CCC interface to one or more outgoing CCC interfaces.

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

Related Documentation

- Configuring CCC Switching for Point-to-Multipoint LSPs on page 28

lsp-switch

Syntax

```
lsp-switch connection-name {
  transmit-lsp label-switched-path;
  receive-lsp label-switched-path;
}
```

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

Release Information Statement introduced before Junos OS Release 7.4.

Description Configure Layer 2 switching cross-connects.

Options ***connection-name***—Connection name.

receive-lsp *label-switched-path*—Name of the LSP from the connection's source.

transmit-lsp *label-switched-path*—Name of the LSP to the connection's destination.

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

Related Documentation

- Configuring LSP Stitching Cross-Connects Using CCC on page 21
- Configuring the Connection for Layer 2 Switching TCCs on page 26

p2mp-receive-switch

Syntax

```
p2mp-receive-switch point-to-multipoint-switch-name {
  output-interface [ interface-name.unit-number ];
  receive-p2mp-lsp receiving-point-to-multipoint-lsp;
}
```

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

Release Information Statement introduced before Junos OS Release 7.4.

Description Configure the CCC switch for a point-to-multipoint LSP on the egress PE router.

Options ***point-to-multipoint-switch-name***—Point-to-multipoint CCC receive switch name.

output-interface *interface-name.unit-number*—Name of the egress interfaces for the point-to-multipoint LSP traffic. You can configure multiple output interfaces.

receive-p2mp-lsp *receiving-point-to-multipoint-lsp*—Name of the point-to-multipoint LSP that is switched to the output interface.

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

Related Documentation

- Configuring the Point-to-Multipoint LSP Switch on Egress PE Routers on page 29

p2mp-transmit-switch

Syntax

p2mp-transmit-switch *point-to-multipoint-transmit-switch-name* {
  input-interface *interface-name.unit-number*;
  transmit-p2mp-lsp *transmitting-point-to-multipoint-lsp*;
}

Hierarchy Level

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

Release Information

Statement introduced before Junos OS Release 7.4.

Description

Configure the CCC switch for the point-to-multipoint LSP on the ingress PE router.

Options

point-to-multipoint-transmit-switch-name—Point-to-multipoint CCC transmit switch name.

input-interface *input-interface-name.unit-number*—Specify the name of the interface carrying incoming traffic to be switched to the point-to-multipoint LSP.

transmit-p2mp-lsp *transmitting-point-to-multipoint-lsp*—Specify the name of the point-to-multipoint LSP carrying traffic to the CCC switch on the egress PE router.

Required Privilege Level

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

Related Documentation

- Configuring the Point-to-Multipoint LSP Switch on Ingress PE Routers on page 28

remote-interface-switch

Syntax

```
remote-interface-switch connection-name {
  interface interface-name.unit-number;
  transmit-lsp label-switched-path;
  receive-lsp label-switched-path;
}
```

Hierarchy Level

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

Release Information

Statement introduced before Junos OS Release 7.4.

Description

Configure MPLS LSP tunnel cross-connects.

Options

connection-name—Connection name.

interface *interface-name.unit-number*—Interface name. Include the logical portion of the name, which corresponds to the logical unit number.

receive-lsp *label-switched-path*—Name of the LSP from the connection's source.

transmit-lsp *label-switched-path*—Name of the LSP to the connection's destination.

Required Privilege Level

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

Related Documentation

- Configuring MPLS LSP Tunnel Cross-Connects Using CCC on page 17

PART 3

Administration

CHAPTER 4

CCC and TCC Operational Commands

show connections

Syntax

show connections
<brief | extensive>
<all | interface-switch | lsp-switch | p2mp-receive-switch | p2mp-transmit-switch |
remote-interface-switch>
<down | up | up-down>
<history>
<labels>
<logical-system (all | *logical-system-name*)>
<*name*>
<status>

Syntax (EX Series Switches)

show connections
<brief | extensive>
<all | interface-switch | lsp-switch | p2mp-receive-switch | p2mp-transmit-switch |
remote-interface-switch>
<down | up | up-down>
<history>
<labels>
<*name*>
<status>

Release Information

Command introduced before Junos OS Release 7.4.
Command introduced in Junos OS Release 9.5 for EX Series switches.

Description

Display information about the configured circuit cross-connect (CCC) connections.

Options

none—Display the standard level of output for all configured CCC connections.

all—(Optional) Display all connections.

brief | extensive—(Optional) Display the specified level of output. Use history to display information about connection history. Use labels to display labels used for transmit and receive LSPs. Use status to display information about the connection and interface status.

interface-switch—(Optional) Display interface switch connections only.

lsp-switch—(Optional) Display LSP switch connections only.

p2mp-receive-switch—(Optional) Display point-to-multipoint LSP to local interfaces switch connections only.

p2mp-transmit-switch—(Optional) Display local interface to point-to-multipoint LSP switch connections only.

remote-interface-switch—(Optional) Display remote interface switch connections only.

down | up | up-down—(Optional) Display nonoperational, operational, or both kinds of connections.

history—(Optional) Display information about connection history.

labels—(Optional) Display labels used for transmit and receive.

logical-system (all | *logical-system-name*)—(Optional) Perform this operation on all logical systems or on a particular logical system.

name—(Optional) Display information about the specified connection only.

status—(Optional) Display information about the connection and interface status.

Required Privilege Level view

Output Fields Table 3 on page 51 describes the output fields for the **show connections** command. Output fields are listed in the approximate order in which they appear.

Table 3: show connections Output Fields

Field Name	Field Description
CCC and TCC connections [Link Monitoring On I Off]	Whether link monitoring is enabled: **On** or **Off**.
Legend for Status (St)	Connection or circuit status. See the output's legend for an explanation of the status field values.
Legend for connection types	Type of connection: • **if-sw**—Layer 2 switching cross-connect. • **rmt-if**—Remote interface switch. While graceful restart is in progress, **rmt-if** will display a state **(St)** of **Restart**. • **lsp-sw**—LSP stitching cross-connect. While graceful restart is in progress, **lsp-sw** will display a state **(St)** of **Restart**.
Legend for circuit types	Type of circuits: • **intf**—Interface circuit. • **tlsp**—Transmit LSP circuit. • **rlsp**—Receive LSP circuit.
Connection/Circuit	Name of the configured CCC connection.
Type	Type of connection.
St	State of the connection.
Time last up	Time that the connection or circuit last transitioned to the **Up** (operational) state.
# Up trans	Number of times that the connection or circuit has transitioned to the **Up** (operational) state.

Sample Output

show connections

```
user@switch> show connections
CCC and TCC connections [Link Monitoring On]
  Legend for status (St)              Legend for connection types
  UN -- uninitialized                 if-sw:  interface switching
  NP -- not present                   rmt-if: remote interface switching
  WE -- wrong encapsulation           lsp-sw: LSP switching
  DS -- disabled
  Dn -- down                          Legend for circuit types
  -> -- only outbound conn is up      intf -- interface
  <- -- only inbound  conn is up      tlsp -- transmit LSP
  Up -- operational                   rlsp -- receive LSP
  RmtDn -- remote CCC down
  Restart -- restarting

CCC Graceful restart : Restarting

Connection/Circuit                Type    St      Time last up     # Up trans
IFSW-ed                           if-sw   Up      Aug  5 15:39:15           1
  so-1/0/2.0                        intf  Up
  t1-0/1/2.0                        intf  Up
SW-db                             rmt-if  Restart                           0
  so-1/0/3.0                        intf  Up
  pro4-ca                           tlsp  Dn
  pro4-ac                           rlsp  NP
```

show mpls lsp

Syntax

show mpls lsp
<brief | detail | extensive | terse>
<autobandwidth>
<bidirectional | unidirectional>
<bypass>
<count-active-routes>
<defaults>
<descriptions>
<down | up>
<logical-system (all | *logical-system-name*)>
<*lsp-type*>
<name *name*>
<p2mp>
<statistics>
<transit>

Syntax (EX Series Switches)

show mpls lsp
<brief | detail | extensive | terse>
<bidirectional | unidirectional>
<bypass>
<descriptions>
<down | up>
<*lsp-type*>
<name *name*>
<p2mp>
<statistics>
<transit>

Release Information

Command introduced before Junos OS Release 7.4.
defaults option added in Junos OS Release 8.5.
Command introduced in Junos OS Release 9.5 for EX Series switches.
autobandwidth option added in Junos OS Release 11.4.

Description

Display information about configured and active dynamic Multiprotocol Label Switching (MPLS) label-switched paths (LSPs).

Options

none—Display standard information about all configured and active dynamic MPLS LSPs.

brief | detail | extensive | terse—(Optional) Display the specified level of output. The extensive option displays the same information as the detail option, but covers the most recent 50 events.

autobandwidth—(Optional) Display automatic bandwidth information. This option is explained separately (see **show mpls lsp autobandwidth**).

bidirectional | unidirectional—(Optional) Display bidirectional or unidirectional LSP information, respectively.

bypass—(Optional) Display LSPs used for protecting other LSPs.

count-active-routes—(Optional) Display active routes for LSPs.

defaults—(Optional) Display the MPLS LSP default settings.

descriptions—(Optional) Display the MPLS label-switched path (LSP) descriptions. To view this information, you must configure the description statement at the **[edit protocol mpls lsp]** hierarchy level. Only LSPs with a description are displayed. This command is only valid for the ingress routing device, because the description is not propagated in RSVP messages.

down | up—(Optional) Display only LSPs that are inactive or active, respectively.

logical-system (all | ***logical-system-name*****)**—(Optional) Perform this operation on all logical systems or on a particular logical system.

lsp-type—(Optional) Display information about a particular LSP type:

- **bypass**—Sessions for bypass LSPs.
- **egress**—Sessions that terminate on this routing device.
- **ingress**—Sessions that originate from this routing device.
- **transit**—Sessions that pass through this routing device.

name ***name***—(Optional) Display information about the specified LSP or group of LSPs.

p2mp—(Optional) Display information about point-to-multipoint LSPs.

statistics—(Optional) (Ingress and transit routers only) Display accounting information about LSPs. Statistics are not available for LSPs on the egress routing device, because the penultimate routing device in the LSP sets the label to 0. Also, as the packet arrives at the egress routing device, the hardware removes its MPLS header and the packet reverts to being an IPv4 packet. Therefore, it is counted as an IPv4 packet, not an MPLS packet.

NOTE: If a bypass LSP is configured for the primary static LSP, display cumulative statistics of packets traversing through the protected LSP and bypass LSP when traffic is re-optimized when the protected LSP link is restored.

When used with the **bypass** option (**show mpls lsp bypass statistics**), display statistics for the traffic that flows only through the bypass LSP.

transit—(Optional) Display LSPs transiting this routing device.

Required Privilege Level

view

Related Documentation

- *clear mpls lsp*
- *show mpls lsp autobandwidth*

List of Sample Output

Output Fields

Table 4 on page 55 describes the output fields for the **show mpls lsp** command. Output fields are listed in the approximate order in which they appear.

Table 4: show mpls lsp Output Fields

Field Name	Field Description	Level of Output
Ingress LSP	Information about LSPs on the ingress routing device. Each session has one line of output.	All levels
Egress LSP	Information about the LSPs on the egress routing device. MPLS learns this information by querying RSVP, which holds all the transit and egress session information. Each session has one line of output.	All levels
Transit LSP	Number of LSPs on the transit routing devices and the state of these paths. MPLS learns this information by querying RSVP, which holds all the transit and egress session information.	All levels
P2MP name	Name of the point-to-multipoint LSP. Dynamically generated P2MP LSPs used for VPLS flooding use dynamically generated P2MP LSP names. The name uses the format ***identifier*:vpls:*router-id*:*routing-instance-name***. The ***identifier*** is automatically generated by Junos OS.	All levels
P2MP branch count	Number of destination LSPs the point-to-multipoint LSP is transmitting to.	All levels
P	An asterisk (*) under this heading indicates that the LSP is a primary path.	All levels
address	(**detail** and **extensive**) Destination (egress routing device) of the LSP.	**detail extensive**
To	Destination (egress routing device) of the session.	**brief**
From	Source (ingress routing device) of the session.	**brief detail**
State	State of the LSP handled by this RSVP session: **Up**, **Dn** (down), or **Restart**.	**brief detail**
Active Route	Number of active routes (prefixes) installed in the forwarding table. For ingress LSPs, the forwarding table is the primary IPv4 table (**inet.0**). For transit and egress RSVP sessions, the forwarding table is the primary MPLS table (**mpls.0**).	**detail extensive**
Rt	Number of active routes (prefixes) installed in the routing table. For ingress RSVP sessions, the routing table is the primary IPv4 table (**inet.0**). For transit and egress RSVP sessions, the routing table is the primary MPLS table (mpls.0).	**brief**

Table 4: show mpls lsp Output Fields *(continued)*

Field Name	Field Description	Level of Output
P	Path. An asterisk (*****) underneath this column indicates that the LSP is a primary path.	**brief**
ActivePath	(Ingress LSP) Name of the active path: **Primary** or **Secondary**.	**detail extensive**
LSPname	Name of the LSP.	**brief detail**
Statistics	Displays the number of packets and the number of bytes transmitted over the LSP. These counters are reset to zero whenever the LSP path is optimized (for example, during an automatic bandwidth allocation).	**extensive**
Aggregate statistics	Displays the number of packets and the number of bytes transmitted over the LSP. These counters continue to iterate even if the LSP path is optimized. You can reset these counters to zero using the **clear mpls lsp statistics** command.	**extensive**
Packets	Displays the number of packets transmitted over the LSP.	**brief extensive**
Bytes	Displays the number of bytes transmitted over the LSP.	**brief extensive**
DiffServeInfo	Type of LSP: multiclass LSP **(multiclass diffServ-TE LSP)** or Differentiated-Services-aware traffic engineering LSP **(diffServ-TE LSP)**.	**detail**
LSPtype	Type of LSP: static **Static configured** or dynamic **Dynamic configured**. Also indicates if the LSP is a **Penultimate hop popping** LSP or an **Ultimate hop popping** LSP.	**detail extensive**
Bypass	(Bypass LSP) Destination address (egress routing device) for the bypass LSP.	All levels
LSPpath	Indicates whether the RSVP session is for the primary or secondary LSP path. **LSPpath** can be either **primary** or **secondary** and can be displayed on the ingress, egress, and transit routing devices.	**detail**
Bidir	(GMPLS) The LSP allows data to travel in both directions between GMPLS devices.	All levels
Bidirectional	(GMPLS) The LSP allows data to travel both ways between GMPLS devices.	All levels
FastReroute desired	Fast reroute has been requested by the ingress routing device.	**detail**
Link protection desired	Link protection has been requested by the ingress routing device.	**detail**
LoadBalance	(Ingress LSP) CSPF load-balancing rule that was configured to select the LSP's path among equal-cost paths: **Most-fill**, **Least-fill**, or **Random**.	**detail extensive**
Signal type	Signal type for GMPLS LSPs. The signal type determines the peak data rate for the LSP: **DS0**, **DS3**, **STS-1**, **STM-1**, or **STM-4**.	All levels

Table 4: show mpls lsp Output Fields *(continued)*

Field Name	Field Description	Level of Output
Encoding type	LSP encoding type: **Packet**, **Ethernet**, **PDH**, **SDH/SONET**, **Lambda**, or **Fiber**.	All levels
Switching type	Type of switching on the links needed for the LSP: **Fiber**, **Lamda**, **Packet**, **TDM**, or **PSC-1**.	All levels
GPID	Generalized Payload Identifier (identifier of the payload carried by an LSP): **HDLC**, **Ethernet**, **IPv4**, **PPP**, or **Unknown**.	All levels
Protection	Configured protection capability desired for the LSP: **Extra**, **Enhanced**, **none**, **One plus one**, **One to one**, or **Shared**.	All levels
Upstream label in	(Bidirectional LSPs) Incoming label for reverse direction traffic for this LSP.	All levels
Upstream label out	(Bidirectional LSPs) Outgoing label for reverse direction traffic for this LSP.	All levels
Suggested label received	(Bidirectional LSPs) Label the upstream node suggests to use in the Resv message that is sent.	All levels
Suggested label sent	(Bidirectional LSPs) Label the downstream node suggests to use in the Resv message that is returned.	All levels
Autobandwidth	(Ingress LSP) The LSP is performing autobandwidth allocation.	**detail extensive**
MinBW	(Ingress LSP) Configured minimum value of the LSP, in bps.	**detail extensive**
MaxBW	(Ingress LSP) Configured maximum value of the LSP, in bps.	**detail extensive**
Dynamic MinBW	(Ingress LSP) Displays the current dynamically specified minimum bandwidth allocation for the LSP, in bps.	**detail extensive**
Adjustment Timer	(Ingress LSP) Configured value for the **adjust-timer** statement, indicating the total amount of time allowed before bandwidth adjustment will take place, in seconds.	**detail extensive**
Adjustment Threshold	(Ingress LSP) Configured value for the **adjust-threshold** statement. Specifies how sensitive the automatic bandwidth adjustment for an LSP is to changes in bandwidth utilization.	**detail extensive**
Time for Next Adjustment	(Ingress LSP) Time in seconds until the next automatic bandwidth adjustment sample is taken.	**detail extensive**
Time of Last Adjustment	(Ingress LSP) Date and time since the last automatic bandwidth adjustment was completed.	**detail extensive**
Max AvgBW util	(Ingress LSP) Current value of the actual maximum average bandwidth utilization, in bps.	**detail extensive**
Overflow limit	(Ingress LSP) Configured value of the threshold overflow limit.	**detail extensive**

Table 4: show mpls lsp Output Fields *(continued)*

Field Name	Field Description	Level of Output
Overflow sample count	(Ingress LSP) Current value for the overflow sample count.	**detail extensive**
Bandwidth Adjustment in *nnn* second(s)	(Ingress LSP) Current value of the bandwidth adjustment timer, indicating the amount of time remaining until the bandwidth adjustment will take place, in seconds.	**detail extensive**
Underflow limit	(Ingress LSP) Configured value of the threshold underflow limit.	**detail extensive**
Underflow sample count	(Ingress LSP) Current value for the underflow sample count.	**detail extensive**
Underflow Max AvgBW	(Ingress LSP) The highest sample bandwidth among the underflow samples recorded currently. This is the signaling bandwidth if an adjustment occurs because of an underflow.	**detail extensive**
Active path indicator	(Ingress LSP) A value of ***** indicates that the path is active. The absence of ***** indicates that the path is not active. In the following example, "long" is the active path. ***Primary long** **Standby short**	**detail extensive**
Primary	(Ingress LSP) Name of the primary path.	**detail extensive**
Secondary	(Ingress LSP) Name of the secondary path.	**detail extensive**
Standby	(Ingress LSP) Name of the path in standby mode.	**detail extensive**
State	(Ingress LSP) State of the path: **Up** or **Dn** (down).	**detail extensive**
COS	(Ingress LSP) Class-of-service value.	**detail extensive**
Bandwidth per class	(Ingress LSP) Active bandwidth for the LSP path for each MPLS class type, in bps.	**detail extensive**
Priorities	(Ingress LSP) Configured value of the setup priority and the hold priority respecitively (the setup priority is displayed first), where 0 is the highest priority and 7 is the lowest priority. If you have not explicitly configured these values, the default values are displayed (7 for the setup priority and 0 for the hold priority).	**detail extensive**
OptimizeTimer	(Ingress LSP) Configured value of the optimize timer, indicating the total amount of time allowed before path reoptimization, in seconds.	**detail extensive**
SmartOptimizeTimer	(Ingress LSP) Configured value of the smart optimize timer, indicating the total amount of time allowed before path reoptimization, in seconds.	**detail extensive**
Reoptimization in xxx seconds	(Ingress LSP) Current value of the optimize timer, indicating the amount of time remaining until the path will be reoptimized, in seconds.	**detail extensive**

Table 4: show mpls lsp Output Fields *(continued)*

Field Name	Field Description	Level of Output
Computed ERO (S [L] denotes strict [loose] hops)	(Ingress LSP) Computed explicit route. A series of hops, each with an address followed by a hop indicator. The value of the hop indicator can be strict (**S**) or loose (**L**).	**detail extensive**
CSPF metric	(Ingress LSP) Constrained Shortest Path First metric for this path.	**detail extensive**
Received RRO	(Ingress LSP) Received record route. A series of hops, each with an address followed by a flag. (In most cases, the received record route is the same as the computed explicit route. If **Received RRO** is different from **Computed ERO**, there is a topology change in the network, and the route is taking a detour.) The following flags identify the protection capability and status of the downstream node: • **0x01**—Local protection available. The link downstream from this node is protected by a local repair mechanism. This flag can be set only if the Local protection flag was set in the **SESSION_ATTRIBUTE** object of the corresponding Path message. • **0x02**—Local protection in use. A local repair mechanism is in use to maintain this tunnel (usually because of an outage of the link it was routed over previously). • **0x03**—Combination of **0x01** and **0x02**. • **0x04**—Bandwidth protection. The downstream routing device has a backup path providing the same bandwidth guarantee as the protected LSP for the protected section. • **0x08**—Node protection. The downstream routing device has a backup path providing protection against link and node failure on the corresponding path section. If the downstream routing device can set up only a link-protection backup path, the **Local protection available** bit is set but the **Node protection** bit is cleared. • **0x09**—Detour is established. Combination of **0x01** and **0x08**. • **0x10**—Preemption pending. The preempting node sets this flag if a pending preemption is in progress for the traffic engine LSP. This flag indicates to the ingress legacy edge router (LER) of this LSP that it should be rerouted. • **0x20**—Node ID. Indicates that the address specified in the RRO's IPv4 or IPv6 sub-object is a node ID address, which refers to the router address or router ID. Nodes must use the same address consistently. • **0xb**—Detour is in use. Combination of **0x01**, **0x02**, and **0x08**.	**detail extensive**
Index number	(Ingress LSP) Log entry number of each LSP path event. The numbers are in chronological descending order, with a maximum of 50 index numbers displayed.	**extensive**
Date	(Ingress LSP) Date of the LSP event.	**extensive**
Time	(Ingress LSP) Time of the LSP event.	**extensive**
Event	(Ingress LSP) Description of the LSP event.	**extensive**
Created	(Ingress LSP) Date and time the LSP was created.	**extensive**

Table 4: show mpls lsp Output Fields *(continued)*

Field Name	Field Description	Level of Output
Resv style	(Bypass) RSVP reservation style. This field consists of two parts. The first is the number of active reservations. The second is the reservation style, which can be **FF** (fixed filter), **SE** (shared explicit), or **WF** (wildcard filter).	**brief detail extensive**
Labelin	Incoming label for this LSP.	**brief detail**
Labelout	Outgoing label for this LSP.	**brief detail**
LSPname	Name of the LSP.	**brief detail**
Time left	Number of seconds remaining in the lifetime of the reservation.	**detail**
Since	Date and time when the RSVP session was initiated.	**detail**
Tspec	Sender's traffic specification, which describes the sender's traffic parameters.	**detail**
Port number	Protocol ID and sender or receiver port used in this RSVP session.	**detail**
PATH rcvfrom	Address of the previous-hop (upstream) routing device or client, interface the neighbor used to reach this router, and number of packets received from the upstream neighbor.	**detail**
PATH sentto	Address of the next-hop (downstream) routing device or client, interface used to reach this neighbor, and number of packets sent to the downstream routing device.	**detail**
RESV rcvfrom	Address of the previous-hop (upstream) routing device or client, interface the neighbor used to reach this routing device, and number of packets received from the upstream neighbor. The output in this field, which is consistent with that in the **PATH rcvfrom** field, indicates that the RSVP negotiation is complete.	**detail**
Record route	Recorded route for the session, taken from the record route object.	**detail**
Soft preempt	Number of soft preemptions that occurred on a path and when the last soft preemption occurred. Only successful soft preemptions are counted (those that actually resulted in a new path being used).	**detail**
Soft preemption pending	Path is in the process of being soft preempted. This display is removed once the ingress router has calculated a new path.	**detail**

Table 4: show mpls lsp Output Fields *(continued)*

Field Name	Field Description	Level of Output
MPLS-TE LSP Defaults	Default settings for MPLS traffic engineered LSPs: • **LSP Holding Priority**—Determines the degree to which an LSP holds on to its session reservation after the LSP has been set up successfully. • **LSP Setup Priority**—Determines whether a new LSP that preempts an existing LSP can be established. • **Hop Limit**—Specifies the maximum number of routers the LSP can traverse (including the ingress and egress). • **Bandwidth**—Specifies the bandwidth in bits per second for the LSP. • **LSP Retry Timer**—Length of time in seconds that the ingress router waits between attempts to establish the primary path.	**defaults**

The XML tag name of the **bandwidth** tag under the **auto-bandwidth** tag has been updated to **maximum-average-bandwidth** . You can see the new tag when you issue the **show mpls lsp extensive** command with the **| display xml** pipe option. If you have any scripts that use the **bandwidth** tag, ensure that they are updated to **maximum-average-bandwidth**.

Sample Output

show mpls lsp defaults

```
user@host> show mpls lsp defaults
   MPLS-TE LSP Defaults
      LSP Holding Priority      0
      LSP Setup Priority        7
      Hop Limit                 255
      Bandwidth                 0
      LSP Retry Timer           30 seconds
```

show mpls lsp descriptions

```
user@host> show mpls lsp descriptions
Ingress LSP: 3 sessions
To               LSP name                             Description
10.0.0.195       to-sanjose                           to-sanjose-desc
10.0.0.195       to-sanjose-other-desc                other-desc
Total 2 displayed, Up 2, Down 0
```

show mpls lsp detail

```
user@host> show mpls lsp detail
Ingress LSP: 1 sessions

192.168.0.4
  From: 192.168.0.5, State: Up, ActiveRoute: 0, LSPname: E-D
  ActivePath:  (primary)
  LSPtype: Static Configured, Penultimate hop popping
  LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
 *Primary                     State: Up
    Priorities: 7 0
    SmartOptimizeTimer: 180
    Computed ERO (S [L] denotes strict [loose] hops): (CSPF metric: 30)
 10.0.0.18 S 10.0.0.22 S
```

```
    Received RRO (ProtectionFlag 1=Available 2=InUse 4=B/W 8=Node 10=SoftPreempt
 20=Node-ID):
          10.0.0.18 10.0.0.22
Total 1 displayed, Up 1, Down 0

Egress LSP: 1 sessions

192.168.0.5
  From: 192.168.0.4, LSPstate: Up, ActiveRoute: 0
  LSPname: E-D, LSPpath: Primary
  Suggested label received: -, Suggested label sent: -
  Recovery label received: -, Recovery label sent: -
  Resv style: 1 FF, Label in: 3, Label out: -
  Time left:  157, Since: Wed Jul 18 17:55:12 2012
  Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
  Port number: sender 1 receiver 46128 protocol 0
  PATH rcvfrom: 10.0.0.18 (lt-1/2/0.17) 3 pkts
  Adspec: received MTU 1500
  PATH sentto: localclient
  RESV rcvfrom: localclient
  Record route: 10.0.0.22 10.0.0.18 <self>
Total 1 displayed, Up 1, Down 0

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

show mpls lsp extensive

```
user@host> show mpls lsp extensive
Ingress LSP: 1 sessions

192.168.0.4
  From: 192.168.0.5, State: Up, ActiveRoute: 0, LSPname: E-D
  ActivePath:  (primary)
  LSPtype: Static Configured, Ultimate hop popping
  LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
 *Primary                    State: Up
    Priorities: 7 0
    SmartOptimizeTimer: 180
    Computed ERO (S [L] denotes strict [loose] hops): (CSPF metric: 30)
 10.0.0.18 S 10.0.0.22 S
    Received RRO (ProtectionFlag 1=Available 2=InUse 4=B/W 8=Node 10=SoftPreempt
 20=Node-ID):
          10.0.0.18 10.0.0.22
   11 Sep 20 15:54:35.032 Make-before-break: Switched to new instance
   10 Sep 20 15:54:34.029 Record Route:  10.0.0.18 10.0.0.22
    9 Sep 20 15:54:34.029 Up
    8 Sep 20 15:54:20.271 Originate make-before-break call
    7 Sep 20 15:54:20.271 CSPF: computation result accepted  10.0.0.18 10.0.0.22

    6 Sep 20 15:52:10.247 Selected as active path
    5 Sep 20 15:52:10.246 Record Route:  10.0.0.18 10.0.0.22
    4 Sep 20 15:52:10.243 Up
    3 Sep 20 15:52:09.745 Originate Call
    2 Sep 20 15:52:09.745 CSPF: computation result accepted  10.0.0.18 10.0.0.22

    1 Sep 20 15:51:39.903 CSPF failed: no route toward 192.168.0.4
  Created: Thu Sep 20 15:51:08 2012
Total 1 displayed, Up 1, Down 0
```

```
Egress LSP: 1 sessions

192.168.0.5
  From: 192.168.0.4, LSPstate: Up, ActiveRoute: 0
  LSPname: E-D, LSPpath: Primary
  Suggested label received: -, Suggested label sent: -
  Recovery label received: -, Recovery label sent: -
  Resv style: 1 FF, Label in: 3, Label out: -
  Time left:  148, Since: Thu Sep 20 15:52:10 2012
  Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
  Port number: sender 1 receiver 49601 protocol 0
  PATH rcvfrom: 10.0.0.18 (lt-1/2/0.17) 27 pkts
  Adspec: received MTU 1500
  PATH sentto: localclient
  RESV rcvfrom: localclient
  Record route: 10.0.0.22 10.0.0.18 <self>
Total 1 displayed, Up 1, Down 0

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

show mpls lsp ingress extensive

```
user@host> show mpls lsp ingress extensive
Ingress LSP: 1 sessions

50.0.0.1
  From: 10.0.0.1, State: Up, ActiveRoute: 0, LSPname: test
  ActivePath:  (primary)
  LSPtype: Static Configured
  LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
 *Primary                    State: Up
    Priorities: 7 0
    OptimizeTimer: 300
    SmartOptimizeTimer: 180
    Reoptimization in 240 second(s).
    Computed ERO (S [L] denotes strict [loose] hops): (CSPF metric: 3)
 1.1.1.2 S 4.4.4.1 S 5.5.5.2 S
    Received RRO (ProtectionFlag 1=Available 2=InUse 4=B/W 8=Node 10=SoftPreempt
 20=Node-ID):
          1.1.1.2 4.4.4.1 5.5.5.2
   17 Aug  3 13:17:33.601 CSPF: computation result ignored, new path less avail
bw[3 times]
   16 Aug  3 13:02:51.283 CSPF: computation result ignored, new path no benefit[2
 times]
   15 Aug  3 12:54:36.678 Selected as active path
   14 Aug  3 12:54:36.676 Record Route:  1.1.1.2 4.4.4.1 5.5.5.2
   13 Aug  3 12:54:36.676 Up
   12 Aug  3 12:54:33.924 Deselected as active
   11 Aug  3 12:54:33.924 Originate Call
   10 Aug  3 12:54:33.923 Clear Call
    9 Aug  3 12:54:33.923 CSPF: computation result accepted  1.1.1.2 4.4.4.1
5.5.5.2
    8 Aug  3 12:54:33.922 2.2.2.2: No Route toward dest
    7 Aug  3 12:54:28.177 CSPF: computation result ignored, new path no benefit[4
 times]
    6 Aug  3 12:35:03.830 Selected as active path
    5 Aug  3 12:35:03.828 Record Route:  2.2.2.2 3.3.3.2
    4 Aug  3 12:35:03.827 Up
    3 Aug  3 12:35:03.814 Originate Call
```

```
    2 Aug  3 12:35:03.814 CSPF: computation result accepted  2.2.2.2 3.3.3.2
    1 Aug  3 12:34:34.921 CSPF failed: no route toward 50.0.0.1
  Created: Tue Aug  3 12:34:35 2010
Total 1 displayed, Up 1, Down 0
```

show mpls lsp extensive (automatic bandwidth adjustment enabled)

```
user@host> show mpls lsp extensive
Ingress LSP: 1 sessions

192.168.0.4
  From: 192.168.0.5, State: Up, ActiveRoute: 0, LSPname: E-D
  ActivePath:  (primary)
  Node/Link protection desired
  LSPtype: Static Configured, Penultimate hop popping
  LoadBalance: Random
  Autobandwidth
  MinBW: 300bps, MaxBW: 1000bps, Dynamic MinBW: 1000bps
  Adjustment Timer: 300 secs AdjustThreshold: 25%
  Max AvgBW util: 963.739bps, Bandwidth Adjustment in 0 second(s).
  Min BW Adjust Interval: 1000, MinBW Adjust Threshold (in %): 50
  Overflow limit: 0, Overflow sample count: 0
  Underflow limit: 0, Underflow sample count: 9, Underflow Max AvgBW: 614.421bps

  Encoding type: Packet, Switching type: Packet, GPID: IPv4
 *Primary                    State: Up
    Priorities: 7 0
    Bandwidth: 1000bps
    SmartOptimizeTimer: 180
    Computed ERO (S [L] denotes strict [loose] hops): (CSPF metric: 30)
 10.0.0.18 S 10.0.0.22 S
    Received RRO (ProtectionFlag 1=Available 2=InUse 4=B/W 8=Node 10=SoftPreempt
 20=Node-ID):
          192.168.0.6(flag=0x20) 10.0.0.18(Label=299792) 192.168.0.4(flag=0x20)
10.0.0.22(Label=3)
   12 Apr 30 10:25:17.024 Make-before-break: Switched to new instance
   11 Apr 30 10:25:16.023 Record Route:  192.168.0.6(flag=0x20)
10.0.0.18(Label=299792) 192.168.0.4(flag=0x20) 10.0.0.22(Label=3)
   10 Apr 30 10:25:16.023 Up
    9 Apr 30 10:25:16.023 Automatic Autobw adjustment succeeded: BW changes from
 300 bps to 1000 bps
    8 Apr 30 10:25:15.946 Originate make-before-break call
    7 Apr 30 10:25:15.946 CSPF: computation result accepted  10.0.0.18 10.0.0.22

    6 Apr 30 10:16:42.891 Selected as active path
    5 Apr 30 10:16:42.891 Record Route:  192.168.0.6(flag=0x20)
10.0.0.18(Label=299776) 192.168.0.4(flag=0x20) 10.0.0.22(Label=3)
    4 Apr 30 10:16:42.890 Up
    3 Apr 30 10:16:42.828 Originate Call
    2 Apr 30 10:16:42.828 CSPF: computation result accepted  10.0.0.18 10.0.0.22

    1 Apr 30 10:16:14.064 CSPF: could not determine self[2 times]
  Created: Tue Apr 30 10:15:16 2013
Total 1 displayed, Up 1, Down 0

Egress LSP: 0 sessions
Total 0 displayed, Up 0, Down 0

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


show mpls lsp p2mp

```
user@host> show mpls lsp p2mp
Ingress LSP: 2 sessions
P2MP name: p2mp-lsp1, P2MP branch count: 1
To              From            State Rt P ActivePath       LSPname
10.255.245.51   10.255.245.50   Up     0 * path1            p2mp-branch-1
P2MP name: p2mp-lsp2, P2MP branch count: 1
To              From            State Rt P ActivePath       LSPname
10.255.245.51   10.255.245.50   Up     0 * path1            p2mp-st-br1
Total 2 displayed, Up 2, Down 0

Egress LSP: 0 sessions
Total 0 displayed, Up 0, Down 0

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

show mpls lsp p2mp detail

```
user@host> show mpls lsp p2mp detail
Ingress LSP: 2 sessions
P2MP name: p2mp-lsp1, P2MP branch count: 1

10.255.245.51
  From: 10.255.245.50, State: Up, ActiveRoute: 0, LSPname: p2mp-branch-1
  ActivePath: path1 (primary)
  P2MP name: p2mp-lsp1
  LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
 *Primary   path1           State: Up
    Computed ERO (S [L] denotes strict [loose] hops): (CSPF metric: 25)
 192.168.208.17 S
   Received RRO (ProtectionFlag 1=Available 2=InUse 4=B/W 8=Node 10=SoftPreempt):

          192.168.208.17
P2MP name: p2mp-lsp2, P2MP branch count: 1

10.255.245.51
  From: 10.255.245.50, State: Up, ActiveRoute: 0, LSPname: p2mp-st-br1
  ActivePath: path1 (primary)
  P2MP name: p2mp-lsp2
  LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
 *Primary   path1           State: Up
    Computed ERO (S [L] denotes strict [loose] hops): (CSPF metric: 25)
 192.168.208.17 S
   Received RRO (ProtectionFlag 1=Available 2=InUse 4=B/W 8=Node 10=SoftPreempt):

          192.168.208.17
Total 2 displayed, Up 2, Down 0
```

show mpls lsp detail count-active-routes

```
user@host> show mpls lsp detail count-active-routes
Ingress LSP: 1 sessions

213.119.192.2
  From: 156.154.162.128, State: Up, ActiveRoute: 1, LSPname: to-lahore
  ActivePath:  (primary)
  LSPtype: Static Configured
```



```
  LoadBalance: Random
  Autobandwidth
  MinBW: 5Mbps MaxBW: 250Mbps
  Adjustment Timer: 300 secs
  Max AvgBW util: 60.2599Mbps, Bandwidth Adjustment in 0 second(s).
  Overflow limit: 0, Overflow sample count: 0
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
 *Primary                    State: Up
    Priorities: 7 0
    Bandwidth: 5Mbps
    SmartOptimizeTimer: 180
    Computed ERO (S [L] denotes strict [loose] hops): (CSPF metric: 4)
 10.252.0.177 S
    Received RRO (ProtectionFlag 1=Available 2=InUse 4=B/W 8=Node 10=SoftPreempt
 20=Node-ID):
          10.252.0.177
Total 1 displayed, Up 1, Down 0

Egress LSP: 0 sessions
Total 0 displayed, Up 0, Down 0

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

show mpls lsp statistics extensive

```
user@host> show mpls lsp statistics extensive
Ingress LSP: 1 sessions

192.168.0.4
  From: 192.168.0.5, State: Up, ActiveRoute: 0, LSPname: E-D
  Statistics: Packets 302, Bytes 28992
  Aggregate statistics: Packets 302, Bytes 28992
  ActivePath:  (primary)
  LSPtype: Static Configured, Penultimate hop popping
  LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
 *Primary                    State: Up
    Priorities: 7 0
    SmartOptimizeTimer: 180
    Computed ERO (S [L] denotes strict [loose] hops): (CSPF metric: 30)
 10.0.0.18 S 10.0.0.22 S
    Received RRO (ProtectionFlag 1=Available 2=InUse 4=B/W 8=Node 10=SoftPreempt
 20=Node-ID):
          10.0.0.18 10.0.0.22
    6 Oct  3 11:18:28.281 Selected as active path
    5 Oct  3 11:18:28.281 Record Route:  10.0.0.18 10.0.0.22
    4 Oct  3 11:18:28.280 Up
    3 Oct  3 11:18:27.995 Originate Call
    2 Oct  3 11:18:27.995 CSPF: computation result accepted  10.0.0.18 10.0.0.22

    1 Oct  3 11:17:59.118 CSPF failed: no route toward 192.168.0.4[2 times]
  Created: Wed Oct  3 11:17:01 2012
Total 1 displayed, Up 1, Down 0
```


show route ccc

Syntax

show route ccc *ccc*
<brief | detail | extensive | terse>
<logical-system (all | *logical-system-name*)>

Release Information

Command introduced before Junos OS Release 7.4.

Description

Display circuit cross-connect (CCC) entries in the Multiprotocol Link Switching (MPLS) routing table.

Options

ccc—Name of an entry with a circuit cross-connect interface.

brief | detail | extensive | terse—(Optional) Display the specified level of output.

logical-system (all | *logical-system-name*)—(Optional) Perform this operation on all logical systems or on a particular logical system.

Required Privilege Level

view

Related Documentation

- show connections on page 50

List of Sample Output

show route ccc extensive on page 67

Output Fields

For information about output fields, see the output field tables for the *show route* command, the *show route detail* command, the *show route extensive* command, or the *show route terse* command.

Sample Output

show route ccc extensive

```
user@host> show route ccc fe-0/1/0.600 extensive
mpls.0: 19 destinations, 19 routes (19 active, 0 holddown, 0 hidden)
fe-0/1/2.600 (1 entry, 1 announced)
TSI:
KRT in-kernel fe-0/1/2.600.0      /16 -> {0.0.0.0}
        *CCC    Preference: 7
                Next-hop reference count: 2
                Next hop: via so-0/0/3.0 weight 0x1, selected
                Label operation: Push 101424
                State: <Active Int>
                Local AS:   100
                Age: 28:13   Metric: 3
                Task: MPLS
                Announcement bits (1): 0-KRT
                AS path: I
```


show route forwarding-table

Syntax

show route forwarding-table
<detail | extensive | summary>
<all>
<ccc *interface-name*>
<destination *destination-prefix*>
<family *family* | matching *matching*>
<interface-name *interface-name*>
<label *name*>
<matching *matching*>
<multicast>
<table (default | *logical-system-name/routing-instance-name* | *routing-instance-name*)>
<vlan (all | *vlan-name*)>
<vpn *vpn*>

Syntax (MX Series Routers)

show route forwarding-table
<detail | extensive | summary>
<all>
<bridge-domain (all | *domain-name*)>
<ccc *interface-name*>
<destination *destination-prefix*>
<family *family* | matching *matching*>
<interface-name *interface-name*>
<label *name*>
<learning-vlan-id *learning-vlan-id*>
<matching *matching*>
<multicast>
<table (default | *logical-system-name/routing-instance-name* | *routing-instance-name*)>
<vlan (all | *vlan-name*)>
<vpn *vpn*>

Syntax (TX Matrix and TX Matrix Plus Routers)

show route forwarding-table
<detail | extensive | summary>
<all>
<ccc *interface-name*>
<destination *destination-prefix*>
<family *family* | matching *matching*>
<interface-name *interface-name*>
<matching *matching*>
<label *name*>
<lcc *number*>
<multicast>
<table *routing-instance-name*>
<vpn *vpn*>

Release Information

Command introduced before Junos OS Release 7.4.
Option **bridge-domain** introduced in Junos OS Release 7.5
Option **learning-vlan-id** introduced in Junos OS Release 8.4
Options **all** and **vlan** introduced in Junos OS Release 9.6.
Command introduced in Junos OS Release 11.3 for the QFX Series.

Description Display the Routing Engine's forwarding table, including the network-layer prefixes and their next hops. This command is used to help verify that the routing protocol process has relayed the correction information to the forwarding table. The Routing Engine constructs and maintains one or more routing tables. From the routing tables, the Routing Engine derives a table of active routes, called the forwarding table.

NOTE: The Routing Engine copies the forwarding table to the Packet Forwarding Engine, the part of the router that is responsible for forwarding packets. To display the entries in the Packet Forwarding Engine's forwarding table, use the **show pfe route** command.

Options **none**—Display the routes in the forwarding tables. By default, the **show route forwarding-table** command does not display information about private, or internal, forwarding tables.

detail | extensive | summary—(Optional) Display the specified level of output.

all—(Optional) Display routing table entries for all forwarding tables, including private, or internal, tables.

bridge-domain (all | *bridge-domain-name*)—(MX Series routers only) (Optional) Display route entries for all bridge domains or the specified bridge domain.

ccc *interface-name*—(Optional) Display route entries for the specified circuit cross-connect interface.

destination *destination-prefix*—(Optional) Destination prefix.

family *family*—(Optional) Display routing table entries for the specified family: **fibre-channel**, **fmembers**, **inet**, **inet6**, **iso**, **mpls**, **tnp**, **unix**, **vpls**, or **vlan-classification**.

interface-name *interface-name*—(Optional) Display routing table entries for the specified interface.

label *name*—(Optional) Display route entries for the specified label.

lcc *number*—(TX Matrix and TX matrix Plus routers only) (Optional) On a routing matrix composed of a TX Matrix router and T640 routers, display information for the specified T640 router (or line-card chassis) connected to the TX Matrix router. On a routing matrix composed of the TX Matrix Plus router and T1600 or T4000 routers, display information for the specified router (line-card chassis) connected to the TX Matrix Plus router.

Replace *number* with the following values depending on the LCC configuration:

- 0 through 3, when T640 routers are connected to a TX Matrix router in a routing matrix.
- 0 through 3, when T1600 routers are connected to a TX Matrix Plus router in a routing matrix.

- 0 through 7, when T1600 routers are connected to a TX Matrix Plus router with 3D SIBs in a routing matrix.
- 0, 2, 4, or 6, when T4000 routers are connected to a TX Matrix Plus router with 3D SIBs in a routing matrix.

learning-vlan-id ***learning-vlan-id***—(MX Series routers only) (Optional) Display learned information for all VLANs or for the specified VLAN.

matching ***matching***—(Optional) Display routing table entries matching the specified prefix or prefix length.

multicast—(Optional) Display routing table entries for multicast routes.

table (default | ***logical-system-name/routing-instance-name*** **|** ***routing-instance-name*****)**—(Optional) Display route entries for all the routing tables in the main routing instance or for the specified routing instance. If your device supports logical systems, you can also display route entries for the specified logical system and routing instance. To view the routing instances on your device, use the **show route instance** command.

vlan (all | ***vlan-name*****)**—(Optional) Display information for all VLANs or for the specified VLAN.

vpn ***vpn***—(Optional) Display routing table entries for a specified VPN.

Required Privilege Level

view

List of Sample Output

show route forwarding-table on page 73
show route forwarding-table detail on page 74
show route forwarding-table destination extensive (Weights and Balances) on page 74
show route forwarding-table extensive on page 75
show route forwarding-table extensive (RPF) on page 76
show route forwarding-table family mpls on page 77
show route forwarding-table family vpls on page 77
show route forwarding-table family vpls extensive on page 77
show route forwarding-table table default on page 79
show route forwarding-table table logical-system-name/routing-instance-name on page 80
show route forwarding-table vpn on page 80

Output Fields

Table 5 on page 71 lists the output fields for the **show route forwarding-table** command. Output fields are listed in the approximate order in which they appear. Field names might be abbreviated (as shown in parentheses) when no level of output is specified, or when the **detail** keyword is used instead of the **extensive** keyword.

Table 5: show route forwarding-table Output Fields

Field Name	Field Description	Level of Output
Logical system	Name of the logical system. This field is displayed if you specify the **table *logical-system-name/routing-instance-name*** option on a device that is configured for and supports logical systems.	All levels
Routing table	Name of the routing table (for example, inet, inet6, mpls).	All levels
Address family	Address family (for example, **IP**, **IPv6**, **ISO**, **MPLS**, and **VPLS**).	All levels
Destination	Destination of the route.	**detail extensive**
Route Type (Type)	How the route was placed into the forwarding table. When the **detail** keyword is used, the route type might be abbreviated (as shown in parentheses): • **cloned** (**clon**)—(TCP or multicast only) Cloned route. • **destination** (**dest**)—Remote addresses directly reachable through an interface. • **destination down** (**iddn**)—Destination route for which the interface is unreachable. • **interface cloned** (**ifcl**)—Cloned route for which the interface is unreachable. • **route down** (**ifdn**)—Interface route for which the interface is unreachable. • **ignore** (**ignr**)—Ignore this route. • **interface** (**intf**)—Installed as a result of configuring an interface. • **permanent** (**perm**)—Routes installed by the kernel when the routing table is initialized. • **user**—Routes installed by the routing protocol process or as a result of the configuration.	All levels
Route Reference (RtRef)	Number of routes to reference.	**detail extensive**
Flags	Route type flags: • **none**—No flags are enabled. • **accounting**—Route has accounting enabled. • **cached**—Cache route. • **incoming-iface *interface-number***—Check against incoming interface. • **prefix load balance**—Load balancing is enabled for this prefix. • **rt nh decoupled**—Route has been decoupled from the next hop to the destination. • **sent to PFE**—Route has been sent to the Packet Forwarding Engine. • **static**—Static route.	**extensive**
Next hop	IP address of the next hop to the destination.	**detail extensive**

Table 5: show route forwarding-table Output Fields *(continued)*

Field Name	Field Description	Level of Output
Next hop Type (Type)	Next-hop type. When the **detail** keyword is used, the next-hop type might be abbreviated (as indicated in parentheses): • **broadcast (bcst)**—Broadcast. • **deny**—Deny. • **discard (dscd)** —Discard. • **hold**—Next hop is waiting to be resolved into a unicast or multicast type. • **indexed (idxd)**—Indexed next hop. • **indirect (indr)**—Indirect next hop. • **local (locl)**—Local address on an interface. • **routed multicast (mcrt)**—Regular multicast next hop. • **multicast (mcst)**—Wire multicast next hop (limited to the LAN). • **multicast discard (mdsc)**—Multicast discard. • **multicast group (mgrp)**—Multicast group member. • **receive (recv)**—Receive. • **reject (rjct)**—Discard. An ICMP unreachable message was sent. • **resolve (rslv)**—Resolving the next hop. • **unicast (ucst)**—Unicast. • **unilist (ulst)**—List of unicast next hops. A packet sent to this next hop goes to any next hop in the list.	**detail extensive**
Index	Software index of the next hop that is used to route the traffic for a given prefix.	**detail extensive** none
Route interface-index	Logical interface index from which the route is learned. For example, for interface routes, this is the logical interface index of the route itself. For static routes, this field is zero. For routes learned through routing protocols, this is the logical interface index from which the route is learned.	**extensive**
Reference (NhRef)	Number of routes that refer to this next hop.	**detail extensive** none
Next-hop interface (Netif)	Interface used to reach the next hop.	**detail extensive** none
Weight	Value used to distinguish primary, secondary, and fast reroute backup routes. Weight information is available when MPLS label-switched path (LSP) link protection, node-link protection, or fast reroute is enabled, or when the standby state is enabled for secondary paths. A lower weight value is preferred. Among routes with the same weight value, load balancing is possible (see the **Balance** field description).	**extensive**
Balance	Balance coefficient indicating how traffic of unequal cost is distributed among next hops when a router is performing unequal-cost load balancing. This information is available when you enable BGP multipath load balancing.	**extensive**
RPF interface	List of interfaces from which the prefix can be accepted. Reverse path forwarding (RPF) information is displayed only when **rpf-check** is configured on the interface.	**extensive**

Sample Output

show route forwarding-table

```
user@host> show route forwarding-table
Routing table: default.inet
Internet:
Destination        Type RtRef Next hop           Type Index NhRef Netif
default            perm     0                    rjct    46     4
0.0.0.0/32         perm     0                    dscd    44     1
1.1.1.0/24         ifdn     0                    rslv   608     1 ge-2/0/1.0
1.1.1.0/32         iddn     0 1.1.1.0            recv   606     1 ge-2/0/1.0
1.1.1.1/32         user     0                    rjct    46     4
1.1.1.1/32         intf     0 1.1.1.1            locl   607     2
1.1.1.1/32         iddn     0 1.1.1.1            locl   607     2
1.1.1.255/32       iddn     0 ff:ff:ff:ff:ff:ff  bcst   605     1 ge-2/0/1.0
10.0.0.0/24        intf     0                    rslv   616     1 ge-2/0/0.0
10.0.0.0/32        dest     0 10.0.0.0           recv   614     1 ge-2/0/0.0
10.0.0.1/32        intf     0 10.0.0.1           locl   615     2
10.0.0.1/32        dest     0 10.0.0.1           locl   615     2
10.0.0.255/32      dest     0 10.0.0.255         bcst   613     1 ge-2/0/0.0
10.1.1.0/24        ifdn     0                    rslv   612     1 ge-2/0/1.0
10.1.1.0/32        iddn     0 10.1.1.0           recv   610     1 ge-2/0/1.0
10.1.1.1/32        user     0                    rjct    46     4
10.1.1.1/32        intf     0 10.1.1.1           locl   611     2
10.1.1.1/32        iddn     0 10.1.1.1           locl   611     2
10.1.1.255/32      iddn     0 ff:ff:ff:ff:ff:ff  bcst   609     1 ge-2/0/1.0
10.206.0.0/16      user     0 10.209.63.254      ucst   419    20 fxp0.0
10.209.0.0/16      user     1 0:12:1e:ca:98:0    ucst   419    20 fxp0.0
10.209.0.0/18      intf     0                    rslv   418     1 fxp0.0
10.209.0.0/32      dest     0 10.209.0.0         recv   416     1 fxp0.0
10.209.2.131/32    intf     0 10.209.2.131       locl   417     2
10.209.2.131/32    dest     0 10.209.2.131       locl   417     2
10.209.17.55/32    dest     0 0:30:48:5b:78:d2   ucst   435     1 fxp0.0
10.209.63.42/32    dest     0 0:23:7d:58:92:ca   ucst   434     1 fxp0.0
10.209.63.254/32   dest     0 0:12:1e:ca:98:0    ucst   419    20 fxp0.0
10.209.63.255/32   dest     0 10.209.63.255      bcst   415     1 fxp0.0
10.227.0.0/16      user     0 10.209.63.254      ucst   419    20 fxp0.0

...

Routing table: iso
ISO:
Destination        Type RtRef Next hop           Type Index NhRef Netif
default            perm     0                   rjct    27     1
47.0005.80ff.f800.0000.0108.0003.0102.5524.5220.00
intf      0                   locl     28      1

Routing table: inet6
Internet6:
Destination        Type RtRef Next hop           Type Index NhRef Netif
default            perm     0                   rjct     6     1
ff00::/8           perm     0                   mdsc     4     1
ff02::1/128        perm     0 ff02::1           mcst     3     1

Routing table: ccc
MPLS:
Interface.Label    Type RtRef Next hop           Type Index NhRef Netif
```

```
default            perm     0                    rjct 16     1
100004(top)fe-0/0/1.0
```

show route forwarding-table detail

```
user@host> show route forwarding-table detail
Routing table: inet
Internet:
Destination        Type RtRef Next hop           Type Index NhRef Netif
default            user     2 0:90:69:8e:b1:1b   ucst   132     4 fxp0.0
default            perm     0                    rjct    14     1
10.1.1.0/24        intf     0 ff.3.0.21          ucst   322     1 so-5/3/0.0
10.1.1.0/32        dest     0 10.1.1.0           recv   324     1 so-5/3/0.0
10.1.1.1/32        intf     0 10.1.1.1           locl   321     1
10.1.1.255/32      dest     0 10.1.1.255         bcst   323     1 so-5/3/0.0
10.21.21.0/24      intf     0 ff.3.0.21          ucst   326     1 so-5/3/0.0
10.21.21.0/32      dest     0 10.21.21.0         recv   328     1 so-5/3/0.0
10.21.21.1/32      intf     0 10.21.21.1         locl   325     1
10.21.21.255/32    dest     0 10.21.21.255       bcst   327     1 so-5/3/0.0
127.0.0.1/32       intf     0 127.0.0.1          locl   320     1
172.17.28.19/32    clon     1 192.168.4.254      ucst   132     4 fxp0.0
172.17.28.44/32    clon     1 192.168.4.254      ucst   132     4 fxp0.0

...

Routing table: private1__.inet
Internet:
Destination        Type RtRef Next hop           Type Index NhRef Netif
default            perm     0                    rjct    46     1
10.0.0.0/8         intf     0                    rslv   136     1 fxp1.0
10.0.0.0/32        dest     0 10.0.0.0           recv   134     1 fxp1.0
10.0.0.4/32        intf     0 10.0.0.4           locl   135     2
10.0.0.4/32        dest     0 10.0.0.4           locl   135     2

...

Routing table: iso
ISO:
Destination        Type RtRef Next hop           Type Index NhRef Netif
default            perm     0                    rjct    38     1

Routing table: inet6
Internet6:
Destination        Type RtRef Next hop           Type Index NhRef Netif
default            perm     0                    rjct    22     1
ff00::/8           perm     0                    mdsc    21     1
ff02::1/128        perm     0 ff02::1            mcst    17     1

...

Routing table: mpls
MPLS:
Destination        Type RtRef Next hop           Type Index NhRef Netif
default            perm     0                    rjct 28     1
```

show route forwarding-table destination extensive (Weights and Balances)

```
user@host> show route forwarding-table destination 3.4.2.1 extensive
Routing table: inet [Index 0]
Internet:
```



```
Destination:  3.4.2.1/32
  Route type: user
  Route reference: 0                    Route interface-index: 0
  Flags: sent to PFE
  Next-hop type: unilist                Index: 262143   Reference: 1
  Nexthop: 4.4.4.4
  Next-hop type: unicast                Index: 335      Reference: 2
  Next-hop interface: so-1/1/0.0        Weight: 22      Balance: 3
  Nexthop: 145.12.1.2
  Next-hop type: unicast                Index: 337      Reference: 2
  Next-hop interface: so-0/1/2.0        Weight: 33      Balance: 33
```

show route forwarding-table extensive

```
user@host> show route forwarding-table extensive
Routing table: inet [Index 0]
Internet:

Destination:  default
  Route type: user
  Route reference: 2                    Route interface-index: 0
  Flags: sent to PFE
  Nexthop: 0:90:69:8e:b1:1b
  Next-hop type: unicast                Index: 132      Reference: 4
  Next-hop interface: fxp0.0

Destination:  default
  Route type: permanent
  Route reference: 0                    Route interface-index: 0
  Flags: none
  Next-hop type: reject                 Index: 14       Reference: 1

Destination:  127.0.0.1/32
  Route type: interface
  Route reference: 0                    Route interface-index: 0
  Flags: sent to PFE
  Nexthop: 127.0.0.1
  Next-hop type: local                  Index: 320      Reference: 1

...

Routing table: private1__.inet [Index 1]
Internet:

Destination:  default
  Route type: permanent
  Route reference: 0                    Route interface-index: 0
  Flags: sent to PFE
  Next-hop type: reject                 Index: 46       Reference: 1

Destination:  10.0.0.0/8
  Route type: interface
  Route reference: 0                    Route interface-index: 3
  Flags: sent to PFE
  Next-hop type: resolve                Index: 136      Reference: 1
  Next-hop interface: fxp1.0

...

Routing table: iso [Index 0]
ISO:
```

```
Destination:  default
  Route type: permanent
  Route reference: 0                     Route interface-index: 0
  Flags: sent to PFE
  Next-hop type: reject                  Index: 38      Reference: 1

Routing table: inet6 [Index 0]
Internet6:

Destination:  default
  Route type: permanent
  Route reference: 0                     Route interface-index: 0
  Flags: sent to PFE
  Next-hop type: reject                  Index: 22      Reference: 1

Destination:  ff00::/8
  Route type: permanent
  Route reference: 0                     Route interface-index: 0
  Flags: sent to PFE
  Next-hop type: multicast discard       Index: 21      Reference: 1

...

Routing table: private1__.inet6 [Index 1]
Internet6:

Destination:  default
  Route type: permanent
  Route reference: 0                     Route interface-index: 0
  Flags: sent to PFE
  Next-hop type: reject                  Index: 54      Reference: 1

Destination:  fe80::2a0:a5ff:fe3d:375/128
  Route type: interface
  Route reference: 0                     Route interface-index: 0
  Flags: sent to PFE
  Nexthop: fe80::2a0:a5ff:fe3d:375
  Next-hop type: local                   Index: 75      Reference: 1

...
```

show route forwarding-table extensive (RPF)

The next example is based on the following configuration, which enables an RPF check on all routes that are learned from this interface, including the interface route:

```
so-1/1/0 {
    unit 0 {
        family inet {
            rpf-check;
            address 15.95.1.2/30;
        }
    }
}
```

```
user@host> show route forwarding-table extensive
Routing table: inet [Index 0]
Internet:
...
...
```



```
Destination:  15.95.1.3/32
  Route type: destination
  Route reference: 0                   Route interface-index: 67
  Flags: sent to PFE
  Nexthop: 15.95.1.3
  Next-hop type: broadcast             Index: 328      Reference: 1
  Next-hop interface: so-1/1/0.0
  RPF interface: so-1/1/0.0
```

show route forwarding-table family mpls

```
user@host> show route forwarding-table family mpls
Routing table: mpls
MPLS:
Destination        Type RtRef Next hop           Type Index NhRef Netif
default            perm     0                    rjct    19     1
0                  user     0                    recv    18     3
1                  user     0                    recv    18     3
2                  user     0                    recv    18     3
100000             user     0 10.31.1.6          swap  100001     fe-1/1/0.0
800002             user     0                    Pop               vt-0/3/0.32770

vt-0/3/0.32770 (VPLS)
                   user     0                    indr   351     4
                                                 Push 800000, Push 100002(top)
so-0/0/0.0
```

show route forwarding-table family vpls

```
user@host> show route forwarding-table family vpls
Routing table: green.vpls
VPLS:
Destination        Type RtRef Next hop           Type Index NhRef Netif
default            dynm     0                    flood   353     1
default            perm     0                    rjct    298     1
fe-0/1/0.0         dynm     0                    flood   355     1
00:90:69:0c:20:1f/48              <<<<<Remote CE

                   dynm     0                    indr   351     4
                                                 Push 800000, Push 100002(top)
so-0/0/0.0
00:90:69:85:b0:1f/48              <<<<<<Local CE

                   dynm     0                    ucst   354     2 fe-0/1/0.0
```

show route forwarding-table family vpls extensive

```
user@host> show route forwarding-table family vpls extensive
Routing table: green.vpls [Index 2]
VPLS:

Destination:  default
  Route type: dynamic
  Route reference: 0                   Route interface-index: 72
  Flags: sent to PFE
  Next-hop type: flood                 Index: 289      Reference: 1
  Next-hop type: unicast               Index: 291      Reference: 3
  Next-hop interface: fe-0/1/3.0
  Next-hop type: unicast               Index: 290      Reference: 3
  Next-hop interface: fe-0/1/2.0

Destination:  default
```



```
  Route type: permanent
  Route reference: 0                  Route interface-index: 0
  Flags: none
  Next-hop type: discard              Index: 341      Reference: 1

Destination:  fe-0/1/2.0
  Route type: dynamic
  Route reference: 0                  Route interface-index: 69
  Flags: sent to PFE
  Next-hop type: flood                Index: 293      Reference: 1
  Next-hop type: indirect             Index: 363      Reference: 4
  Next-hop type: Push 800016
  Next-hop interface: at-1/0/1.0
  Next-hop type: indirect             Index: 301      Reference: 5
  Next hop: 10.31.3.2
  Next-hop type: Push 800000
  Next-hop interface: fe-0/1/1.0
  Next-hop type: unicast              Index: 291      Reference: 3
  Next-hop interface: fe-0/1/3.0

Destination:  fe-0/1/3.0
  Route type: dynamic
  Route reference: 0                  Route interface-index: 70
  Flags: sent to PFE
  Next-hop type: flood                Index: 292      Reference: 1
  Next-hop type: indirect             Index: 363      Reference: 4
  Next-hop type: Push 800016
  Next-hop interface: at-1/0/1.0
  Next-hop type: indirect             Index: 301      Reference: 5
  Next hop: 10.31.3.2
  Next-hop type: Push 800000
  Next-hop interface: fe-0/1/1.0
  Next-hop type: unicast              Index: 290      Reference: 3
  Next-hop interface: fe-0/1/2.0

Destination:  10:00:00:01:01:01/48
  Route type: dynamic
  Route reference: 0                  Route interface-index: 70
  Flags: sent to PFE, prefix load balance
  Next-hop type: unicast              Index: 291      Reference: 3
  Next-hop interface: fe-0/1/3.0
  Route used as destination:
    Packet count:         6640    Byte count:      675786
  Route used as source
    Packet count:         6894    Byte count:      696424

Destination:  10:00:00:01:01:04/48
  Route type: dynamic
  Route reference: 0                  Route interface-index: 69
  Flags: sent to PFE, prefix load balance
  Next-hop type: unicast              Index: 290      Reference: 3
  Next-hop interface: fe-0/1/2.0
  Route used as destination:
    Packet count:           96    Byte count:        8079
  Route used as source:
    Packet count:          296    Byte count:       24955

Destination:  10:00:00:01:03:05/48
  Route type: dynamic
  Route reference: 0                  Route interface-index: 74
  Flags: sent to PFE, prefix load balance
```



```
Next-hop type: indirect            Index: 301      Reference: 5
Next hop: 10.31.3.2
Next-hop type: Push 800000
Next-hop interface: fe-0/1/1.0
```

show route forwarding-table table default

```
user@host> show route forwarding-table table default
Routing table: default.inet
Internet:
Destination        Type RtRef Next hop           Type Index NhRef Netif
default            perm     0                    rjct    36     2
0.0.0.0/32         perm     0                    dscd    34     1
10.0.60.0/30       user     0 10.0.60.13         ucst   713     5 fe-0/1/3.0
10.0.60.12/30      intf     0                    rslv   688     1 fe-0/1/3.0
10.0.60.12/32      dest     0 10.0.60.12         recv   686     1 fe-0/1/3.0
10.0.60.13/32      dest     0 0:5:85:8b:bc:22    ucst   713     5 fe-0/1/3.0
10.0.60.14/32      intf     0 10.0.60.14         locl   687     2
10.0.60.14/32      dest     0 10.0.60.14         locl   687     2
10.0.60.15/32      dest     0 10.0.60.15         bcst   685     1 fe-0/1/3.0
10.0.67.12/30      user     0 10.0.60.13         ucst   713     5 fe-0/1/3.0
10.0.80.0/30       ifdn     0 ff.3.0.21          ucst   676     1 so-0/0/1.0
10.0.80.0/32       dest     0 10.0.80.0          recv   678     1 so-0/0/1.0
10.0.80.2/32       user     0                    rjct    36     2
10.0.80.2/32       intf     0 10.0.80.2          locl   675     1
10.0.80.3/32       dest     0 10.0.80.3          bcst   677     1 so-0/0/1.0
10.0.90.12/30      intf     0                    rslv   684     1 fe-0/1/0.0
10.0.90.12/32      dest     0 10.0.90.12         recv   682     1 fe-0/1/0.0
10.0.90.14/32      intf     0 10.0.90.14         locl   683     2
10.0.90.14/32      dest     0 10.0.90.14         locl   683     2
10.0.90.15/32      dest     0 10.0.90.15         bcst   681     1 fe-0/1/0.0
10.5.0.0/16        user     0 192.168.187.126    ucst   324    15 fxp0.0
10.10.0.0/16       user     0 192.168.187.126    ucst   324    15 fxp0.0
10.13.10.0/23      user     0 192.168.187.126    ucst   324    15 fxp0.0
10.84.0.0/16       user     0 192.168.187.126    ucst   324    15 fxp0.0
10.150.0.0/16      user     0 192.168.187.126    ucst   324    15 fxp0.0
10.157.64.0/19     user     0 192.168.187.126    ucst   324    15 fxp0.0
10.209.0.0/16      user     0 192.168.187.126    ucst   324    15 fxp0.0

...

Routing table: default.iso
ISO:
Destination        Type RtRef Next hop           Type Index NhRef Netif
default            perm     0                    rjct    60     1

Routing table: default.inet6
Internet6:
Destination        Type RtRef Next hop           Type Index NhRef Netif
default            perm     0                    rjct    44     1
::/128             perm     0                    dscd    42     1
ff00::/8           perm     0                    mdsc    43     1
ff02::1/128        perm     0 ff02::1            mcst    39     1

Routing table: default.mpls
MPLS:
Destination        Type RtRef Next hop           Type Index NhRef Netif
default            perm     0                    dscd    50     1
```

show route forwarding-table table logical-system-name/routing-instance-name

```
user@host> show route forwarding-table table R4/vpn-red
Logical system: R4
Routing table: vpn-red.inet
Internet:
Destination        Type RtRef Next hop           Type Index NhRef Netif
default            perm     0                    rjct   563     1
0.0.0.0/32         perm     0                    dscd   561     2
1.0.0.1/32         user     0                    dscd   561     2
2.0.2.0/24         intf     0                    rslv   771     1 ge-1/2/0.3
2.0.2.0/32         dest     0 2.0.2.0            recv   769     1 ge-1/2/0.3
2.0.2.1/32         intf     0 2.0.2.1            locl   770     2
2.0.2.1/32         dest     0 2.0.2.1            locl   770     2
2.0.2.2/32         dest     0 0.4.80.3.0.1b.c0.d5.e4.bd.0.1b.c0.d5.e4.bc.8.0
                                                 ucst   789     1 ge-1/2/0.3
2.0.2.255/32       dest     0 2.0.2.255          bcst   768     1 ge-1/2/0.3
224.0.0.0/4        perm     1                    mdsc   562     1
224.0.0.1/32       perm     0 224.0.0.1          mcst   558     1
255.255.255.255/32 perm     0                    bcst   559     1

Logical system: R4
Routing table: vpn-red.iso
ISO:
Destination        Type RtRef Next hop           Type Index NhRef Netif
default            perm     0                    rjct   608     1

Logical system: R4
Routing table: vpn-red.inet6
Internet6:
Destination        Type RtRef Next hop           Type Index NhRef Netif
default            perm     0                    rjct   708     1
::/128             perm     0                    dscd   706     1
ff00::/8           perm     0                    mdsc   707     1
ff02::1/128        perm     0 ff02::1            mcst   704     1

Logical system: R4
Routing table: vpn-red.mpls
MPLS:
Destination        Type RtRef Next hop           Type Index NhRef Netif
default            perm     0                    dscd   638
```

show route forwarding-table vpn

```
user@host> show route forwarding-table vpn VPN-A
      Routing table:: VPN-A.inet
Internet:
      Destination        Type RtRef Nexthop          Type Index NhRef Netif
      default            perm     0                  rjct     4     4
      10.39.10.20/30     intf     0 ff.3.0.21        ucst    40     1
      so-0/0/0.0
      10.39.10.21/32     intf     0 10.39.10.21      locl    36     1
      10.255.14.172/32   user     0                  ucst    69     2
      so-0/0/0.0
      10.255.14.175/32   user     0                  indr    81     3
                                                     Push 100004, Push
      100004(top) so-1/0/0.0
      224.0.0.0/4        perm     2                  mdsc     5     3
      224.0.0.1/32       perm     0 224.0.0.1        mcst     1     8
```



```
224.0.0.5/32       user     1 224.0.0.5         mcst     1     8
255.255.255.255/32 perm     0                   bcst     2     3
```

PART 4

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