JUNIPER NETWORKS

Junos® OS

MPLS Network Operations Guide

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Juniper Networks, Inc.
1194 North Mathilda Avenue
Sunnyvale, California 94089
USA
408-745-2000
www.juniper.net

Junos® OS MPLS Network Operations Guide

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YEAR 2000 NOTICE

Juniper Networks hardware and software products are Year 2000 compliant. The 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 This Guide

This preface provides the following guidelines for using the *Junos® operating system (Junos OS) MPLS Network Operations Guide*:

Objectives

This guide provides descriptions of the tasks you need to perform to configure, monitor, and troubleshoot an example MPLS network. This guide is not directly related to any particular release of the Junos operating system (Junos OS).

For information about configuration statements and guidelines related to the commands described in this reference, see the following configuration guides:

- *Junos OS MPLS Applications Configuration Guide*—Provides an overview of traffic engineering concepts and describes how to configure traffic engineering protocols..
- *Junos OS Feature Guide*—Provides a detailed explanation and configuration examples for several of the most complex features in the Junos OS.

For information about related tasks performed by Network Operations Center (NOC) personnel, see the following network operations guides:

- *Junos OS MPLS Fast Reroute Network Operations Guide*
- *Junos OS MPLS Log Reference Network Operations Guide*
- *Junos OS Baseline Network Operations Guide*
- *Junos OS Interfaces Network Operations Guide*

NOTE: To obtain the most current version of this manual, see the product documentation page on the Juniper Networks Web site, located at http://www.juniper.net/.

Audience

This guide is designed for Network Operations Center (NOC) personnel who monitor a Juniper Networks M Series or T Series routing platform.

To use this guide, you need a broad understanding of networks in general, the Internet in particular, networking principles, and network configuration. You must also be familiar with one or more of the following Internet routing protocols:

- Border Gateway Protocol (BGP)
- Routing Information Protocol (RIP)
- Intermediate System-to-Intermediate System (IS-IS)
- Open Shortest Path First (OSPF)
- Internet Control Message Protocol (ICMP) router discovery
- Internet Group Management Protocol (IGMP)
- Distance Vector Multicast Routing Protocol (DVMRP)
- Protocol-Independent Multicast (PIM)
- Multiprotocol Label Switching (MPLS)
- Resource Reservation Protocol (RSVP)
- Simple Network Management Protocol (SNMP)

Supported Routing Platforms

For the features described in this manual, Junos OS currently supports the following routing platforms:

- M Series
- T Series

Using the Index

This guide contains a complete index. For a list and description of glossary terms, see the *Junos OS Comprehensive Index and Glossary*.

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. 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 *Junos OS CLI User Guide*.

Document Conventions

Table 1 on page xx 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 xx 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)*

Convention	Description	Examples
Italic text like this	• Introduces important new terms. • Identifies book names. • Identifies RFC and Internet draft titles.	• A policy *term* is a named structure that defines match conditions and actions. • *Junos OS System Basics Configuration Guide* • RFC 1997, *BGP Communities Attribute*
Italic text like this	Represents variables (options for which you substitute a value) in commands or configuration statements.	Configure the machine's domain name: [edit] root@# **set system domain-name** *domain-name*
Text like this	Represents names of configuration statements, commands, files, and directories; IP addresses; configuration hierarchy levels; or labels on routing platform components.	• To configure a stub area, include the **stub** statement at the **[edit protocols ospf area area-id]** hierarchy level. • The console port is labeled **CONSOLE**.
< > (angle brackets)	Enclose optional keywords or variables.	**stub** <**default-metric** *metric*>**;**
| (pipe symbol)	Indicates a choice between the mutually exclusive keywords or variables on either side of the symbol. The set of choices is often enclosed in parentheses for clarity.	**broadcast | multicast** (***string1*** **|** ***string2*** **|** ***string3***)
# (pound sign)	Indicates a comment specified on the same line as the configuration statement to which it applies.	**rsvp { # Required for dynamic MPLS only**
[ ] (square brackets)	Enclose a variable for which you can substitute one or more values.	**community name members [** *community-ids* **]**

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

; (semicolon)	Identifies a leaf statement at a configuration hierarchy level.	
J-Web GUI Conventions		
Bold text like this	Represents J-Web graphical user interface (GUI) items you click or select.	• In the Logical Interfaces box, select **All Interfaces**. • To cancel the configuration, click **Cancel**.
> (bold right angle bracket)	Separates levels in a hierarchy of J-Web selections.	In the configuration editor hierarchy, select **Protocols>Ospf**.

List of Technical Publications

Table 3 on page xxii lists the software and hardware guides and release notes for Juniper Networks M-series, MX-series, and T-series routing platforms and describes the contents of each document. Table 4 on page xxiii lists the books included in the *Network Operations Guide* series. Table 5 on page xxiv lists the manuals and release notes supporting Junos OS for J-series and SRX-series platforms. All documents are available at http://www.juniper.net/techpubs/.

Table 6 on page xxv lists additional books on Juniper Networks solutions that you can order through your bookstore. A complete list of such books is available at http://www.juniper.net/books.

Table 3: Technical Documentation for Supported Routing Platforms

Book	Description
Hardware Documentation	
Hardware Guide	Describes how to install, maintain, and troubleshoot routing platforms and components. Each platform has its own hardware guide.
PIC Guide	Describes the routing platform's Physical Interface Cards (PICs). Each platform has its own PIC guide.
DPC Guide	Describes the Dense Port Concentrators (DPCs) for all MX-series routers.
Junos Scope Documentation	
Junos Scope Software User Guide	Describes the Junos Scope software graphical user interface (GUI), how to install and administer the software, and how to use the software to manage routing platform configuration files and monitor routing platform operations.
Advanced Insight Solutions (AIS) Documentation	
Advanced Insight Solutions Guide	Describes the Advanced Insight Manager (AIM) application, which provides a gateway between Junos devices and Juniper Support Systems (JSS) for case management and intelligence updates. Explains how to run AI-Scripts on Juniper Networks devices.
Release Notes	
Junos OS Release Notes	Summarize new features and known problems for a particular software release, provide corrections and updates to published Junos, Junos XML protocol, and NETCONF manuals, provide information that might have been omitted from the manuals, and describe upgrade and downgrade procedures.
Hardware Release Notes	Describe the available documentation for the routing platform and summarize known problems with the hardware and accompanying software. Each platform has its own release notes.

Table 3: Technical Documentation for Supported Routing Platforms *(continued)*

Book	Description
Junos Scope Release Notes	Contain corrections and updates to the published Junos Scope manual, provide information that might have been omitted from the manual, and describe upgrade and downgrade procedures.
AIS Release Notes	Summarize AIS new features and guidelines, identify known and resolved problems, provide information that might have been omitted from the manuals, and provide initial setup, upgrade, and downgrade procedures.
AIS AI-Scripts Release Notes	Summarize AI-Scripts new features, identify known and resolved problems, provide information that might have been omitted from the manuals, and provide instructions for automatic and manual installation, including deleting and rolling back.

Table 4: Junos OS Network Operations Guides

Book	Description
Baseline	Describes the most basic tasks for running a network using Juniper Networks products. Tasks include upgrading and reinstalling Junos OS, gathering basic system management information, verifying your network topology, and searching log messages.
Interfaces	Describes tasks for monitoring interfaces. Tasks include using loopback testing and locating alarms.
MPLS	Describes tasks for configuring, monitoring, and troubleshooting an example MPLS network. Tasks include verifying the correct configuration of the MPLS and RSVP protocols, displaying the status and statistics of MPLS running on all routing platforms in the network, and using the layered MPLS troubleshooting model to investigate problems with an MPLS network.
MPLS Log Reference	Describes MPLS status and error messages that appear in the output of the **show mpls lsp extensive** command. The guide also describes how and when to configure Constrained Shortest Path First (CSPF) and RSVP trace options, and how to examine a CSPF or RSVP failure in a sample network.
MPLS Fast Reroute	Describes operational information helpful in monitoring and troubleshooting an MPLS network configured with fast reroute (FRR) and load balancing.
Hardware	Describes tasks for monitoring M-series and T-series routing platforms.

To configure and operate a J-series Services Router or an SRX-series Services Gateway running Junos OS, you must also use the configuration statements and operational mode commands documented in Junos configuration guides and command references. To

configure and operate a WX Integrated Services Module, you must also use WX documentation.

Table 5: Junos OS for J-series Services Routers and SRX-series Services Gateways Documentation

Book	Description
J-series and SRX-series Platforms	
Junos OS Interfaces and Routing Configuration Guide	Explains how to configure SRX-series and J-series interfaces for basic IP routing with standard routing protocols, ISDN service, firewall filters (access control lists), and class-of-service (CoS) traffic classification.
Junos OS Security Configuration Guide	Explains how to configure and manage SRX-series and J-series security services such as stateful firewall policies, IPsec VPNs, firewall screens, Network Address Translation (NAT), Public Key Cryptography, chassis clusters, Application Layer Gateways (ALGs), and Intrusion Detection and Prevention (IDP).
Junos OS Administration Guide for Security Devices	Shows how to monitor SRX-series and J-series devices and routing operations, firewall and security services, system alarms and events, and network performance. This guide also shows how to administer user authentication and access, upgrade software, and diagnose common problems.
Junos OS CLI Reference	Provides the complete configuration hierarchy available on SRX-series and J-series devices. This guide also describes the configuration statements and operational mode commands unique to these devices.
Network and Security Manager: Configuring J Series Services Routers and SRX Series Services Gateways Guide	Explains how to configure, manage, and monitor J-series Services Routers and SRX-series services gateways through NSM.
Junos OS Release Notes	Summarize new features and known problems for a particular release of Junos OS, including Junos OS for J-series and SRX-series devices.The release notes also contain corrections and updates to the manuals and software upgrade and downgrade instructions for Junos OS.
J-series Only	
Junos OS Design and Implementation Guide	Provides guidelines and examples for designing and implementing IPsec VPNs, firewalls, and routing on J-series Services Routers running Junos OS.
J Series Services Routers Quick Start	Explains how to quickly set up a J-series Services Router. This document contains router declarations of conformity.
JUNOS Software with Enhanced Services J-series Services Router Hardware Guide	Provides an overview, basic instructions, and specifications for J-series Services Routers. This guide explains how to prepare a site, unpack and install the router, replace router hardware, and establish basic router connectivity. This guide contains hardware descriptions and specifications.

Table 5: Junos OS for J-series Services Routers and SRX-series Services Gateways Documentation *(continued)*

Book	Description
Junos OS Migration Guide	Provides instructions for migrating an SSG device running ScreenOS software to Junos OS or upgrading a J-series device to a later version of the Junos OS.
WXC Integrated Services Module Installation and Configuration Guide	Explains how to install and initially configure a WXC Integrated Services Module in a J-series Services Router for application acceleration.

Table 6: Additional Books Available Through http://www.juniper.net/books

Book	Description
Interdomain Multicast Routing	Provides background and in-depth analysis of multicast routing using Protocol Independent Multicast sparse mode (PIM SM) and Multicast Source Discovery Protocol (MSDP); details any-source and source-specific multicast delivery models; explores multiprotocol BGP (MBGP) and multicast IS-IS; explains Internet Gateway Management Protocol (IGMP) versions 1, 2, and 3; lists packet formats for IGMP, PIM, and MSDP; and provides a complete glossary of multicast terms.
Junos Cookbook	Provides detailed examples of common Junos OS configuration tasks, such as basic router configuration and file management, security and access control, logging, routing policy, firewalls, routing protocols, MPLS, and VPNs.
MPLS-Enabled Applications	Provides an overview of Multiprotocol Label Switching (MPLS) applications (such as Layer 3 virtual private networks [VPNs], Layer 2 VPNs, virtual private LAN service [VPLS], and pseudowires), explains how to apply MPLS, examines the scaling requirements of equipment at different points in the network, and covers the following topics: point-to-multipoint label switched paths (LSPs), DiffServ-aware traffic engineering, class of service, interdomain traffic engineering, path computation, route target filtering, multicast support for Layer 3 VPNs, and management and troubleshooting of MPLS networks.
OSPF and IS-IS: Choosing an IGP for Large-Scale Networks	Explores the full range of characteristics and capabilities for the two major link-state routing protocols: Open Shortest Path First (OSPF) and IS-IS. Explains architecture, packet types, and addressing; demonstrates how to improve scalability; shows how to design large-scale networks for maximum security and reliability; details protocol extensions for MPLS-based traffic engineering, IPv6, and multitopology routing; and covers troubleshooting for OSPF and IS-IS networks.
Routing Policy and Protocols for Multivendor IP Networks	Provides a brief history of the Internet, explains IP addressing and routing (Routing Information Protocol [RIP], OSPF, IS-IS, and Border Gateway Protocol [BGP]), explores ISP peering and routing policies, and displays configurations for both Juniper Networks and other vendors' routers.
The Complete IS-IS Protocol	Provides the insight and practical solutions necessary to understand the IS-IS protocol and how it works by using a multivendor, real-world approach.

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

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- 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/
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PART 1

Monitoring an MPLS Network

CHAPTER 1

Configuring MPLS on a Network

This chapter describes how to configure a network to run Multiprotocol Label Switching (MPLS), including the components and supporting protocols.

Checklist for Configuring and Verifying an MPLS Network

This checklist provides the steps and commands to configure and verify an MPLS network. The checklist includes links to more detailed information about the commands to configure and verify MPLS and supporting protocols, and example configurations for an example MPLS topology. (See Table 7 on page 3.)

Table 7: Checklist for Configuring and Verifying an MPLS Network

Tasks	Command or Action
"Configure IP Addresses on Router Interfaces" on page 8	
1. Configure IP Addresses on Router Interfaces on page 8	**[edit]** **edit interfaces** *type-fpc/pic/port* **unit** *logical-unit-number* **set family inet address** *address* **show** **commit**
2. Configure IS-IS as the IGP on page 9	

Table 7: Checklist for Configuring and Verifying an MPLS Network *(continued)*

Tasks	Command or Action
a. Enable IS-IS on Routers in Your Network on page 10	[edit] edit protocols isis set level 1 disable set interface *type-fpc/pic/port* level *level-number* metric *metric* set interface fxp0.0 disable set interface lo0.0 set interface lo0 passive show commit
b. Configure ISO Addressing on page 12	[edit] edit interfaces set lo0 unit *number* family iso address *address* show commit
c. Enable IS-IS on Router Interfaces on page 13	[edit] edit interfaces set *type-fpc/pic/port* unit *number* family iso show commit
d. Verify That IS-IS Adjacencies Are Established on page 14	show isis adjacency
3. Configure OSPF as the IGP on page 15	
a. Enable OSPF on Routers in Your Network on page 16	[edit] edit protocols ospf [edit protocols ospf] set area *area-id* interface *type-fpc/pic/port* set interface fxp0.0 disable set area 0.0.0.0 interface lo0 set area 0.0.0.0 interface lo0 passive set traffic engineering [edit routing-options] set router-id *router-id* show commit
b. Verify That OSPF Neighbors Are Established on page 18	show ospf neighbor
4. Set Up BGP on Routers in Your Network on page 19	
a. Define the Local Autonomous System on page 20	[edit] edit routing-options set autonomous-system *as-number* show commit

Table 7: Checklist for Configuring and Verifying an MPLS Network *(continued)*

Tasks	Command or Action
b. Configure BGP Neighbor Connections on page 21	[edit] edit protocols bgp set group *group-name* type *type* neighbor *neighbor-address* set group *group-name* local-address *local-address* show commit
c. Configure a Simple Routing Policy on page 22	[edit] edit routing-options set static route *destination* /24 reject [edit policy-options] set policy-statement *policy-name* term *term-name* from route-filter *address* exact set policy-statement *policy-name* term *term-name* then accept [edit protocols bgp] set export *policy-name* show commit
d. Verify That BGP Sessions Are Up on page 24	show bgp summary
5. Enable MPLS and RSVP on page 24	
a. Enable MPLS and RSVP on Routers on page 25	[edit] edit protocols set mpls interface all set rsvp interface all [edit protocols mpls] set interface fxp0.0 disable [edit protocols rsvp] set interface fxp0.0 disable show commit
b. Enable MPLS on Transit Router Interfaces on page 26	[edit] edit interfaces set *type-fpc/pic/port* unit *number* family mpls show commit
6. Establish an LSP in Your Network on page 27	
a. Configure the LSP on page 27	[edit] edit protocols mpls set label-switched-path *lsp-path-name* to *address* show commit

Table 7: Checklist for Configuring and Verifying an MPLS Network *(continued)*

Tasks	Command or Action
b. Verify the LSP on page 110	**show mpls lsp extensive**
"Example Configurations for an MPLS Topology" on page 30	**show configuration | no-more**

Configuring MPLS on Your Network

Purpose For MPLS to run on the routers in your network, you must enable MPLS and the Resource Reservation Protocol (RSVP), configure an interior gateway protocol (IGP) and Border Gateway Protocol (BGP) to run over the relevant interfaces, and configure each interface with the following:

- Basic IP information
- MPLS support

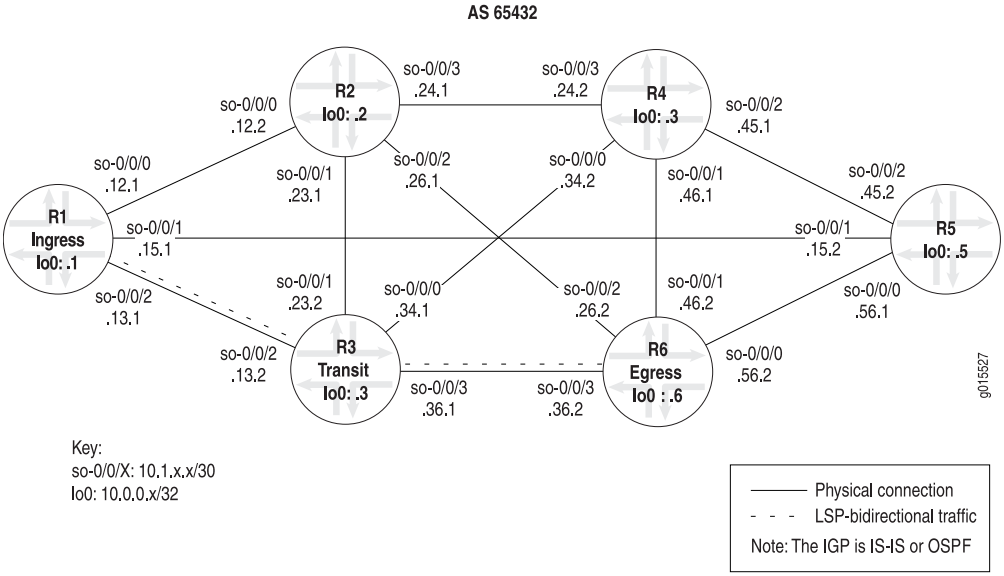
In addition, you must configure a label-switched path (LSP) from the ingress router to the egress router. For more information on ingress and egress routers, see the *Junos MPLS Applications Configuration Guide*.

You can configure your MPLS network with either Intermediate System-to-Intermediate System (IS-IS) or Open Shortest Path First (OSPF) as the IGP. The example network in Figure 1 on page 7 is configured with IS-IS. To configure interfaces with OSPF, see the *Junos Routing Protocols Configuration Guide*.

An IGP is required for the Constrained Shortest Path First (CSPF) LSP, which is the default with the Junos OS. The example network in Figure 1 on page 7 focuses on CSPF LSPs.

Figure 1 on page 7 illustrates the example MPLS network topology used in this section and throughout this book. The example network uses IS-IS Level 2 and a policy to create traffic. However, IS-IS Level 1 or an OSPF area can be used and the policy omitted if the network has existing BGP traffic.

Figure 1: MPLS Network Topology



The MPLS network in Figure 1 on page 7 illustrates a router-only network with SONET interfaces that consist of the following components:

- A full-mesh interior BGP (IBGP) topology, using AS 65432
- MPLS and RSVP enabled on all routers
- A **send-statics** policy on routers R1 and R6 that allow a new route to be advertised into the network
- Two unidirectional LSPs between routers R1 and R6, which allow for bidirectional traffic

The network shown in Figure 1 on page 7 is a BGP full-mesh network. Since route reflectors and confederations are not used to propagate BGP learned routes, each router must have a BGP session with every other router running BGP.

See “Example Configurations for an MPLS Topology” on page 30 for complete configurations for all routers in this example MPLS network. The following sections outline the steps for configuring MPLS on a network based on the topology shown in Figure 1 on page 7.

You can enable MPLS throughout the rest of the network by repeating Step 1, “Configure IP Addresses on Router Interfaces” on page 8 through Step 5, “Enable MPLS and RSVP” on page 24 as appropriate on other routers until all routers and interfaces are enabled for MPLS.

To configure the MPLS network, follow these steps:

1. Configure IP Addresses on Router Interfaces on page 8
2. Configure IS-IS as the IGP on page 9
3. Configure OSPF as the IGP on page 15

4. Set Up BGP on Routers in Your Network on page 19
5. Enable MPLS and RSVP on page 24
6. Establish an LSP in Your Network on page 27

Related Documentation

- For more information on configuring MPLS, see the *Junos MPLS Applications Configuration Guide*.

Configure IP Addresses on Router Interfaces

Purpose

Before you can run MPLS on your network, you must have an IP address configured on all interfaces. Repeat this procedure as appropriate on other router interfaces in your network until all interfaces have an IP address.

Action

To configure an IP address, follow these steps:

1. In configuration mode, go to the following hierarchy level:

   [edit]
   user@host# **edit interfaces *type-fpc/pic/port* unit *logical-unit-number***

2. Configure the IP address:

   [edit interfaces *type-fpc/pic/port* unit *number*]
   user@host# **set family inet address *address***

3. Verify the configuration:

   user@host# **show**

   user@host# **commit**

Sample Output

```
user@R1> edit
Entering configuration mode

[edit]
user@R1# edit interfaces so-0/0/2 unit 0

[edit interfaces so-0/0/2 unit 0]
user@R1# set family inet address 10.1.13.1/30

[edit interfaces so-0/0/2 unit 0]
user@R1# show
family inet   {
     address 10.1.13.1/30  ;
}

[edit interfaces so-0/0/2 unit 0]
user@R1# commit
commit complete
```

Meaning

The sample output shows an interface configured with an IP address. The IP address is assigned when you configure the protocol family. In this instance, the IP address is included in the **inet** family. The **family** statement identifies which protocol packets are accepted

into the interfaces. For example, valid IP packets are dropped if the interface is not configured with the **family inet** statement.

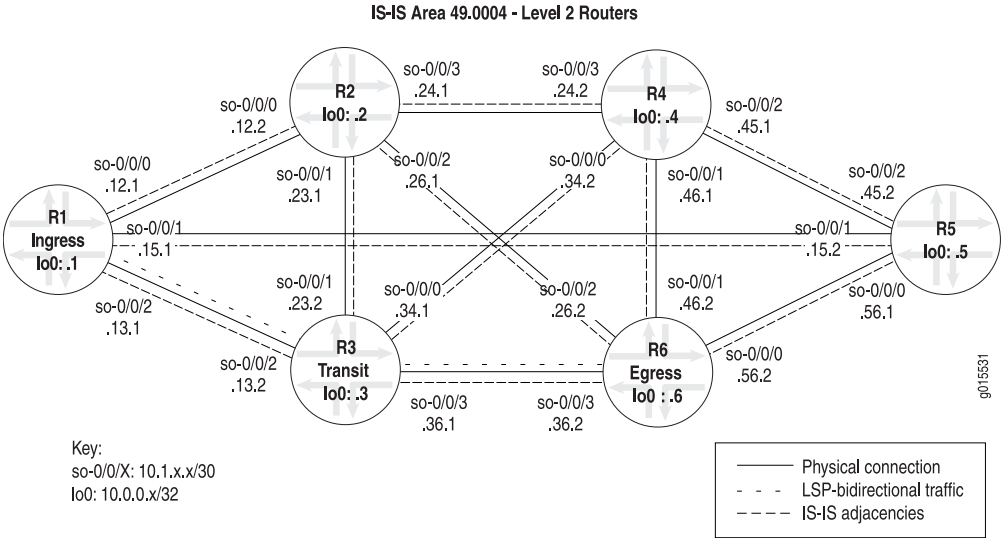
Related Documentation

- For more information on interface addressing, see the *Junos Network Interfaces Configuration Guide*.
- Checklist for Configuring and Verifying an MPLS Network on page 3

Configure IS-IS as the IGP

Before you can run MPLS on your network, you should have an IGP running on all specified routers and interfaces. The IGP can be either IS-IS or OSPF. For the steps to configure OSPF, see “Configure OSPF as the IGP” on page 15.

Figure 2: IS-IS Network Topology



The IS-IS IGP in the MPLS network in Figure 2 on page 9 consists of the following:

- All routers are configured for Level 2, therefore default CSPF LSPs can occur.
- All routers are in IS-IS area 49.0004. However, the routers in this network could be in any area because Level 2 adjacencies occur between all directly connected Level 2 routers regardless of which area they are in.
- Level 2 adjacencies between all directly connected Level 2 routers as follows:
  - R1 is adjacent to R2, R3, and R5
  - R2 is adjacent to R1, R3, R4, and R6
  - R3 is adjacent to R1, R2, R4, and R6
  - R4 is adjacent to R2, R3, R5, and R6

- R5 is adjacent to R1, R4, and R6
- R6 is adjacent to R2, R3, R4, and R5

When you configure IS-IS as the IGP, you must enable IS-IS on the router, configure International Organization for Standardization (ISO) addressing, and enable IS-IS on all router interfaces.

You can enable IS-IS throughout the rest of the network by repeating Step 1, "Enable IS-IS on Routers in Your Network" on page 10 through Step 3, "Enable IS-IS on Router Interfaces" on page 13 as appropriate on other routers until all routers and interfaces establish IS-IS adjacencies.

To configure IS-IS and establish IS-IS adjacencies, follow these steps:

1. Enable IS-IS on Routers in Your Network on page 10
2. Configure ISO Addressing on page 12
3. Enable IS-IS on Router Interfaces on page 13
4. Verify That IS-IS Adjacencies Are Established on page 14

Enable IS-IS on Routers in Your Network

Action To enable IS-IS on routers in your network, follow these steps:

1. In configuration mode, go to the following hierarchy level:

   ```
   [edit]
   user@host# edit protocols isis
   ```

2. Disable Level 1 if appropriate for your network:

   ```
   [edit protocols isis]
   user@host# set level 1 disable
   ```

3. Configure the interface:

   ```
   [edit protocols isis]
   user@host# edit interface type-fpc/pic/port level level-number metric metric
   ```

4. Disable the management interface if you have included the **interface all** statement, as shown in **Sample Output 2 on page 11**:

   ```
   [edit protocols isis]
   user@host# set interface fxp0.0 disable
   ```

5. Include the loopback interface (**lo0**) if you have listed all interfaces separately, as shown in **Sample Output 1 on page 11**:

   ```
   [edit protocols isis]
   user@host# set interface lo0.0
   ```

6. Set the loopback interface (**lo0**) to passive:

   ```
   [edit protocols isis]
   user@R1# set interface lo0 passive
   ```

7. Verify and commit the configuration:


```
user@host# show
user@host# commit
```

Sample Output 1

```
user@R1> edit
Entering configuration mode

[edit]
user@R1# edit protocols isis

[edit protocols isis]
user@R1# set level 1 disable

[edit protocols isis]
user@host# edit interface all level 2 metric 10

[edit protocols isis]
user@host# set interface lo0.0

[edit protocols isis]
user@host# set interface lo0 passive

[edit protocols isis]
user@R1# show
level 1 disable;
interface so-0/0/0.0;
interface so-0/0/1.0;
interface so-0/0/2.0;
interface lo0.0;
     passive;
}

[edit protocols isis]
user@R1# commit
commit complete
```

Sample Output 2

```
[edit protocols isis]
user@R6# show
level 1 disable;
interface all  {
     level 2 metric 15;
}
interface fxp0.0  {
    disable;
}
interface lo0.0 {
     passive;
}
```

Meaning Sample Output 1 shows that IS-IS Level 1 is disabled, making this a Level 2 router. All routers in the network shown in Figure 1 on page 7 are running at one IS-IS level (Level 2), therefore default CSPF LSPs can occur.

Because **R1** in Sample Output 1 has all IS-IS enabled interfaces listed, including the loopback interface (**lo0**), you do not need to include the **disable** statement for the management interface (**fxp0**). All interfaces have unit number **0**, the default if a unit number is not specified. When you configure an interface at the [**edit protocols isis**]

hierarchy level, and you do not include the logical unit, the default **0** is appended to the interface name, for example, **so-0/0/1.0.**

Sample Output 2 does not list the interfaces configured with IS-IS; instead, all interfaces are configured, including the loopback interface (**lo0**) and the management interface (**fxp0**). Therefore, you do not need to include a separate statement for the loopback (**lo0**) interface. However, in this instance, it is best practice to disable the management interface (**fxp0**) so that IS-IS packets are not sent over it. If you do not disable the management interface (**fxp0**) when you include the **interface-all** statement, the IS-IS protocol can form adjacencies over the management backbone, but traffic does not flow because transit traffic does not go out of the management interface.

Sample Output 2 also shows that all interfaces on **R6** are configured with a metric of **15**. A metric is not required to configure IS-IS on your interfaces. The default metric value is **10** (with the exception of the loopback [**lo0**] interface, which has a default metric of **0**). A metric is included to demonstrate that you can configure a metric for IS-IS if the default (**10**) is not appropriate for your network.

Both sample outputs show the **passive** statement included in the configuration of the loopback (**lo0**) interface. Including the **passive** statement is considered best practice and ensures the following:

- Protocols are not run over the loopback (**lo0**) interface
- When the router ID (RID) is configured manually, ensures that the loopback (**lo0**) interface is advertised to other networks.

NOTE: It is considered best practice to configure the RID manually to avoid duplicate RID problems.

Configure ISO Addressing

Purpose For a router to support IS-IS, you must configure an ISO network entity title (NET) address on one of the router's interfaces, preferably the loopback interface (**lo0**).

Action To configure ISO addressing, follow these steps:

1. In configuration mode, go to the following hierarchy level:

   ```
   [edit]
   user@host# edit interfaces
   ```

2. Include a NET address for the loopback interface:

   ```
   [edit interfaces]
   user@host#  set lo0 unit number family iso address address
   ```

3. Verify and commit the configuration:

   ```
   user@host# show

   user@host# commit
   ```

Sample Output

```
user@R1> edit
Entering configuration mode

[edit]
user@R1# edit interfaces

[edit interfaces]
user@R1# set lo0 unit 0 family iso address 49.0004.1000.0000.0001.00

[edit interfaces]
userR1# show
[...Output truncated...]
lo0 {
    unit 0 {
        family inet {
            address 10.0.0.1/32;
        }
         family iso {
            address 49.0004.1000.0000.0001.00;
        }
    }
}

[edit interfaces]
user@R1# commit
commit complete
```

Meaning The sample output shows that the loopback (**lo0**) interface is configured with the NET address **49.0004.1000.0000.0001.00**. The loopback interface (**lo0**) becomes a point of connection from the router to the IS-IS network. Every router in an IS-IS network must have at least one ISO NET address that identifies a point of connection to the IS-IS network. The NET address is generally configured on the loopback **(lo0**) interface. Routers that participate in multiple areas can have multiple NET addresses.

All the routers in the network shown in Figure 1 on page 7 share a Level 2 database containing identical information. A common Level 2 database occurs in this case because all adjacencies are Level 2, and all routers are within the same IS-IS area (**49.0004**). Level 2 LSP flooding reaches all routers in the network due to the presence of a single level. For more information on determining the NET address, see the *Junos Routing Protocols Configuration Guide*.

Enable IS-IS on Router Interfaces

Purpose Enable reception and transmission of ISO protocol data units (PDUs) on each router interface in the network with the **family** statement, which identifies which protocol packets are accepted into the interfaces. For example, valid IS-IS packets are dropped if the interface is not configured with the **family iso** statement.

Action To configure support for IS-IS on router interfaces in your network, follow these steps:

1. In configuration mode, go to the following hierarchy level:

   ```
   [edit]
   user@host# edit interfaces
   ```

2. Configure IS-IS:

```
[edit interfaces]
user@host# set type-fpc/pic/port unit number  family iso
```

3. Verify and commit the configuration:

```
user@host# show

user@host# commit
```

Sample Output

```
user@R1> edit
Entering configuration mode

[edit]
user@R1# edit interfaces

[edit interfaces]
user@R1# set so-0/0/2 unit 0 family iso

[edit interfaces]
userR1# show
[...Output truncated...]
so-0/0/2 {
    unit 0 {
        family inet {
            address 10.1.13.1/30;
        }
         family iso;
    }
}

[edit interfaces]
user@R1# commit
commit complete
```

Meaning The sample output shows that the interface **so-0/0/2** is configured with IS-IS.

Verify That IS-IS Adjacencies Are Established

Purpose After configuring IS-IS, you must verify that neighboring routers have formed adjacencies with each other.

Action To verify IS-IS adjacencies, enter the following Junos OS command-line interface (CLI) operational mode command:

```
user@host>  show isis adjacency
```

Sample Output

```
user@R1> show isis adjacency
Interface             System         L State       Hold (secs) SNPA
so-0/0/0.0            R2             2 Up                  25
so-0/0/1.0            R5             2 Up                  23
so-0/0/2.0            R3             2 Up                  20

user@R3> show isis adjacency
Interface             System         L State       Hold (secs) SNPA
so-0/0/0.0            R4             2 Up                  25
so-0/0/1.0            R2             2 Up                  25
so-0/0/2.0            R1             2 Up                  26
so-0/0/3.0            R6             2 Up                  25
```

```
user@R6> show isis adjacency
Interface             System         L State       Hold (secs) SNPA
so-0/0/0.0            R5             2 Up                   19
so-0/0/1.0            R4             2 Up                   22
so-0/0/2.0            R2             2 Up                   22
so-0/0/3.0            R3             2 Up                   19
```

Sample Output

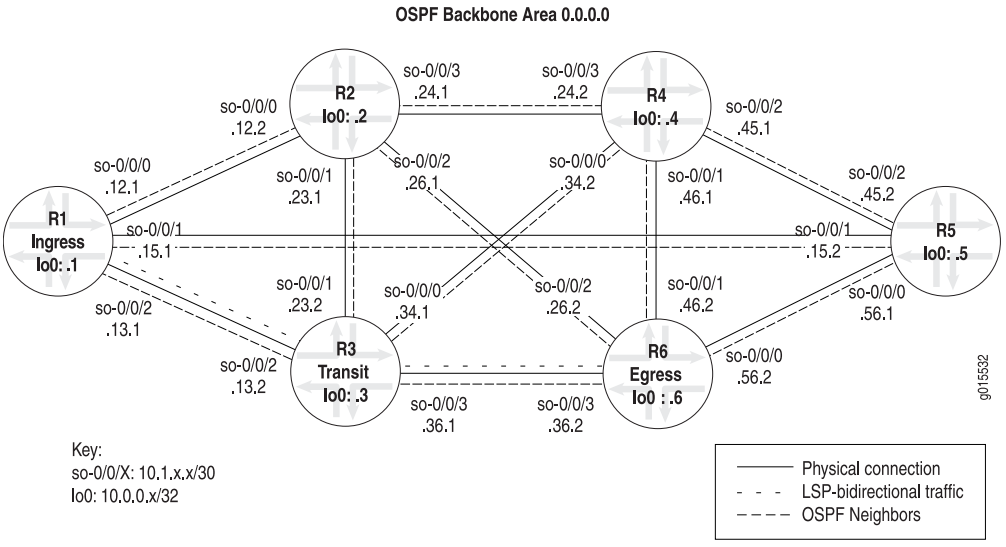
```
user@R1> show isis adjacency
Interface             System         L State       Hold (secs) SNPA
so-0/0/0.0            R2             2 Up                   25
so-0/0/1.0            R5             2 Up                   23
so-0/0/2.0            R3             2 Up                   20

user@R3> show isis adjacency
Interface             System         L State       Hold (secs) SNPA
so-0/0/0.0            R4             2 Up                   25
so-0/0/1.0            R2             2 Up                   25
so-0/0/2.0            R1             2 Up                   26
so-0/0/3.0            R6             2 Up                   25

user@R6> show isis adjacency
Interface             System         L State       Hold (secs) SNPA
so-0/0/0.0            R5             2 Up                   19
so-0/0/1.0            R4             2 Up                   22
so-0/0/2.0            R2             2 Up                   22
so-0/0/3.0            R3             2 Up                   19
```

Meaning The sample output from the ingress, transit, and egress routers shows that all routers in the network shown in Figure 1 on page 7 have formed IS-IS adjacencies.

Configure OSPF as the IGP

Before you can run MPLS on your network, you must have an IGP running on all specified routers and interfaces. The IGP can be either OSPF or IS-IS. For the steps to configure IS-IS, see “Configure IS-IS as the IGP” on page 9.

Figure 3: OSPF Network Topology



The OSPF IGP in the MPLS network in Figure 2 on page 9 consists of the following:

- All routers are configured for the backbone OSPF area 0.0.0.0.
- All routers have the RID manually configured to avoid possible problems when the OSPF RID changes; for example, when multiple loopback addresses are configured.
- All routers have traffic engineering enabled. When traffic engineering is enabled for OSPF, the SPF algorithm takes into account the various LSPs configured under MPLS and configures OSPF to generate link-state advertisements (LSAs) that carry traffic engineering parameters. These routes are installed into the primary routing table **inet.0**,but the LSPs are installed by default into the **inet.3** routing table.
- Adjacencies between all OSPF neighbors are as follows:
  - R1 is adjacent to R2, R3, and R5
  - R2 is adjacent to R1, R3, R4, and R6
  - R3 is adjacent to R1, R2, R4, and R6
  - R4 is adjacent to R2, R3, R5, and R6
  - R5 is adjacent to R1, R4, and R6
  - R6 is adjacent to R2, R3, R4, and R5

When you configure OSPF as the IGP, you must enable OSPF and traffic engineering on the router. We also recommend that you manually configure the RID and include the loopback interface (**lo0**) at the [**edit protocols ospf**] hierarchy level.

You can enable OSPF throughout the rest of the network by repeating this step as appropriate on other routers until all routers and interfaces establish OSPF neighbors.

To configure OSPF and establish OSPF neighbors, follow these steps:

1. Enable OSPF on Routers in Your Network on page 16
2. Verify That OSPF Neighbors Are Established on page 18

Enable OSPF on Routers in Your Network

Action To enable OSPF on routers in your MPLS network, follow these steps:

1. In configuration mode, go to the following hierarchy level:

   ```
   [edit]
   user@host#  edit protocols ospf
   ```

2. Configure the area and the interface:

   ```
   [edit protocols ospf]
   user@host#  set area area-id interface type-fpc/pic/port
   ```

3. Disable the management interface if you have included the **interface all** statement in the previous step:

   ```
   [edit protocols ospf]
   user@host# set interface  fxp0.0 disable
   ```

4. Include the loopback (**lo0**) interface if you intend to manually configure the RID:

   ```
   [edit protocols ospf]
   user@host# set area 0.0.0.0 interface lo0
   ```

5. Set the loopback interface (**lo0**) to passive:

   ```
   [edit protocols ospf]
   user@host# set area 0.0.0.0 interface lo0 passive
   ```

6. Configure traffic engineering:

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

7. Manually configure the RID at the [**routing-options**] hierarchy level:

   ```
   [edit]
   user@host# edit routing-options
   [edit routing-options]
   user@host# set router-id router-id
   ```

8. Verify and commit the entire configuration:

   ```
   user@host# show
   ```

   ```
   user@host# commit
   ```

Sample Output

```
user@R6> edit
Entering configuration mode

[edit]
user@R6# edit protocols ospf

[edit protocols ospf]
user@R6# set area 0.0.0.0 interface so-0/0/0.0

[edit protocols ospf]
user@R6# set area 0.0.0.0 interface lo0

[edit protocols ospf]
user@R6# set area 0.0.0.0 interface lo0 passive

[edit protocols ospf]
user@R6# set traffic-engineering

[edit protocols ospf]
user@R6# show
traffic-engineering;
area 0.0.0.0 {
    interface so-0/0/0.0;
    interface so-0/0/1.0;
    interface so-0/0/2.0;
    interface so-0/0/3.0;
    interface lo0.0 {
        passive;
}

[edit protocols ospf]
user@R6# commit
commit complete
```

```
[edit]
user@R6# edit routing-options

[edit routing-options]
user@R6# set router-id 10.0.0.6

[edit routing-options]
user@R6# show
[...Output truncated...]
router-id 10.0.0.6;
autonomous-system 65432;

[edit routing-options]
user@R6# commit
commit complete
```

Meaning The sample output shows that OSPF, with traffic engineering, is enabled on the interfaces on egress router **R6**. In addition, the RID is configured manually to avoid possible problems when the OSPF RID changes; for example, when multiple loopback addresses are configured. The RID uniquely identifies the router within the OSPF network. It is transmitted within the LSAs used to populate the link-state database and calculate the shortest-path tree. In a link-state network, it is important that two routers do not share the same RID value, otherwise IP routing problems may occur.

The sample outputs also shows the **passive** statement included in the configuration of the loopback (**lo0**) interface. Including the **passive** statement is considered best practice and ensures the following:

- Protocols are not run over the loopback (**lo0**) interface
- When the router ID (RID) is configured manually, ensures that the loopback (**lo0**) interface is advertised to other networks.

Verify That OSPF Neighbors Are Established

Purpose After configuring OSPF, you must verify that neighboring routers have formed adjacencies with each other.

Action To verify OSPF neighbors, enter the following Junos OS CLI operational mode command:

```
user@host> show ospf neighbor
```

Sample Output

```
user@R1> show ospf neighbor
  Address          Interface              State       ID               Pri  Dead
10.1.12.2          so-0/0/0.0             Full        10.0.0.2         128   37
10.1.15.2          so-0/0/1.0             Full        10.0.0.5         128   35
10.1.13.2          so-0/0/2.0             Full        10.0.0.3         128   38

user@R3> show ospf neighbor
  Address          Interface              State       ID               Pri  Dead
10.1.34.2          so-0/0/0.0             Full        10.0.0.4         128   38
10.1.23.1          so-0/0/1.0             Full        10.0.0.2         128   35
10.1.13.1          so-0/0/2.0             Full        10.0.0.1         128   37
10.1.36.2          so-0/0/3.0             Full        10.0.0.6         128   36

user@R6> show ospf neighbor
  Address          Interface              State       ID               Pri  Dead
```

```
10.1.56.1          so-0/0/0.0          Full       10.0.0.5          128   39
10.1.46.1          so-0/0/1.0          Full       10.0.0.4          128   37
10.1.26.1          so-0/0/2.0          Full       10.0.0.2          128   36
10.1.36.1          so-0/0/3.0          Full       10.0.0.3          128   37
```

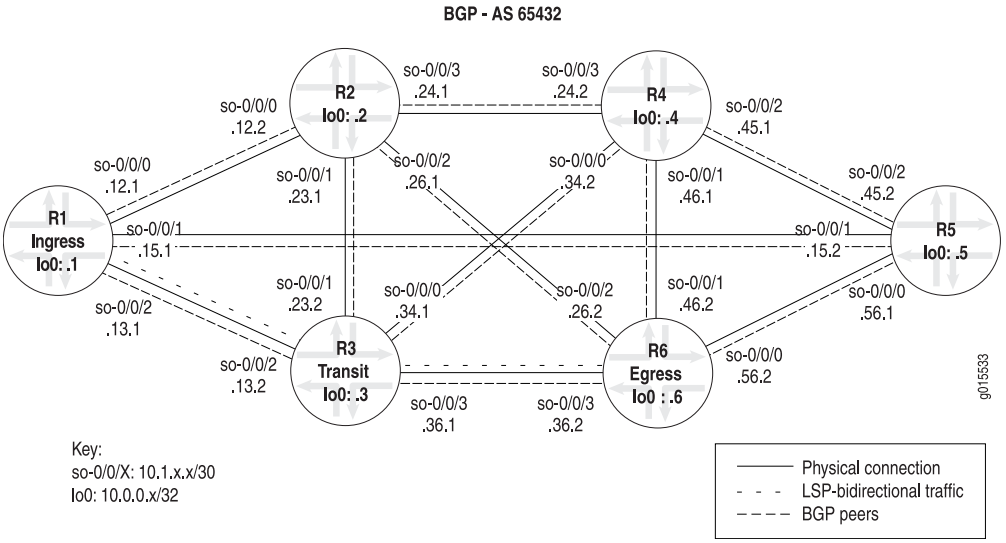
Meaning The sample output from the ingress, transit, and egress routers shows that all routers in the network shown in Figure 1 on page 7 have formed OSPF neighbor adjacencies.

Set Up BGP on Routers in Your Network

Before BGP can function in your MPLS network, you must define the autonomous system (AS) number on the routers in your network, and configure at least one group that includes at least one peer.

Optionally, you can configure a routing policy. The routing policy allows you to control the information shared with BGP neighbors and provides the opportunity to filter and modify the information you receive.

Figure 4: BGP Network Topology



The BGP configuration in the MPLS network in Figure 4 on page 19 consists of the following:

- A full-mesh IBGP topology, using AS 65432.
- All IBGP sessions peer between loopback addresses because significant stability advantages are gained.
- All routers are configured with one group, **group internal**.
- A **send-statics** policy on routers R1 and R6 allows a new route to be advertised into the network.

The example network uses IS-IS Level 2 and a policy to create routes that are reachable through the LSP. However, IS-IS Level 1 or an OSPF area can be used and the policy omitted if the network has existing BGP traffic.

You can set up BGP throughout the rest of the network by repeating Step 1, “Define the Local Autonomous System” on page 20 through Step 3, “Configure a Simple Routing Policy” on page 22 as appropriate on other routers until all routers are set up with BGP.

To set up BGP on routers in your network, follow these steps:

1. Define the Local Autonomous System on page 20
2. Configure BGP Neighbor Connections on page 21
3. Configure a Simple Routing Policy on page 22
4. Verify That BGP Sessions Are Up on page 24

Define the Local Autonomous System

Purpose Before BGP can function, you need to define a local AS number on the routers in your network. In the example network in Figure 4 on page 19, all routers are in AS 65432.

Action To define an AS number on routers in your network, follow these steps:

1. In configuration mode, go to the following hierarchy level:

   ```
   [edit]
   user@host# edit routing-options
   ```

2. Configure all interfaces to a specific AS:

   ```
   [edit routing-options]
   user@host# set autonomous-system as-number
   ```

3. Verify the configuration:

   ```
   user@host# show
   ```

   ```
   user@host# commit
   ```

Sample Output

```
user@R1> edit
Entering configuration mode

[edit]
user@R1# edit routing-options

[edit routing-options]
user@R1# set autonomous-system 65432

[edit routing-options]
user@R1# show
[...Output truncated...]
autonomous-system 65432;

[edit routing-options]
user@R6# commit
commit complete
```

Meaning The output shows that router **R1** resides in **AS 65432**. All other routers in the example network shown in Figure 4 on page 19 also reside in **AS 65432**.

Configure BGP Neighbor Connections

Purpose You must configure at least one group that includes at least one peer for BGP to run in your network. First determine which neighbors are internal or external to your local AS boundary. Internal neighbors are inside your local AS boundary. In the example network shown in Figure 4 on page 19, all the routers are in one AS and are therefore internal. In this example, all IBGP sessions peer between loopback addresses because significant stability advantages are gained. For more information about configuring BGP neighbor connections, see the *Junos Routing Protocols Configuration Guide*.

Action To configure BGP neighbor connections, follow these steps:

1. In configuration mode, go to the following hierarchy level:

   ```
   [edit]
   user@host#  edit protocols bgp
   ```

2. Configure the group and peer's IP address:

   ```
   [edit protocols bgp]
   user@host# set group group-name type type neighbor neighbor-address
   ```

   NOTE: For external neighbors, use the following form of the command that includes the peer's AS number:

   ```
   user@host# set group group-name neighbor neighbor-address peer-as
     peer-as-number
   ```

3. Configure the local address:

   ```
   [edit protocols bgp]
   user@host# set group group-name local-address local-address
   ```

4. Verify and commit the configuration:

   ```
   user@host# show

   user@host# commit
   ```

Sample Output

```
user@R1> edit
Entering configuration mode

[edit]
user@R1#  edit protocols bgp

[edit protocols bgp]
user@R1#  set group internal type internal neighbor 10.0.0.2

[edit protocols bgp]
users@R1#  set group internal local-address 10.0.0.1

[edit protocols bgp]
user@R1# show
group internal  {
    type internal;
```

```
     local-address 10.0.0.1;
     neighbor 10.0.0.2;
    neighbor 10.0.0.3;
    neighbor 10.0.0.5;
    neighbor 10.0.0.4;
    neighbor 10.0.0.6;
}

[edit protocols bgp]
user@R1# commit
commit complete
```

Meaning The sample output shows that router **R1** is in an internal group with five BGP neighbors. The **local-address** statement is included in this example configuration because IBGP is used. It is considered best practice to configure a local address when you use an IBGP. BGP messages are sourced from the loopback address because the **local-address** statement is included in the configuration. Generally, you would not configure a local address when external BGP is configured.

Configure a Simple Routing Policy

Purpose Routing policy allows you to control the information shared with BGP neighbors and provides the opportunity to filter and modify the information you receive. Typically, a network is injected into BGP using a policy. This may also be done through a static route. In the network in Figure 4 on page 19, a static route export policy is used to inject routes into BGP.

Action To configure a simple routing policy, follow these steps:

1. In configuration mode, go to the following hierarchy level:

   ```
   [edit]
   user@host# edit routing-options
   ```

2. Configure a static route for redistribution to other autonomous systems:

   ```
   [edit routing-options]
   user@host# set static route destination/24 reject
   ```

3. Configure a routing policy that matches and accepts the configured static routes into BGP updates:

   ```
   [edit]
   user@host# edit policy-options
   [edit policy-options]
   user@host# set policy-statement policy-name term term-name from route-filter
     address exact
   user@host# set policy-statement policy-name term term-name then accept
   ```

4. Apply the policy created in Step 3 to all BGP neighbors:

   ```
   [edit]
   user@host# edit protocols bgp
   [edit protocols bgp]
   user@host# set export policy-name
   ```

5. Verify and commit the configuration:

user@host# show

user@host# commit

Sample Output

```
user@R1> edit
Entering configuration mode

[edit]
user@R1# edit routing-options

[edit routing-options]
user@R1# set static route 100.100.1.0/24 reject

[edit routing-options]
user@R1# show
[...Output truncated...]
    route 100.100.1.0/24 reject;
}
router-id 10.0.0.1;
autonomous-system 65432;

[edit routing-options]
user@R1# top

[edit]
user@R1# edit policy-options

[edit policy-options]
user@R1# set policy-statement send-statics term statics from route-filter 100.100.1.0/24 exact

[edit policy-options]
user@R1# set policy-statement send-statics term statics then accept

[edit policy-options]
user@R1# top

[edit]
user@R1# edit protocols bgp

[edit protocols bgp]
user@R1# set export send-statics

[edit protocols bgp]
user@R1# show
export send-statics;
group internal {
    type internal;
    local-address 10.0.0.1;
    neighbor 10.0.0.2;
    neighbor 10.0.0.3;
    neighbor 10.0.0.5;
    neighbor 10.0.0.4;
    neighbor 10.0.0.6;
}

[edit protocols bgp]
user@R1# commit
commit complete
```

Meaning The sample output shows that routing policy **send-statics** is configured on the router. The routing policy matches and accepts the configured static routes into the routing table and injects the routes into BGP updates. Typically, a routing policy is applied at the group level, although it can be applied at the global level, as shown in this example.

Verify That BGP Sessions Are Up

Purpose After configuring BGP, you must verify that BGP peers are established and the sessions are up.

Action To verify BGP peers and sessions, enter the following Junos OS CLI operational mode command:

```
user@host> show bgp summary
```

Sample Output

```
user@R1> show bgp summary
Groups: 1 Peers: 5 Down peers: 0
Table          Tot Paths  Act Paths Suppressed    History Damp State    Pending
inet.0                 1          1          0          0          0          0
Peer             AS      InPkt     OutPkt    OutQ   Flaps Last Up/Dwn State|#Active/Received/Damped...
10.0.0.2       65432       1369       1373       0       0    11:25:11 0/0/0                0/0/0
10.0.0.3       65432       1369       1372       0       0    11:24:55 0/0/0                0/0/0
10.0.0.4       65432       1369       1372       0       0    11:25:03 0/0/0                0/0/0
10.0.0.5       65432       1369       1372       0       0    11:25:07 0/0/0                0/0/0
10.0.0.6       65432       1343       1344       0       1    11:10:55 1/1/0                0/0/0

user@R3> show bgp summary
Groups: 1 Peers: 4 Down peers: 0
Table          Tot Paths  Act Paths Suppressed    History Damp State    Pending
inet.0                 2          2          0          0          0          0
Peer             AS      InPkt     OutPkt    OutQ   Flaps Last Up/Dwn State|#Active/Received/Damped...
10.0.0.1       65432       1375       1375       0       6    11:26:57 1/1/0                0/0/0
10.0.0.2       65432      43016      43016       0       0     2w0d22h 0/0/0                0/0/0
10.0.0.4       65432      74460      74461       0       0     3w4d20h 0/0/0                0/0/0
10.0.0.6       65432       1347       1347       0       6    11:13:10 1/1/0                0/0/0

user@R6> show bgp summary
Groups: 1 Peers: 5 Down peers: 0
Table          Tot Paths  Act Paths Suppressed    History Damp State    Pending
inet.0                 1          1          0          0          0          0
Peer             AS      InPkt     OutPkt    OutQ   Flaps Last Up/Dwn State|#Active/Received/Damped...
10.0.0.1       65432       1348       1350       0       0    11:13:46 1/1/0                0/0/0
10.0.0.2       65432       1347       1351       0       0    11:14:02 0/0/0                0/0/0
10.0.0.3       65432       1347       1350       0       0    11:13:58 0/0/0                0/0/0
10.0.0.4       65432       1347       1350       0       0    11:13:54 0/0/0                0/0/0
10.0.0.5       65432       1347       1350       0       0    11:13:50 0/0/0                0/0/0
```

Meaning The sample output from the ingress, transit, and egress routers shows that all routers in the network shown in Figure 4 on page 19 have BGP peers established and sessions up.

Enable MPLS and RSVP

You can enable MPLS and RSVP throughout the rest of the network by repeating Step 1, “Enable MPLS and RSVP on Routers” on page 25 and Step 2, “Enable MPLS on Transit

Router Interfaces" on page 26 as appropriate on other routers until all routers are enabled with MPLS and RSVP.

NOTE: Even though the MPLS and RSVP protocols are enabled, you must complete all five steps in "Configuring MPLS on Your Network" on page 6 to have the MPLS protocol running on your network.

1. Enable MPLS and RSVP on Routers on page 25
2. Enable MPLS on Transit Router Interfaces on page 26

Enable MPLS and RSVP on Routers

Action To enable MPLS and RSVP on routers in your network, follow these steps:

1. In configuration mode, go to the following hierarchy level:

   ```
   [edit]
   user@host# edit protocols
   ```

2. Configure MPLS and RSVP:

   ```
   [edit protocols]
   user@host#  set mpls interface all
   user@host#  set rsvp interface all
   ```

3. Disable the management interface for MPLS and RSVP:

   ```
   [edit protocols mpls]
   user@host# set interface  fxp0.0 disable
   [edit protocols rsvp]
   user@host# set interface  fxp0.0 disable
   ```

4. Verify and commit the configuration:

   ```
   user@host# show

   user@host# commit
   ```

Sample Output

```
user@R1> edit
Entering configuration mode

[edit]
user@R1# edit protocols

[edit protocols]
user@R1#  set mpls interface all

[edit protocols]
user@R1#  set rsvp interface all

[edit protocols]
user@R1# show
rsvp {
    interface all;
    interface fxp0.0 {
        disable;
    }
}
```

```
mpls {
    interface all;
    interface fxp0.0 {
        disable;
    }
}

[edit protocols]
user@R1# commit
commit complete
```

Meaning The sample output shows that router **R1** has MPLS and RSVP enabled on all interfaces, except for the management interface (**fxp0.0**), which is disabled. It is considered best practice to disable the management interlace (**fxp0.0**) for MPLS and RSVP to preempt any problems. The sample network shown in Figure 1 on page 7 has all interfaces (with the management interface [**fxp0.0**]) disabled on all routers configured with the MPLS and RSVP protocols.

Typically every interface that you want to use is listed. For an example of a router configured with specific interfaces, see “Enable IS-IS on Routers in Your Network” on page 10.

Enable MPLS on Transit Router Interfaces

Purpose Even though transit interfaces are enabled with MPLS when you include the **family mpls** statement in the configuration, MPLS as a whole is not configured on your router or in your network. You must complete all five steps in this topic to have the MPLS protocol running on your network.

NOTE: The management interface (fxp0) and the loopback interface (lo0) are not transit interfaces.

Action To configure transit interfaces to support MPLS, follow these steps:

1. In configuration mode, go to the following hierarchy level:

   [edit]
   user@host# **edit interfaces**

2. Configure MPLS:

   [edit interfaces]
   user@host# **set** *type-fpc/pic/port* **unit** *number* **family mpls**

3. Verify and commit the configuration:

   user@host# **show**

   user@host# **commit**

Sample Output

```
user@R1> edit
Entering configuration mode
```



```
[edit]
user@R1# edit interfaces

[edit interfaces]
user@R1# set so-0/0/2 unit 0 family mpls

[edit interfaces]
user@R1# show
so-0/0/2 {
    unit 0 {
        family inet {
            address 10.1.13.1/30;
        }
        family iso;
         family mpls;
    }
}

[edit interfaces]
user@R1# commit
commit complete
```

Meaning The sample output shows that the interface **so-0/0/2** is configured to support MPLS. The **family** statement identifies which protocol packets are accepted into the interfaces. For example, valid MPLS packets are dropped if the interface is not configured with the MPLS protocol.

Establish an LSP in Your Network

Create a label-switched path on specified routers in your network using the loopback address of the ingress and egress routers.

To establish an LSP in your network, follow these steps:

1. Configure the LSP on page 27
2. Verify the LSP on page 28

Configure the LSP

Action To configure an LSP in your network, follow these steps:

1. In configuration mode, go to the following hierarchy level:

   ```
   [edit]
   user@host# edit protocols mpls
   ```

2. Configure the LSP on the ingress and egress routers:

   ```
   [edit protocols mpls]
   user@host# set label-switched-path lsp-path-name to address
   ```

3. Verify and commit the configuration:

   ```
   user@host# show

   user@host# commit
   ```

Sample Output 1

```
user@R1> edit
Entering configuration mode

[edit]
user@R1# edit protocols mpls

[edit protocols mpls]
user@R1# set label-switched-path R1-to-R6 to 10.0.0.6

[edit protocols mpls]
user@R1# show
label-switched-path R1-to-R6  {
    to 10.0.0.6;
}
interface all;
interface fxp0.0 {
    disable;
}

[edit protocols mpls
user@R1# commit
commit complete
```

Sample Output 2

```
[edit protocols mpls]
user@R6# show
label-switched-path R6-to-R1 {
    to 10.0.0.1;
}
interface all;
interface fxp0.0 {
    disable;
}
```

Meaning The sample output shows that two CSPF LSPs (**R1-to-R6** and **R6-to-R1**) are configured between routers **R1** and **R6**. CSPF is enabled by default with the Junos OS. The example network shown in Figure 1 on page 7 focuses on CSPF LSPs.

The CSPF algorithm is an advanced form of the SPF algorithm used in OSPF and IS-IS route computations. CSPF is used in computing paths for LSPs that are subject to multiple constraints. When computing paths for LSPs, CSPF considers not only the topology of the network, but also the attributes of the LSP and the links, and attempts to minimize congestion by intelligently balancing the network load.

Typically in a network, LSPs are configured to every other egress router, resulting in a full mesh of LSPs that correspond to the BGP full mesh. In the example network shown in Figure 1 on page 7, two LSPs are configured between **R1** and **R6** to allow for bidirectional traffic. The first LSP is from **R1** to **R6** (**R1-to-R6**) and the second is from **R6** to **R1** (**R6-to-R1**). If only one LSP was configured, for example, from **R1** to **R6**, only unidirectional traffic would be allowed.

Verify the LSP

Purpose After configuring the LSP, you must verify that the LSP is up. LSPs can be ingress, transit, or egress. Use the **show mpls lsp** command for quick verification of the LSP state, with the **extensive** option (**show mpls lsp extensive**) as a follow-up if the LSP is down. If your

network has numerous LSPs, you might consider specifying the name of the LSP, using the **name** option (**show mpls lsp name *name*** or **show mpls lsp name *name* extensive**).

Action To verify that the LSP is up, enter the following command from the ingress router:

```
user@host> show mpls lsp extensive
```

Sample Output

```
user@R1> show mpls lsp extensive
Ingress LSP: 1 sessions

10.0.0.6
  From: 10.0.0.1, State: Up, ActiveRoute: 1, LSPname: R1-to-R6
  ActivePath:  (primary)
  LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
 *Primary                    State: Up
    Computed ERO (S [L] denotes strict [loose] hops): (CSPF metric: 20)
 10.1.13.2 S 10.1.36.2 S
   Received RRO (ProtectionFlag 1=Available 2=InUse 4=B/W 8=Node 10=SoftPreempt):

         10.1.13.2 10.1.36.2
    6 Dec 13 11:50:15 Selected as active path
    5 Dec 13 11:50:15 Record Route:  10.1.13.2 10.1.36.2
    4 Dec 13 11:50:15 Up
    3 Dec 13 11:50:15 Originate Call
    2 Dec 13 11:50:15 CSPF: computation result accepted
    1 Dec 13 11:49:45 CSPF failed: no route toward 10.0.0.6[6 times]
  Created: Mon Dec 13 11:47:19 2004
Total 1 displayed, Up 1, Down 0

Egress LSP: 1 sessions

10.0.0.1
  From: 10.0.0.6, LSPstate: Up, ActiveRoute: 0
  LSPname: R6-to-R1, 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:  127, Since: Mon Dec 13 11:50:10 2004
  Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
  Port number: sender 1 receiver 39136 protocol 0
  PATH rcvfrom: 10.1.13.2 (so-0/0/2.0) 28709 pkts
  Adspec: received MTU 1500
  PATH sentto: localclient
  RESV rcvfrom: localclient
  Record route: 10.1.36.2 10.1.13.2 <self>
Total 1 displayed, Up 1, Down 0

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

Meaning The sample output from ingress router **R1** show two LSPs in which this router participates: ingress LSP **R1-to-R6** and egress LSP **R6-to-R1** (the reverse LSP which allows bidirectional traffic). Both LSPs have active routes to the destination: **10.0.0.6** for the ingress LSP and **10.0.0.1** for the egress LSP. The state for both LSPs is up.

For more information on verifying the LSP, see “Checklist for Determining the LSP State” on page 53.

Example Configurations for an MPLS Topology

Purpose The configurations in this topic are for the six routers in the example network illustrated in Figure 1 on page 7.

Action To display the configuration of a router, use the following Junos OS CLI operational mode command:

```
user@host> show configuration | no-more
```

Sample Output 1

```
user@R1> show configuration | no-more
system {
    host-name R1;
    [...Output truncated...]
interfaces {
    so-0/0/0 {
        unit 0 {
            family inet {
                address 10.1.12.1/30;
            }
            family iso;
            family mpls;
        }
    }
    so-0/0/1 {
        unit 0 {
            family inet {
                address 10.1.15.1/30;
            }
            family iso;
            family mpls;
        }
    }
    so-0/0/2 {
        unit 0 {
            family inet {
                address 10.1.13.1/30;
            }
            family iso;
            family mpls;
        }
    }
    fxp0 {
        unit 0 {
            family inet {
                address 192.168.70.143/21;
            }
        }
    }
    lo0 {
        unit 0 {
            family inet {
                address 10.0.0.1/32;
            }
            family iso {
                address 49.0004.1000.0000.0001.00;
            }                                          #family mpls is not
        }                                              #configured because the
    }                                                  #loopback (lo0) interface
```

```
is
}                                                    #not a transit interface
routing-options {
    static {
        [...Output truncated...]
        route 100.100.1.0/24 reject;
    }
     router-id 10.0.0.1;
    autonomous-system 65432;
}
protocols {
    rsvp {
        inactive: traceoptions {
            file rsvp.log;
            flag packets;
        }
        interface all;
        interface fxp0.0 {
            disable;
        }
    }
    mpls {
        label-switched-path R1-to-R6 {
            to 10.0.0.6;
        }
        interface all;
        interface fxp0.0 {
            disable;
        }
    }
    bgp {
        export send-statics;
        group internal {
            type internal;
            local-address 10.0.0.1;
            neighbor 10.0.0.2;
            neighbor 10.0.0.3;
            neighbor 10.0.0.5;
            neighbor 10.0.0.4;
            neighbor 10.0.0.6;
        }
    }
    isis {
        level 1 disable;
        interface all {
            level 2 metric 10;
        }
        interface fxp0.0 {
            disable;
        }
        interface lo0.0;
             passive
    }
}
policy-options {
    policy-statement send-statics {
        term statics {
            from {
                route-filter 100.100.1.0/24 exact;
            }
            then accept;
```

```
        }
    }
}
```

Sample Output 2

```
user@R2> show configuration | no-more
system {
    host-name R2;
[...Output truncated...}
interfaces {
    so-0/0/0 {
        unit 0 {
            family inet {
                address 10.1.12.2/30;
            }
            family iso;
            family mpls;
        }
    }
    so-0/0/1 {
        unit 0 {
            family inet {
                address 10.1.23.1/30;
            }
            family iso;
            family mpls;
        }
    }
    so-0/0/2 {
        unit 0 {
            family inet {
                address 10.1.26.1/30;
            }
            family iso;
            family mpls;
        }
    }
    so-0/0/3 {
        unit 0 {
            family inet {
                address 10.1.24.1/30;
            }
            family iso;
            family mpls;
        }
    }
    fxp0 {
        unit 0 {
            family inet {
                address 192.168.70.144/21;
            }
        }
    }
    lo0 {
        unit 0 {
            family inet {
                address 10.0.0.2/32;
            }
            family iso {
                address 49.0004.1000.0000.0002.00;
            }                                       #family mpls is not
        }                                           #configured because the
```

```
    }                                                    #loopback (lo0) interface is
}                                                        #not a transit interface
routing-options {
    [...Output truncated...]
     router-id 10.0.0.2;
    autonomous-system 65432;
}
protocols {
rsvp {
        interface all;
        interface fxp0.0 {
            disable;
        }
    }
    mpls {
        interface all;
        interface fxp0.0 {
            disable;
        }
    }
    bgp {
        group internal {
            type internal;
            local-address 10.0.0.2;
            neighbor 10.0.0.1;
            neighbor 10.0.0.3;
            neighbor 10.0.0.4;
            neighbor 10.0.0.6;
        }
    }
    isis {
        level 1 disable;
        interface all {
            level 2 metric 10;
        }
        interface fxp0.0 {
            disable;
        }
        interface lo0.0;
             passive
    }
}
```

Sample Output 3

```
user@R3> show configuration | no-more
system {
    host-name R3;
    [...Output truncated...]
interfaces {
    so-0/0/0 {
        unit 0 {
            family inet {
                address 10.1.34.1/30;
            }
            family iso;
            family mpls;
        }
    }
    so-0/0/1 {
        unit 0 {
            family inet {
                address 10.1.23.2/30;
```

```
            }
            family iso;
            family mpls;
        }
    }
    so-0/0/2 {
        unit 0 {
            family inet {
                address 10.1.13.2/30;
            }
            family iso;
            family mpls;
        }
    }
    so-0/0/3 {
        unit 0 {
            family inet {
                address 10.1.36.1/30;
            }
            family iso;
            family mpls;
        }
    }
    fxp0 {
        unit 0 {
            family inet {
                address 192.168.70.145/21;
            }
        }
    }
    lo0 {
        unit 0 {
            family inet {
                address 10.0.0.3/32;
            }
            family iso {
                address 49.0004.1000.0000.0003.00;
            }                                          #family mpls is not
        }                                              #configured because the
    }                                                  #loopback (lo0) interface is

}                                                      #not a transit interface
routing-options {
    static {
        [...Output truncated...]
     router-id 10.0.0.3;
    autonomous-system 65432;
}
protocols {
rsvp {
        interface all;
        interface fxp0.0 {
            disable;
        }
    }
    mpls {
        interface all;
        interface fxp0.0 {
            disable;
        }
    }
```

```
    bgp {
        group internal {
            type internal;
            local-address 10.0.0.3;
            neighbor 10.0.0.1;
            neighbor 10.0.0.2;
            neighbor 10.0.0.4;
            neighbor 10.0.0.6;
        }
    }
    isis {
        level 1 disable;
        interface all {
            level 2 metric 10;
        }
        interface fxp0.0 {
            disable;
        }
        interface lo0.0;
             passive
    }
}
```

Sample Output 4

```
user@R4> show configuration | no-more
system {
    host-name R4;
    [...Output truncated...]
interfaces {
    so-0/0/0 {
        unit 0 {
            family inet {
                address 10.1.34.2/30;
            }
            family iso;
            family mpls;
        }
    }
    so-0/0/1 {
        unit 0 {
            family inet {
                address 10.1.46.1/30;
            }
            family iso;
            family mpls;
        }
    }
    so-0/0/2 {
        unit 0 {
            family inet {
                address 10.1.45.1/30;
            }
            family iso;
            family mpls;
        }
    }
    so-0/0/3 {
        unit 0 {
            family inet {
                address 10.1.24.2/30;
            }
            family iso;
```

```
            family mpls;
        }
    }
    fxp0 {
        unit 0 {
            family inet {
                address 192.168.70.146/21;
            }
        }
    }
    lo0 {
        unit 0 {
            family inet {
                address 10.0.0.4/32;
            }
            family iso {
                address 49.0004.1000.0000.0004.00;
            }                                          #family mpls is not
        }                                              #configured because the
    }                                                  #loopback (lo0) interface is
}                                                      #not a transit interface
routing-options {
    static {
        [...Output truncated...]
     router-id 10.0.0.4;
    autonomous-system 65432;
}
protocols {
rsvp {
        interface all;
        interface fxp0.0 {
            disable;
        }
    }
    mpls {
        interface all;
        interface fxp0.0 {
            disable;
        }
    }
    bgp {
        group internal {
            type internal;
            local-address 10.0.0.4;
            neighbor 10.0.0.2;
            neighbor 10.0.0.3;
            neighbor 10.0.0.5;
            neighbor 10.0.0.6;
        }
    }
    isis {
        level 1 disable;
        interface all {
            level 2 metric 10;
        }
        interface fxp0.0 {
            disable;
        }
        interface lo0.0;
             passive
```

```
    }
}
```

Sample Output 5

```
user@R5> show configuration | no-more
system {
    host-name R5;
    [...Output truncated...]
interfaces {
    so-0/0/0 {
        unit 0 {
            family inet {
                address 10.1.56.1/30;
            }
            family iso;
            family mpls;
        }
    }
    so-0/0/1 {
        unit 0 {
            family inet {
                address 10.1.15.2/30;
            }
            family iso;
            family mpls;
        }
    }
    so-0/0/2 {
        unit 0 {
            family inet {
                address 10.1.45.2/30;
            }
            family iso;
            family mpls;
        }
    }
    fxp0 {
        unit 0 {
            family inet {
                address 192.168.70.147/21;
            }
        }
    }
    lo0 {
        unit 0 {
            family inet {
                address 10.0.0.5/32;
            }
            family iso {
                address 49.0004.1000.0000.0005.00;
            }                                          #family mpls is not
        }                                              #configured because the
    }                                                 #loopback (lo0) interface is

}                                                      #not a transit interface
routing-options {
    static {
        [...Output truncated...]
     router-id 10.0.0.5;
    autonomous-system 65432;
}
protocols {
```

```
rsvp {
        interface all;
        interface fxp0.0 {
            disable;
        }
    }
    mpls {
        interface all;
        interface fxp0.0 {
            disable;
        }
    }
    bgp {
        group internal {
            type internal;
            local-address 10.0.0.5;
            neighbor 10.0.0.1;
            neighbor 10.0.0.4;
            neighbor 10.0.0.6;
        }
    }
    isis {
        level 1 disable;
        interface all {
            level 2 metric 10;
        }
        interface fxp0.0 {
            disable;
        }
        interface lo0.0;
             passive
    }
}
```

Sample Output 6

```
user@R6> show configuration | no-more
system {
    host-name R6;
    [...Output truncated...]
interfaces {
    so-0/0/0 {
        unit 0 {
            family inet {
                address 10.1.56.2/30;
            }
            family iso;
            family mpls;
        }
    }
    so-0/0/1 {
        unit 0 {
            family inet {
                address 10.1.46.2/30;
            }
            family iso;
            family mpls;
        }
    }
    so-0/0/2 {
        unit 0 {
            family inet {
                address 10.1.26.2/30;
```

```
            }
            family iso;
            family mpls;
        }
    }
    so-0/0/3 {
        unit 0 {
            family inet {
                address 10.1.36.2/30;
            }
            family iso;
            family mpls;
        }
    }
    fxp0 {
        unit 0 {
            family inet {
                address 192.168.70.148/21;
            }
        }
    }
    lo0 {
        unit 0 {
            family inet {
                address 10.0.0.6/32;
            }
            family iso {
                address 49.0004.1000.0000.0006.00;
            }                                          #family mpls is not
        }                                              #configured because the
    }                                                  #loopback (lo0) interface is

}                                                      #not a transit interface
routing-options {
    static {
        [...Output truncated...]
        route 100.100.6.0/24 reject;
    }
     router-id 10.0.0.6;
    autonomous-system 65432;
}
protocols {
    rsvp {
        interface all;
        interface fxp0.0 {
            disable;
        }
    }
    mpls {
        label-switched-path R6-to-R1 {
            to 10.0.0.1;
        }
        interface all;
        interface fxp0.0 {
            disable;
        }
    }
    bgp {
        group internal {
            type internal;
            local-address 10.0.0.6;
```

```
            export send-statics;
            neighbor 10.0.0.2;
            neighbor 10.0.0.3;
            neighbor 10.0.0.4;
            neighbor 10.0.0.5;
            neighbor 10.0.0.1;
        }
    }
    isis {
        level 1 disable;
        interface all {
            level 2 metric 10;
        }
        interface fxp0.0 {
            disable;
        }
        interface lo0.0;
             passive
    }
}
policy-options {
    policy-statement send-statics {
        term statics {
            from {
                route-filter 100.100.6.0/24 exact;
            }
            then accept;
        }
    }
}
```

Meaning Sample Outputs 1 through 6 show the configurations of all six routers in the example network illustrated in Figure 1 on page 7. LSPs **R1-to-R6** and **R6-to-R1** are configured on **R1** and **R6**, respectively.

Two static routes, **100.100.1/24** on **R1** and **100.100.6/24** on **R6,** are configured at the [**edit routing-options static route**] hierarchy level. Both prefixes are included in the send-statics policy at the [**edit policy-options send statics**] hierarchy level so the routes can become BGP routes.

In addition, the RID is configured manually at the [**edit routing-options**] hierarchy level to avoid duplicate RID problems, and the **passive** statement is included at the [**edit protocols isis interface lo0**] hierarchy level to ensure that protocols are not run over the loopback (**lo0**) interface and the loopback (**lo0**) interface is advertised correctly throughout the network.

CHAPTER 2

Checking the MPLS and RSVP Configuration

This chapter describes how to verify the correct configuration of both the Multiprotocol Label Switching (MPLS) protocol and Resource Reservation Protocol (RSVP). Incorrect configuration of either protocol prevents successful label-switched path (LSP) creation.

Checklist for Checking the MPLS and RSVP Configuration

Purpose This checklist provides the steps and commands for checking the MPLS and RSVP configuration of the Multiprotocol Label Switching (MPLS) network. The checklist provides links to an overview of the MPLS configuration and more detailed information about the commands used to investigate the problem.

Table 8 on page 41 provides commands for checking the MPLS and RSVP configuration.

Action

Table 8: Checklist for Checking the MPLS and RSVP Configuration

Tasks	Command or Action
"Verifying the MPLS Configuration" on page 42	
1. Verify MPLS Interfaces on page 43	**show mpls interface**
2. Verify the RSVP Protocol on page 44	**show rsvp version**
3. Verify RSVP Interfaces on page 45	**show rsvp interface**
4. Verify Protocol Families on page 47	**show interfaces terse**
5. Verify MPLS Labels on page 50	
a. Use the traceroute Command to Verify MPLS Labels on page 50	**traceroute** ***host-name*** **or** ***ip-address-of-remote-host***

Table 8: Checklist for Checking the MPLS and RSVP Configuration *(continued)*

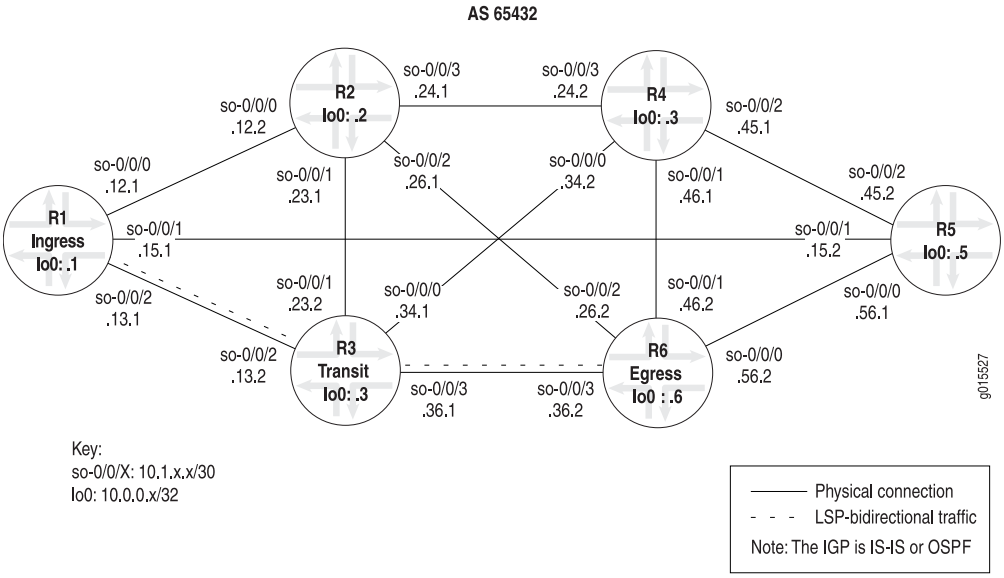
Tasks	Command or Action
b. Use the ping Command to Verify MPLS Labels on page 51	On the egress router, enter the following commands: **[edit]** **edit interfaces lo0 unit *number*** **set family inet address 127.0.0.1/32** **show** **commit** **ping mpls rsvp *lsp-name* detail**

Verifying the MPLS Configuration

After configuring MPLS on your network, you must verify the correct configuration of both the MPLS and RSVP protocols. Incorrect configuration of either protocol prevents successful LSP creation.

Figure 5 on page 42 illustrates the network with the example configurations used in this topic. For more details about the router configurations in this network, see "Configuring MPLS on Your Network" on page 6.

Figure 5: MPLS Network Topology



To verify the MPLS configuration, follow these steps:

1. Verify MPLS Interfaces on page 43
2. Verify the RSVP Protocol on page 44

3. Verify RSVP Interfaces on page 45
4. Verify Protocol Families on page 47

Verify MPLS Interfaces

Purpose If the MPLS protocol is not configured correctly on the routers in your network, the interfaces are not able to perform MPLS switching.

Action To verify MPLS interfaces, enter the following Junos OS command-line interface (CLI) operational mode command:

```
user@host> show mpls interface
```

Sample Output 1 The following sample output is for all routers in the network shown in Figure 5 on page 42.

```
user@R1> show mpls interface
Interface           State       Administrative groups
so-0/0/0.0          Up          <none>
so-0/0/1.0          Up          <none>
so-0/0/2.0          Up          <none>

user@R2> show mpls interface
Interface           State       Administrative groups
so-0/0/0.0          Up          <none>
so-0/0/1.0          Up          <none>
so-0/0/2.0          Up          <none>
so-0/0/3.0          Up          <none>

user@R3> show mpls interface
Interface           State       Administrative groups
so-0/0/0.0          Up          <none>
so-0/0/1.0          Up          <none>
so-0/0/2.0          Up          <none>
so-0/0/3.0          Up          <none>

user@R4> show mpls interface
Interface           State       Administrative groups
so-0/0/0.0          Up          <none>
so-0/0/1.0          Up          <none>
so-0/0/2.0          Up          <none>
so-0/0/3.0          Up          <none>

user@R5> show mpls interface
Interface           State       Administrative groups
so-0/0/0.0          Up          <none>
so-0/0/1.0          Up          <none>
so-0/0/2.0          Up          <none>

user@R6> show mpls interface
Interface           State       Administrative groups
so-0/0/0.0          Up          <none>
so-0/0/1.0          Up          <none>
so-0/0/2.0          Up          <none>
so-0/0/3.0          Up          <none>
```

Sample Output 2

```
user@R6>  show mpls interface
Interface           State       Administrative groups
so-0/0/0.0          Up          <none>
```

```
so-0/0/1.0          Up          <none>
so-0/0/3.0          Up          <none>        # so-0/0/2.0 is missing
```

Sample Output 3

```
user@host> show mpls interface
MPLS not configured
```

Meaning Sample Output 1 shows that all MPLS interfaces on all routers in the network are enabled (**Up**) and can perform MPLS switching. If you fail to configure the correct interface at the [**edit protocols mpls**] hierarchy level or include the **family mpls** statement at the [**edit interfaces** *type-fpc/pic/port* **unit** *number*] hierarchy level, the interface cannot perform MPLS switching, and does not appear in the output for the **show mpls interface** command.

Administrative groups are not configured on any of the interfaces shown in the example network in Figure 5 on page 42. However, if they were, the output would indicate which affinity class bits are enabled on the router.

Sample Output 2 shows that interface **so-0/0/2.0** is missing and therefore might be incorrectly configured. For example, the interface might not be included at the [**edit protocols mpls**] hierarchy level, or the **family mpls** statement might not be included at the [**edit interfaces** *type-fpc/pic/port* **unit** *number*] hierarchy level. If the interface is configured correctly, RSVP might not have signaled over this interface yet. For more information on determining which interface is incorrectly configured, see “Verify Protocol Families” on page 47.

Sample Output 3 shows that the MPLS protocol is not configured at the [**edit protocols mpls**] hierarchy level.

For more information on configuring MPLS on routers in your network, see “Configuring MPLS on Your Network” on page 6

Verify the RSVP Protocol

Purpose If the RSVP protocol is not enabled on the routers in your network, the interface cannot signal LSPs.

Action To verify that the RSVP protocol is enabled, enter the following Junos OS CLI command:

```
user@host> show rsvp version
```

Sample Output

```
user@R1> show rsvp version
Resource ReSerVation Protocol, version 1. rfc2205
   RSVP protocol           =  Enabled
   R(refresh timer)        = 30 seconds
   K(keep multiplier)      = 3
   Preemption              = Normal
   Soft-preemption cleanup = 30 seconds
   Graceful restart        = Disabled
   Restart helper mode     = Enabled
   Restart time            = 0 msec
```

Meaning The sample output shows that the RSVP protocol is enabled on **R1**. The supported RSVP protocol is version 1, as defined in RFC 2205.

The RSVP refresh timer is set to 30 seconds, indicating that every 30 seconds, plus or minus 50 percent, the router will refresh the RSVP state with its directly connected neighbors by sending either a **Path** or a **Resv** message. The variable refresh time helps prevent harmonic oscillations in network traffic caused by periodic protocol updates.

The keepalive multiplier, **K(keep multiplier)**, is input to a formula that helps determine the lifetime of an RSVP session. The session lifetime is reset each time the state is updated. The lifetime represents the duration of an RSVP session that does not receive any state updates (**Path** or **Resv** messages). The formula is:

RSVP session lifetime = (keep-multiplier + 0.5) * 1.5 * refresh-time

The RSVP **preemption** state is currently configured for normal preemption, indicating that only an LSP with a stronger priority can preempt an existing session; that is, the setup value of the new LSP is lower than the hold value of the existing LSP. Other options include **aggressive** preemption, which always preempts when there is insufficient bandwidth, and **disabled**, which prevents any preemption, regardless of LSP priority values.

Graceful restart is currently disabled and **Restart helper mode** is enabled. There are four combinations for **Graceful restart** and **restart helper mode**:

1. Both **Graceful restart** and **Restart helper mode** are enabled.
2. **Graceful restart** is enabled but **Restart helper mode** is disabled. An LSR with this configuration can restart gracefully but cannot help a neighbor with its restart and recovery procedures.
3. **Graceful restart** is disabled but **Restart helper mode** is enabled. An LSR with this configuration can only help a restarting neighbor. It cannot restart gracefully itself.
4. **Graceful restart** and **Restart helper mode** are both disabled. This configuration completely disables RSVP graceful restart (including restart and recovery procedures and helper mode). It is the same as an LSR that is not supported by RSVP graceful restart.

Restart time is the estimated time (in milliseconds) for an LSR to restart the RSVP traffic engineering component. In the example output, the restart time is 0 milliseconds, indicating that it is disabled.

The output is identical for all routers in the network shown in Figure 5 on page 42.

Verify RSVP Interfaces

Purpose If the RSVP protocol is not configured correctly on the routers in your network, the interfaces cannot signal LSPs.

Action To verify RSVP interfaces, enter the following Junos OS CLI operational mode command:

```
user@host> show rsvp interface
```

Sample Output 1

```
user@R1> show rsvp interface
RSVP interface: 4 active
                  Active Subscr- Static      Available   Reserved    Highwater
```

```
Interface   State resv   iption  BW          BW          BW          mark
so-0/0/0.0  Up         2   100%  155.52Mbps  155.52Mbps  0bps        0bps
so-0/0/1.0  Up         0   100%  155.52Mbps  155.52Mbps  0bps        0bps
so-0/0/2.0  Up         0   100%  155.52Mbps  155.52Mbps  0bps        0bps

user@R2> show rsvp interface
RSVP interface: 5 active
                Active Subscr- Static      Available   Reserved    Highwater
Interface   State resv   iption  BW          BW          BW          mark
so-0/0/0.0  Up         1   100%  155.52Mbps  155.52Mbps  0bps        0bps
so-0/0/1.0  Up         0   100%  155.52Mbps  155.52Mbps  0bps        0bps
so-0/0/2.0  Up         0   100%  155.52Mbps  155.52Mbps  0bps        0bps
so-0/0/3.0  Up         1   100%  155.52Mbps  155.52Mbps  0bps        0bps

user@R3> show rsvp interface
RSVP interface: 5 active
                Active Subscr- Static      Available   Reserved    Highwater
Interface   State resv   iption  BW          BW          BW          mark
so-0/0/0.0  Up         0   100%  155.52Mbps  155.52Mbps  0bps        0bps
so-0/0/1.0  Up         0   100%  155.52Mbps  155.52Mbps  0bps        0bps
so-0/0/2.0  Up         0   100%  155.52Mbps  155.52Mbps  0bps        0bps
so-0/0/3.0  Up         0   100%  155.52Mbps  155.52Mbps  0bps        0bps

user@R4> show rsvp interface
RSVP interface: 5 active
                Active Subscr- Static      Available   Reserved    Highwater
Interface   State resv   iption  BW          BW          BW          mark
so-0/0/0.0  Up         0   100%  155.52Mbps  155.52Mbps  0bps        0bps
so-0/0/1.0  Up         1   100%  155.52Mbps  155.52Mbps  0bps        0bps
so-0/0/2.0  Up         0   100%  155.52Mbps  155.52Mbps  0bps        0bps
so-0/0/3.0  Up         1   100%  155.52Mbps  155.52Mbps  0bps        0bps

user@R5> show rsvp interface
RSVP interface: 4 active
                Active Subscr- Static      Available   Reserved    Highwater
Interface   State resv   iption  BW          BW          BW          mark
so-0/0/0.0  Up         0   100%  155.52Mbps  155.52Mbps  0bps        0bps
so-0/0/1.0  Up         0   100%  155.52Mbps  155.52Mbps  0bps        0bps
so-0/0/2.0  Up         0   100%  155.52Mbps  155.52Mbps  0bps        0bps

user@R6> show rsvp interface
RSVP interface: 5 active
                Active Subscr- Static      Available   Reserved    Highwater
Interface   State resv   iption  BW          BW          BW          mark
so-0/0/0.0  Up         0   100%  155.52Mbps  155.52Mbps  0bps        0bps
so-0/0/1.0  Up         1    100%  155.52Mbps  155.52Mbps  0bps        0bps

so-0/0/2.0  Up         0   100%  155.52Mbps  155.52Mbps  0bps        0bps
so-0/0/3.0  Up         0   100%  155.52Mbps  155.52Mbps  0bps        0bps
```

Sample Output 2

```
user@R6> show rsvp interface
RSVP interface: 3 active
                Active Subscr- Static      Available   Reserved    Highwater
Interface   State resv   iption  BW          BW          BW          mark
so-0/0/0.0  Up         1   100%  155.52Mbps  155.52Mbps  0bps        0bps
so-0/0/1.0  Up         0   100%  155.52Mbps  155.52Mbps  0bps        0bps
so-0/0/2.0  Up         0   100%  155.52Mbps  155.52Mbps  0bps        0bps
#so-0/0/3.0 is missing
```

Sample Output 3

```
user@host# show rsvp interface
RSVP not configured
```

Meaning

Sample Output 1 shows that all interfaces on all routers in the network are enabled with RSVP, including the management interface (**fxp0**). The output for all routers in the network includes similar information, so we will examine R6 in detail.

R6 has five interfaces enabled with RSVP (**Up**). Interface **so-0/1/1.0** has a single active RSVP reservation (**Active resv**) that did not change the default subscription percentage of 100 percent (**Subscription**). Interface **so-0/1/1.0** did not assign a static bandwidth (**Static BW**) to the logical unit and therefore inherited 100 percent of the physical interface rate as the bandwidth available (**Available BW**) for RSVP sessions. Interface **so-0/1/1.0** has no bandwidth assigned (**Reserved BW**), and no RSVP bandwidth allocation at any single instant in time (**Highwater mark**).

Sample Output 2 shows that interface **so-0/0/3.0** is missing. If you do not configure the correct interface at the [**edit protocols rsvp**] hierarchy level, the interface cannot signal LSPs, and does not appear in the output for the **show rsvp interface** command. For more information on configuring MPLS on routers in your network, see "Configuring MPLS on Your Network" on page 6.

Sample Output 3 shows that the RSVP protocol is not configured at the [**edit protocols rsvp**] hierarchy level.

Verify Protocol Families

Purpose

If a logical interface does not have MPLS enabled, it cannot perform MPLS switching. This step allows you to quickly determine which interfaces are configured with MPLS and other protocol families.

Action

To verify the protocol families configured on the routers in your network, enter the following Junos OS CLI operational mode command:

```
user@host> show interfaces terse
```

Sample Output 1

```
user@R1> show interfaces terse
Interface               Admin Link Proto Local                 Remote
so-0/0/0                up    up
so-0/0/0.0              up  up inet  10.1.12.1/30
                                    iso
                                    mpls
so-0/0/1                up    up
so-0/0/1.0              up    up   inet  10.1.15.1/30
                                    iso
                                    mpls
so-0/0/2                up    up
so-0/0/2.0              up    up   inet  10.1.13.1/30
                                    iso
                                    mpls
so-0/0/3                up    down

user@R2> show interfaces terse
Interface               Admin Link Proto Local                 Remote
so-0/0/0                up    up
so-0/0/0.0              up    up   inet  10.1.12.2/30
```

```
                                    iso
                                    mpls
so-0/0/1                up    up
so-0/0/1.0              up    up    inet  10.1.23.1/30
                                    iso
                                    mpls
so-0/0/2                up    up
so-0/0/2.0              up    up    inet  10.1.26.1/30
                                    iso
                                    mpls
so-0/0/3                up    up
so-0/0/3.0              up    up    inet  10.1.24.1/30
                                    iso
                                    mpls

user@R3> show interfaces terse
Interface               Admin Link Proto Local                 Remote
so-0/0/0                up    up
so-0/0/0.0              up    up   inet  10.1.34.1/30
                                    iso
                                    mpls
so-0/0/1                up    up
so-0/0/1.0              up    up   inet  10.1.23.2/30
                                    iso
                                    mpls
so-0/0/2                up    up
so-0/0/2.0              up    up   inet  10.1.13.2/30
                                    iso
                                    mpls
so-0/0/3                up    up
so-0/0/3.0              up    up   inet  10.1.36.1/30
                                    iso
                                    mpls

user@R4> show interfaces terse
Interface               Admin Link Proto Local                 Remote
so-0/0/0                up    up
so-0/0/0.0              up    up   inet  10.1.34.2/30
                                    iso
                                    mpls
so-0/0/1                up    up
so-0/0/1.0              up    up   inet  10.1.46.1/30
                                    iso
                                    mpls
so-0/0/2                up    up
so-0/0/2.0              up    up   inet  10.1.45.1/30
                                    iso
                                    mpls
so-0/0/3                up    up
so-0/0/3.0              up    up   inet  10.1.24.2/30
                                    iso
                                    mpls

user@R5> show interfaces terse
Interface               Admin Link Proto Local                 Remote
so-0/0/0                up    up
so-0/0/0.0              up    up   inet  10.1.56.1/30
                                    iso
                                    mpls
so-0/0/1                up    up
so-0/0/1.0              up    up   inet  10.1.15.2/30
```

```
                                        iso
                                        mpls
so-0/0/2                up    up
so-0/0/2.0              up    up   inet  10.1.45.2/30
                                        iso
                                        mpls
so-0/0/3                up    down

user@R6>  show interfaces terse
Interface               Admin Link Proto Local                 Remote
so-0/0/0                up    up
so-0/0/0.0              up    up   inet  10.1.56.2/30
                                        iso
                                        mpls
so-0/0/1                up    up
so-0/0/1.0              up    up   inet  10.1.46.2/30
                                        iso
                                        mpls
so-0/0/2                up    up
so-0/0/2.0              up    up   inet  10.1.26.2/30
                                        iso
                                        mpls
so-0/0/3                up    up
so-0/0/3.0              up    up   inet  10.1.36.2/30
                                        iso
                                        mpls
```

Sample Output 2

```
user@R6> show interfaces terse
Interface               Admin Link Proto Local                 Remote
so-0/0/0                up    up
so-0/0/0.0              up    up   inet  10.1.56.2/30
                                        iso
                                        mpls
so-0/0/1                up    up
so-0/0/1.0              up    up   inet  10.1.46.2/30
                                        iso
                                        mpls
so-0/0/2                up    up
so-0/0/2.0              up  up inet 10.1.26.2/30
                                        iso  #The mpls statement is missing.
so-0/0/3                up    up
so-0/0/3.0              up    up   inet  10.1.36.2/30
                                        iso
                                        mpls
```

Meaning Sample Output 1 shows the interface, the administrative status of the link (**Admin**), the data link layer status of the link (**Link**), the protocol families configured on the interface (**Proto**), and the local and remote addresses on the interface.

All interfaces on all routes in the network shown in Figure 5 on page 42 are administratively enabled and functioning at the data link layer with MPLS and IS-IS, and have an **inet** address. All are configured with an IPv4 protocol family (**inet**), and have the IS-IS (**iso**) and MPLS (**mpls**) protocol families configured at the [**edit interfaces** *type-fpc/pic/port* **unit** *number*] hierarchy level.

Sample Output 2 shows that interface **so-0/0/2.0** on **R6** does not have the **mpls** statement included at the [**edit interfaces** *type-fpc/pic/port* **unit** *number*] hierarchy level.

For information on how to configure MPLS on an interface, see “Configuring MPLS on Your Network” on page 6.

Verify MPLS Labels

You can use the **traceroute** command or the **ping mpls** command to verify that packets are being sent over the LSP.

To verify MPLS labels and that packets are sent over the LSP, follow these steps:

1. Use the traceroute Command to Verify MPLS Labels on page 50
2. Use the ping Command to Verify MPLS Labels on page 51

Use the traceroute Command to Verify MPLS Labels

Purpose You can use the **traceroute** command to verify that packets are being sent over the LSP.

Action To verify MPLS labels, enter the following Junos OS CLI operational mode command, where ***host-name*** is the IP address or the name of the remote host:

user@host> **traceroute** ***host-name***

Sample Output 1

```
user@R1> traceroute 100.100.6.1
traceroute to 100.100.6.1 (100.100.6.1), 30 hops max, 40 byte packets
 1  10.1.12.2 (10.1.12.2)  0.861 ms  0.718 ms  0.679 ms
      MPLS Label=100048 CoS=0 TTL=1 S=1
 2  10.1.24.2 (10.1.24.2)  0.822 ms  0.731 ms  0.708 ms
      MPLS Label=100016 CoS=0 TTL=1 S=1
 3  10.1.46.2 (10.1.46.2)  0.571 ms !N  0.547 ms !N  0.532 ms !N
```

Sample Output 2

```
user@R1> traceroute 10.0.0.6
traceroute to 10.0.0.6 (10.0.0.6), 30 hops max, 40 byte packets
 1  10.1.13.2 (10.1.13.2)  0.605 ms  0.548 ms  0.503 ms
 2  10.0.0.6 (10.0.0.6)  0.761 ms  0.676 ms  0.675 ms
```

Meaning Sample Output 1 shows that MPLS labels are used to forward packets through the network. Included in the output is a label value (**MPLS Label=100048**), the time-to-live value (**TTL=1**), and the stack bit value (**S=1**).

The **MPLS Label** field is used to identify the packet to a particular LSP. It is a 20-bit field, with a maximum value of (2^^20-1), or approximately 1,000,000.

The TTL value contains a limit on the number of hops that this MPLS packet can travel through the network (1). It is decremented at each hop, and if the TTL value drops below one, the packet is discarded.

The bottom of the stack bit value (**S=1**) indicates that is the last label in the stack and that this MPLS packet has one label associated with it. The MPLS implementation in the Junos OS supports a stacking depth of 3 on the M-series routers and up to 5 on the T-series platforms. For more information on MPLS label stacking, see RFC 3032, *MPLS Label Stack Encoding*.

MPLS labels appear in Sample Output 1 because the **traceroute** command is issued to a BGP destination where the BGP next hop for that route is the LSP egress address. The Junos OS default behavior uses LSPs for BGP traffic when the BGP next hop equals the LSP egress address.

Sample Output 2 shows that MPLS labels do not appear in the output for the **traceroute** command. If the BGP next hop does not equal the LSP egress address or the destination is an IGP route, the BGP traffic does not use the LSP. Instead of using the LSP, the BGP traffic is using the IGP (IS-IS, in this case) to reach the egress address (**R6**).

Use the ping Command to Verify MPLS Labels

Purpose On the egress router (the router receiving the MPLS echo packets), you must configure the address 127.0.0.1/32 on its loopback (**lo0**) interface, resulting in echo requests being sent as MPLS packets destined for the address 127.0.0.1 and the well-known port 3503. When the echo request arrives at the egress router, the receiver checks the contents of the packet and sends a reply containing the correct return value. The sender of the echo request waits 2 seconds for the echo reply, then times out. In the example network shown in Figure 5 on page 42, the egress router is **R6**. If address 127.0.0.1/32 is not configured, the egress router does not have this forwarding entry and therefore simply drops the incoming MPLS pings and replies with "ICMP host unreachable" messages.

Action To verify MPLS labels, follow these steps:

1. On the egress router, in configuration mode, go to the following hierarchy level:

   ```
   [edit]
   user@egress-router#  edit interfaces lo0 unit number
   ```

2. Configure the loopback (**lo0**) interface with the following IP address:

   ```
   [edit interfaces lo0 unit  number]
   user@egress-router#  set family inet address 127.0.0.1/32
   ```

3. Verify the configuration:

   ```
   user@egress-router# show
   user@egress-router# commit
   ```

4. On the ingress router, in operational mode, enter the following command to ping the egress router:

   ```
   user@ingress-router> ping mpls rsvp lsp-name detail
   ```

Sample Output 1

```
user@R6> edit
Entering configuration mode

[edit]
user@R6# edit interfaces lo0 unit 0

[edit interfaces lo0 unit 0]
user@R6# set family inet address 127.0.0.1/32

[edit interfaces lo0 unit 0]
user@R6# show
family inet {
```

```
    address 10.0.0.6/32;
    address 127.0.0.1/32;
}
family iso {
    address 49.0004.1000.0000.0006.00;
}

[edit interfaces lo0 unit 0]
user@R6# commit
commit complete
```

Sample Output 2

```
user@R1> ping mpls rsvp R1-to-R6 detail
Request for seq 1, to interface 69,  label 100064
Reply for seq 1, return code: Egress-ok
Request for seq 2, to interface 69, label 100064
Reply for seq 2, return code: Egress-ok
Request for seq 3, to interface 69, label 100064
Reply for seq 3, return code: Egress-ok
Request for seq 4, to interface 69, label 100064
Reply for seq 4, return code: Egress-ok
Request for seq 5, to interface 69, label 100064
Reply for seq 5, return code: Egress-ok

--- lsping statistics ---
5 packets transmitted, 5 packets received, 0% packet loss
```

Meaning Sample Output 1 from egress router **R6** shows that the IP address **127.0.0.1/32** is configured.

Sample Output 2 from ingress router **R1** shows that an echo request is sent with a label (**100064**), indicating that the echo requests were sent over the LSP **R1-to-R6**.

CHAPTER 3

Determining the LSP State

This chapter describes how to display the status and statistics of the Multiprotocol Label Switching (MPLS) protocol running on all routers in a network. You can use a variety of operational mode commands to determine status and statistics information useful in diagnosing problem situations.

Checklist for Determining LSP Status

Purpose This checklist provides the steps and commands to verify the state of a label-switched path (LSP) in an MPLS network. The checklist includes links to more detailed information about the commands to verify the LSP and supporting protocols. Table 9 on page 53 provides commands for determining the LSP state.

Table 9: Checklist for Determining the LSP State

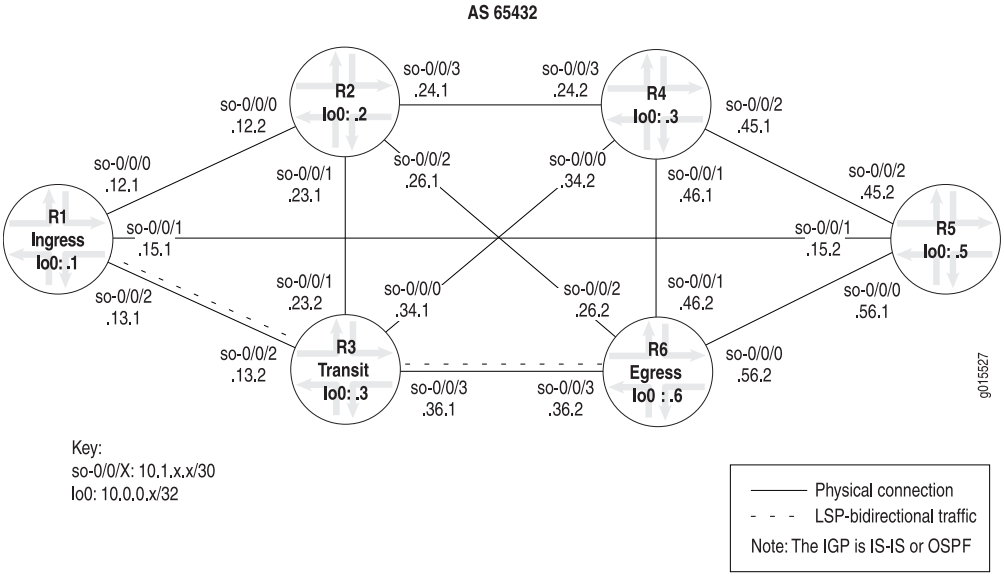
Tasks	Command or Action
"Determining LSP Status" on page 53	
1. Check the Status of the LSP on page 54	**show mpls lsp**
2. Display Extensive Status About the LSP on page 55	**show mpls lsp extensive**
"Determining LSP Statistics" on page 58	**show rsvp session detail**

Determining LSP Status

Display detailed information about Resource Reservation Protocol (RSVP) objects and the label-switched path (LSP) history to pinpoint a problem with the LSP.

Figure 6 on page 54 illustrates the network topology used in this topic. For more details about the router configurations in this network, see "Checklist for Configuring and Verifying an MPLS Network" on page 3.

Figure 6: MPLS Network Topology



To determine the LSP state, follow these steps:

1. Check the Status of the LSP on page 54
2. Display Extensive Status About the LSP on page 55

Check the Status of the LSP

Purpose Display the status of the label-switched pathe (LSP).

Action To determine the LSP status, on the ingress router, enter the following Junos OS command-line interface (CLI) operational mode command:

```
user@host> show mpls lsp
```

Sample Output

```
user@R1> show mpls lsp
Ingress LSP: 1 sessions
To              From            State Rt ActivePath       P     LSPname
10.0.0.6    10.0.0.1    Up  1       *  R1-to-R6
Total 1 displayed, Up 1, Down 0

Egress LSP: 1 sessions
To              From            State Rt  Style   Labelin  Labelout LSPname
10.0.0.1    10.0.0.6    Up  01 FF    3    - R6-to-R1
Total 1 displayed, Up 1, Down 0

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

Meaning The sample output is from the ingress router (**R1**), and shows ingress, egress, and transit LSP information. Ingress information is for the sessions that originate from this router, egress information is for sessions that terminate on this router, and transit information is for sessions that transit through this router.

There is one ingress route from **R1** (**10.0.0.1**) to **R6** (**10.0.0.6**). This route is currently up, and is an active route installed in the routing table (**Rt**). The LSP **R1-to-R6** is the primary path (**P**) as opposed to the secondary path, and is indicated by an asterisk (*****). The route to **R6** does not contain a named path (**ActivePath**).

There is one egress LSP from **R6** to **R1**. The **State** is up, with no routes installed in the routing table. RSVP reservation style (**Style**) consists of two parts. The first is the number of active reservations (**1**). The second is the reservation style, which is **FF** (fixed filter). The reservation style can be **FF**, **SE** (shared explicit), or **WF** (wildcard filter). There are three incoming labels (**Labelin**) and no labels going out (**Labelout**) for this LSP.

There are no transit LSPs.

For more information on checking the LSP state, see "Checklist for Working with the Layered MPLS Troubleshooting Model" on page 77.

Display Extensive Status About the LSP

Purpose Display extensive information about LSPs, including all past state history and the reasons why an LSP might have failed.

Action To display extensive information about LSPs, on the ingress router, enter the following Junos OS CLI operational mode command:

```
user@host> show mpls lsp extensive
```

Sample Output

```
user@R1> show mpls lsp extensive
Ingress LSP: 1 sessions

10.0.0.6
  From: 10.0.0.1, State:  Up , ActiveRoute:  1 , LSPname:  R1-to-R6
  ActivePath:   (primary)
  LoadBalance:  Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
  *Primary                    State:  Up
     Computed ERO  (S [L] denotes strict [loose] hops): (CSPF metric: 20)
 10.1.13.2 S 10.1.36.2 S
   Received RRO (ProtectionFlag 1=Available 2=InUse 4=B/W 8=Node 10=SoftPreempt):

         10.1.13.2 10.1.36.2
  91 Aug 17 12:22:52 Selected as active path
  90 Aug 17 12:22:52 Record Route:  10.1.13.2 10.1.36.2
  89 Aug 17 12:22:52 Up
  88 Aug 17 12:22:52 Originate Call
  87 Aug 17 12:22:52 CSPF: computation result accepted
  86 Aug 17 12:22:23 CSPF failed: no route toward 10.0.0.6[13920 times]
  85 Aug 12 19:12:51 Clear Call
  84 Aug 12 19:12:50 10.1.56.2: MPLS label allocation failure
  83 Aug 12 19:12:47 Deselected as active
  82 Aug 12 19:12:47 10.1.56.2: MPLS label allocation failure
  81 Aug 12 19:12:47 ResvTear received
  80 Aug 12 19:12:47 Down
  79 Aug 12 19:12:31 10.1.56.2: MPLS label allocation failure[4 times]
  78 Aug 12 19:09:58 Selected as active path
  77 Aug 12 19:09:58 Record Route:  10.1.15.2 10.1.56.2
  76 Aug 12 19:09:58 Up
  75 Aug 12 19:09:57 Originate Call
```

```
   74 Aug 12 19:09:57 CSPF: computation result accepted
   73 Aug 12 19:09:29 CSPF failed: no route toward 10.0.0.6[11 times]
   72 Aug 12 19:04:36 Clear Call
   71 Aug 12 19:04:23 Deselected as active
   70 Aug 12 19:04:23 ResvTear received
   69 Aug 12 19:04:23 Down
   68 Aug 12 19:04:23 CSPF failed: no route toward 10.0.0.6
   67 Aug 12 19:04:23 10.1.15.2: Session preempted
   66 Aug 12 16:45:35 Record Route:  10.1.15.2 10.1.56.2
   65 Aug 12 16:45:35 Up
   64 Aug 12 16:45:35 Clear Call
   63 Aug 12 16:45:35 CSPF: computation result accepted
   62 Aug 12 16:45:35 ResvTear received
   61 Aug 12 16:45:35 Down
   60 Aug 12 16:45:35 10.1.13.2: Session preempted
   59 Aug 12 14:50:52 Selected as active path
   58 Aug 12 14:50:52 Record Route:  10.1.13.2 10.1.36.2
   57 Aug 12 14:50:52 Up
   56 Aug 12 14:50:52 Originate Call
   55 Aug 12 14:50:52 CSPF: computation result accepted
   54 Aug 12 14:50:23 CSPF failed: no route toward 10.0.0.6[7 times]
   53 Aug 12 14:47:22 Deselected as active
   52 Aug 12 14:47:22 CSPF failed: no route toward 10.0.0.6
   51 Aug 12 14:47:22 Clear Call
   50 Aug 12 14:47:22 CSPF: link down/deleted
10.1.12.1(R1.00/10.0.0.1)->10.1.12.2(R2.00/10.0.0.2)
   49 Aug 12 14:47:22 CSPF: link down/deleted
10.1.15.1(R1.00/10.0.0.1)->10.1.15.2(R5.00/10.0.0.5)
   48 Aug 12 14:47:22 10.1.15.1: MPLS label allocation failure
   47 Aug 12 14:47:22 Clear Call
   46 Aug 12 14:47:22 CSPF: computation result accepted
   45 Aug 12 14:47:22 10.1.12.1: MPLS label allocation failure
   44 Aug 12 14:47:22 MPLS label allocation failure
   43 Aug 12 14:47:22 Down
   42 Jul 23 11:27:21 Selected as active path
   Created: Sat Jul 10  18:18:44 2004
Total 1 displayed, Up 1, Down 0

Egress LSP: 1 sessions

10.0.0.1
  From: 10.0.0.6,  LSPstate: Up  , ActiveRoute: 0
  LSPname:  R6-to-R1  , 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:  141, Since: Tue Aug 17 12:23:14 2004
  Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
  Port number: sender 1 receiver 39024 protocol 0
  PATH rcvfrom: 10.1.15.2 (so-0/0/1.0) 130 pkts
  Adspec: received MTU 1500
  PATH sentto: localclient
  RESV rcvfrom: localclient
  Record route: 10.1.56.2 10.1.15.2 <self>
Total 1 displayed, Up 1, Down 0

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


Meaning The sample output is from the ingress router (**R1**), and shows ingress, egress, and transit LSP information in detail, including all past state history and the reasons why an LSP failed. Ingress information is for sessions that originate from this router, egress information is for sessions that terminate on this router, and transit information is for sessions that transit through this router.

There is one ingress route from **R1** (**10.0.0.1**) to **R6** (**10.0.0.6**). This route is currently up (**State**), with one route actively using the LSP, **R1-to-R6**. The LSP active path is the primary path. Even if the LSP does not contain a **primary** or **secondary** keyword, the router still treats the LSP as a primary LSP, indicating that if the LSP fails, the router will attempt to signal inactive LSPs at 30-second intervals, by default.

Load balancing is **Random**, which is the default, indicating that when selecting the physical path for an LSP, the router randomly selects among equal-cost paths that have an equal hop count. Other options that you can configure are **Least-fill** and **Most-fill**. **Least-fill** places the LSP over the least utilized link of the equal-cost paths with equal hop count. **Most-fill** places the LSP over the most utilized link of the equal-cost paths sharing an equal hop count. Utilization is based on the percentage of available bandwidth.

The **Encoding type** field shows Generalized MPLS (GMPLS) signaling parameters (**Packet)**, indicating IPv4. The **Switching type** is **Packet**, and the Generalized Payload Identifier (**GPID**) is IPv4.

The primary path is the active path, as indicated by an asterisk (*). The state of the LSP is **Up**.

The Explicit Route Object (**ERO**) includes the Constrained Shortest Path First (CSPF) cost (**20**) for the physical path that the LSP follows. The presence of the CSPF metric indicates that this is a CSPF LSP. The absence of the CSPF metric indicates a no-CSPF LSP.

The field **10.1.13.2 S** indicates the actual ERO. The RSVP signaling messages went to **10.1.13.2** strictly (as a next hop) and finished at **10.1.36.2** strictly. All ERO addresses are strict hops when the LSP is a CSPF LSP. Loose hops can only display in a no-CSPF LSP.

The received Record Route Object (**RRO**) has the following protection flags:

- **0x01**—Local protection available. The link downstream of this node is protected by a local repair mechanism. This flag can only be set 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).
- **0x04**— Bandwidth protection. The downstream router has a backup path providing the same bandwidth guarantee as the protected LSP for the protected section.
- **0x08**—Node protection. The downstream router has a backup path providing protection against link and node failure on the corresponding path section. If the downstream

router can set up only a link-protection backup path, the “Local protection available” bit is set but the “Node protection” bit is cleared.

- **0x10**—Preemption pending. The preempting node sets this flag if a pending preemption is in progress for the traffic engineered LSP. This indicates to the ingress label edge router (LER) of this LSP that it should be rerouted.

For more information on protection flags, see the *Junos Routing Protocols and Policies Command Reference.*

The field **10.1.13.2.10.1.36.2** is the actual received record route (**RRO**). Note that the addresses in the **RRO** field match those in the **ERO** field. This is the normal case for CSPF LSPs. If the RRO and ERO addresses do not match for a CSPF LSP, the LSP has to reroute or detour.

The lines numbered 91 through 42 contain the 49 most recent entries to the history log. Each line is time stamped. The most recent entries have the largest log history number and are at the top of the log, indicating that line 91 is the most recent history log entry. When you read the log, start with the oldest entry (**42**) to the most recent (**91**).

The history log was started on July 10, and displays the following sequence of activities: an LSP was selected as active, was found to be down, MPLS label allocation failed several times, was deleted several times, was preempted because of an ResvTear, was deselected as active, and was cleared. In the end, the router computed a CSPF ERO, signaled the call, the LSP came up with the listed RRO (line 90), and was listed as active.

For more information on error messages, see the *Junos MPLS Network Operations Guide Log Reference.*

The total number of ingress LSPs displayed is **1**, with **1** up and **0** down. The number in the **Up** field plus the number in the **Down** field should equal the total.

There is one egress LSP session from **R6** to **R1**. The **State** is up, with no routes installed in the routing table. RSVP reservation style (**Style**) consists of two parts. The first is the number of active reservations (**1**). The second is the reservation style, which is **FF** (fixed filter). The reservation style can be **FF**, **SE** (shared explicit), or **WF** (wildcard filter). There are three incoming labels (**Labelin**) and no labels going out (**Labelout**) for this LSP.

There are no transit LSPs.

For more information on checking the LSP state, see “Checklist for Working with the Layered MPLS Troubleshooting Model” on page 77.

Determining LSP Statistics

Purpose Display detailed information about RSVP objects to assist the diagnosis of an LSP problem.

Action To verify RSVP objects, enter the following Junos OS CLI operational mode command:

```
user@host> show rsvp session detail
```


Sample Output

```
user@R1> show rsvp session detail
Ingress RSVP: 1 sessions

10.0.0.6
  From: 10.0.0.1, LSPstate: Up, ActiveRoute: 1
  LSPname:  R1-to-R6 , LSPpath:  Primary
  Suggested label received: -, Suggested label sent: -
  Recovery label received: -, Recovery label sent:  100064
  Resv style: 1 FF, Label in: -, Label out: 100064
  Time left:    -, Since: Tue Aug 17 12:22:52 2004
  Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
  Port number: sender 12 receiver 44251 protocol 0
  PATH rcvfrom: localclient
  Adspec: sent MTU 1500
  PATH sentto: 10.1.13.2 (so-0/0/2.0) 182 pkts
  RESV rcvfrom: 10.1.13.2 (so-0/0/2.0) 159 pkts
  Explct route: 10.1.13.2 10.1.36.2
  Record route: <self> 10.1.13.2 10.1.36.2
Total 1 displayed, Up 1, Down 0

Egress RSVP: 1 sessions

10.0.0.1
  From:  10.0.0.6 , LSPstate: Up, ActiveRoute: 0
  LSPname: R6-to-R1, 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:  135, Since: Tue Aug 17 12:23:14 2004
  Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
  Port number: sender 1 receiver 39024 protocol 0
  PATH rcvfrom: 10.1.15.2 (so-0/0/1.0) 158 pkts
  Adspec: received MTU 1500
  PATH sentto: localclient
  RESV rcvfrom: localclient
  Record route: 10.1.56.2 10.1.15.2 <self>
Total 1 displayed, Up 1, Down 0

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

Meaning The sample output shows that there is one ingress and one egress RSVP session. The ingress session has a source address of **10.0.0.1** (**R1**), and the session is up, with one active route. The LSP name is **R1-to-R6** and it is the primary path for the LSP.

The recovery label (**100064**) is sent by a graceful restart router to its neighbor to recover a forwarding state. It is probably the old label that the router advertised before it went down.

This session is using the fixed filter (**FF**) reservation style (**Resv style**). Since this is an ingress router, there is no inbound label. The outbound label (provided by the next downstream router) is **100064**.

The **Time Left** field provides the number of seconds remaining in the RSVP session, and the **Tspec** object provides information about the controlled load rate (**rate**) and maximum burst size (**peak**), an infinite value (**Infbps**) for the guaranteed delivery option, and the

indication that packets smaller than 20 bytes are treated as 20 bytes, while packets larger than 1500 bytes are treated as 1500 bytes.

The port number is the IPv4 tunnel ID, while the sender/receiver port number is the LSP ID. The IPv4 tunnel ID is unique for the life of the LSP, while the sender/receiver LSP ID can change, for example, with an SE style reservation.

The **PATH rcvfrom** field includes the source of the path message. Since this is the ingress router, the local client originated the path message.

The **PATH sentto** field includes the path message destination (**10.1.13.2**) and outgoing interface (**so-0/0/2.0**). The **RESV rcvfrom** field includes both the source of the Resv message received (**10.1.13.2**) and the incoming interface (**so-0/0/2.0**).

The RSVP explicit route and the route record values are identical: **10.1.13.2** and **10.1.36.2**. In most cases, the explicit route and the record route values are identical. Differences indicate that some path rerouting has occurred, typically during Fast-Reroute.

The **Total** fields indicate the total number of ingress, egress, and transit RSVP sessions, with the total being equal to the sum of the up and down sessions. In this example, there is one ingress session, one egress session, and no transit RSVP sessions.

CHAPTER 4

Verifying RSVP Signal Processing

This chapter describes how to determine that the Resource Reservation Protocol (RSVP) path messages are sent and received.

Checklist for Verifying RSVP Signal Processing

Purpose This checklist provides the steps and commands to verify Resource Reservation Protocol (RSVP) signal processing in an MPLS network. The checklist includes links to more detailed information about checking RSVP messages, examining the history log, determining RSVP neighbors, and commands to configure RSVP traceoptions.

Table 10 on page 61 provides commands for verifying RSVP signal processing.

Table 10: Checklist for Verifying RSVP Signal Processing

Tasks	Command or Action
"Checking That RSVP Path Messages Are Sent and Received" on page 62	**show rsvp statistics**
"Examining the History Log" on page 63	**show mpls lsp extensive**
"Determining the Current RSVP Neighbor State" on page 64	**show rsvp neighbor**
"Enabling RSVP Traceoptions" on page 65	**[edit]** **edit protocols rsvp traceoptions** **set file *filename*.log** **set flag packets** **show** **commit** **run show log rsvp.log** **deactivate traceoptions** **show** **commit**

Checking That RSVP Path Messages Are Sent and Received

Purpose The presence or absence of various RSVP messages can help determine if there is a problem with Multiprotocol Label Switching (MPLS) in your network. For example, if path messages occur in the output without Resv messages, it might indicate that label-switched paths (LSPs) are not being created.

Action To check that RSVP Path messages are sent and received, enter the following Junos OS command-line interface (CLI) operational mode command:

```
user@host> show rsvp statistics
```

Sample Output

```
user@R1> show rsvp statistics
  PacketType                Total                 Last 5 seconds
                       Sent      Received        Sent      Received
Path       114523     80185     1             0
  PathErr       5      10            0             0
   PathTear      12       6            0             0
  Resv FF      80515    111476            0             0
  Resv WF          0         0            0             0
  Resv SE          0         0            0             0
  ResvErr          0         0            0             0
   ResvTear       0       5            0             0
  ResvConf         0         0            0             0
  Ack              0         0            0             0
  SRefresh         0         0            0             0
  Hello       915851    915881            0             0
  EndtoEnd RSVP        0         0            0             0

  Errors                           Total            Last 5 seconds
  Rcv pkt bad length                 0                        0
  Rcv pkt unknown type               0                        0
  Rcv pkt bad version                0                        0
  Rcv pkt auth fail                  0                        0
  Rcv pkt bad checksum               0                        0
  Rcv pkt bad format                 0                        0
  Memory allocation fail             0                        0
  No path information                0                        0
  Resv style conflict                0                        0
  Port conflict                      0                        0
  Resv no interface                  0                        0
  PathErr to client       15                        0
  ResvErr to client                  0                        0
  Path timeout                       0                        0
  Resv timeout                       0                        0
  Message out-of-order               0                        0
  Unknown ack msg                    0                        0
  Recv nack                          0                        0
  Recv duplicated msg-id             0                        0
  No TE-link to recv Hop             0                        0
```

Meaning The sample output shows RSVP messages sent and received. The total number of RSVP Path messages is 11,4532 sent and 80,185 received. Within the last 5 seconds, no messages have been sent or received.

A total of 5 **PathErr** messages were sent and 10 received. When path errors occur (usually because of parameter problems in a path message), the router sends a unicast PathErr

message to the sender that issued the path message. In this case, **R1** sent at least 10 path messages with an error, as indicated by the 10 PathErr messages that **R1** has received. The downstream router sent **R1** five path messages with an error, as indicated by the five PathErr messages that **R1** has sent. PathErr messages transmit in the opposite direction to path messages.

A total of 12 **PathTear** messages were sent and 6 received, none in the last 5 seconds. In contrast to PathErr messages, PathTear messages travel in the same direction as path messages. Since path messages are both sent and received, PathTear messages are also sent and received. However, if only path messages are sent, then only the PathTear messages that are sent appear in the output.

A total of 80,515 reservation (**Resv**) messages with the fixed filter (**FF**) reservation style were sent and 111,476 received, none in the last 5 seconds. An **FF** reservation style indicates that within each session, each receiver establishes its own reservation with each upstream sender, and that all selected senders are listed. No messages for the wildcard filter (**WF**) or shared explicit (**SE**) reservation styles are sent or received. For more information on RSVP reservation styles, see the *Junos MPLS Applications Configuration Guide*.

Other RSVP message types are not sent or received. For information on the ResvErr, ResvTear, and Resvconf message types, see the *Junos MPLS Applications Configuration Guide*.

Ack and summary refresh (SRefresh) messages do not appear in the output. Ack and summary refresh messages are defined in RFC 2961 and are part of the RSVP extensions. Ack messages are used to reduce the amount of RSVP control traffic in the network.

A total of 915,851 hello messages were sent and 915,881 received, with none transmitted or received in the last 5 seconds. The RSVP hello interval is 9 seconds. If more than one hello message is sent or received in the last 5 seconds, it implies that more than one interface supports RSVP.

EndtoEnd RSVP messages are legacy RSVP messages that are not used for RSVP traffic engineering. These counters increment only when RSVP forwards legacy RSVP messages issued by a virtual private network (VPN) customer for transit across the backbone to the other site(s) in the VPN. They are called end-to-end messages because they are intended for the opposite side of the network and only have meaning at the two ends of the provider network.

The **Errors** section of the output shows statistics about RSVP packets with errors. A total of 15 **PathErr to client** packets were sent to the Routing Engine. The total combines the sent and received **PathErr** packets. For more information about error statistics and packets, see the *Junos System Basics and Services Command Reference.*

Examining the History Log

Purpose The history log for the **show mpls lsp** extensive command contains information that is useful in determining a possible reason for any errors in MPLS functioning in your network.

Action To examine the history log, enter the following Junos OS CLI operational mode command:

user@host> **show mpls lsp extensive**

Sample Output

```
user@R6> show mpls lsp extensive
Ingress LSP: 1 sessions

10.0.0.1
From: 10.0.0.6, State: Up, ActiveRoute: 1, LSPname: R6-to-R1
  ActivePath:  (primary)
  LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
 *Primary                    State: Up
    Computed ERO (S [L] denotes strict [loose] hops): (CSPF metric: 20)
 10.1.56.1 S 10.1.15.1 S
   Received RRO (ProtectionFlag 1=Available 2=InUse 4=B/W 8=Node 10=SoftPreempt):

         10.1.56.1 10.1.15.1
     6 Aug 17 12:19:04 Selected as active path
     5 Aug 17 12:19:03 Record Route: 10.1.56.1 10.1.15.1
     4 Aug 17 12:19:03 Up
     3 Aug 17 12:19:03 Originate Call
     2 Aug 17 12:19:03 CSPF: computation result accepted
     1 Aug 17 12:18:34 CSPF failed: no route toward 10.0.0.1
  Created: Tue Aug 17 12:18:33 2004
Total 1 displayed, Up 1, Down 0
[...Output truncated...]
```

Meaning Lines 1through 6 contain the six most recent entries to the history log. Each line is time stamped. The most recent entries have the largest log history number and are at the top of the log, indicating that line 6 is the most recent entry in the history log.

The history log was started on August 17, and displays the following sequence of activities: a call failed because the address could not be reached (line 1); 31 seconds later, probably because the addressing problem was resolved, the call was signaled (line 2); the call was completed (line 3); the LSP came up with a route (lines 4 and 5); and the LSP was selected as active (line 6).

For more details about the messages that can appear in the history log, see *Junos MPLS Operations Guide: Log Files.*

Determining the Current RSVP Neighbor State

Purpose Display a list of RSVP neighbors that were learned dynamically when exchanging RSVP packets. Once a neighbor is learned, it is never removed from the list of RSVP neighbors.

Action To determine the current RSVP neighbor state, enter the following Junos OS CLI operational mode command:

user@host> **show rsvp neighbor**

Sample Output

```
user@R6> show rsvp neighbor
RSVP neighbor:  2  learned
Address   Idle Up/Dn LastChange   HelloInt  HelloTx/Rx     MsgRcvd
10.1.36.1    5  1/0  1w5d 6:30:50    9      116734/116734   23558
10.1.56.1   10  1/0  2w2d 23:44:15   9      161600/161600   23570
```

Meaning The sample output shows that **R6** has learned about two different RSVP neighbors. Each neighbor has one line of output that includes the neighbor RSVP address, the length of time the interface was idle, the current interface up/down counter, the time of the last interface state change, the current RSVP hello interval, the total number of RSVP hello messages transmitted and received, and the total number of RSVP messages received on the interface.

The **show rsvp neighbor** command only indicates a neighbor after a session is established. Once an interface is displayed in this command output, it always appears, even if the RSVP neighbor state is down.

The RSVP neighbor **10.1.36.1** was idle for 5 seconds, came up once and has not gone down, indicating that the interface is currently in an **Up** state. As long as the up counter is one greater than the down counter, the RSVP interface is up. If the up/down counters are equal, the interface is down.

The last state change occurred 6 hours and 30 minutes ago. The current hello interval is 9 seconds. A total of 116,734 hello messages were transmitted and received on this interface, and a total of 23,558 RSVP Path/Resv messages were processed.

The RSVP neighbor **10.1.56.1** was idle for 10 seconds, came up once and has not gone down, indicating that the interface is currently in an **Up** state. The last state change occurred 23 hours and 44 minutes ago. The current Hello interval is 9 seconds. A total of 161,600 hello messages were transmitted and received on this interface, and a total of 23,570 RSVP Path/Resv messages were processed.

Enabling RSVP Traceoptions

Purpose Global routing protocol tracing operations track all general routing operations and record them in a log file. Any global tracing operations that you configure are inherited by the individual routing protocols. To modify the global tracing operations for an individual protocol, enable tracing when configuring that protocol.

The error descriptions logged by the remote operations daemon can often provide more detailed information to help you solve the problem faster.

Action To enable traceoptions for RSVP packets in your network, follow these steps:

1. In configuration mode, go to the following hierarchy level:

   ```
   [edit]
   user@host# edit protocols rsvp traceoptions
   ```

2. Configure the RSVP log file:

   ```
   [edit protocols rsvp traceoptions]
   user@host# set file filename.log
   ```

3. Configure the tracing operations:

   ```
   [edit protocols rsvp traceoptions]
   user@host#  set flag packets
   ```

4. Verify and commit the configuration:

user@host# show

user@host# commit

5. View the contents of the log file:

   user@host# run show log rsvp.log

6. Stop monitoring the **rsvp** log file:

   [edit protocols rsvp]
   user@host# deactivate traceoptions

7. Verify and commit the new configuration:

   user@host# show

   user@host# commit

Sample Output

```
user@R1> edit
Entering configuration mode

[edit]
user@R1# edit protocols rsvp traceoptions

[edit protocols rsvp traceoptions]
user@R1# set file rsvp.log

[edit protocols rsvp traceoptions]
user@R1# set flag packets

[edit protocols rsvp traceoptions]
user@R1# show
file rsvp.log;
flag packets;

[edit protocols rsvp traceoptions]
user@R1# commit
commit complete

[edit protocols rsvp traceoptions]
user@R1# run show log rsvp.log
Aug 26 10:05:54 trace_on: Tracing to "/var/log/rsvp.log" started
Aug 26 10:05:54 RSVP send Hello New 10.1.13.1->10.1.13.2 Len=32 so-0/0/2.0
Aug 26 10:05:55 RSVP recv Resv 10.1.13.2->10.1.13.1 Len=128 so-0/0/2.0
Aug 26 10:05:55 RSVP send Hello New 10.1.12.1->10.1.12.2 Len=32 so-0/0/0.0
Aug 26 10:05:55 RSVP send Hello New 10.1.15.1->10.1.15.2 Len=32 so-0/0/1.0
Aug 26 10:05:55 RSVP recv Hello New 10.1.12.2->10.1.12.1 Len=32 so-0/0/0.0
Aug 26 10:05:55 RSVP recv Hello New 10.1.15.2->10.1.15.1 Len=32 so-0/0/1.0
Aug 26 10:05:57 RSVP recv Path 10.0.0.6->10.0.0.1 Len=208 so-0/0/1.0
Aug 26 10:05:57 RSVP send Resv 10.1.15.1->10.1.15.2 Len=120 so-0/0/1.0
---(more)---[abort]

[edit protocols rsvp traceoptions]
user@R1# up

[edit protocols rsvp]
user@R1# deactivate traceoptions

[edit protocols rsvp]
user@R1# show
inactive: traceoptions {
```

```
    file rsvp.log;
    flag packets;
}
interface so-0/0/0.0;
interface so-0/0/1.0;
interface so-0/0/2.0;
interface fxp0.0 {
    disable;
}

[edit protocols rsvp]
user@R1# commit
commit complete
```

Meaning The sample output shows the configuration of RSVP traceoptions, the output for the log file, and the deactivation of the traceoptions configuration.

To specify more than one tracing operation, include multiple flag statements in the configuration, at the following hierarchy level:

```
[edit protocols rsvp traceoptions]
user@R1# set flag flag
```

Table 11: RSVP Tracing Flags

Flag	Description
all	All tracing operations
error	All detected error conditions
event	RSVP-related events
lmp	RSVP-LMP interactions
packets	All RSVP packets
path	All path messages
pathtear	PathTear messages
resv	Resv messages
resvtear	ResvTear messages
route	Routing information
state	Session state transitions

For more information on configuring traceoptions, see the *Junos MPLS Applications Configuration Guide* and the *Junos Routing Protocols Configuration Guide*.

CHAPTER 5

Verifying LSP Use

This chapter describes how to verify the availability and valid use of a label-switched path (LSP) in your network.

Checklist for Verifying LSP Use

Purpose This checklist provides the steps and commands to verify the use of the LSP in an MPLS network. The checklist includes links to more detailed information about verifying the LSP on the ingress and transit routers in the network.

This checklist describes how to verify the availability and valid use of a label-switched path (LSP) in your network.

Table 12: Checklist for Verifying LSP Use

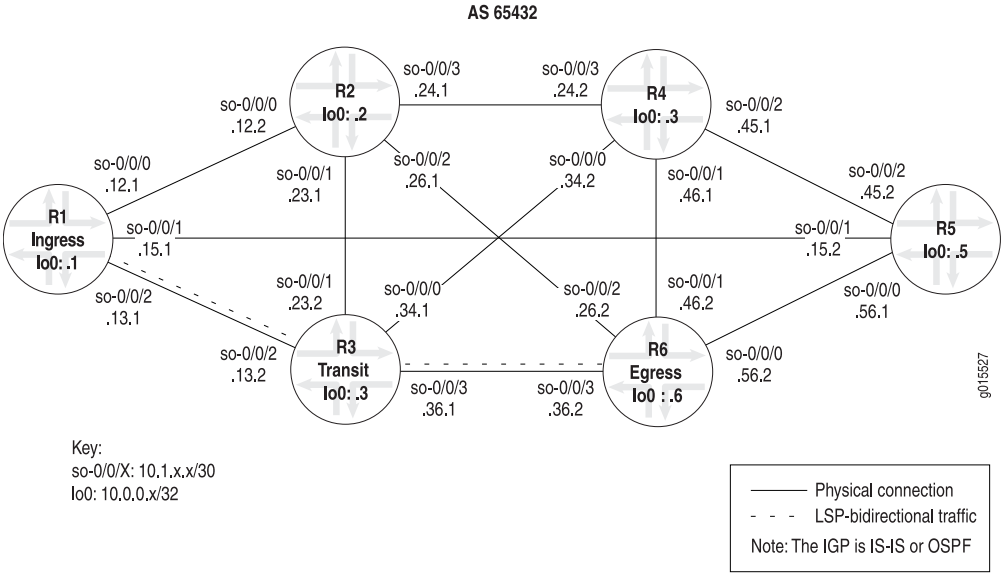
Tasks	Command or Action
"Verifying LSP Use in Your Network" on page 69	
"Verifying an LSP on the Ingress Router" on page 70	**show route table inet.3**
"Verifying an LSP on a Transit Router" on page 71	**show route table mpls.0**

Table 12 on page 69 provides commands for verifying LSP use.

Verifying LSP Use in Your Network

Purpose When you verify the valid use of an LSP on the ingress and transit routers in your network, you can determine if there is a problem with Multiprotocol Label Switching (MPLS) in your network. Figure 7 on page 70 describes the example network used in this topic.

Figure 7: MPLS Topology for Verifying LSP Use



The MPLS network in Figure 7 on page 70 illustrates a router-only network with SONET interfaces that consist of the following components:

- A full-mesh interior Border Gateway Protocol (IBGP) topology, using AS 65432
- MPLS and Resource Reservation Protocol (RSVP) enabled on all routers
- A **send-statics** policy on routers R1 and R6 that allows a new route to be advertised into the network
- An LSP between routers R1 and R6

The network shown in Figure 7 on page 70 is a Border Gateway Protocol (BGP) full-mesh network. Since route reflectors and confederations are not used to propagate BGP learned routes, each router must have a BGP session with every other router running BGP. For the full configuration for each router in the example network, see"Checklist for Configuring and Verifying an MPLS Network" on page 3 .

To verify LSP use in your network, follow these steps:

1. Verifying an LSP on the Ingress Router on page 70
2. Verifying an LSP on a Transit Router on page 71

Verifying an LSP on the Ingress Router

Purpose You can verify the availability of an LSP when it is up by examining the **inet.3** routing table on the ingress router. The **inet.3** routing table contains the host address of each LSP's egress router. This routing table is used on ingress routers to route BGP packets to the destination egress router. BGP uses the **inet.3** routing table on the ingress router to help resolve next-hop addresses.

Action To verify an LSP on an ingress router, enter the following Junos OS command-line interface (CLI) operational mode command:

user@host> **show route table inet.3**

Sample Output

```
user@R1> show route table inet.3
inet.3: 1 destinations, 1 routes (1 active, 0 holddown, 0 hidden)
+ = Active Route, - = Last Active, * = Both

10.0.0.6/32        *[RSVP/7] 4w0d 22:40:57, metric 20
                    > via so-0/0/2.0, label-switched-path R1-to-R6
```

Meaning

The sample output shows the **inet.3** routing table. By default, only BGP and MPLS virtual private networks (VPNs) can use the **inet.3** route table to resolve next-hop information. One destination is listed in the route table, **10.0.0.6**. This destination (**10.0.0.6**) is signaled by RSVP, and is the current active path, as indicated by the asterisk (*****). The protocol preference for this route is **7**, and the metric associated with it is **20**. The label-switched path is **R1-to-R6**, through interface **so-0/0/2.0**, which is the physical next-hop transit interface.

Typically, the penultimate router in the LSP either pops the packet's label or changes the label to a value of 0. If the penultimate router pops the top label and an IPv4 packet is underneath, the egress router routes the IPv4 packet, consulting the IP routing table **inet.0** to determine how to forward the packet. If another type of label (such as one created by Label Distribution Protocol (LDP) tunneling or VPNs, but not IPv4) is underneath the top label, the egress router does not examine the **inet.0** routing table. Instead, it examines the **mpls.0** routing table for forwarding decisions.

If the penultimate router changes the packet's label to a value of 0, the egress router strips off the 0 label, indicating that an IPv4 packet follows. The packet is examined by the **inet.0** routing table for forwarding decisions.

When a transit or egress router receives an MPLS packet, information in the MPLS forwarding table is used to determine the next transit router in the LSP or whether this router is the egress router.

When BGP resolves a next-hop prefix, it examines both the **inet.0** and **inet.3** routing tables, seeking the next hop with the lowest preference; for example, RSVP preference 7 is preferred over OSPF preference 10. The RSVP signaled LSP is used to reach the BGP next hop. This is the default when the BGP next hop equals the LSP egress address. Once the BGP next hop is resolved through an LSP, the BGP traffic uses the LSP to forward BGP transit traffic.

Verifying an LSP on a Transit Router

Purpose

You can verify the availability of an LSP when it is up by examining the **mpls.0** routing table on a transit router. MPLS maintains the **mpls.0** routing table, which contains a list of the next label-switched router in each LSP. This routing table is used on transit routers to route packets to the next router along an LSP.

Action

To verify an LSP on a transit router, enter the following Junos OS CLI operational mode command:

user@host> **show route table mpls.0**

Sample Output

```
user@R3> show route table mpls.0
mpls.0: 5 destinations, 5 routes (5 active, 0 holddown, 0 hidden)
+ = Active Route, - = Last Active, * = Both

0                  *[MPLS/0] 7w3d 22:20:56, metric 1
                    Receive
1                  *[MPLS/0] 7w3d 22:20:56, metric 1
                    Receive
2                  *[MPLS/0] 7w3d 22:20:56, metric 1
                    Receive
100064             *[RSVP/7] 2w1d 04:17:36, metric 1
                    > via so-0/0/3.0, label-switched-path R1-to-R6
100064 (S=0)        *[RSVP/7] 2w1d 04:17:36, metric 1
                   > via so-0/0/3.0, label-switched-path R1-to-R6
```

Meaning

The sample output from transit router **R3** shows route entries in the form of MPLS label entries, indicating that there is only one active route, even though there are five active entries.

The first three MPLS labels are reserved MPLS labels defined in RFC 3032. Packets received with these label values are sent to the Routing Engine for processing. Label 0 is the IPv4 explicit null label. Label 1 is the MPLS equivalent of the IP Router Alert label and Label 2 is the IPv6 explicit null label.

The two entries with the **100064** label are for the same LSP, **R1-to-R6.** There are two entries because the stack values in the MPLS header may be different. The second entry, **100064 (S=0)**, indicates that the stack depth is not 1 and additional label values are included in the packet. In contrast, the first entry of **100064** has an inferred S=1 which indicates a stack depth of 1 and makes it the last label in the packet. The dual entry indicates that this is the penultimate router. For more information on MPLS label stacking, see RFC 3032, *MPLS Label Stack Encoding*.

The incoming label is the MPLS header of the MPLS packet, and is assigned by RSVP to the upstream neighbor. Juniper Networks routers dynamically assign labels for RSVP traffic-engineered LSPs in the range from 100,000 through 1,048,575.

The router assigns labels starting at label 100,000, in increments of 16. The sequence of label assignments is 100,000, 100,016, 100,032, 100,048, and so on. At the end of the assigned labels, the label numbers start over at 100001, incrementing in units of 16. Juniper Networks reserves labels for various purposes. Table 13 on page 72 lists the various label range allocations for incoming labels.

Table 13: MPLS Label Range Allocations

Incoming Label	Status
0 through **15**	Reserved by IETF
16 through **1023**	Reserved for static LSP assignment
1024 through **9999**	Reserved for internal use (for example, CCC labels)
10,000 through **99,999**	Reserved for static LSP assignment

Table 13: MPLS Label Range Allocations *(continued)*

Incoming Label	Status
100,000 through **1,048,575**	Reserved for dynamic label assignment

PART 2

Working with Problems on Your Network

CHAPTER 6

Working with the Layered MPLS Troubleshooting Model

This chapter describes the different layers that you must verify when troubleshooting a Multiprotocol Label Switching (MPLS) network. The chapter also includes the example network used throughout the book to illustrate various problems that can occur in an MPLS network.

Checklist for Working with the Layered MPLS Troubleshooting Model

Problem This checklist provides a link to more detailed information about the layered Multiprotocol Label Switching network.

Solution Table 14 on page 77 provides commands for working with the layered MPLS troubleshooting model.

Table 14: Checklist for Working with the Layered MPLS Troubleshooting Model

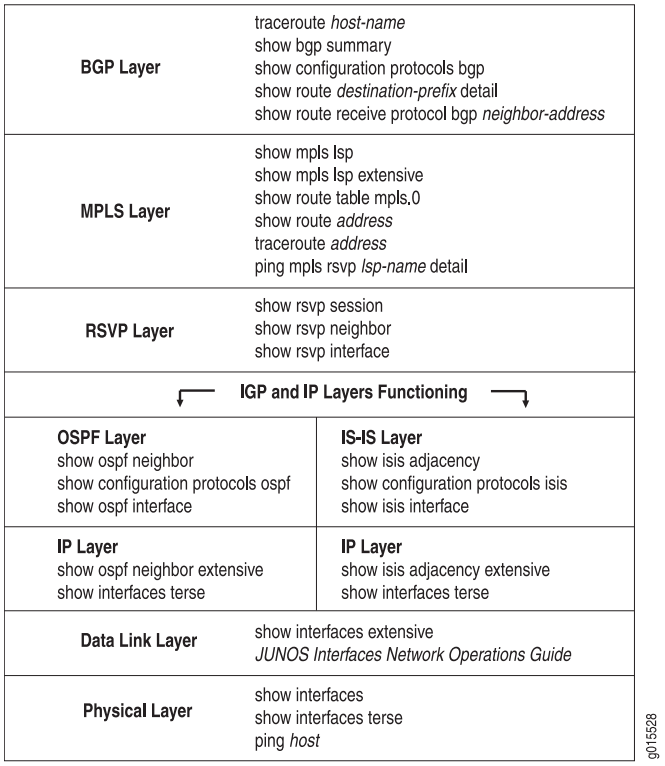
Tasks	Command or Action
"Understanding the Layered MPLS Troubleshooting Model" on page 77	**show mpls lsp** **show mpls lsp extensive** **show mpls lsp name *name*** **show mpls lsp name *name* extensive**

Understanding the Layered MPLS Troubleshooting Model

Problem The layered MPLS troubleshooting model is a disciplined approach to investigating problems with an MPLS network. Figure 8 on page 78 illustrates the layers in the model, and the commands you can use to structure your investigation. Because of the complexity of the MPLS network, you can obtain much better results from your investigations if you progress through the layers and verify the functioning of each layer on the ingress, egress, and transit routers before moving on to the next layer.

Solution Figure 8 on page 78 shows the layered MPLS troubleshooting model that you can use to troubleshoot problems with your MPLS network.

Figure 8: Layered MPLS Network Troubleshooting Model



As you move from one layer of the model to the next, you verify the correct functioning of a different component of the MPLS network and eliminate that layer as the source of the problem.

Physical Layer When you investigate the physical layer, you check that the routers are connected, and the interfaces are up and configured correctly. To check the physical layer, enter the **show interfaces**, **show interfaces terse**, and **ping** commands. If there is a problem in the physical layer, take appropriate action to fix it; then check that the LSP is operating as expected using the **show mpls lsp extensive** command. For more information on checking the physical layer, see “Checklist for Verifying the Physical Layer” on page 85.

Data Link Layer When you investigate the data link layer, you check the encapsulation mode, for example, Point-to-Point Protocol (PPP) or Cisco High-Level Data Link Control (HDLC); PPP options, for example, header encapsulation; frame check sequence (FCS) size; and whether keepalive frames are enabled or disabled.To check the data link layer, enter the **show interfaces extensive** command. If there is a problem in the data link layer, take appropriate action to fix it; then check that the LSP is operating as expected using the **show mpls lsp extensive** command. For more information on checking the data link layer, see “Checking the Data Link Layer” on page 94 and the *Junos Interfaces Operations Guide*.

IP Layer

When you investigate the IP layer, you verify that interfaces have correct IP addressing, and that the interior gateway protocol (IGP) neighbor adjacencies are established. To check the IP layer, enter the **show interfaces terse**, **show ospf neighbor extensive**, and **show isis adjacency extensive** commands. If there is a problem in the IP layer, take appropriate action to fix it; then check that the LSP is operating as expected using the **show mpls lsp extensive** command.

IGP Layer

When you investigate the IGP layer, you verify that the the Open Shortest Path First (OSPF) or Intermediate System-to-Intermediate System (IS-IS) protocols are configured and running correctly. For more information about configuring OSPF and IS-IS, see "Configuring MPLS on Your Network" on page 6.

- If you have the OSPF protocol configured, you must check the IP layer first, and then the OSPF configuration. When you investigate the OSPF layer, you check that the protocol, interfaces, and traffic engineering are configured correctly. To check the OSPF layer, enter the **show configuration protocols ospf** and **show ospf interface** commands. If the problem exists in the OSFP layer, take appropriate action to fix it; then check that the LSP is operating as expected using the **show mpls lsp extensive** command. For more information about checking the OSPF layer, see "Verifying the OSPF Protocol" on page 119.
- If you have the IS-IS protocol configured, because IS-IS and IP are independent of each other, it doesn't matter which one you check first. When you check the IS-IS configuration, you verify that IS-IS adjacencies are up, and the interfaces and IS-IS protocol are configured correctly. To check the IS-IS layer, enter the **show isis adjacency**, **show configuration protocols isis**, and **show isis interfaces** commands. If the problem exists in the IS-IS layer, take appropriate action to fix it; then check that the LSP is operating as expected using the **show mpls lsp extensive** command. For more information about checking the IS-IS layer, see "Verifying the IS-IS Protocol" on page 129.

NOTE: The IS-IS protocol has traffic engineering enabled by default.

RSVP and MPLS Layers

After you have both the IP and IGP layers functioning and the problem is still not solved, you can begin to check the Resource Reservation Protocol (RSVP) and MPLS layers to determine if the problem is in one of these layers.

- When you investigate the RSVP layer, you are checking that dynamic RSVP signaling is occurring as expected, neighbors are connected, and interfaces are configured correctly for RSVP. To check the RSVP layer, enter the **show rsvp session**, **show rsvp neighbor**, and **show rsvp interface** commands. If there is a problem in the RSVP layer, take appropriate action to fix it; then check that the LSP is operating as expected using the **show mpls lsp extensive** command.
- When you investigate the MPLS layer, you are checking whether the LSP is up and functioning correctly. To check the MPLS layer, enter the **show mpls lsp**, **show mpls lsp extensive**, **show route table mpls.0**,**show route *address***, **traceroute *address***, and **ping mpls rsvp *lsp-name* detail** commands. If there is a problem in the MPLS layer, take

appropriate action to fix it; then check that the LSP is operating as expected using the **show mpls lsp extensive** command.

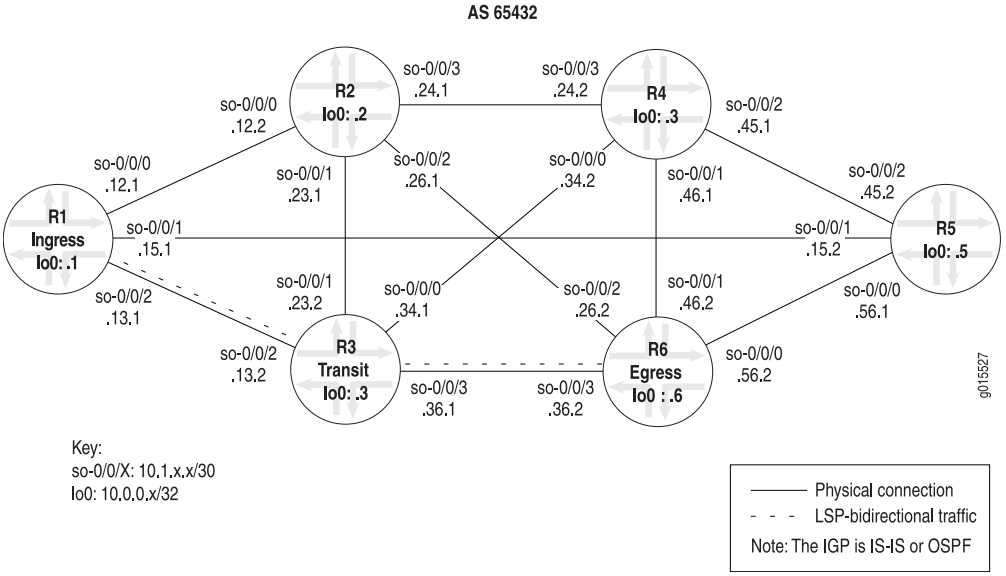
BGP Layer If the problem persists after you have checked the RSVP and MPLS layers, you must verify that the Border Gateway Protocol (BGP) is working correctly. There is no point in checking the BGP layer unless the LSP is established because BGP uses the MPLS LSP to forward traffic. When you check the BGP layer, you verify that the route is present and active, and more importantly, you ensure that the next hop is the LSP. To check the BGP layer, enter the **traceroute** ***host-name***, **show bgp summary**, **show configuration protocols bgp**, **show route** ***destination-prefix*** **detail**, and **show route receive protocol bgp** ***neighbor-address*** commands. For more information on checking the BGP layer, see "Checking the BGP Layer" on page 170.

In reality, you could start at any level of the MPLS model to investigate a problem with your MPLS network. However, a disciplined approach, as the one described here, produces more consistent and reliable results.

Figure 9 on page 80 illustrates the basic network topology used in the following topics that demonstrate how to troubleshoot an MPLS network:

- Checklist for Verifying the Physical Layer on page 85
- Checklist for Checking the Data Link Layer on page 93
- Checklist for Verifying the IP and IGP Layers on page 105
- Checklist for Checking the RSVP Layer on page 137
- Checklist for Checking the MPLS Layer on page 151
- Checklist for Checking the BGP Layer on page 169

Figure 9: MPLS Basic Network Topology Example



The MPLS network consists of the following components:

- Router-only network with SONET interfaces
- MPLS protocol enabled on all routers, with interfaces selectively deactivated to illustrate a particular problem scenario
- All interfaces configured with MPLS
- A full-mesh IBGP topology, using AS 65432
- IS-IS or OSPF as the underlying IGP, using one level (IS-IS Level 2) or one area (OSPF area 0.0.0.0)
- A **send-statics** policy on routers R1 and R6, allowing a new route to be advertised into the network
- Two LSPs between routers R1 and R6, allowing for bidirectional traffic.

After you have configured an LSP, it is considered best practice to issue the **show mpls lsp** command to verify that the LSP is up, and to investigate further if you find an error message in the output. The error message can indicate a problem at any layer of the MPLS network.

The LSPs can be ingress, transit, or egress. Use the **show mpls lsp** command for quick verification of the LSP state, with the **extensive** option (**show mpls lsp extensive)** as a follow-up if the LSP is down. If your network has numerous LSPs, you might consider specifying the name of the LSP, using the **name** option (**show mpls lsp name *name*** or **show mpls lsp name *name* extensive)**.

Action To begin the investigation of an error in your MPLS network, from the ingress router, enter some or all of the following Junos OS command-line interface (CLI) operational mode commands:

```
user@host> show mpls lsp
user@host> show mpls lsp extensive
user@host> show mpls lsp name name
user@host> show mpls lsp name name extensive
```

Sample Output 1

```
user@R1> show mpls lsp
Ingress LSP: 1 sessions
To              From            State Rt ActivePath       P     LSPname
10.0.0.6        10.0.0.1        Up     1                  *     R1-to-R6
Total 1 displayed, Up 1, Down 0

Egress LSP: 1 sessions
To              From            State Rt Style Labelin Labelout LSPname
10.0.0.1        10.0.0.6        Up     0 1 FF       3        - R6-to-R1
Total 1 displayed, Up 1, Down 0

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

Sample Output 2

```
user@R1>  show mpls lsp extensive
Ingress LSP: 1 sessions

10.0.0.6
  From: 10.0.0.1, State: Up, ActiveRoute: 1, LSPname: R1-to-R6
  ActivePath:  (primary)
  LoadBalance: Random
```

```
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
 *Primary                    State: Up
    Computed ERO (S [L] denotes strict [loose] hops): (CSPF metric: 20)
 10.1.13.2 S 10.1.36.2 S
    Received RRO (ProtectionFlag 1=Available 2=InUse 4=B/W 8=Node 10=SoftPreempt):

          10.1.13.2 10.1.36.2
   30 Dec 28 13:47:29 Selected as active path
   29 Dec 28 13:47:29 Record Route:  10.1.13.2 10.1.36.2
   28 Dec 28 13:47:29 Up
   27 Dec 28 13:47:29 Originate Call
   26 Dec 28 13:47:29 CSPF: computation result accepted
   25 Dec 28 13:46:59 CSPF failed: no route toward 10.0.0.6
   24 Dec 28 13:46:39 Deselected as active
   23 Dec 28 13:46:39 CSPF failed: no route toward 10.0.0.6
   22 Dec 28 13:46:39 Clear Call
   21 Dec 28 13:46:39 ResvTear received
   20 Dec 28 13:46:39 Down
   19 Dec 28 13:46:39 10.1.13.2: Session preempted
   18 Dec 28 13:42:07 Selected as active path
   17 Dec 28 13:42:07 Record Route:  10.1.13.2 10.1.36.2
   16 Dec 28 13:42:07 Up
   15 Dec 28 13:42:07 Originate Call
   14 Dec 28 13:42:07 CSPF: computation result accepted
   13 Dec 28 13:41:37 CSPF failed: no route toward 10.0.0.6
   12 Dec 28 13:41:16 Deselected as active
   11 Dec 28 13:41:16 CSPF failed: no route toward 10.0.0.6
   10 Dec 28 13:41:16 Clear Call
    9 Dec 28 13:41:16 ResvTear received
    8 Dec 28 13:41:16 Down
    7 Dec 28 13:41:16 10.1.13.2: Session preempted
    6 Dec 13 11:50:15 Selected as active path
    5 Dec 13 11:50:15 Record Route:  10.1.13.2 10.1.36.2
    4 Dec 13 11:50:15 Up
    3 Dec 13 11:50:15 Originate Call
    2 Dec 13 11:50:15 CSPF: computation result accepted
    1 Dec 13 11:49:45 CSPF failed: no route toward 10.0.0.6[6 times]
---(more)---[abort]
```

Sample Output 3

```
user@R1>            show mpls lsp name R1-to-R6
Ingress LSP: 1 sessions
To              From            State Rt ActivePath       P     LSPname
10.0.0.6        10.0.0.1        Up     1                  *     R1-to-R6
Total 1 displayed, Up 1, Down 0

Egress LSP: 1 sessions
Total 0 displayed, Up 0, Down 0

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

Sample Output 4

```
user@R1>            show mpls lsp name R1-to-R6 extensive
Ingress LSP: 1 sessions

10.0.0.6
  From: 10.0.0.1, State: Up, ActiveRoute: 1, LSPname: R1-to-R6
  ActivePath:  (primary)
  LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
 *Primary                    State: Up
    Computed ERO (S [L] denotes strict [loose] hops): (CSPF metric: 20)
```

```
 10.1.13.2 S 10.1.36.2 S
   Received RRO (ProtectionFlag 1=Available 2=InUse 4=B/W 8=Node 10=SoftPreempt):

          10.1.13.2 10.1.36.2
  30 Dec 28 13:47:29 Selected as active path
  29 Dec 28 13:47:29 Record Route:  10.1.13.2 10.1.36.2
  28 Dec 28 13:47:29 Up
  27 Dec 28 13:47:29 Originate Call
  26 Dec 28 13:47:29 CSPF: computation result accepted
  25 Dec 28 13:46:59 CSPF failed: no route toward 10.0.0.6
  24 Dec 28 13:46:39 Deselected as active
  23 Dec 28 13:46:39 CSPF failed: no route toward 10.0.0.6
  22 Dec 28 13:46:39 Clear Call
  21 Dec 28 13:46:39 ResvTear received
  20 Dec 28 13:46:39 Down
  19 Dec 28 13:46:39 10.1.13.2: Session preempted
  18 Dec 28 13:42:07 Selected as active path
  17 Dec 28 13:42:07 Record Route:  10.1.13.2 10.1.36.2
  16 Dec 28 13:42:07 Up
  15 Dec 28 13:42:07 Originate Call
  14 Dec 28 13:42:07 CSPF: computation result accepted
  13 Dec 28 13:41:37 CSPF failed: no route toward 10.0.0.6
  12 Dec 28 13:41:16 Deselected as active
  11 Dec 28 13:41:16 CSPF failed: no route toward 10.0.0.6
  10 Dec 28 13:41:16 Clear Call
   9 Dec 28 13:41:16 ResvTear received
   8 Dec 28 13:41:16 Down
   7 Dec 28 13:41:16 10.1.13.2: Session preempted
   6 Dec 13 11:50:15 Selected as active path
   5 Dec 13 11:50:15 Record Route:  10.1.13.2 10.1.36.2
   4 Dec 13 11:50:15 Up
   3 Dec 13 11:50:15 Originate Call
   2 Dec 13 11:50:15 CSPF: computation result accepted
   1 Dec 13 11:49:45 CSPF failed: no route toward 10.0.0.6[6 times]
  Created: Mon Dec 13 11:47:19 2004
Total 1 displayed, Up 1, Down 0

Egress LSP: 1 sessions
Total 0 displayed, Up 0, Down 0

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

Meaning The sample output from the ingress router **R1** shows that the label-switched path is traversing the network as intended, from **R1** through **R3** to **R6,** and another LSP in the reverse direction, from **R6** through **R3** to **R1**.

If your network has numerous LSPs, you might consider using the **show mpls lsp** command for quick verification of the LSP state. and the **show mpls lsp name** *name* **extensive** command to continue your investigation if you find that the LSP is down.

For more information about the status and statistics of the **show mpls lsp** command, see “Checklist for Determining the LSP State” on page 53. For more information on the availability and valid use of an LSP, see “Checklist for Verifying LSP Use” on page 69.

In all the following topics, the network topology is broken at different layers of the network so that you can investigate various MPLS network problems. The problems presented

are not inclusive. Instead, the problems serve to illustrate one possible process of investigation into the different layers of the troubleshooting model.

Related Documentation

- Verifying the Physical Layer on page 86
- Checking the Data Link Layer on page 94
- Verifying the IP and IGP Layers on page 107
- Checking the RSVP Layer on page 138
- Checking the MPLS Layer on page 152
- Checking the BGP Layer on page 170

CHAPTER 7

Verifying the Physical Layer

This chapter describes how to investigate a problem at the physical layer of a Multiprotocol Label Switching (MPLS) network.

Checklist for Verifying the Physical Layer

Problem This checklist provides the steps and commands for investigating a problem at the physical layer of a Multiprotocol Label Switching (MPLS) network. The checklist provides links to an overview of verifying the physical layer and more detailed information about the commands used to investigate the problem.

Solution Table 15 on page 85 provides commands for verifying the physical layer.

Table 15: Checklist for Verifying the Physical Layer

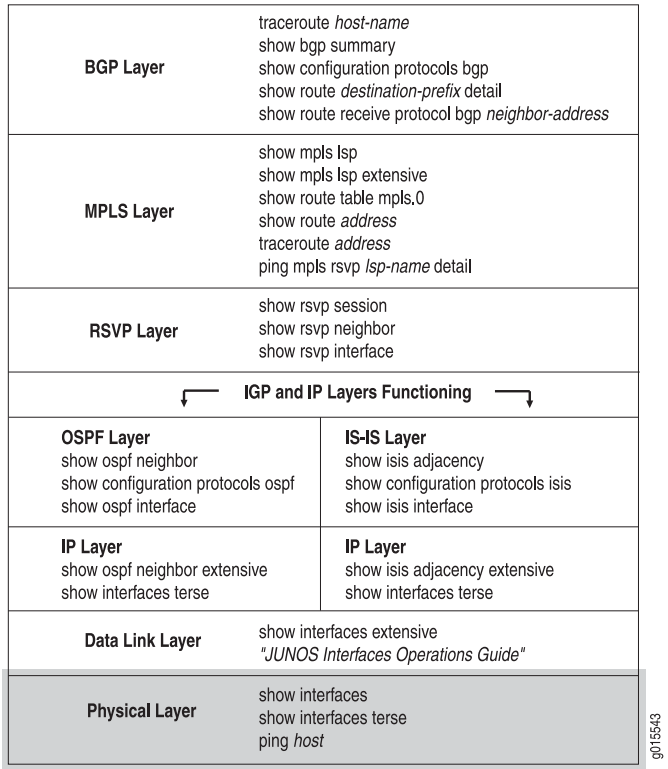
Tasks	Command or Action
"Verifying the Physical Layer" on page 86	
1. Verify the LSP on page 87	**show mpls lsp extensive**
2. Verify Router Connection on page 89	**ping** *host*
3. Verify Interfaces on page 89	**show interfaces terse** **show configuration interfaces** *type-fpc/pic/port*
4. Take Appropriate Action on page 90	The following sequence of commands addresses the specific problem described in this topic: [**edit interfaces** *type-fpc/pic/port*] **set family mpls** **show** **commit**
5. Verify the LSP Again on page 91	**show mpls lsp extensive**

Verifying the Physical Layer

Purpose After you have configured the LSP, issued the **show mpls lsp extensive** command, and determined that there is an error, you can start investigating the problem at the physical layer of the network.

Figure 10 on page 86 illustrates the physical layer of the layered MPLS model.

Figure 10: Verifying the Physical Layer

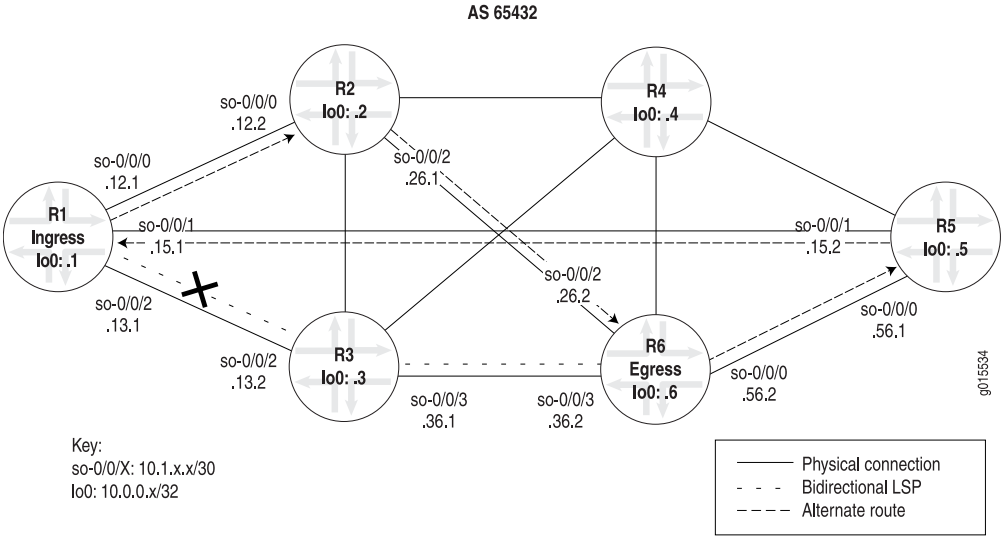


With this layer, you must ensure that the routers are connected, and that the interfaces are up and configured correctly on the ingress, egress, and transit routers.

If the network is not functioning at this layer, the label-switched path (LSP) does not work as configured.

Figure 11 on page 87 illustrates the MPLS network and the problem described in this topic.

Figure 11: MPLS Network Broken at the Physical Layer



The network shown in Figure 11 on page 87 is a fully meshed configuration where every directly connected interface can receive and send packets to every other similar interface. The LSP in this network is configured to run from ingress router **R1**, through transit router **R3**, to egress router **R6**. In addition, a reverse LSP is configured to run from **R6** through **R3** to **R1**, creating bidirectional traffic.

However, in this example, traffic does not use the configured LSP. Instead traffic uses the alternate route from **R1** through **R2** to **R6**, and in the reverse direction, from **R6** through **R5 to R1**.

When you become aware of a situation where an alternate route is used rather than the configured LSP, verify that the physical layer is functioning correctly. You might find that routers are not connected, or that interfaces are not up and configured correctly on the ingress, egress, or transit routers.

The cross shown in Figure 11 on page 87 indicates where the LSP is broken because of a configuration error on ingress router **R1**.

To check the physical layer, follow these steps:

1. Verify the LSP on page 87
2. Verify Router Connection on page 89
3. Verify Interfaces on page 89
4. Take Appropriate Action on page 90
5. Verify the LSP Again on page 91

Verify the LSP

Purpose Typically, you use the **show mpls lsp extensive** command to verify the LSP. However, for quick verification of the LSP state, use the **show mpls lsp** command. If the LSP is down, use the **extensive** option (**show mpls lsp extensive)** as a follow-up. If your network has

numerous LSPs, you might consider specifying the name of the LSP, using the **name** option (**show mpls lsp name** *name* or **show mpls lsp name** *name* **extensive**).

Action To determine whether the LSP is up, enter the following command from the ingress router:

```
user@ingress-router> show mpls lsp extensive
```

Sample Output

```
user@R1> show mpls lsp extensive
Ingress LSP: 1 sessions

10.0.0.6
  From: 10.0.0.1, State: Up, ActiveRoute: 1, LSPname: R1-to-R6
  ActivePath:  (primary)
  LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
 *Primary                    State: Up
    Computed ERO (S [L] denotes strict [loose] hops): (CSPF metric: 20)
 10.1.12.2 S 10.1.26.2 S
    Received RRO (ProtectionFlag 1=Available 2=InUse 4=B/W 8=Node 10=SoftPreempt):

          10.1.12.2 10.1.26.2
   99 Sep 18 14:19:04 CSPF: computation result accepted
    98 Sep 18 14:19:04 CSPF: link down/deleted
   10.1.13.1(R1.00/10.0.0.1)->10.1.13.2(R3.00/10.0.0.3)
   97 Sep 18 14:19:01 Record Route:  10.1.12.2 10.1.26.2
   96 Sep 18 14:19:01 Up
   95 Sep 18 14:19:01 Clear Call
   94 Sep 18 14:19:01 CSPF: computation result accepted
   93 Sep 18 14:19:01 MPLS label allocation failure
   92 Sep 18 14:19:01 Down
   91 Aug 17 12:22:52 Selected as active path
   90 Aug 17 12:22:52 Record Route:  10.1.13.2 10.1.36.2
   89 Aug 17 12:22:52 Up
   [...Output truncated...]
  Created: Sat Jul 10 18:18:44 2004
Total 1 displayed, Up 1, Down 0

Egress LSP: 1 sessions

10.0.0.1
  From: 10.0.0.6, LSPstate: Up, ActiveRoute: 0
  LSPname: R6-to-R1, 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:  144, Since: Tue Aug 17 12:23:14 2004
  Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
  Port number: sender 1 receiver 39024 protocol 0
  PATH rcvfrom: 10.1.15.2 (so-0/0/1.0) 67333 pkts
  Adspec: received MTU 1500
  PATH sentto: localclient
  RESV rcvfrom: localclient
  Record route:  10.1.56.2 10.1.15.2 <self>
Total 1 displayed, Up 1, Down 0

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


Meaning The sample output from ingress router **R1** shows that the LSP is using an alternate path rather than the configured path. The configured path for the LSP is **R1** through **R3** to **R6,** and for the reverse LSP, **R6** through **R3** to **R1**. The alternate path used by the LSP is **R1** through **R2** to **R6,** and for the reverse LSP, **R6 t**hrough **R5** to **R1**.

Verify Router Connection

Purpose Confirm that the appropriate ingress, transit, and egress routers are functioning by examining whether the packets have been received and transmitted with 0% packet loss.

Action To determine that the routers are connected, enter the following command from the ingress and transit routers:

```
user@host> ping host
```

Sample Output

```
user@R1> ping 10.0.0.3 count 3
PING 10.0.0.3 (10.0.0.3): 56 data bytes
64 bytes from 10.0.0.3: icmp_seq=0 ttl=254 time=0.859 ms
64 bytes from 10.0.0.3: icmp_seq=1 ttl=254 time=0.746 ms
64 bytes from 10.0.0.3: icmp_seq=2 ttl=254 time=0.776 ms

--- 10.0.0.3 ping statistics ---
3 packets transmitted, 3 packets received, 0% packet loss
round-trip min/avg/max/stddev = 0.746/0.794/0.859/0.048 ms

user@R3>  ping 10.0.0.6 count 3
PING 10.0.0.6 (10.0.0.6): 56 data bytes
64 bytes from 10.0.0.6: icmp_seq=0 ttl=255 time=0.968 ms
64 bytes from 10.0.0.6: icmp_seq=1 ttl=255 time=3.221 ms
64 bytes from 10.0.0.6: icmp_seq=2 ttl=255 time=0.749 ms

--- 10.0.0.6 ping statistics ---
3 packets transmitted, 3 packets received, 0% packet loss
round-trip min/avg/max/stddev = 0.749/1.646/3.221/1.117 ms
```

Meaning The sample output shows that ingress router **R1** is receiving packets from transit router **R3**, and that the transit router is receiving packets from the egress router. Therefore, the routers in the LSP are connected.

Verify Interfaces

Purpose Confirm that the interfaces are configured correctly with the **family mpls** statement.

Action To determine that the relevant interfaces are up and configured correctly, enter the following commands from the ingress, transit, and egress routers:

```
user@host> show interfaces terse
user@host> show configuration interfaces type-fpc/pic/port
```

Sample Output

```
user@R1> show interfaces so* terse
Interface               Admin Link Proto Local                 Remote
so-0/0/0                up    up
so-0/0/0.0              up    up   inet  10.1.12.1/30
                                  iso
                                  mpls
```

```
so-0/0/1                up    up
so-0/0/1.0              up    up   inet  10.1.15.1/30
                                  iso
                                  mpls
so-0/0/2                up    up
so-0/0/2.0              up    up   inet  10.1.13.1/30
                                  iso   <<< family mpls is missing
so-0/0/3                up    down

user@R1>  show configuration interfaces so-0/0/2
unit 0 {
    family inet {
        address 10.1.13.1/30;
    }
    family iso; <<<  family mpls is missing
}
```

Meaning The sample output shows that interface **so-0/0/2.0** on the ingress router does not have the **family mpls** statement configured at the [**edit interfaces** *type-fpc/pic/port*] hierarchy level, indicating that the interface is incorrectly configured to support the LSP. The LSP is configured correctly at the [**edit protocols mpls**] hierarchy level.

The output from the transit and egress routers (not shown) shows that the interfaces on those routers are configured correctly.

Take Appropriate Action

Problem Depending on the error you encountered in your investigation, you must take the appropriate action to correct the problem. In the example below, the **family mpls** statement, which was missing, is included in the configuration of ingress router **R1**.

Solution To correct the error in this example, enter the following commands:

```
[edit interfaces type-fpc/pic/port]
user@R1# set family mpls
user@R1# show
user@R1# commit
```

Sample Output

```
[edit interfaces so-0/0/2 unit 0]
user@R1# set family mpls

[edit interfaces so-0/0/2 unit 0]
user@R1# show
family inet {
    address 10.1.13.1/30;
}
family iso;
family mpls;

[edit interfaces so-0/0/2 unit 0]
user@R1# commit
commit complete
```

Meaning The sample output from ingress router **R1** shows that the **family mpls** statement is configured correctly for interface **so-0/0/2.0**, and that the LSP is now functioning as originally configured.

Verify the LSP Again

Purpose After taking the appropriate action to correct the error, the LSP needs to be checked again to confirm that the problem in the physical layer has been resolved.

Action To verify that the LSP is up and traversing the network as expected, enter the following command:

```
user@host> show mpls lsp extensive
```

Sample Output 1

```
user@R1> show mpls lsp extensive
Ingress LSP: 1 sessions

10.0.0.6
  From: 10.0.0.1, State: Up, ActiveRoute: 1, LSPname: R1-to-R6
  ActivePath:  (primary)
  LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
 *Primary                    State: Up
    Computed ERO (S [L] denotes strict [loose] hops): (CSPF metric: 20)
  10.1.13.2 S 10.1.36.2 S
    Received RRO (ProtectionFlag 1=Available 2=InUse 4=B/W 8=Node 10=SoftPreempt):

          10.1.13.2 10.1.36.2
   112 Sep 21 16:27:33 Record Route:  10.1.13.2 10.1.36.2
   111 Sep 21 16:27:33 Up
   110 Sep 21 16:27:33 CSPF: computation result accepted
   109 Sep 21 16:27:33 CSPF: link down/deleted
10.1.12.1(R1.00/10.0.0.1)->10.1.12.2(R2.00/10.0.0.2)
   108 Sep 21 16:27:33 CSPF: link down/deleted
10.1.15.1(R1.00/10.0.0.1)->10.1.15.2(R5.00/10.0.0.5)
   [Output truncated...]
  Created: Sat Jul 10 18:18:44 2004
Total 1 displayed, Up 1, Down 0

Egress LSP: 1 sessions

10.0.0.1
  From: 10.0.0.6, LSPstate: Up, ActiveRoute: 0
  LSPname: R6-to-R1, 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:  149, Since: Tue Sep 21 16:29:43 2004
  Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
  Port number: sender 2 receiver 39024 protocol 0
  PATH rcvfrom: 10.1.13.2 (so-0/0/2.0) 7 pkts
  Adspec: received MTU 1500
  PATH sentto: localclient
  RESV rcvfrom: localclient
   Record route: 10.1.36.2 10.1.13.2 <self>
Total 1 displayed, Up 1, Down 0

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

Sample Output 2

```
[edit protocols mpls]
user@R1# show
label-switched-path R1-to-R6 {
```

```
    to 10.0.0.6;
}
interface fxp0.0 {
    disable;
}
inactive: interface so-0/0/0.0;
inactive: interface so-0/0/1.0;
interface so-0/0/2.0;
```

Meaning Sample Output 1 from ingress router **R1** shows that the LSP is now traversing the network along the expected path, from **R1** through **R3** to **R6**, and the reverse LSP, from **R6** through **R3** to **R1**.

Sample Output 2 from ingress router **R1** shows that the LSP is forced to take the intended path because MPLS is deactivated on **R1** interfaces **so-0/0/0.0** and **so-0/0/1.0**. If these interfaces were not deactivated, even though the configuration is now correct, the LSP would still traverse the network through the alternate path.

CHAPTER 8

Checking the Data Link Layer

This chapter describes how to investigate a problem at the data link layer of the Multiprotocol Label Switching (MPLS) network.

- Checklist for Checking the Data Link Layer on page 93
- Checking the Data Link Layer on page 94

Checklist for Checking the Data Link Layer

Problem This checklist provides the steps and commands for investigating a problem at the data link layer of the Multiprotocol Label Switching (MPLS) network. The checklist provides links to an overview of the data link layer and more detailed information about the commands used to investigate the problem.

Solution Table 16 on page 93 provides commands for checking the data link layer.

Table 16: Checklist for Checking the Data Link Layer

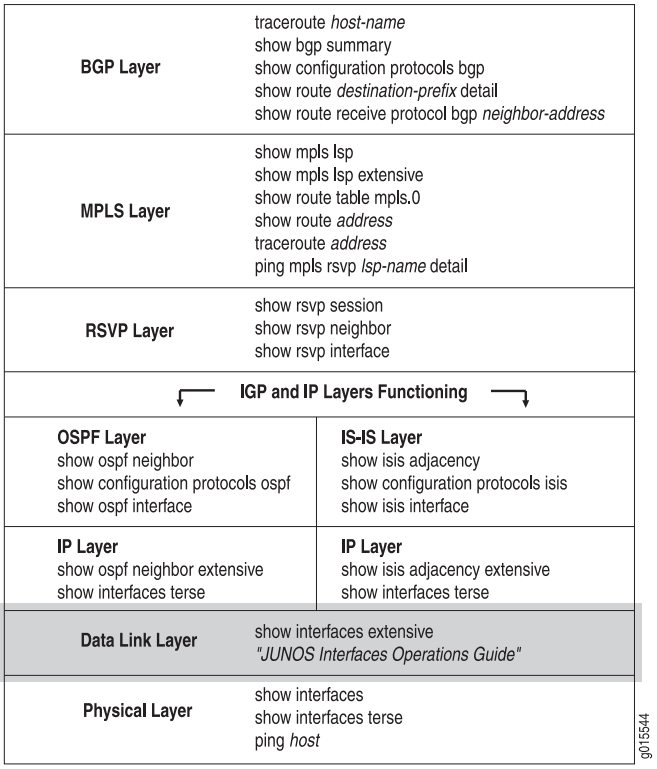
Tasks	Command or Action
"Checking the Data Link Layer" on page 94	
1. Verify the LSP on page 95	**show mpls lsp extensive**
2. Verify Interfaces on page 96	**show interfaces *type-fpc/pic/port* extensive** **show interfaces *type-fpc/pic/port***
3. Take Appropriate Action on page 100	The following sequence of commands addresses the specific problem described in this topic: **[edit interfaces *type-fpc/pic/port*]** **show** **delete encapsulation** **show** **commit**
4. Verify the LSP Again on page 100	**show mpls lsp extensive**

Checking the Data Link Layer

Purpose After you have configured the label-switched path (LSP), issued the **show mpls lsp extensive** command, and determined that there is an error, you might find that the error is not in the physical layer. Continue investigating the problem at the data link layer of the network.

Figure 12 on page 94 illustrates the data link layer of the layered MPLS model.

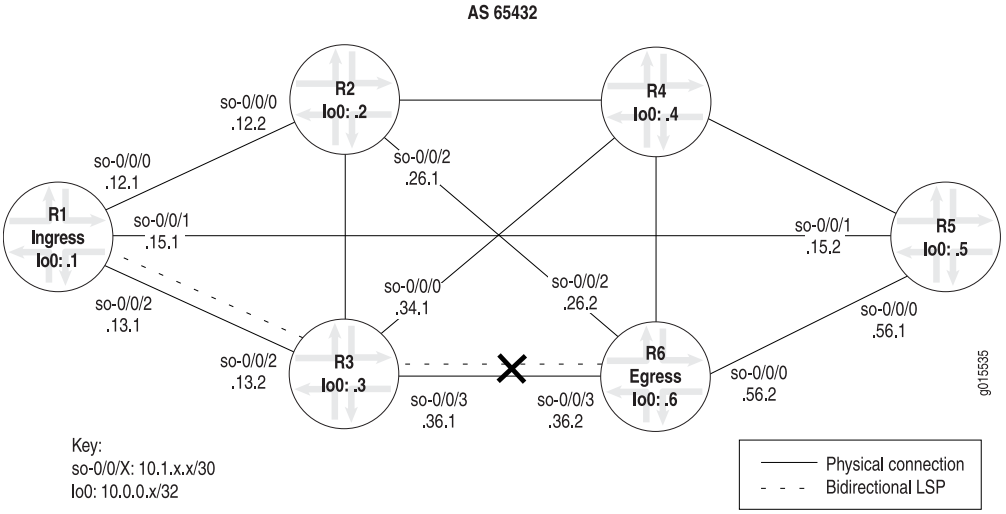
Figure 12: Checking the Data Link Layer



With this layer, you must check the encapsulation mode, for example, Point-to-Point Protocol (PPP) or Cisco High-Level Data Link Control (HDLC); PPP options, for example, header encapsulation; frame check sequence (FCS) size; and whether keepalive frames are enabled or disabled. Also, check the ingress, egress, and transit routers.

Figure 13 on page 95 illustrates the MPLS network used in this topic.

Figure 13: MPLS Network Broken at the Data Link Layer



The network shown in Figure 13 on page 95 is a fully meshed configuration where every directly connected interface can receive and send packets to every other similar interface. The LSP in this network is configured to run from ingress router **R1**, through transit router **R3**, to egress router **R6**. In addition, a reverse LSP is configured to run from **R6** through **R3** to **R1**, creating bidirectional traffic.

However, in this example, the LSP is down without a path in either direction, from **R1** to **R6** or from **R6** to **R1**.

When you verify that the data link layer is not functioning correctly, you might find a mismatch with PPP or Cisco HDLC encapsulation, PPP options, or keepalive frames.

The cross shown in Figure 13 on page 95 indicates where the LSP is broken because of a configuration error on ingress router **R1** that prevents the LSP from traversing the network as expected.

To check the data link layer, follow these steps:

1. Verify the LSP on page 95
2. Verify Interfaces on page 96
3. Take Appropriate Action on page 100
4. Verify the LSP Again on page 100

Verify the LSP

Purpose Typically, you use the **show mpls lsp extensive** command to verify the LSP. However for quick verification of the LSP state, use the **show mpls lsp** command. If the LSP is down, use the **extensive** option (**show mpls lsp extensive)** as a follow-up. If your network has numerous LSPs, you might consider specifying the name of the LSP, using the **name** option (**show mpls lsp name *name*** or **show mpls lsp name *name* extensive).**

Action To determine whether the LSP is up, enter the following command from the ingress router:

user@host> **show mpls lsp extensive**

Sample Output 1

```
user@R1> show mpls lsp extensive
Ingress LSP: 1 sessions

10.0.0.6
  From: 10.0.0.1 , State: Dn, ActiveRoute: 0, LSPname: R1-to-R6
   ActivePath: (none)
  LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
  Primary                   State: Dn
    Will be enqueued for recomputation in 15 second(s).
    140 Sep 30 12:01:12 CSPF failed: no route toward 10.0.0.6[26 times]
   139 Sep 30 11:48:57 Deselected as active
   138 Sep 30 11:48:56 CSPF failed: no route toward 10.0.0.6
   137 Sep 30 11:48:56 Clear Call
   136 Sep 30 11:48:56 CSPF: link down/deleted
10.1.36.1(R3.00/10.0.0.3)->10.1.36.2(R6.00/10.0.0.6)
135 Sep 30 11:48:56 ResvTear received
   134 Sep 30 11:48:56 Down
   133 Sep 30 11:48:56 CSPF failed: no route toward 10.0.0.6
   132 Sep 30 11:48:56 10.1.13.2: No Route toward dest
   [...Output truncated...]
  Created: Sat Jul 10 18:18:44 2004
Total 1 displayed, Up 0, Down 1

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

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

Meaning The sample output from ingress router **R1** shows the LSPs within which it participates. The ingress LSP is down, without a path from **R1** to **R6.** Because a reverse LSP is configured in the network shown in Figure 13 on page 95, we would expect an egress LSP session to be up. However, **R1** does not have any egress LSPs, indicating that the LSP from **R6** to **R1** is not functioning.

Verify Interfaces

Purpose From your network topology, determine the adjacent interfaces through which the LSP is meant to traverse, and examine the output for the encapsulation type, PPP options, FCS size, and whether keepalive frames are enabled or disabled

NOTE: Before you proceed with this step, check the physical layer to ensure that the problem is not in the physical layer.

Action To verify the functioning of adjacent interfaces, enter the following commands from the relevant routers:

user@host> **show interfaces *type-fpc/pic/port* extensive**
user@host> **show interfaces *type-fpc/pic/port***

Sample Output 1

```
user@R6> show interfaces so-0/0/3 extensive
Physical interface: so-0/0/3, Enabled, Physical link is Up
  Interface index: 131, SNMP ifIndex: 27, Generation: 14
   Link-level type: Cisco-HDLC , MTU: 4474, Clocking: Internal, SONET mode, Speed:
OC3, Loopback: None,
   FCS: 16 , Payload scrambler: Enabled
  Device flags   : Present Running
   Interface flags: Link-Layer-Down  Point-To-Point SNMP-Traps 16384
   Link flags   : Keepalives
  Hold-times     : Up 0 ms, Down 0 ms
  Keepalive settings: Interval 10 seconds, Up-count 1, Down-count 3
  Keepalive statistics:
    Input : 0 (last seen: never)
    Output: 357 (last sent 00:00:04 ago)
  CoS queues     : 4 supported
  Last flapped   : 2004-07-21 16:03:49 PDT (10w0d 07:01 ago)
  Statistics last cleared: Never
  Traffic statistics:
   Input  bytes  :            203368873                    0 bps
   Output bytes  :            186714992                   88 bps
   Input  packets:              3641808                    0 pps
   Output packets:              3297569                    0 pps
  Input errors:
    Errors: 0, Drops: 0, Framing errors: 0, Runts: 0, Giants: 0, Bucket drops:
0,
    Policed discards: 1770, L3 incompletes: 0, L2 channel errors: 0, L2 mismatch
 timeouts: 0,
    HS link CRC errors: 0, HS link FIFO overflows: 0
  Output errors:
    Carrier transitions: 1, Errors: 0, Drops: 0, Aged packets: 0, HS link FIFO
underflows: 0,
    MTU errors: 0
  Queue counters:       Queued packets  Transmitted packets      Dropped packets

    0 best-effort               197012               197012                    0

    1 expedited-fo                   0                    0                    0

    2 assured-forw                   0                    0                    0

    3 network-cont             3100557              3100557                    0

   SONET alarms  : None
   SONET defects : None
  SONET PHY:            Seconds        Count   State
    PLL Lock                  0            0   OK
    PHY Light                 0            0   OK
  SONET section:
    BIP-B1                    0            0
    SEF                       1            3   OK
    LOS                       1            1   OK
    LOF                       1            1   OK
    ES-S                      1
    SES-S                     1
    SEFS-S                    1
  SONET line:
    BIP-B2                    0            0
    REI-L                     0            0
    RDI-L                     0            0   OK
    AIS-L                     0            0   OK
    BERR-SF                   0            0   OK
```

```
  BERR-SD                   0            0   OK
  ES-L                      1
  SES-L                     1
  UAS-L                     0
  ES-LFE                    0
  SES-LFE                   0
  UAS-LFE                   0
SONET path:
  BIP-B3                    0            0
  REI-P                     0            0
  LOP-P                     0            0   OK
  AIS-P                     0            0   OK
  RDI-P                     0            0   OK
  UNEQ-P                    0            0   OK
  PLM-P                     0            0   OK
  ES-P                      1
  SES-P                     1
  UAS-P                     0
  ES-PFE                    0
  SES-PFE                   0
  UAS-PFE                   0
Received SONET overhead:
  F1      : 0x00, J0      : 0x00, K1      : 0x00, K2      : 0x00
  S1      : 0x00, C2      : 0xcf, C2(cmp) : 0xcf, F2      : 0x00
  Z3      : 0x00, Z4      : 0x00, S1(cmp) : 0x00
Transmitted SONET overhead:
  F1      : 0x00, J0      : 0x01, K1      : 0x00, K2      : 0x00
  S1      : 0x00, C2      : 0xcf, F2      : 0x00, Z3      : 0x00
  Z4      : 0x00
 Received path trace: R3 so-0/0/3
  52 33 20 73 6f 2d 30 2f 30 2f 33 00 00 00 00 00    R3 so-0/0/3.. ...
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
  00 00 00 00 00 00 00 00 00 00 00 00 00 0d 0a      ..............
 Transmitted path trace: R6 so-0/0/3
  52 36 20 73 6f 2d 30 2f 30 2f 33 00 00 00 00 00    R6 so-0/0/3 .....
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
HDLC configuration:
  Policing bucket: Disabled
  Shaping bucket : Disabled
  Giant threshold: 4484, Runt threshold: 3
Packet Forwarding Engine configuration:
  Destination slot: 0, PLP byte: 1 (0x00)
  CoS transmit queue             Bandwidth           Buffer Priority   Limit
                            %          bps   %         bytes
  0 best-effort            95    147744000  95             0      low    none
  3 network-control         5      7776000   5             0      low    none

Logical interface so-0/0/3.0 (Index 71) (SNMP ifIndex 28) (Generation 16)
   Flags: Device-Down  Point-To-Point SNMP-Traps  Encapsulation: Cisco-HDLC
  Traffic statistics:
   Input  bytes  :            406737746
   Output bytes  :            186714992
   Input  packets:              7283616
   Output packets:              3297569
  Local statistics:
   Input  bytes  :            203368873
   Output bytes  :            186714992
   Input  packets:              3641808
```

```
    Output packets:              3297569
   Transit statistics:
    Input  bytes  :            203368873                    0 bps
    Output bytes  :                    0                    0 bps
    Input  packets:              3641808                    0 pps
    Output packets:                    0                    0 pps
   Protocol inet, MTU: 4470, Generation: 46, Route table: 0
     Flags: None
       Addresses, Flags: Dest-route-down Is-Preferred Is-Primary
         Destination: 10.1.36.0/30, Local: 10.1.36.2, Broadcast: 10.1.36.3, Generation: 38
   Protocol iso, MTU: 4469, Generation: 47, Route table: 0
     Flags: None
   Protocol mpls, MTU: 4458, Generation: 48, Route table: 0
     Flags: None
```

Sample Output 2

```
user@R3> show interfaces so-0/0/3
Physical interface: so-0/0/3, Enabled, Physical link is Up
  Interface index: 131, SNMP ifIndex: 24
    Link-level type: PPP , MTU: 4474, Clocking: Internal, SONET mode, Speed: OC3,
Loopback: None,  FCS: 16 ,
  Payload scrambler: Enabled
  Device flags   : Present Running
  Interface flags: Point-To-Point SNMP-Traps
   Link flags   : Keepalives
  Keepalive settings: Interval 10 seconds, Up-count 1, Down-count 3
  Keepalive: Input: 736827 (00:00:03 ago), Output: 736972 (00:00:05 ago)
  LCP state: Opened
  NCP state: inet: Opened, inet6: Not-configured, iso: Opened, mpls: Opened
  CHAP state: Not-configured
  CoS queues     : 4 supported
  Last flapped   : 2004-07-21 16:08:01 PDT (10w5d 19:57 ago)
  Input rate     : 40 bps (0 pps)
  Output rate    : 48 bps (0 pps)
  SONET alarms   : None
  SONET defects  : None

   Logical interface so-0/0/3.0 (Index 70) (SNMP ifIndex 51)
    Flags: Point-To-Point SNMP-Traps  Encapsulation: PPP
    Protocol inet, MTU: 4470
      Flags: None
      Addresses, Flags: Is-Preferred Is-Primary
        Destination: 10.1.36.0/30, Local: 10.1.36.1, Broadcast: 10.1.36.3
    Protocol iso, MTU: 4470
      Flags: None
    Protocol mpls, MTU: 4458
      Flags: None
```

Meaning

Sample Output 1 from egress router **R6** shows that there are no SONET alarms or defects (**none**), the states are all **OK**, and the path trace shows the distant end (**R3 so-0.0.0**), indicating that the physical link is up. However, the logical link is down, and the link-level type is Cisco HDLC.

Sample Output 2 from transit router **R3** shows that the link-level type is PPP, indicating that the encapsulation types are mismatched, resulting in the LSP going down.

Take Appropriate Action

Problem Depending on the error you encountered in your investigation, you must take the appropriate action to correct the problem. In the example below, the encapsulation types are mismatched.

Solution To correct the error in this example, enter the following commands:

```
[edit interfaces so-0/0/3]
user@R1# show
user@R1# delete encapsulation
user@R1# show
user@R1# commit
```

Sampel Output

```
[edit interfaces so-0/0/3]
user@R6# show
encapsulation cisco-hdlc;
unit 0 {
    family inet {
        address 10.1.36.2/30;
    }
    family iso;
    family mpls;
}

[edit interfaces so-0/0/3]
user@R6# delete encapsulation

[edit interfaces so-0/0/3]
user@R6# show
unit 0 {
    family inet {
        address 10.1.36.2/30;
    }
    family iso;
    family mpls;
}

[edit interfaces so-0/0/3]
user@R6# commit
commit complete
```

Meaning The sample output from egress router **R6** shows that the Cisco HDLC was incorrectly configured on interface **so-0/0/3** which prevented the LSP from using the intended path. The problem was corrected when the **encapsulation** statement was deleted and the configuration committed.

Verify the LSP Again

Purpose After taking the appropriate action to correct the error, the LSP needs to be checked again to confirm that the problem in the data link layer has been resolved.

Action From the ingress, egress, and transit routers, verify that the LSP is up and traversing the network as expected:

```
user@host> show mpls lsp extensive
```

Sample Output 1

```
user@R1> show mpls lsp extensive
Ingress LSP: 1 sessions

10.0.0.6
  From: 10.0.0.1 , State: Up,  ActiveRoute: 1 , LSPname: R1-to-R6
  ActivePath:  (primary)
  LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
 *Primary                    State: Up
    Computed ERO (S [L] denotes strict [loose] hops): (CSPF metric: 20)
  10.1.13.2 S 10.1.36.2 S
    Received RRO (ProtectionFlag 1=Available 2=InUse 4=B/W 8=Node 10=SoftPreempt):

          10.1.13.2 10.1.36.2
   145 Sep 30 12:25:01 Selected as active path
   144 Sep 30 12:25:01 Record Route:  10.1.13.2 10.1.36.2
   143 Sep 30 12:25:01 Up
   142 Sep 30 12:25:01 Originate Call
   141 Sep 30 12:25:01 CSPF: computation result accepted
   140 Sep 30 12:24:32 CSPF failed: no route toward 10.0.0.6[74 times]
   139 Sep 30 11:48:57 Deselected as active
   138 Sep 30 11:48:56 CSPF failed: no route toward 10.0.0.6
   137 Sep 30 11:48:56 Clear Call
   136 Sep 30 11:48:56 CSPF: link down/deleted
10.1.36.1(R3.00/10.0.0.3)->10.1.36.2(R6.00/10.0.0.6)
   [...Output truncated...]
  Created: Sat Jul 10 18:18:43 2004
Total 1 displayed, Up 1 , Down 0

Egress LSP: 1 sessions

10.0.0.1
  From: 10.0.0.6 , LSPstate: Up, ActiveRoute: 0
  LSPname: R6-to-R1, 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:  134, Since: Thu Sep 30 12:24:56 2004
  Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
  Port number: sender 6 receiver 39024 protocol 0
  PATH rcvfrom: 10.1.13.2 (so-0/0/2.0) 7 pkts
  Adspec: received MTU 1500
  PATH sentto: localclient
  RESV rcvfrom: localclient
   Record route: 10.1.36.2 10.1.13.2 <self>
Total 1 displayed, Up 1, Down 0

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

Sample Output 2

```
user@R6> show mpls lsp extensive
Ingress LSP: 1 sessions

10.0.0.1
  From: 10.0.0.6, State: Up, ActiveRoute: 1, LSPname: R6-to-R1
  ActivePath:  (primary)
  LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
 *Primary                    State: Up
    Computed ERO (S [L] denotes strict [loose] hops): (CSPF metric: 20)
  10.1.36.1 S 10.1.13.1 S
```

```
    Received RRO (ProtectionFlag 1=Available 2=InUse 4=B/W 8=Node 10=SoftPreempt):

          10.1.36.1 10.1.13.1
   50 Sep 30 12:24:12 Selected as active path
   49 Sep 30 12:24:12 Record Route:  10.1.36.1 10.1.13.1
   48 Sep 30 12:24:12 Up
   47 Sep 30 12:24:12 Originate Call
   46 Sep 30 12:24:12 CSPF: computation result accepted
   45 Sep 30 12:23:43 CSPF failed: no route toward 10.0.0.1[73 times]
   44 Sep 30 11:48:12 Deselected as active
   43 Sep 30 11:48:12 CSPF failed: no route toward 10.0.0.1
   42 Sep 30 11:48:12 CSPF: link down/deleted
10.1.36.2(R6.00/10.0.0.6)->10.1.36.1(R3.00/10.0.0.3)
   [...Output truncated...]
  Created: Tue Aug 17 12:18:34 2004
Total 1 displayed, Up 1, Down 0

Egress LSP: 1 sessions

10.0.0.6
  From: 10.0.0.1 , LSPstate: Up, ActiveRoute: 0
  LSPname: R1-to-R6, 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:  159, Since: Thu Sep 30 12:24:16 2004
  Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
  Port number: sender 19 receiver 44251 protocol 0
  PATH rcvfrom: 10.1.36.1 (so-0/0/3.0) 4 pkts
  Adspec: received MTU 1500
  PATH sentto: localclient
  RESV rcvfrom: localclient
   Record route: 10.1.13.1 10.1.36.1 <self>
Total 1 displayed, Up 1, Down 0

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

Sample Output 3

```
user@R3> show mpls lsp extensive
Ingress LSP: 0 sessions
Total 0 displayed, Up 0, Down 0

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

Transit LSP: 2 sessions

10.0.0.1
  From: 10.0.0.6 , LSPstate: Up, ActiveRoute: 1
  LSPname: R6-to-R1, LSPpath: Primary
  Suggested label received: -, Suggested label sent: -
  Recovery label received: -, Recovery label sent: 3
  Resv style: 1 FF, Label in: 100176, Label out: 3
  Time left:  143, Since: Thu Sep 30 12:21:25 2004
  Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
  Port number: sender 6 receiver 39024 protocol 0
  PATH rcvfrom: 10.1.36.2 (so-0/0/3.0) 10 pkts
  Adspec: received MTU 1500 sent MTU 1500
  PATH sentto: 10.1.13.1 (so-0/0/2.0) 9 pkts
  RESV rcvfrom: 10.1.13.1 (so-0/0/2.0) 9 pkts
  Explct route: 10.1.13.1
```

```
    Record route: 10.1.36.2 <self> 10.1.13.1

10.0.0.6
  From: 10.0.0.1 , LSPstate: Up, ActiveRoute: 1
  LSPname: R1-to-R6, LSPpath: Primary
  Suggested label received: -, Suggested label sent: -
  Recovery label received: -, Recovery label sent: 3
  Resv style: 1 FF, Label in: 100192, Label out: 3
  Time left:  148, Since: Thu Sep 30 12:21:30 2004
  Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
  Port number: sender 19 receiver 44251 protocol 0
  PATH rcvfrom: 10.1.13.1 (so-0/0/2.0) 9 pkts
  Adspec: received MTU 1500 sent MTU 1500
  PATH sentto: 10.1.36.2 (so-0/0/3.0) 9 pkts
  RESV rcvfrom: 10.1.36.2 (so-0/0/3.0) 9 pkts
  Explct route: 10.1.36.2
   Record route: 10.1.13.1 <self> 10.1.36.2
Total 2 displayed, Up 2, Down 0
```

Sample Output 4

```
user@R1> show configuration protocols mpls
label-switched-path R1-to-R6 {
    to 10.0.0.6;
}
inactive: interface so-0/0/0.0;
inactive: interface so-0/0/1.0;
interface so-0/0/2.0;

user@R6> show configuration protocols mpls
label-switched-path R6-to-R1 {
    to 10.0.0.1;
}
inactive: interface so-0/0/0.0;
inactive: interface so-0/0/1.0;
inactive: interface so-0/0/2.0;
interface so-0/0/3.0;

user@R3> show configuration protocols mpls
interface fxp0.0 {
    disable;
}
inactive: interface so-0/0/0.0;
inactive: interface so-0/0/1.0;
interface so-0/0/2.0;
interface so-0/0/3.0;
```

Meaning

Sample Outputs 1 and 2 from ingress router **R1** and egress router **R6,** respectively, show that the LSP is now traversing the network along the expected path, from **R1** through **R3** to **R6**, and the reverse LSP, from **R6** through **R3** to **R1**.

Sample Output 3 from transit router **R3** shows that there are two transit LSP sessions, one from **R1** to **R6** and the other from **R6** to **R1**.

Sample Output 4 shows the interfaces that were deactivated on the ingress, egress, and transit routers, forcing the LSP to take the intended path. If these interfaces were not deactivated, even though the configuration is now correct, the LSP would still traverse the network through the alternate path.

CHAPTER 9

Verifying the IP and IGP Layers

This chapter describes how to check the Internet Protocol (IP) and interior gateway protocol (IGP) layers of the layered Multiprotocol Label Switching (MPLS) model.

Checklist for Verifying the IP and IGP Layers

Problem This checklist provides the steps and commands for investigating a problem at the Internet Protocol (IP) and interior gateway protocol (IGP) layers of the layered Multiprotocol Label Switching (MPLS) model. The checklist provides links to an overview of the IP and IGP layers and more detailed information about the commands used to investigate the problem.

Solution Table 17 on page 105 provides commands for verifying the IP and IGP layers.

Table 17: Checklist for Verifying the IP and IGP Layers

Tasks	Command or Action
"Verifying the IP and IGP Layers" on page 107	
"Verifying the IP Layer" on page 109	
1. Verify the LSP on page 110	**show mpls lsp extensive**
2. Verify IP Addressing on page 111	**show interfaces terse**
3. Verify Neighbors or Adjacencies at the IP Layer on page 112	**show ospf neighbor extensive** **show isis adjacency extensive**

Table 17: Checklist for Verifying the IP and IGP Layers *(continued)*

Tasks	Command or Action
4. Take Appropriate Action on page 115	The following sequence of commands addresses the specific problem described in this topic: **[edit interfaces so-0/0/2]** **show** **rename unit 0 family inet address 10.1.13.2/30 to address 10.1.13.1/30** **show** **commit**
5. Verify the LSP Again on page 116	**show mpls lsp extensive**
"Verifying the OSPF Protocol" on page 119	
1. Verify the LSP on page 119	**show mpls lsp extensive**
2. Verify OSPF Interfaces on page 122	**show ospf interface**
3. Verify OSPF Neighbors on page 123	**show ospf neighbor**
4. Verify the OSPF Protocol Configuration on page 124	**show configuration protocols ospf**
5. Take Appropriate Action on page 125	The following sequence of commands addresses the specific problem described in this topic: **[edit]** **edit protocols ospf area 0.0.0.0** **[edit protocols ospf area 0.0.0.0]** **set interface lo0** **set interface lo0 passive** **up** **[edit protocols ospf]** **set traffic-engineering** **show** **commit**
6. Verify the LSP Again on page 126	**show mpls lsp extensive**
"Verifying the IS-IS Protocol" on page 129	
1. Verify the LSP on page 129	**show mpls lsp extensive**
2. Verify IS-IS Adjacencies and Interfaces on page 131	**show isis adjacency** **show isis interface**
3. Verify the IS-IS Configuration on page 132	**show configuration protocols isis**

Table 17: Checklist for Verifying the IP and IGP Layers *(continued)*

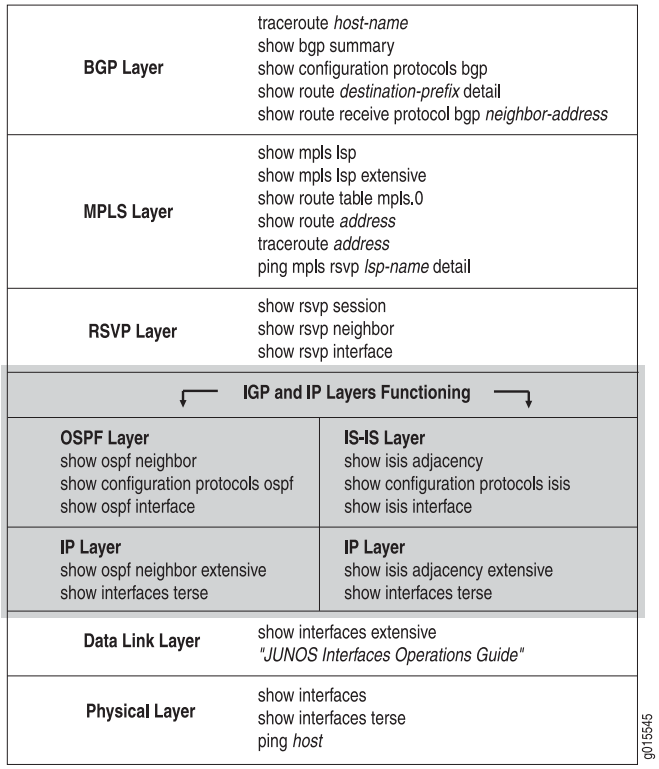
Tasks	Command or Action
4. Take Appropriate Action on page 133	The following sequence of commands addresses the specific problem described in this topic: **edit** **[edit]** **edit protocols isis** **[edit protocols isis]** **show** **delete level 2** **set level 1 disable** **show** **commit** **run show isis adjacency**
5. Verify the LSP Again on page 134	**show mpls lsp extensive**

Verifying the IP and IGP Layers

Problem After you have configured the label-switched path (LSP), issued the **show mpls lsp extensive** command, and determined that there is an error, you might find that the error is not in the physical or data link layers. Continue investigating the problem at the IP and IGP layers of the network.

Figure 14 on page 108 illustrates the IP and IGP layers of the layered MPLS model.

Figure 14: IP and IGP Layers



Solution At the IP and IGP layers, you must check the following:

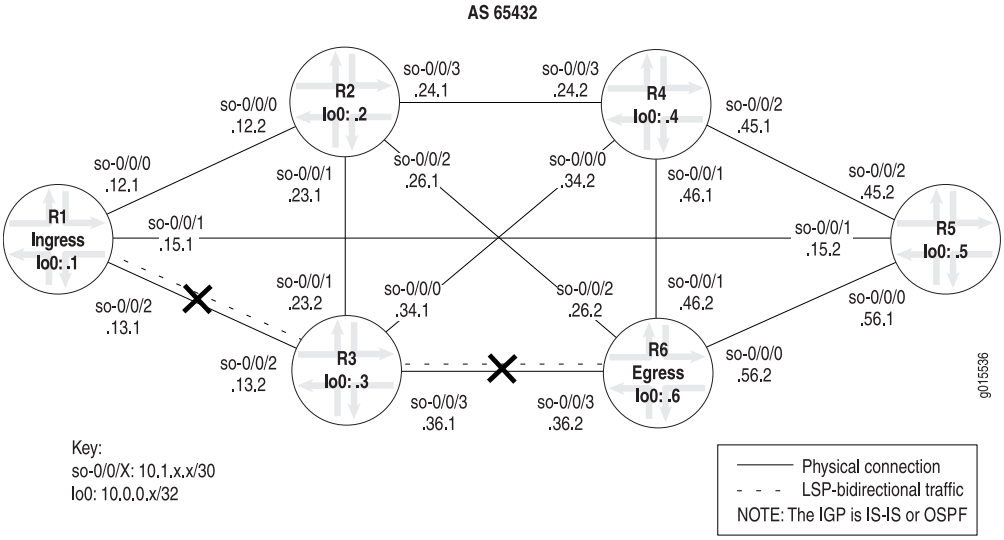
- Interfaces have correct IP addressing, and the IGP neighbors or adjacencies are established.
- Open Shortest Path First (OSPF) or Intermediate System-to-Intermediate System (IS-IS) protocols are configured and running correctly.
  - If the OSPF protocol is configured, check the IP layer first, then the OSPF configuration, making sure that the protocol, interfaces, and traffic engineering are configured correctly.
  - If the IS-IS protocol is configured, it doesn't matter whether you check IS-IS or IP first because both protocols are independent of each other. Verify that IS-IS adjacencies are up, and that the interfaces and IS-IS protocol are configured correctly.

NOTE: The IS-IS protocol has traffic engineering enabled by default.

If the network is not functioning at the IP or IGP layers, the LSP does not work as configured.

Figure 15 on page 109 illustrates the MPLS network used in this topic.

Figure 15: MPLS Network Broken at the IP and IGP Layers



The network shown in Figure 15 on page 109 is a fully meshed configuration where every directly connected interface can receive and send packets to every other similar interface. The LSP in this network is configured to run from ingress router **R1**, through transit router **R3**, to egress router **R6**. In addition, a reverse LSP is configured to run from **R6**, through **R3**, to **R1**, creating bidirectional traffic. The crosses in Figure 15 on page 109 indicate where the LSP is not working because of the following problems at the IP and IGP layer:

- An IP address is configured incorrectly on the ingress router (**R1**).
- The OSPF protocol is configured with a router ID (RID) but without the loopback (**lo0**) interface, and traffic engineering is missing from the transit router (**R3**).
- Levels in the IS-IS network are mismatched.

Related Documentation

To check the IP and IGP layers, follow these steps:

- Verifying the IP Layer on page 109
- Verifying the OSPF Protocol on page 119
- Verifying the IS-IS Protocol on page 129

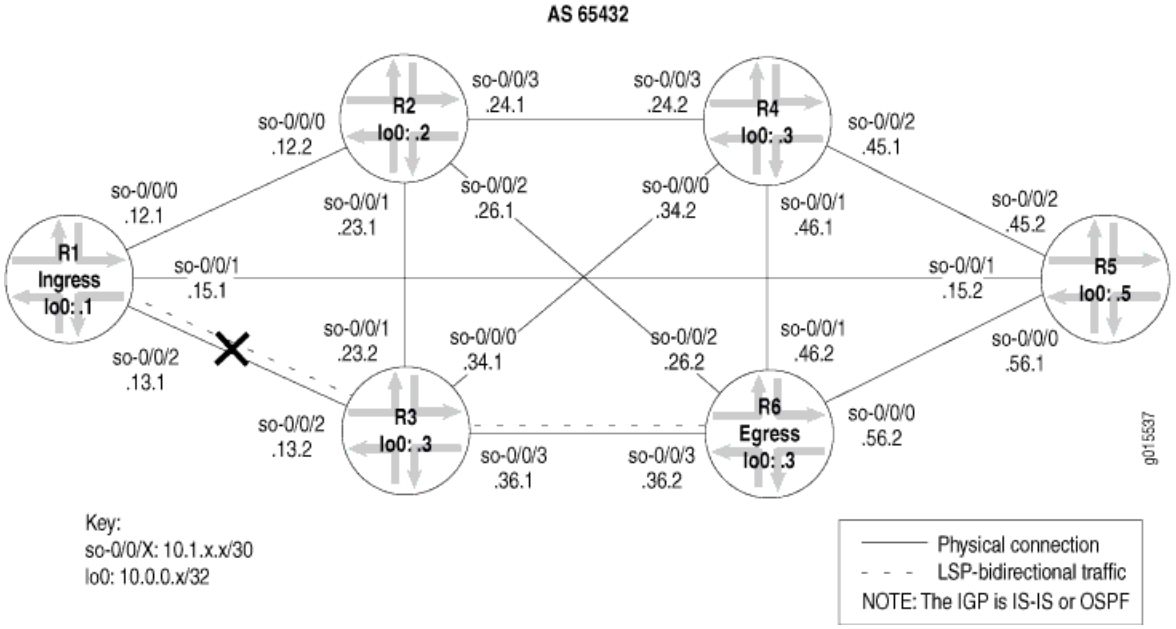
Verifying the IP Layer

Purpose

You can check the IP layer before or after you check the IGP layer, depending on whether you have OSPF or IS-IS configured as the IGP. If your MPLS network is configured with OSPF as the IGP, you must first verify the IP layer, checking that the interfaces have correct IP addressing and that the OSPF neighbors are established before you check the OSPF layer.

If you have IS-IS configured as the IGP in your MPLS network, you can verify either the IP layer or the IS-IS protocol layer first. The order in which you check the IP or IS-IS layer does not affect the results.

Figure 16: MPLS Network Broken at the IP Layer



The cross in Figure 16 on page 110 indicates where the LSP is broken because of the incorrect configuration of an IP address on ingress router **R1**.

1. Verify the LSP on page 110
2. Verify IP Addressing on page 111
3. Verify Neighbors or Adjacencies at the IP Layer on page 112
4. Take Appropriate Action on page 115
5. Verify the LSP Again on page 116

Verify the LSP

Purpose After configuring the LSP, you must verify that the LSP is up. LSPs can be ingress, transit, or egress. Use the **show mpls lsp** command for quick verification of the LSP state, with the **extensive** option (**show mpls lsp extensive)** as a follow-up if the LSP is down. If your network has numerous LSPs, you might consider specifying the name of the LSP, using the **name** option (**show mpls lsp name *name*** or **show mpls lsp name *name* extensive)**.

Action To verify that the LSP is up, enter the following command from the ingress router:

```
user@host> show mpls lsp extensive
```

Sample Output 1

```
user@R1> show mpls lsp extensive
Ingress LSP: 1 sessions

10.0.0.6
  From: 10.0.0.1, State: Dn, ActiveRoute: 0, LSPname: R1-to-R6
   ActivePath: (none)
  LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
  Primary                    State: Dn
    Will be enqueued for recomputation in 25 second(s).
```

```
   44 Oct 15 16:56:11 CSPF failed:  no route toward 10.0.0.6 [2685 times]
   43 Oct 14 19:07:09 Clear Call
   42 Oct 14 19:06:56 Deselected as active
   41 Oct 14 19:06:56 10.1.12.1: MPLS label allocation failure
   40 Oct 14 19:06:56 Down
   39 Oct 14 18:43:43 Selected as active path
   38 Oct 14 18:43:43 Record Route:  10.1.13.2 10.1.36.2
   37 Oct 14 18:43:43 Up
   [...Output truncated...]
  Created: Thu Oct 14 16:04:33 2004
Total 1 displayed, Up 0,  Down 1

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

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

Meaning The sample output from ingress router **R1** shows that an MPLS label allocation failure occurred and the Constrained Shortest Path First (CSPF) algorithm failed, resulting in no route to destination **10.0.0.6** on **R6**.

Verify IP Addressing

Purpose When you investigate the IP layer, you verify that interfaces have correct IP addressing, and that OSPF neighbors or IS-IS adjacencies are established. In this example, an IP address is configured incorrectly on the ingress router (**R1**).

Action To verify IP addressing, enter the following command from the ingress, transit, and egress routers:

```
user@host> show interfaces terse
```

Sample Output

```
user@R1> show interfaces terse
Interface               Admin Link Proto Local                 Remote
so-0/0/0                up    up
so-0/0/0.0              up    up   inet  10.1.12.1/30
                                  iso
                                  mpls
so-0/0/1                up    up
so-0/0/1.0              up    up   inet  10.1.15.1/30
                                  iso
                                  mpls
so-0/0/2                up    up
so-0/0/2.0      up  up  inet 10.1.13.2 <<< Incorrect IP address
                                  iso
                                  mpls
lo0                     up    up
lo0.0                   up    up   inet  10.0.0.1
                                  iso   49.0004.1000.0000.0001.00

user@R3> show interfaces terse
Interface               Admin Link Proto Local                 Remote
so-0/0/0                up    up
so-0/0/0.0              up    up   inet  10.1.34.1/30
                                  iso
                                  mpls
so-0/0/1                up    up
```

```
so-0/0/1.0              up    up   inet  10.1.23.2/30
                                   iso
                                   mpls
so-0/0/2                up    up
so-0/0/2.0      up   up  inet 10.1.13.2/30 <<< Identical to R1
                                   iso
                                   mpls
so-0/0/3                up    up
so-0/0/3.0              up    up   inet  10.1.36.1/30
                                   iso
                                   mpls
lo0                     up    up
lo0.0                   up    up   inet  10.0.0.3
                                   iso   49.0004.1000.0000.0003.00

user@R6> show interfaces terse
Interface               Admin Link Proto Local                 Remote
so-0/0/0                up    up
so-0/0/0.0              up    up   inet  10.1.56.2/30
                                   iso
                                   mpls
so-0/0/1                up    up
so-0/0/1.0              up    up   inet  10.1.46.2/30
                                   iso
                                   mpls
so-0/0/2                up    up
so-0/0/2.0              up    up   inet  10.1.26.2/30
                                   iso
                                   mpls
so-0/0/3                up    up
so-0/0/3.0              up    up   inet  10.1.36.2/30
                                   iso
                                   mpls
lo0.0                   up    up   inet  10.0.0.6
                                   iso   49.0004.1000.0000.0006.00
```

Meaning The sample output shows that the IP addresses for interface **so-0/0/2.0** on **R1** and interface **so-0/0/2.0** on **R3** are identical. Interface IP addresses within a network must be unique for the interface to be identified correctly.

Verify Neighbors or Adjacencies at the IP Layer

Purpose If the IP addressing is configured incorrectly then the OSPF neighbors or IS-IS adjacencies both need to be checked to determine if one or both of them are established.

Action To verify neighbors (OSPF) or adjacencies (IS-IS), enter the following commands from the ingress, transit, and egress routers:

```
user@host> show ospf neighbor extensive
user@host> show isis adjacency extensive
```

Sample Output 1

```
user@R1> show ospf neighbor extensive
Address         Interface             State      ID              Pri  Dead
10.1.12.2        so-0/0/0.0             Full      10.0.0.2          128   34
  area 0.0.0.0, opt 0x42, DR 0.0.0.0, BDR 0.0.0.0
  Up 1d 04:45:20, adjacent 1d 04:45:20
10.1.15.2        so-0/0/1.0             Full      10.0.0.5          128   35
  area 0.0.0.0, opt 0x42, DR 0.0.0.0, BDR 0.0.0.0
```

```
  Up 1d 04:45:20, adjacent 1d 04:45:10  <<< no adjacency with R3 so-0/0/2

user@R3> show ospf neighbor extensive
Address         Interface             State      ID              Pri  Dead
10.1.23.1        so-0/0/1.0             Full      10.0.0.2          128   35
  area 0.0.0.0, opt 0x42, DR 0.0.0.0, BDR 0.0.0.0
  Up 1w2d 04:54:30, adjacent 1w2d 04:54:21
10.1.36.2        so-0/0/3.0             Full      10.0.0.6          128   39
  area 0.0.0.0, opt 0x42, DR 0.0.0.0, BDR 0.0.0.0
  Up 1w2d 04:54:30, adjacent 1w2d 04:54:30  <<< no adjacency with R1 so-0/0/2

user@R6> show ospf neighbor extensive
Address         Interface             State      ID              Pri  Dead
10.1.56.1        so-0/0/0.0             Full      10.0.0.5          128   39
  area 0.0.0.0, opt 0x42, DR 0.0.0.0, BDR 0.0.0.0
  Up 1d 02:59:35, adjacent 1d 02:59:35
10.1.26.1        so-0/0/2.0             Full      10.0.0.2          128   36
  area 0.0.0.0, opt 0x42, DR 0.0.0.0, BDR 0.0.0.0
  Up 1w2d 04:57:30, adjacent 1w2d 04:57:30
10.1.36.1        so-0/0/3.0             Full      10.0.0.3          128   36
  area 0.0.0.0, opt 0x42, DR 0.0.0.0, BDR 0.0.0.0
  Up 1w2d 04:56:11, adjacent 1w2d 04:56:11
```

Sample Output 2

```
user@R1> show isis adjacency extensive
R2
  Interface: so-0/0/0.0,  Level: 2, State: Up , Expires in 23 secs
  Priority: 0, Up/Down transitions: 1, Last transition: 05:57:16 ago
  Circuit type: 2,  Speaks: IP , IPv6
  Topologies: Unicast
  Restart capable: Yes
   IP addresses: 10.1.12.2
  Transition log:
  When                  State        Reason
  Fri Oct 15 14:58:35   Up           Seenself

R5
  Interface: so-0/0/1.0,  Level: 2, State: Up, Expires in 26 secs
  Priority: 0, Up/Down transitions: 1, Last transition: 05:56:52 ago
  Circuit type: 2,  Speaks: IP , IPv6
  Topologies: Unicast
  Restart capable: Yes
   IP addresses: 10.1.15.2
  Transition log:
  When                  State        Reason
  Fri Oct 15 14:59:00   Up           Seenself

R3
  Interface: so-0/0/2.0, Level: 2, State: Up, Expires in 26 secs
  Priority: 0, Up/Down transitions: 1, Last transition: 05:56:51 ago
  Circuit type: 2,  Speaks: IP , IPv6
  Topologies: Unicast
  Restart capable: Yes
  IP addresses: 10.1.13.2
  Transition log:
  When                  State        Reason
  Fri Oct 15 14:59:01   Up           Seenself

user@R3> show isis adjacency extensive
R4
  Interface: so-0/0/0.0,  Level: 2, State: Up , Expires in 25 secs
  Priority: 0, Up/Down transitions: 1, Last transition: 1w1d 00:22:51 ago
```

```
  Circuit type: 2,  Speaks: IP , IPv6
  Topologies: Unicast
  Restart capable: Yes
   IP addresses: 10.1.34.2
  Transition log:
  When                  State        Reason
  Thu Oct 28 15:13:12   Up           Seenself

R2
  Interface: so-0/0/1.0,  Level: 2, State: Up , Expires in 25 secs
  Priority: 0, Up/Down transitions: 1, Last transition: 2w2d 18:02:48 ago
  Circuit type: 2,  Speaks: IP , IPv6
  Topologies: Unicast
  Restart capable: Yes
   IP addresses: 10.1.23.1
  Transition log:
  When                  State        Reason
  Tue Oct 19 21:33:15   Up           Seenself

R1
  Interface: so-0/0/2.0,  Level: 2, State: Up , Expires in 22 secs
  Priority: 0, Up/Down transitions: 1, Last transition: 2w2d 17:24:06 ago
  Circuit type: 2,  Speaks: IP , IPv6
  Topologies: Unicast
  Restart capable: Yes
   IP addresses: 10.1.13.1
  Transition log:
  When                  State        Reason
  Tue Oct 19 22:11:57   Up           Seenself

R6
  Interface: so-0/0/3.0,  Level: 2, State: Up , Expires in 21 secs
  Priority: 0, Up/Down transitions: 1, Last transition: 2w1d 00:07:00 ago
  Circuit type: 2,  Speaks: IP , IPv6
  Topologies: Unicast
  Restart capable: Yes
   IP addresses: 10.1.36.2
  Transition log:
  When                  State        Reason
  Thu Oct 21 15:29:03   Up           Seenself

user@R6>  show isis adjacency extensive
R5
  Interface: so-0/0/0.0,  Level: 2, State: Up , Expires in 23 secs
  Priority: 0, Up/Down transitions: 1, Last transition: 1w2d 01:10:03 ago
  Circuit type: 2,  Speaks: IP , IPv6
  Topologies: Unicast
  Restart capable: Yes
   IP addresses: 10.1.56.1
  Transition log:
  When                  State        Reason
  Wed Oct 27 14:35:32   Up           Seenself

R4
  Interface: so-0/0/1.0,  Level: 2, State: Up , Expires in 25 secs
  Priority: 0, Up/Down transitions: 1, Last transition: 1w1d 00:26:50 ago
  Circuit type: 2,  Speaks: IP , IPv6
  Topologies: Unicast
  Restart capable: Yes
   IP addresses: 10.1.46.1
  Transition log:
```

```
  When                  State       Reason
  Thu Oct 28 15:18:45   Up          Seenself

R2
  Interface: so-0/0/2.0,  Level: 2, State: Up , Expires in 24 secs
  Priority: 0, Up/Down transitions: 1, Last transition: 2w1d 00:11:40 ago
  Circuit type: 2,  Speaks: IP , IPv6
  Topologies: Unicast
  Restart capable: Yes
   IP addresses: 10.1.26.1
  Transition log:
  When                  State       Reason
  Thu Oct 21 15:33:55   Up          Seenself

R3
  Interface: so-0/0/3.0,  Level: 2, State: Up , Expires in 19 secs
  Priority: 0, Up/Down transitions: 1, Last transition: 2w1d 00:11:40 ago
  Circuit type: 2,  Speaks: IP , IPv6
  Topologies: Unicast
  Restart capable: Yes
   IP addresses: 10.1.36.1
  Transition log:
  When                  State       Reason
  Thu Oct 21 15:33:55   Up          Seenself
```

Meaning Sample Output 1 from the ingress, transit, and egress routers shows that **R1** and **R3** are not established OSPF neighbors. Considering that the two interfaces **so-0/0/2.0** (**R1** and **R3**) are configured with identical IP addresses, you would expect this. The OSPF protocol routes IP packets based solely on the destination IP address contained in the IP packet header. Therefore, identical IP addresses in the autonomous system (AS) result in neighbors not establishing.

Sample Output 2 from the ingress, transit, and egress routers shows that **R1** and **R3** have established an IS-IS adjacency despite the identical IP addresses configured on interfaces **so-0/0/2.0** on **R1** and **R3**. The IS-IS protocol behaves differently from the OSPF protocol because it does not rely on IP to establish an adjacency. However, if the LSP is not up, it is still useful to check the IP subnet addressing in case there is a mistake in that layer. Correcting the addressing error might bring the LSP back up.

Take Appropriate Action

Problem Depending on the error you encountered in your investigation, you must take the appropriate action to correct the problem. In this example, the IP address of an interface on transit router **R2** is incorrectly configured.

Solution To correct the error in this example, enter the following commands:

```
[edit interfaces  so-0/0/2]
user@R1# show
user@R1#  rename unit 0 family inet address 10.1.13.2/30 to address  10.1.13.1/30
user@R1# show
user@R1# commit
```

Sample Output

```
[edit interfaces so-0/0/2]
user@R1# show
unit 0 {
```

```
    family inet {
        address 10.1.13.2/30;  <<< Incorrect IP address
    }
    family iso;
    family mpls;
}

[edit interfaces so-0/0/2]
user@R1# rename unit 0 family inet address 10.1.13.2/30 to address 10.1.13.1/30

[edit interfaces so-0/0/2]
user@R1# show
unit 0 {
    family inet {
        address 10.1.13.1/30;  <<< Correct IP address.
    }
    family iso;
    family mpls;
}

[edit interfaces so-0/0/2]
user@R1# commit
commit complete
```

Meaning The sample output shows that interface **so-0/0/2** on ingress router **R1** is now configured with the correct IP address. This correction results in unique subnet IP addresses for all interfaces in the MPLS network in Figure 15 on page 109, and the possibility that the LSP might come up.

Verify the LSP Again

Purpose After taking the appropriate action to correct the error, the LSP needs to be checked again to confirm that the problem in the OSPF protocol has been resolved.

Action To verify the LSP again, enter the following command on the ingress, transit, and egress routers:

```
user@host> show mpls lsp extensive
```

Sample Output 1

```
user@R1> show mpls lsp extensive
Ingress LSP: 1 sessions

10.0.0.6
  From: 10.0.0.1, State: Up,  ActiveRoute: 1 , LSPname: R1-to-R6
  ActivePath:  (primary)
  LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
 *Primary                    State: Up
    Computed ERO (S [L] denotes strict [loose] hops): (CSPF metric: 20)
 10.1.13.2 S 10.1.36.2 S
   Received RRO (ProtectionFlag 1=Available 2=InUse 4=B/W 8=Node 10=SoftPreempt):

         10.1.13.2 10.1.36.2
   54 Oct 15 21:28:16 Selected as active path
   53 Oct 15 21:28:16 Record Route:  10.1.13.2 10.1.36.2
   52 Oct 15 21:28:16 Up
   51 Oct 15 21:28:16 10.1.15.1: MPLS label allocation failure[2 times]
   50 Oct 15 21:28:11 CSPF: computation result accepted
```

```
    49 Oct 15 21:27:42 10.1.15.1: MPLS label allocation failure
    48 Oct 15 21:27:42 CSPF: computation result accepted
    47 Oct 15 21:27:31 10.1.15.1: MPLS label allocation failure[4 times]
    46 Oct 15 21:27:13 Originate Call
    45 Oct 15 21:27:13 CSPF: computation result accepted
    [...Output truncated...]
  Created: Thu Oct 14 16:04:34 2004
Total 1 displayed,  Up 1 , Down 0

Egress LSP: 1 sessions

10.0.0.1
  From: 10.0.0.6,  LSPstate: Up , ActiveRoute: 0
   LSPname: R6-to-R1 , 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:  149, Since: Fri Oct 15 21:28:13 2004
  Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
  Port number: sender 13 receiver 39024 protocol 0
  PATH rcvfrom: 10.1.13.2 (so-0/0/2.0) 10 pkts
  Adspec: received MTU 1500
  PATH sentto: localclient
  RESV rcvfrom: localclient
   Record route: 10.1.36.2 10.1.13.2 <self>
Total 1 displayed,  Up 1 , Down 0

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

Sample Output 2

```
user@R3> show mpls lsp extensive
Ingress LSP: 0 sessions
Total 0 displayed, Up 0, Down 0

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

Transit LSP: 2 sessions

10.0.0.1
  From: 10.0.0.6,  LSPstate: Up , ActiveRoute: 1
   LSPname: R6-to-R1 , LSPpath: Primary
  Suggested label received: -, Suggested label sent: -
  Recovery label received: -, Recovery label sent: 3
  Resv style: 1 FF, Label in: 100336, Label out: 3
  Time left:  156, Since: Fri Oct 15 21:15:47 2004
  Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
  Port number: sender 13 receiver 39024 protocol 0
  PATH rcvfrom: 10.1.36.2 (so-0/0/3.0) 11 pkts
  Adspec: received MTU 1500 sent MTU 1500
  PATH sentto: 10.1.13.1 (so-0/0/2.0) 11 pkts
  RESV rcvfrom: 10.1.13.1 (so-0/0/2.0) 11 pkts
  Explct route: 10.1.13.1
   Record route: 10.1.36.2 <self> 10.1.13.1

10.0.0.6
  From: 10.0.0.1,  LSPstate: Up , ActiveRoute: 1
   LSPname: R1-to-R6 , LSPpath: Primary
  Suggested label received: -, Suggested label sent: -
  Recovery label received: -, Recovery label sent: 3
  Resv style: 1 FF, Label in: 100352, Label out: 3
```

```
  Time left:  159, Since: Fri Oct 15 21:15:50 2004
  Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
  Port number: sender 5 receiver 47901 protocol 0
  PATH rcvfrom: 10.1.13.1 (so-0/0/2.0) 11 pkts
  Adspec: received MTU 1500 sent MTU 1500
  PATH sentto: 10.1.36.2 (so-0/0/3.0) 11 pkts
  RESV rcvfrom: 10.1.36.2 (so-0/0/3.0) 11 pkts
  Explct route: 10.1.36.2
   Record route: 10.1.13.1 <self> 10.1.36.2
Total 2 displayed,  Up 2 , Down 0
```

Sample Output 3

```
user@R6> show mpls lsp extensive
Ingress LSP: 1 sessions

10.0.0.1
  From: 10.0.0.6,  State: Up , ActiveRoute: 1,  LSPname: R6-to-R1
  ActivePath:  (primary)
  LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
 *Primary                    State: Up
    Computed ERO (S [L] denotes strict [loose] hops): (CSPF metric: 20)
 10.1.36.1 S 10.1.13.1 S
    Received RRO (ProtectionFlag 1=Available 2=InUse 4=B/W 8=Node 10=SoftPreempt):

          10.1.36.1 10.1.13.1
   187 Oct 15 21:20:05 Selected as active path
   186 Oct 15 21:20:05 Record Route:  10.1.36.1 10.1.13.1
   185 Oct 15 21:20:05 Up
   184 Oct 15 21:20:05 Clear Call
   183 Oct 15 21:20:05 CSPF: computation result accepted
   182 Oct 15 21:20:05 CSPF: link down/deleted
10.1.13.2(R3.00/10.0.0.3)->10.1.13.2(R1.00/10.0.0.1)
   [...Output truncated...]
  Created: Tue Aug 17 12:18:33 2004
Total 1 displayed,  Up 1 , Down 0

Egress LSP: 1 sessions

10.0.0.6
  From: 10.0.0.1, LSPstate: Up, ActiveRoute: 0
   LSPname: R1-to-R6 , 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:  144, Since: Fri Oct 15 21:20:08 2004
  Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
  Port number: sender 5 receiver 47901 protocol 0
  PATH rcvfrom: 10.1.36.1 (so-0/0/3.0) 11 pkts
  Adspec: received MTU 1500
  PATH sentto: localclient
  RESV rcvfrom: localclient
   Record route: 10.1.13.1 10.1.36.1 <self>
Total 1 displayed,  Up 1 , Down 0

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

Meaning Sample Output 1 from ingress router **R1** shows that LSP **R1-to-R6** has an active route to **R6** and the state is up. The output shows that the egress LSP session **R6-to-R1** received and sent a recovery label.

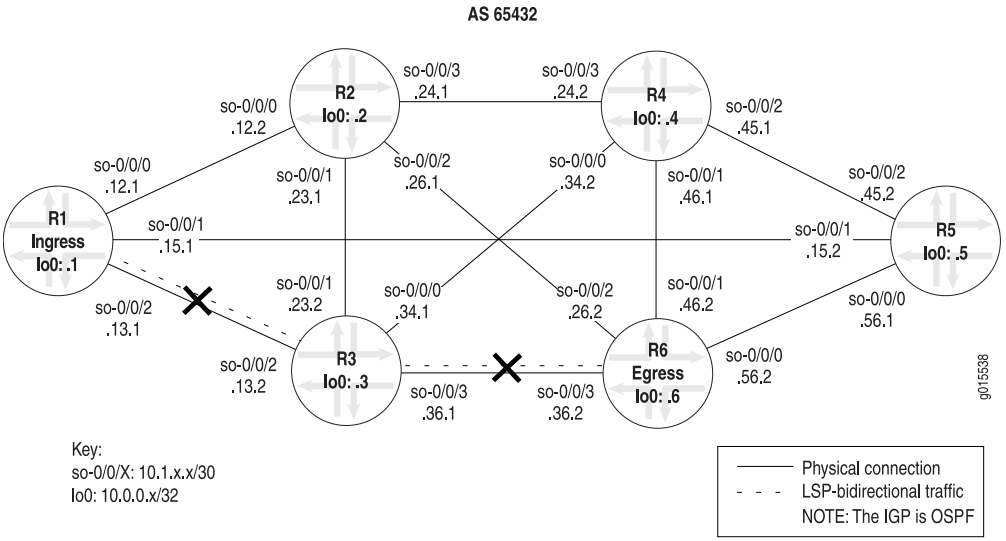
Sample Output 2 from transit router **R3** shows that there are two transit LSP sessions, one from **R1** to **R6** and the other from **R6** to **R1.** Both LSPs are up.

Sample Output 3 from egress router **R6** shows that the LSP is up and the active route is the primary route. The LSP is now traversing the network along the expected path, from **R1** through **R3** to **R6**, and the reverse LSP, from **R6** through **R3** to **R1**.

Verifying the OSPF Protocol

Purpose After you have verified that the LSP is down, and the cause is not in the physical, datalink, or IP layer, verify the OSPF configuration. Check the routers in your network to ensure that the interfaces and the OSPF protocol are configured correctly, and that the neighbors are established.

Figure 17: MPLS Network Broken at the OSPF Protocol Layer



1. Verify the LSP on page 119
2. Verify OSPF Interfaces on page 122
3. Verify OSPF Neighbors on page 123
4. Verify the OSPF Protocol Configuration on page 124
5. Take Appropriate Action on page 125
6. Verify the LSP Again on page 126

Verify the LSP

Purpose Confirm that interfaces are configured for OSPF, the OSPF protocol is configured correctly and that neighbors are established.

Action To verify the LSP, enter the following command on the ingress, transit, and egress routers:

```
user@host> show mpls lsp extensive
```

Sample Output 1

```
user@R1> show mpls lsp extensive
Ingress LSP: 1 sessions

10.0.0.6
  From: 10.0.0.1, State: Dn, ActiveRoute: 0,  LSPname: R1-to-R6
  ActivePath: (none)
  LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
  Primary                   State: Dn
   11 Oct 19 18:06:04 No Route toward dest[78 times]
   10 Oct 19 17:08:09 Deselected as active
  Created: Mon Oct 18 21:48:42 2004
Total 1 displayed, Up 0,  Down 1

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

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

Sample Output 2

```
user@R3> show mpls lsp extensive
Ingress LSP: 0 sessions
Total 0 displayed, Up 0, Down 0

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

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

Sample Output 3

```
user@R6> show mpls lsp extensive
Ingress LSP: 1 sessions
To              From            State Rt ActivePath       P     LSPname
10.0.0.1        10.0.0.6        Dn     0 -                      R6-to-R1
Total 1 displayed, Up 0,  Down 1

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

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

Sample Output 4

```
user@R1> show mpls lsp extensive
Ingress LSP: 1 sessions

10.0.0.6
  From: 10.0.0.1, State: Up, ActiveRoute: 1,  LSPname: R1-to-R6
   ActivePath: (primary)
  LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
 *Primary                   State: Up
    Received RRO (ProtectionFlag 1=Available 2=InUse 4=B/W 8=Node 10=SoftPreempt):

            10.1.13.2 10.1.36.2
    5 Oct 19 10:37:55 Selected as active path
    4 Oct 19 10:37:55 Record Route:  10.1.13.2 10.1.36.2
    3 Oct 19 10:37:55 Up
    2 Oct 19 10:37:10 No Route toward dest[1029 times]
    1 Oct 18 21:48:42 Originate Call
  Created: Mon Oct 18 21:48:42 2004
```

```
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
```

Sample Output 5

```
user@R3> show mpls lsp extensive
Ingress LSP: 0 sessions
Total 0 displayed, Up 0, Down 0

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

Transit LSP: 1 sessions

10.0.0.6
  From: 10.0.0.1, LSPstate: Up, ActiveRoute: 1
   LSPname: R1-to-R6 , LSPpath: Primary
  Suggested label received: -, Suggested label sent: -
  Recovery label received: -, Recovery label sent: 3
  Resv style: 1 FF, Label in: 100368, Label out: 3
  Time left:  154, Since: Tue Oct 19 10:25:24 2004
  Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
  Port number: sender 1 receiver 47933 protocol 0
  PATH rcvfrom: 10.1.13.1 (so-0/0/2.0) 209 pkts
  Adspec: received MTU 1500 sent MTU 1500
  PATH sentto: 10.1.36.2 (so-0/0/3.0) 209 pkts
  RESV rcvfrom: 10.1.36.2 (so-0/0/3.0) 209 pkts
  Record route: 10.1.13.1 <self> 10.1.36.2
Total 1 displayed, Up 1, Down 0
```

Sample Output 6

```
user@R6> show mpls lsp extensive
Ingress LSP: 1 sessions

10.0.0.1
  From: 10.0.0.6, State: Dn, ActiveRoute: 0,  LSPname: R6-to-R1
   ActivePath: (none)
  LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
  Primary                  State: Dn
    2 Oct 19 13:01:54 10.1.56.2:  MPLS label allocation failure [9 times]
    1 Oct 19 12:57:51 Originate Call
  Created: Tue Oct 19 12:57:51 2004
Total 1 displayed, Up 0,  Down 1

Egress LSP: 1 sessions

10.0.0.6
  From: 10.0.0.1, LSPstate: Up, ActiveRoute: 0
  LSPname: R1-to-R6, 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: Tue Oct 19 10:30:03 2004
  Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
  Port number: sender 1 receiver 47933 protocol 0
  PATH rcvfrom: 10.1.36.1 (so-0/0/3.0) 206 pkts
  Adspec: received MTU 1500
```

```
  PATH sentto: localclient
  RESV rcvfrom: localclient
  Record route: 10.1.13.1 10.1.36.1 <self>
Total 1 displayed, Up 1, Down 0

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

Meaning Sample Outputs 1, 2, and 3 show that the LSP and the reverse LSP are down:

- Sample Output 1 from ingress router **R1** shows that LSP **R1-to-R6** does not have a route towards the destination (**R6**).
- Sample Output 2 from transit router **R3** shows that there are no LSP sessions.
- Sample Output 3 from egress router **R6** also shows that reverse LSP **R6-to-R1** is down.

Sample Outputs 4, 5, and 6 show that the LSP is up and the reverse LSP is down:

- Sample Output 4 from ingress router **R1** shows that LSP **R1-to-R6** is up and there are no egress LSP sessions.
- Sample Output 5 from transit router R3 shows that there is one ingress LSP session (**R1-to-R6)** and no egress LSP sessions.
- Sample Output 6 from egress router **R6** shows that LSP **R6-to-R1** is down due to an MPLS label allocation failure.

Verify OSPF Interfaces

Purpose After you have verified that the LSP is down, and the cause is not in the physical, data link, or IP layer, check the routers in your network to determine that all relevant OSPF interfaces are configured correctly.

Action To verify OSPF interfaces, enter the following commands from the ingress, transit, and egress routers:

```
user@host> show ospf interface
```

Sample Output 1

```
user@R1> show ospf interface
Interface      State     Area            DR ID           BDR ID       Nbrs
so-0/0/0.0      PtToPt   0.0.0.0         0.0.0.0         0.0.0.0         1
so-0/0/1.0      PtToPt   0.0.0.0         0.0.0.0         0.0.0.0         1
so-0/0/2.0      PtToPt   0.0.0.0         0.0.0.0         0.0.0.0         1

user@R3> show ospf interface
Interface      State     Area            DR ID           BDR ID       Nbrs
so-0/0/0.0      PtToPt   0.0.0.0         0.0.0.0         0.0.0.0         1
so-0/0/1.0      PtToPt   0.0.0.0         0.0.0.0         0.0.0.0         1
so-0/0/2.0      PtToPt   0.0.0.0         0.0.0.0         0.0.0.0         1
so-0/0/3.0      PtToPt   0.0.0.0         0.0.0.0         0.0.0.0         1

user@R6> show ospf interface
Interface      State     Area            DR ID           BDR ID       Nbrs
so-0/0/0.0      PtToPt   0.0.0.0         0.0.0.0         0.0.0.0         1
so-0/0/1.0      PtToPt   0.0.0.0         0.0.0.0         0.0.0.0         1
```

```
so-0/0/2.0         PtToPt   0.0.0.0          0.0.0.0          0.0.0.0          1
so-0/0/3.0         PtToPt   0.0.0.0          0.0.0.0          0.0.0.0          1
```

Sample Output 2

```
user@R1> show ospf interface
Interface          State       Area            DR ID            BDR ID           Nbrs
lo0.0              DR          0.0.0.0         10.0.0.1         0.0.0.0          0
so-0/0/0.0         PtToPt      0.0.0.0         0.0.0.0          0.0.0.0          1
so-0/0/1.0         PtToPt      0.0.0.0         0.0.0.0          0.0.0.0          1
so-0/0/2.0         PtToPt      0.0.0.0         0.0.0.0          0.0.0.0          1

user@R3> show ospf interface
Interface          State       Area            DR ID            BDR ID           Nbrs
lo0.0              DR          0.0.0.0         10.0.0.3         0.0.0.0          0
so-0/0/0.0         Down        0.0.0.0         0.0.0.0          0.0.0.0          0
so-0/0/1.0         PtToPt      0.0.0.0         0.0.0.0          0.0.0.0          1
so-0/0/2.0         PtToPt      0.0.0.0         0.0.0.0          0.0.0.0          1
so-0/0/3.0         PtToPt      0.0.0.0         0.0.0.0          0.0.0.0          1

user@R6> show ospf interface
Interface          State       Area            DR ID            BDR ID           Nbrs
lo0.0              DR          0.0.0.0         10.0.0.6         0.0.0.0          0
so-0/0/0.0         PtToPt      0.0.0.0         0.0.0.0          0.0.0.0          1
so-0/0/1.0         Down        0.0.0.0         0.0.0.0          0.0.0.0          0
so-0/0/2.0         PtToPt      0.0.0.0         0.0.0.0          0.0.0.0          1
so-0/0/3.0         PtToPt      0.0.0.0         0.0.0.0          0.0.0.0          1
```

Meaning Sample Output 1 shows that all interfaces on all routers are in the correct area (**0.0.0.0**), and the loopback (**lo0**) interface is missing from the list of interfaces on all routers. The missing loopback (**lo0**) interface is a problem in this configuration.

In an MPLS network configured with OSPF as the IGP, when you manually configure the RID, it is important to explicitly configure the loopback interface at the [**edit protocols ospf**] hierarchy level. If the RID is not manually configured, OSPF automatically advertises the loopback (**lo0**) interface. In the configuration of all the routers in this network, the RID is configured manually, therefore, the loopback (**lo0**) interface must be explicitly configured at the [**edit protocols ospf**] hierarchy level. In addition, the loopback (**lo0**) interface is configured with the **passive** statement to ensure that the protocols are not run over the loopback (**lo0**) interface and it is correctly advertised throughout the network.

Sample Output 2 shows that all the relevant interfaces on the ingress, transit, and egress routers, including the loopback (**lo0**) interface, are in the correct area (**0.0.0.0**). Because the configuration of the interfaces is correct, further investigation is required to determine the reason for the LSP problem.

Verify OSPF Neighbors

Purpose After you have checked OSPF interfaces, check your network topology to determine that all relevant neighbors are established.

Action To verify OSPF neighbors, enter the following commands from the ingress, transit, and egress routers:

```
user@host> show ospf neighbor
```

Sample Output

```
user@R1> show ospf neighbor
  Address          Interface              State      ID               Pri  Dead
10.1.12.2          so-0/0/0.0             Full       10.0.0.2         128   39
10.1.15.2          so-0/0/1.0             Full       10.0.0.5         128   39
10.1.13.2          so-0/0/2.0             Full       10.0.0.3         128   33

user@R3> show ospf neighbor
Address          Interface              State      ID               Pri  Dead
10.1.34.2          so-0/0/0.0               Full       10.0.0.4         128   33
10.1.23.1          so-0/0/1.0               Full       10.0.0.2         128   33
10.1.13.1          so-0/0/2.0               Full       10.0.0.1         128   33
10.1.36.2          so-0/0/3.0               Full       10.0.0.6         128   33

user@R6> show ospf neighbor
Address          Interface              State      ID               Pri  Dead
10.1.56.1          so-0/0/0.0               Full       10.0.0.5         128   30
10.1.46.1          so-0/0/1.0               Full       10.0.0.4         128   38
10.1.26.1          so-0/0/2.0               Full       10.0.0.2         128   34
10.1.36.1          so-0/0/3.0               Full       10.0.0.3         128   35
```

Meaning The sample output shows that all neighbors are fully adjacent, indicating that each router has exchanged a full copy of its link-state database with the other routers, passed through several neighbor states, and become fully adjacent. These adjacencies are created by router link and network link advertisements.

Verify the OSPF Protocol Configuration

Purpose After you have checked interfaces and neighbors, verify the OSPF protocol configuration.

Action To verify the OSPF protocol configuration, enter the following command from the ingress, transit, and egress routers:

```
user@host> show configuration protocols ospf
```

Sample Output 1

```
user@R1> show configuration protocols ospf
traffic-engineering;
area 0.0.0.0 {
    interface so-0/0/0.0;
    interface so-0/0/1.0;
    interface so-0/0/2.0;       <<< The loopback interface (lo0) is missing
}
```

Sample Output 2

```
user@R3>show configuration protocols ospf
area 0.0.0.0 { <<< traffic engineering is missing
    interface so-0/0/0.0;
    interface so-0/0/1.0;
    interface so-0/0/2.0;
    interface so-0/0/3.0;      <<< The loopback interface (lo0) is missing
}
```

Sample Output 3

```
user@R6> show configuration protocols ospf
traffic-engineering;
area 0.0.0.0 {
    interface so-0/0/0.0;
    interface so-0/0/1.0;
    interface so-0/0/2.0;
```

```
    interface so-0/0/3.0;      <<< The loopback interface (lo0) is missing
}
```

Meaning All three sample outputs show that the loopback interface is not included on any of the routers. Including the loopback (**lo0**) interface is important when you have the RID manually configured.

In addition, Sample Output 2 from transit router **R3** shows that traffic engineering is not configured. Traffic engineering must be manually enabled when you configure OSPF for an MPLS network.

Because the loopback interface and traffic engineering are missing from the OSPF protocol configuration, the LSP does not work as expected.

Take Appropriate Action

Problem Depending on the error you encountered in your investigation, you must take the appropriate action to correct the problem. In this example, the loopback (**lo0**) interface is missing from all routers, and traffic engineering is missing from the transit router (**R3**).

Solution To correct the errors in this example, follow these steps:

1. Include the loopback (**lo0**) interface on all routers that have the RID manually configured. Enter the following configuration mode commands:

   ```
   [edit]
   user@R3# edit protocols ospf area 0.0.0.0
   [edit protocols ospf area 0.0.0.0]
   user@R3# set interface lo0
   user@R3# set interface lo0 passive
   ```

2. Move up one level of the configuration hierarchy:

   ```
   [edit protocols ospf area 0.0.0.0]
   user@R3# up
   [edit protocols ospf]
   user @R3#
   ```

3. Include traffic engineering on the transit router (**R3**). Enter the following configuration mode command:

   ```
   [edit protocols ospf]
   user@R3#  set traffic-engineering
   ```

4. On all routers, verify and commit the configuration:

   ```
   user@R3# show
   user@R3# commit
   ```

Sample Output

```
user@R3> edit
Entering configuration mode

[edit]
user@R3# edit protocols ospf area 0.0.0.0

[edit protocols ospf area 0.0.0.0]
user@R3#  set interface lo0
```

```
[edit protocols ospf area 0.0.0.0]
user@R3# set interface lo0 passive

[edit protocols ospf area 0.0.0.0]
user@R3# up

[edit protocols ospf]
user@R3# set traffic-engineering

[edit protocols ospf]
user@R3# show
traffic-engineering;
area 0.0.0.0 {
    interface so-0/0/0.0;
    interface so-0/0/1.0;
    interface so-0/0/2.0;
     interface lo0.0; {
          passive
}
}

[edit protocols ospf]
user@R3# commit
commit complete
```

Meaning The sample output shows that the loopback (**lo0**) interface and traffic engineering are now correctly configured on transit router **R3**. When traffic engineering is configured, OSPF advertises the traffic engineering capabilities of the links.

In the OSPF configuration, you must manually include the loopback (**lo0**) interface and set it to passive when you manually configure an RID. Setting the loopback (**lo0**) interface to passive ensures that protocols are not run over the loopback (**lo0**) interface and the loopback (**lo0**) interface is advertised correctly throughout the network.. If you do not manually configure an RID, there is no need to explicitly include the loopback interface because the OSPF protocol automatically includes the loopback (**lo0**) interface.

For more information about configuring LSPs and MPLS, see the *Junos MPLS Applications Configuration Guide*.

Verify the LSP Again

Purpose After taking the appropriate action to correct the error, the LSP needs to be checked again to confirm that the problem in the IS-IS protocol has been resolved.

Action To verify that the LSP is up and traversing the network as expected, enter the following command from the ingress, egress, and transit routers:

```
user@host> show mpls lsp extensive
```

Sample Output

```
user@R1> show mpls lsp extensive
Ingress LSP: 1 sessions

10.0.0.6
  From: 10.0.0.1,  State: Up , ActiveRoute: 1,  LSPname: R1-to-R6
   ActivePath: (primary)
```



```
  LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
 *Primary                    State: Up
    Received RRO (ProtectionFlag 1=Available 2=InUse 4=B/W 8=Node 10=SoftPreempt):

          10.1.13.2 10.1.36.2
     4 Oct 19 21:22:54 Selected as active path
     3 Oct 19 21:22:53 Record Route:  10.1.13.2 10.1.36.2
     2 Oct 19 21:22:53 Up
     1 Oct 19 21:22:53 Originate Call
  Created: Tue Oct 19 21:22:53 2004
Total 1 displayed,  Up 1 , Down 0

Egress LSP: 1 sessions

10.0.0.1
  From: 10.0.0.6,  LSPstate: Up , ActiveRoute: 0
   LSPname: R6-to-R1 , 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:  117, Since: Tue Oct 19 21:17:42 2004
  Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
  Port number: sender 2 receiver 39064 protocol 0
  PATH rcvfrom: 10.1.13.2 (so-0/0/2.0) 10 pkts
  Adspec: received MTU 1500
  PATH sentto: localclient
  RESV rcvfrom: localclient
  Record route: 10.1.36.2 10.1.13.2 <self>
Total 1 displayed,  Up 1 , Down 0

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

user@R3> show mpls lsp extensive
Ingress LSP: 0 sessions
Total 0 displayed, Up 0, Down 0

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

Transit LSP:  2 sessions

10.0.0.1
  From: 10.0.0.6, LSPstate: Up, ActiveRoute: 1
   LSPname: R6-to-R1 , LSPpath: Primary
  Suggested label received: -, Suggested label sent: -
  Recovery label received: -, Recovery label sent: 3
  Resv style: 1 FF, Label in: 100416, Label out: 3
  Time left:  139, Since: Tue Oct 19 21:05:11 2004
  Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
  Port number: sender 2 receiver 39064 protocol 0
  PATH rcvfrom: 10.1.36.2 (so-0/0/3.0) 11 pkts
  Adspec: received MTU 1500 sent MTU 1500
  PATH sentto: 10.1.13.1 (so-0/0/2.0) 11 pkts
  RESV rcvfrom: 10.1.13.1 (so-0/0/2.0) 11 pkts
  Explct route: 10.1.13.1
  Record route: 10.1.36.2 <self> 10.1.13.1

10.0.0.6
  From: 10.0.0.1, LSPstate: Up, ActiveRoute: 1
```

```
   LSPname: R1-to-R6 , LSPpath: Primary
  Suggested label received: -, Suggested label sent: -
  Recovery label received: -, Recovery label sent: 3
  Resv style: 1 FF, Label in: 100448, Label out: 3
  Time left:  135, Since: Tue Oct 19 21:10:22 2004
  Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
  Port number: sender 1 receiver 47951 protocol 0
  PATH rcvfrom: 10.1.13.1 (so-0/0/2.0) 4 pkts
  Adspec: received MTU 1500 sent MTU 1500
  PATH sentto: 10.1.36.2 (so-0/0/3.0) 4 pkts
  RESV rcvfrom: 10.1.36.2 (so-0/0/3.0) 4 pkts
  Record route: 10.1.13.1 <self> 10.1.36.2
Total 2 displayed,  Up 2 , Down 0

user@R6>  run show mpls lsp extensive
Ingress LSP: 1 sessions

10.0.0.1
  From: 10.0.0.6, State: Up, ActiveRoute: 1, LSPname: R6-to-R1
  ActivePath:  (primary)
  LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
 *Primary                    State: Up
    Computed ERO (S [L] denotes strict [loose] hops): (CSPF metric: 2)
 10.1.36.1 S 10.1.13.1 S
    Received RRO (ProtectionFlag 1=Available 2=InUse 4=B/W 8=Node 10=SoftPreempt):

          10.1.36.1 10.1.13.1
   19 Oct 19 21:09:52 Selected as active path
   18 Oct 19 21:09:52 Record Route:  10.1.36.1 10.1.13.1
   17 Oct 19 21:09:52 Up
   16 Oct 19 21:09:52 Originate Call
   15 Oct 19 21:09:52 CSPF: computation result accepted
  Created: Tue Oct 19 18:30:09 2004
Total 1 displayed,  Up 1 , Down 0

Egress LSP: 1 sessions

10.0.0.6
  From: 10.0.0.1, LSPstate: Up, ActiveRoute: 0
   LSPname: R1-to-R6 , 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:  120, Since: Tue Oct 19 21:15:03 2004
  Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
  Port number: sender 1 receiver 47951 protocol 0
  PATH rcvfrom: 10.1.36.1 (so-0/0/3.0) 4 pkts
  Adspec: received MTU 1500
  PATH sentto: localclient
  RESV rcvfrom: localclient
  Record route: 10.1.13.1 10.1.36.1 <self>
Total 1 displayed,  Up 1 , Down 0

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

Meaning The sample output from ingress router **R1** and egress router **R6** shows that the LSP is now traversing the network along the expected path, from **R1** through **R3** to **R6**, and the reverse LSP, from **R6** through **R3** to **R1**. In addition, the sample output from transit router

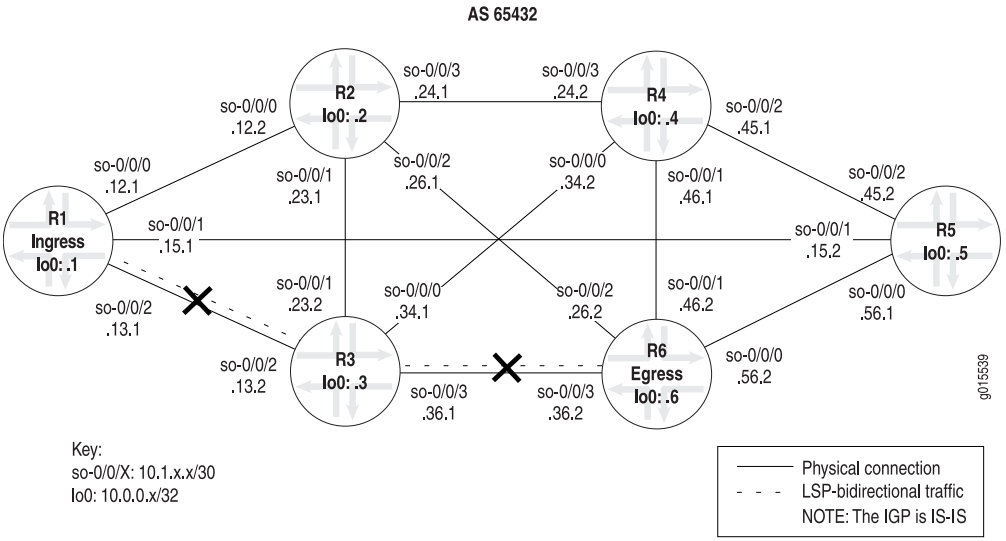
R3 shows that there are two transit LSP sessions, one from **R1** to **R6**, and the other from **R6** to **R1**.

Verifying the IS-IS Protocol

Purpose If your MPLS network is configured with IS-IS as the IGP, and the output of the **show mpls lsp extensive** command shows that there is a problem, check the IP and IS-IS layers. Because IS-IS and IP are independent of each other, you can check either layer first. For more information on checking the IP layer, see "Verifying the IP Layer" on page 109.

After you have checked the IP layer and determined that there is still a problem, check the IS-IS layer, verify that IS-IS adjacencies are up, and make sure that the interfaces and IS-IS protocol are configured correctly.

Figure 18: MPLS Network Broken at the IS-IS Protocol Layer



To check the IS-IS protocol, follow these steps:

1. Verify the LSP on page 129
2. Verify IS-IS Adjacencies and Interfaces on page 131
3. Verify the IS-IS Configuration on page 132
4. Take Appropriate Action on page 133
5. Verify the LSP Again on page 134

Verify the LSP

Purpose Confirm that interfaces are configured for IS-IS, the IS-IS protocol is configured correctly and that adjacencies are established.

Action To verify the LSP, enter the following command on the ingress, transit, and egress routers:

```
user@host> show mpls lsp extensive
```

Sample Output 1

```
user@R1> show mpls lsp extensive
Ingress LSP: 1 sessions

10.0.0.6
  From: 10.0.0.1, State: Dn,  ActiveRoute: 0 , LSPname: R1-to-R6
   ActivePath: (none)
  LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
  Primary                   State: Dn
   24 Oct 21 13:48:01  No Route toward dest [3 times]
   23 Oct 21 13:47:44 Deselected as active
   22 Oct 21 13:47:43 No Route toward dest[2 times]
   21 Oct 21 13:47:43  ResvTear received
   20 Oct 21 13:47:43 Down
   19 Oct 21 13:47:43 10.1.13.2: No Route toward dest[2 times]
   18 Oct 21 13:47:38 Record Route:  10.1.13.2 10.1.36.2
   [...Output truncated...]
  Created: Tue Oct 19 21:22:53 2004
Total 1 displayed, Up 0,  Down 1

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

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

Sample Output 2

```
user@R3> show mpls lsp extensive
Ingress LSP: 0 sessions
Total 0 displayed, Up 0, Down 0

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

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

Sample Output 3

```
user@R6> show mpls lsp extensive
Ingress LSP: 1 sessions

10.0.0.1
  From: 10.0.0.6, State: Dn,  ActiveRoute: 0 , LSPname:  R6-to-R1
   ActivePath: (none)
  LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
  Primary                   State: Dn
    Will be enqueued for recomputation in 3 second(s).
   13 Oct 21 14:23:33 CSPF failed: no route toward 10.0.0.1[90 times]
   12 Oct 21 13:39:56 Deselected as active
   11 Oct 21 13:39:56 CSPF: could not determine self
   [...Output truncated...]
  Created: Tue Oct 19 22:28:30 2004
Total 1 displayed, Up 0,  Down 1

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

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

Meaning The sample output shows that LSP **R1-to-R6** and the reverse LSP **R6-to-R1** are down, and there are no LSP sessions on transit router **R3**.

Verify IS-IS Adjacencies and Interfaces

Purpose When you check the IS-IS layer, you verify that IS-IS adjacencies are up, and that the IS-IS interfaces are included at the protocol level.

Action To verify the functioning of adjacent interfaces, enter the following commands from the relevant routers:

```
user@host> show isis adjacency
user@host> show isis interface
```

Sample Output 1

```
user@R1> show isis adjacency
Interface             System         L State       Hold (secs) SNPA
so-0/0/0.0            R2             2 Up                   20
so-0/0/1.0            R5             2 Up                   23
so-0/0/2.0            R3             2 Up                   26

user@R3> show isis adjacency
Interface             System         L State       Hold (secs) SNPA
so-0/0/0.0            R4             2 Up                   23
so-0/0/1.0            R2             2 Up                   21
so-0/0/2.0            R1             2 Up                   19
so-0/0/3.0      R6      2 Down                    0

user@R6> show isis adjacency

user@R6>   <<< No IS-IS adjacencies are established
```

Sample Output 2

```
user@R1> show isis interface
IS-IS interface database:
Interface             L CirID Level 1 DR        Level 2 DR        L1/L2 Metric
lo0.0                 0   0x1 Passive           Passive                0/0
so-0/0/0.0            2   0x1 Disabled          Point to Point        10/10
so-0/0/1.0            2   0x1 Disabled          Point to Point        10/10
so-0/0/2.0            2   0x1 Disabled          Point to Point        10/10

user@R3> show isis interface
IS-IS interface database:
Interface             L CirID Level 1 DR        Level 2 DR        L1/L2 Metric
lo0.0                 0   0x1 Passive           Passive                0/0
so-0/0/0.0            2   0x1 Disabled          Point to Point        10/10
so-0/0/1.0            2   0x1 Disabled          Point to Point        10/10
so-0/0/2.0            2   0x1 Disabled          Point to Point        10/10
so-0/0/3.0            2   0x1 Disabled          Point to Point        10/10

user@R6> show isis interface
IS-IS interface database:
Interface             L  CirID Level 1 DR        Level 2 DR        L1/L2 Metric
lo0.0                 0   0x1 Passive           Passive                0/0
so-0/0/0.0            1    0x1 Point to Point    Disabled              10/10
so-0/0/1.0            1    0x1 Down              Disabled              10/10
so-0/0/2.0            1    0x1 Point to Point    Disabled              10/10
so-0/0/3.0            1    0x1 Point to Point    Disabled              10/10
```

Meaning Sample Output 1 shows that ingress router **R1** has established adjacencies with the relevant routers. Transit router **R3** does not have an adjacency with egress router **R6**, and egress router **R6** has no adjacencies established in the network shown in Figure 15 on page 109, indicating that the problem might be at the IS-IS protocol level.

Sample Output 2 shows that **R1** and **R2** are Level 2 routers, in contrast to **R6** which is a Level 1 router. When a router is configured explicitly as a Level 1 or Level 2 router, it does not communicate with routers configured at a different level. Level 1 routers communicate with other Level 1 routers within their area, while Level 2 routers communicate with other Level 2 routers, and towards other autonomous systems. Because all the routers in this network are configured for Level 2, they cannot form an adjacency with **R6**, which is incorrectly configured as a Level 1 router.

Verify the IS-IS Configuration

Purpose When you have determined that the problem is probably at the IS-IS protocol level, check the IS-IS configuration of the routers in your network.

Action To verify the IS-IS configuration, enter the following command from the relevant routers:

```
user@host> show configuration protocols isis
```

Sample Output

```
user@R1> show configuration protocols isis
level 1 disable;
interface so-0/0/0.0;
interface so-0/0/1.0;
interface so-0/0/2.0;
interface lo0.0; {
    passive

user@R3> show configuration protocols isis
level 1 disable;
interface all {
    level 2 metric 10;
}
interface fxp0.0 {
    disable;
}
interface lo0.0; {
    passive

user@R6> show configuration protocols isis
level 2 disable; <<< Incorrect level disabled
interface all {
    level 2 metric 10;
}
interface fxp0.0 {
    disable;
}
interface lo0.0; {
    passive
```

Meaning The sample output shows that **R6** has Level 2 disabled, while **R1** and **R3** have Level 1 disabled. For IS-IS adjacencies to establish, routers need to be at the same level. Another common configuration error is to omit the loopback (**lo0**) interface from the configuration at the [**edit protocols isis**] hierarchy level. IS-IS does not function correctly if the loopback

(**lo0**) interface is not configured at this level. In addition, including the **passive** statement ensures that protocols are not run over the loopback (**lo0**) interface and the loopback (**lo0**) interface is advertised correctly throughout the network.

Take Appropriate Action

Problem Depending on the error you encountered in your investigation, you must take the appropriate action to correct the problem. In the example below, the routers are configured to function at different levels of the IS-IS protocol.

Solution To correct the error in this example, enter the following commands:

```
user@R6> edit
[edit]
user@R6>  edit protocols isis
[edit protocols isis]
user@R6# show
user@R6#  delete level 2
user@R6#  set level 1 disable
user@R6# show
user@R6# commit
user@R6#  run show isis adjacency
```

Sample Output

```
user@R6> edit
Entering configuration mode

[edit]
user@R6# edit protocols isis

[edit protocols isis]
user@R6# show
level 2 disable;
interface all {
    level 2 metric 10;
}
interface fxp0.0 {
    disable;
}
interface lo0.0; {
passive

[edit protocols isis]
user@R6# delete level 2

[edit protocols isis]
user@R6# set level 1 disable

[edit protocols isis]
user@R6# show
level 1 disable;
interface all {
    level 2 metric 10;
}
interface fxp0.0 {
    disable;
}
interface lo0.0; {
passive
```

```
[edit protocols isis]
user@R6# commit
commit complete

[edit protocols isis]
user@R6# run show isis adjacency
Interface             System         L State       Hold (secs) SNPA
so-0/0/0.0            R5             2 Up                    22
so-0/0/1.0            R4             2 Up                    22
so-0/0/2.0            R2             2 Up                    22
so-0/0/3.0            R3             2 Up                    22
```

Meaning The sample output shows that the configuration error on egress router **R6** has been corrected and IS-IS adjacencies are now established.

Verify the LSP Again

Purpose After taking the appropriate action to correct the error, the LSP needs to be checked again to confirm that the problem in the RSVP layer has been resolved.

Action To verify that the LSP is up and traversing the network as expected, enter the following command from the ingress, egress, and transit routers:

```
user@host> show mpls lsp extensive
```

Sample Output 1

```
user@R1> show mpls lsp extensive
Ingress LSP: 1 sessions

10.0.0.6
  From: 10.0.0.1, State: Up,  ActiveRoute: 1, LSPname: R1-to-R6
  ActivePath:  (primary)
  LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
 *Primary                    State: Up
    Computed ERO (S [L] denotes strict [loose] hops): (CSPF metric: 20)
  10.1.13.2 S 10.1.36.2 S
    Received RRO (ProtectionFlag 1=Available 2=InUse 4=B/W 8=Node 10=SoftPreempt):

          10.1.13.2 10.1.36.2
    5 Oct 21 15:52:07 Selected as active path
    4 Oct 21 15:52:07 Record Route:  10.1.13.2 10.1.36.2
    3 Oct 21 15:52:07 Up
    2 Oct 21 15:52:07 Originate Call
    1 Oct 21 15:52:07 CSPF: computation result accepted
  Created: Thu Oct 21 15:52:06 2004
Total 1 displayed,  Up 1 , Down 0

Egress LSP: 1 sessions

10.0.0.1
  From: 10.0.0.6, LSPstate: Up, ActiveRoute: 0
   LSPname: R6-to-R1 , 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:  142, Since: Thu Oct 21 15:41:59 2004
  Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
  Port number: sender 2 receiver 39082 protocol 0
```

```
  PATH rcvfrom: 10.1.13.2 (so-0/0/2.0) 17 pkts
  Adspec: received MTU 1500
  PATH sentto: localclient
  RESV rcvfrom: localclient
   Record route: 10.1.36.2 10.1.13.2 <self>
Total 1 displayed,  Up 1 , Down 0

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

Sample Output 2

```
user@R3> show mpls lsp extensive
Ingress LSP: 0 sessions
Total 0 displayed, Up 0, Down 0

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

Transit LSP: 2 sessions

10.0.0.1
  From: 10.0.0.6, LSPstate: Up, ActiveRoute: 1
   LSPname: R6-to-R1 , LSPpath: Primary
  Suggested label received: -, Suggested label sent: -
  Recovery label received: -, Recovery label sent: 3
  Resv style: 1 FF, Label in: 100528, Label out: 3
  Time left:  125, Since: Thu Oct 21 15:29:26 2004
  Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
  Port number: sender 2 receiver 39082 protocol 0
  PATH rcvfrom: 10.1.36.2 (so-0/0/3.0) 17 pkts
  Adspec: received MTU 1500 sent MTU 1500
  PATH sentto: 10.1.13.1 (so-0/0/2.0) 17 pkts
  RESV rcvfrom: 10.1.13.1 (so-0/0/2.0) 17 pkts
  Explct route: 10.1.13.1
  Record route: 10.1.36.2 <self> 10.1.13.1

10.0.0.6
  From: 10.0.0.1, LSPstate: Up, ActiveRoute: 1
   LSPname: R1-to-R6 , LSPpath: Primary
  Suggested label received: -, Suggested label sent: -
  Recovery label received: -, Recovery label sent: 3
  Resv style: 1 FF, Label in: 100544, Label out: 3
  Time left:  147, Since: Thu Oct 21 15:39:33 2004
  Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
  Port number: sender 1 receiver 47963 protocol 0
  PATH rcvfrom: 10.1.13.1 (so-0/0/2.0) 4 pkts
  Adspec: received MTU 1500 sent MTU 1500
  PATH sentto: 10.1.36.2 (so-0/0/3.0) 4 pkts
  RESV rcvfrom: 10.1.36.2 (so-0/0/3.0) 4 pkts
  Explct route: 10.1.36.2
  Record route: 10.1.13.1 <self> 10.1.36.2
Total 2 displayed, Up 2, Down 0
```

Sample Output 3

```
user@R6> show mpls lsp extensive
Ingress LSP: 1 sessions

10.0.0.1
  From: 10.0.0.6, State: Up, ActiveRoute: 1,  LSPname: R6-to-R1
  ActivePath:  (primary)
  LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
```

```
 *Primary                    State: Up
    Computed ERO (S [L] denotes strict [loose] hops): (CSPF metric: 20)
   10.1.36.1 S 10.1.13.1 S
    Received RRO (ProtectionFlag 1=Available 2=InUse 4=B/W 8=Node 10=SoftPreempt):

          10.1.36.1 10.1.13.1
   18 Oct 21 15:34:18 Selected as active path
   17 Oct 21 15:34:17 Record Route:  10.1.36.1 10.1.13.1
   16 Oct 21 15:34:17 Up
   15 Oct 21 15:34:17 Originate Call
   14 Oct 21 15:34:17 CSPF: computation result accepted
   [...Output truncated...]
  Created: Tue Oct 19 22:28:30 2004
Total 1 displayed, Up 1, Down 0

Egress LSP: 1 sessions

10.0.0.6
  From: 10.0.0.1, LSPstate: Up, ActiveRoute: 0
   LSPname: R1-to-R6 , 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:  126, Since: Thu Oct 21 15:44:25 2004
  Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
  Port number: sender 1 receiver 47963 protocol 0
  PATH rcvfrom: 10.1.36.1 (so-0/0/3.0) 4 pkts
  Adspec: received MTU 1500
  PATH sentto: localclient
  RESV rcvfrom: localclient
   Record route: 10.1.13.1 10.1.36.1 <self>
Total 1 displayed, Up 1, Down 0

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

Meaning Sample Outputs 1 and 3 from ingress router **R1** and egress router **R6** show that the LSP is now traversing the network along the expected path, from **R1** through **R3** to **R6**, and the reverse LSP, from **R6** through **R3** to **R1**. In addition, Sample Output 2 from transit router **R3** shows that there are two transit LSP sessions, one from **R1** to **R6**, and the other from **R6** to **R1**.

CHAPTER 10

Checking the RSVP Layer

This chapter describes how to check the Resource Reservation Protocol (RSVP) layer of the layered Multiprotocol Label Switching (MPLS) model.

Checklist for Checking the RSVP Layer

Problem This checklist provides the steps and commands for checking the Resource Reservation Protocol (RSVP) layer of the layered Multiprotocol Label Switching (MPLS) model. The checklist provides links to an overview of the RSVP layer and more detailed information about the commands used to investigate the problem.

Table 18 on page 137 provides commands for checking the RSVP layer.

Solution

Table 18: Checklist for Checking the RSVP Layer

Tasks	Command or Action
"Checking the RSVP Layer" on page 138	
1. Verify the LSP on page 140	**show mpls lsp extensive**
2. Verify RSVP Sessions on page 141	**show rsvp session**
3. Verify RSVP Neighbors on page 142	**show rsvp neighbor**
4. Verify RSVP Interfaces on page 143	**show rsvp interface**
5. Verify the RSVP Protocol Configuration on page 145	**show configuration protocols rsvp**

Table 18: Checklist for Checking the RSVP Layer *(continued)*

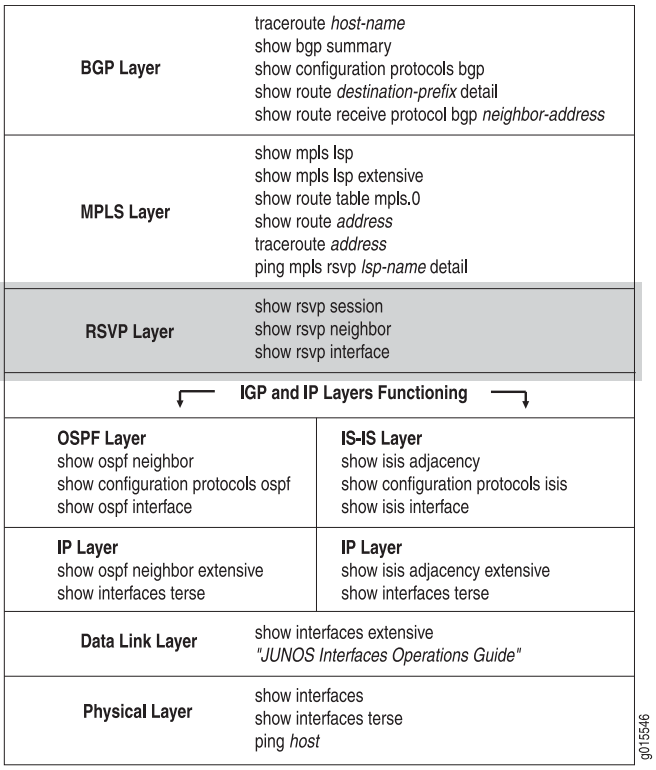
Tasks	Command or Action
6. Take Appropriate Action on page 145	The following sequence of commands addresses the specific problem described in this topic: **[edit]** **edit protocols rsvp** **[edit protocols rsvp]** **show** **set interface *type-fpc/pic/port*** **show** **commit**
7. Verify the LSP Again on page 146	**show mpls lsp extensive**

Checking the RSVP Layer

Purpose After you have configured the label-switched path (LSP), issued the **show mpls lsp extensive** command, and determined that there is an error, you might find that the error is not in the physical, data link, or Internet Protocol (IP) and interior gateway protocol (IGP) layers. Continue investigating the problem at the RSVP layer of the network.

Figure 19 on page 138 illustrates the RSVP layer of the layered MPLS model.

Figure 19: Checking the RSVP Layer

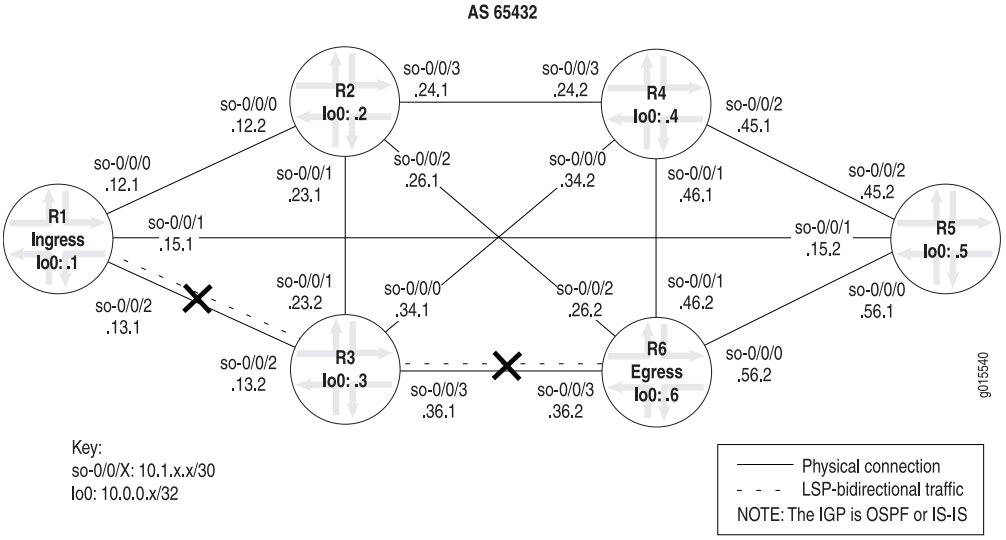


With this layer, you check that dynamic RSVP signaling is occurring as expected, neighbors are connected, and interfaces are configured correctly for RSVP. Check the ingress, egress, and transit routers.

If the network is not functioning at this layer, the LSP does not work as configured.

Figure 20 on page 139 illustrates the MPLS network used in this topic.

Figure 20: MPLS Network Broken at the RSVP Layer



The network shown in Figure 20 on page 139 is a fully meshed configuration where every directly connected interface can receive and send packets to every other similar interface. The LSP in this network is configured to run from ingress router **R1**, through transit router **R3**, to egress router **R6**. In addition, a reverse LSP is configured to run from **R6** through **R3** to **R1**, creating bidirectional traffic.

However, in this example, the LSP is down without a path in either direction, from **R1** to **R6** or from **R6** to **R1**.

The crosses shown in Figure 20 on page 139 indicate where the LSP is broken. Some possible reasons the LSP is broken might include that dynamic RSVP signaling is not occurring as expected, neighbors are not connected, or interfaces are incorrectly configured for RSVP.

In the network in Figure 20 on page 139, a configuration error on transit router **R3** prevents the LSP from traversing the network as expected.

To check the RSVP layer, follow these steps:

1. Verify the LSP on page 140
2. Verify RSVP Sessions on page 141
3. Verify RSVP Neighbors on page 142
4. Verify RSVP Interfaces on page 143
5. Verify the RSVP Protocol Configuration on page 145

6. Take Appropriate Action on page 145
7. Verify the LSP Again on page 146

Verify the LSP

Purpose Typically, you use the **show mpls lsp extensive** command to verify the LSP. However for quick verification of the LSP state, use the **show mpls lsp** command. If the LSP is down, use the **extensive** option (**show mpls lsp extensive)** as a follow-up. If your network has numerous LSPs, you might consider specifying the name of the LSP, using the **name** option (**show mpls lsp name *name*** or **show mpls lsp name *name* extensive).**

Action To determine whether the LSP is up, enter the following command from the ingress router:

```
user@host> show mpls lsp extensive
```

Sample Output 1

```
user@R1> show mpls lsp extensive
Ingress LSP: 1 sessions

10.0.0.6
  From: 10.0.0.1, State: Dn, ActiveRoute: 0,  LSPname: R1-to-R6
  ActivePath: (none)
  LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
  Primary                   State: Dn
    2 Oct 27 15:06:05 10.1.13.2:  No Route toward dest [4 times]
    1 Oct 27 15:05:56 Originate Call
  Created: Wed Oct 27 15:05:55 2004
Total 1 displayed, Up 0,  Down 1

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

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

user@R3> show mpls lsp extensive
Ingress LSP: 0 sessions
Total 0 displayed, Up 0, Down 0

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

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

user@R6> show mpls lsp extensive
Ingress LSP: 1 sessions

10.0.0.1
  From: 10.0.0.6, State: Dn, ActiveRoute: 0,  LSPname: R6-to-R1
  ActivePath: (none)
  LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
  Primary                   State: Dn
    Will be enqueued for recomputation in 22 second(s).
    1 Oct 27 14:59:12  CSPF failed: no route toward 10.0.0.1 [4 times]
  Created: Wed Oct 27 14:57:44 2004
Total 1 displayed, Up 0,  Down 1
```

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

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

Meaning The sample output shows that the LSP is down in both directions, from **R1** to **R6**, and from **R6** to **R1**. The output from **R1** shows that **R1** is using a no-cspf LSP since it tried to originate the call without being able to reach the destination. The output from **R6** shows that the Constrained Shortest Path First (CSPF) algorithm failed, resulting in no route to destination **10.0.0.1**.

Verify RSVP Sessions

Purpose When an RSVP session is successfully created, the LSP is set up along the paths created by the RSVP session. If the RSVP session is unsuccessful, the LSP does not work as configured.

Action To verify currently active RSVP sessions, enter the following command from the ingress, transit, and egress routers:

```
user@host> show rsvp session
```

Sample Output 1

```
user@R1> show rsvp session
Ingress RSVP: 0 sessions
Total 0 displayed, Up 0, Down 0

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

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

user@R3> show rsvp session
Ingress RSVP: 0 sessions
Total 0 displayed, Up 0, Down 0

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

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

user@R6> show rsvp session
Ingress RSVP: 0 sessions
Total 0 displayed, Up 0, Down 0

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

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

Sample Output 2

```
user@R1> show rsvp session
Ingress RSVP: 1 sessions
To              From            State Rt Style Labelin Labelout LSPname
```

```
10.0.0.6        10.0.0.1        Up     1 1 FF       -   100768  R1-to-R6
Total 1 displayed,  Up 1 , Down 0

Egress RSVP: 1 sessions
To              From            State Rt Style Labelin Labelout LSPname
10.0.0.1        10.0.0.6        Up     0 1 FF       3        -  R6-to-R1
Total 1 displayed,  Up 1 , Down 0

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

user@R3> show rsvp session
Ingress RSVP: 0 sessions
Total 0 displayed, Up 0, Down 0

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

Transit RSVP:  2 sessions
To              From            State Rt Style Labelin Labelout LSPname
10.0.0.1        10.0.0.6        Up     1 1 FF  100784        3  R6-to-R1
10.0.0.6        10.0.0.1        Up     1 1 FF  100768        3  R1-to-R6
Total 2 displayed,  Up 2 , Down 0

user@R6> show rsvp session
Ingress RSVP: 1 sessions
To              From            State Rt Style Labelin Labelout LSPname
10.0.0.1        10.0.0.6        Up     1 1 FF       -   100784  R6-to-R1
Total 1 displayed,  Up 1 , Down 0

Egress RSVP: 1 sessions
To              From            State Rt Style Labelin Labelout LSPname
10.0.0.6        10.0.0.1        Up     0 1 FF       3        -  R1-to-R6
Total 1 displayed,  Up 1 , Down 0

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

Meaning Sample Output 1 from all routers shows that no RSVP sessions were successfully created, even though the LSP **R6-to-R1** is configured. Continue investigating the problem in "Verify RSVP Neighbors" on page 142.

In contrast to Sample Output 1and to illustrate correct output, Sample Output 2 shows the output from the ingress, transit, and egress routers when the RSVP configuration is correct, and the LSP is traversing the network as configured. **R1** and **R6** both show an ingress and egress RSVP session, with the LSP **R1-to-R6**, and the reverse LSP **R6-to-R1**. Transit router **R3** shows two transit RSVP sessions.

Verify RSVP Neighbors

Purpose Display a list of RSVP neighbors that were learned dynamically when exchanging RSVP packets. Once a neighbor is learned, it is never removed from the list of RSVP neighbors unless the RSVP configuration is removed from the router.

Action To verify RSVP neighbors, enter the following command from the ingress, transit, and egress routers:


```
user@host> show rsvp neighbor
```

Sample Output 1

```
user@R1> show rsvp neighbor
RSVP neighbor: 1 learned
Address            Idle Up/Dn LastChange HelloInt HelloTx/Rx MsgRcvd
10.1.13.2            10   1/0         9:22        9    64/64   32

user@R3> show rsvp neighbor
RSVP neighbor: 2 learned
Address            Idle Up/Dn LastChange HelloInt HelloTx/Rx MsgRcvd
10.1.13.1             0  1/0       28:20        9   190/190  41
10.1.36.2         16:50   1/1        15:37        9   105/78   38

user@R6> show rsvp neighbor
RSVP neighbor: 1 learned
Address            Idle Up/Dn LastChange HelloInt HelloTx/Rx MsgRcvd
10.1.36.1         17:30   1/1        16:15        9   104/78   39
```

Sample Output 2

```
user@R3> show rsvp neighbor
RSVP neighbor: 2 learned
Address            Idle Up/Dn LastChange HelloInt HelloTx/Rx MsgRcvd
10.1.13.1             5   1/0         9:14        9    63/63   33
10.1.36.2             5   1/0         9:05        9    62/62   32

user@R6> show rsvp neighbor
RSVP neighbor: 1 learned
Address            Idle Up/Dn LastChange HelloInt HelloTx/Rx MsgRcvd
10.1.36.1             5   1/0         8:54        9    61/61   32
```

Meaning Sample Output 1 shows that **R1** and **R6** have one RSVP neighbor each, **R3**. However, the values in the **Up/Dn** field are different. **R1** has a value of **1/0** and **R6** has a value of **1/1**, indicating that **R1** is an active neighbor with **R3**, but **R6** is not. When the up count is one more than the down count, the neighbor is active; if the values are equal, the neighbor is down. The values for **R6** are equal, **1/1**, indicating that the neighbor **R3** is down.

Transit router **R3** knows about two neighbors, **R1** and **R6**. The **Up/Dn** field indicates that **R1** is an active neighbor and **R6** is down. At this point it is not possible to determine if the problem resides with **R3** or **R6**, because both neighbors are not active. Continue investigating the problem in “Verify RSVP Interfaces” on page 143.

In contrast to Sample Output 1 and to illustrate correct output, Sample Output 2 shows the correct neighbor relationship between transit router **R3** and egress router **R6**. The **Up/Dn** field shows the up count to be one more than the down count, **1/0**, indicating that the neighbors are active.

Verify RSVP Interfaces

Purpose Display the status of each interface on which RSVP is enabled to determine where the configuration error occurred.

Action To verify the status of RSVP interfaces, enter the following command from the ingress, transit, and egress routers:

```
user@host> show rsvp interface
```

Sample Output 1

```
user@R1> show rsvp interface
RSVP interface: 3 active
                    Active  Subscr- Static      Available   Reserved    Highwater
Interface   State   resv    iption  BW          BW          BW          mark
so-0/0/0.0  Up          0   100%  155.52Mbps  155.52Mbps  0bps        0bps
so-0/0/1.0  Up          0   100%  155.52Mbps  155.52Mbps  0bps        0bps
so-0/0/2.0  Up          0    100%  155.52Mbps  155.52Mbps  0bps        0bps


user@R3> show rsvp interface
RSVP interface: 3 active
                    Active  Subscr- Static      Available   Reserved    Highwater
Interface   State   resv    iption  BW          BW          BW          mark
so-0/0/0.0  Up          0   100%  155.52Mbps  155.52Mbps  0bps        0bps
so-0/0/1.0  Up          0   100%  155.52Mbps  155.52Mbps  0bps        0bps
so-0/0/2.0  Up          0    100%  155.52Mbps  155.52Mbps  0bps        0bps

<<< Missing interface so-0/0/3.0

user@R6> show rsvp interface
RSVP interface: 4 active
                    Active  Subscr- Static      Available   Reserved    Highwater
Interface   State   resv    iption  BW          BW          BW          mark
so-0/0/0.0  Up          0   100%  155.52Mbps  155.52Mbps  0bps        0bps
so-0/0/1.0  Up          0   100%  155.52Mbps  155.52Mbps  0bps        0bps
so-0/0/2.0  Up          0   100%  155.52Mbps  155.52Mbps  0bps        0bps
so-0/0/3.0  Up          0    100%  155.52Mbps  155.52Mbps  0bps        0bps
```

Sample Output 2

```
user@R1> show rsvp interface
RSVP interface: 3 active
                   Active Subscr- Static      Available   Reserved    Highwater
Interface   State  resv   iption  BW          BW          BW          mark
so-0/0/0.0  Up         0   100%  155.52Mbps  155.52Mbps  0bps        0bps
so-0/0/1.0  Up         0   100%  155.52Mbps  155.52Mbps  0bps        0bps
so-0/0/2.0  Up         1    100%  155.52Mbps  155.52Mbps  0bps        0bps


user@R3> show rsvp interface
RSVP interface: 4 active
                   Active Subscr- Static      Available   Reserved    Highwater
Interface   State  resv   iption  BW          BW          BW          mark
so-0/0/0.0  Up         0   100%  155.52Mbps  155.52Mbps  0bps        0bps
so-0/0/1.0  Up         0   100%  155.52Mbps  155.52Mbps  0bps        0bps
so-0/0/2.0  Up         1    100%  155.52Mbps  155.52Mbps  0bps        0bps

so-0/0/3.0  Up         1    100%  155.52Mbps  155.52Mbps  0bps        0bps


user@R6> show rsvp interface
RSVP interface: 4 active
                   Active Subscr- Static      Available   Reserved    Highwater
Interface   State  resv   iption  BW          BW          BW          mark
so-0/0/0.0  Up         0   100%  155.52Mbps  155.52Mbps  0bps        0bps
so-0/0/1.0  Up         0   100%  155.52Mbps  155.52Mbps  0bps        0bps
so-0/0/2.0  Up         0   100%  155.52Mbps  155.52Mbps  0bps        0bps
so-0/0/3.0  Up         1    100%  155.52Mbps  155.52Mbps  0bps        0bps
```

Meaning Sample Output 1 shows that even though each router has interfaces that are up and have RSVP active, there are no reservations (**Active resv**) on any of the routers. In this example,

we would expect at least one reservation on the ingress and egress routers, and two reservations on the transit router.

In addition, interface **so-0/0/3** on transit router **R3** is not included in the configuration. The inclusion of this interface is critical to the success of the LSP.

In contrast to Sample Output 1 and to illustrate correct output, Sample Output 2 shows the relevant interfaces with active reservations.

Verify the RSVP Protocol Configuration

Purpose After you have checked RSVP sessions, interfaces, neighbors, and determined that there might be a configuration error, verify the RSVP protocol configuration.

Action To verify the RSVP configuration, enter the following command from the ingress, transit, and egress routers:

```
user@host> show configuration protocols rsvp
```

Sample Output

```
user@R1> show configuration protocols rsvp
interface so-0/0/0.0;
interface so-0/0/1.0;
interface so-0/0/2.0;
interface fxp0.0 {
    disable;
}

user@R3> show configuration protocols rsvp
interface so-0/0/0.0;
interface so-0/0/1.0;
interface so-0/0/2.0; <<< Missing interface so-0/0/3.0
interface fxp0.0 {
    disable;
}

user@R6> show configuration protocols rsvp
interface so-0/0/0.0;
interface so-0/0/1.0;
interface so-0/0/2.0;
interface so-0/0/3.0;
interface fxp0.0 {
    disable;
}
```

Meaning The sample output shows that **R3** has interface **so-0/0/3.0** missing from the RSVP protocol configuration. This interface is critical for the correct functioning of the LSP.

Take Appropriate Action

Problem Depending on the error you encountered in your investigation, you must take the appropriate action to correct the problem. In this example, an interface is missing from the configuration of router R3.

Solution To correct the error in this example, follow these steps:

1. Include the missing interface in the configuration of transit router R3:

   ```
   user@R3> edit
   user@R3#  edit protocols rsvp
   [edit protocols rsvp]
   user@R3# show
   user@R3#  set interface so-0/0/3.0
   ```

2. Verify and commit the configuration:

   ```
   [edit protocols rsvp]
   user@R3# show
   user@R3# commit
   ```

Sample Output

```
user@R3> edit
Entering configuration mode

[edit]
user@R3# edit protocols rsvp

[edit protocols rsvp]
user@R3# show
interface so-0/0/0.0;
interface so-0/0/1.0;
interface so-0/0/2.0; <<< Missing interface so-0/0/3.0
interface fxp0.0 {
    disable;
}
[edit protocols rsvp]
user@R3# set interface so-0/0/3.0

[edit protocols rsvp]
user@R3# show
interface so-0/0/0.0;
interface so-0/0/1.0;
interface so-0/0/2.0;
interface fxp0.0 {
    disable;
}
interface so-0/0/3.0; <<< Interface now included in the configuration

[edit protocols rsvp]
user@R3# commit
commit complete
```

Meaning The sample output shows that the missing interface **so-0/0/3.0** on transit router **R3** is now correctly included at the [**edit protocols rsvp**] hierarchy level. This results in the possibility that the LSP might come up.

Verify the LSP Again

Purpose After taking the appropriate action to correct the error, the LSP needs to be checked again to confirm that the problem in the MPLS layer has been resolved.

Action To verify the LSP again, enter the following command on the ingress, transit, and egress routers:

```
user@host>  show mpls lsp extensive
```

Sample Output 1

```
user@R1> show mpls lsp extensive
Ingress LSP: 1 sessions

10.0.0.6
  From: 10.0.0.1, State: Up,  ActiveRoute: 1, LSPname: R1-to-R6
  ActivePath:  (primary)
  LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
 *Primary                    State: Up
    Received RRO (ProtectionFlag 1=Available 2=InUse 4=B/W 8=Node 10=SoftPreempt):

          10.1.13.2 10.1.36.2
     5 Oct 27 15:28:57 Selected as active path
     4 Oct 27 15:28:57  Record Route: 10.1.13.2 10.1.36.2
     3 Oct 27 15:28:57 Up
     2 Oct 27 15:28:44 10.1.13.2: No Route toward dest[35 times]
     1 Oct 27 15:05:56 Originate Call
  Created: Wed Oct 27 15:05:56 2004
Total 1 displayed, Up 1, Down 0

Egress LSP: 1 sessions

10.0.0.1
  From: 10.0.0.6, LSPstate: Up, ActiveRoute: 0
  LSPname: R6-to-R1, 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:  136, Since: Wed Oct 27 15:29:20 2004
  Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
  Port number: sender 1 receiver 39092 protocol 0
  PATH rcvfrom: 10.1.13.2 (so-0/0/2.0) 6 pkts
  Adspec: received MTU 1500
  PATH sentto: localclient
  RESV rcvfrom: localclient
  Record route: 10.1.36.2 10.1.13.2 <self>
Total 1 displayed, Up 1, Down 0

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

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

Sample Output 2

```
user@R3> show mpls lsp extensive
Ingress LSP: 0 sessions
Total 0 displayed, Up 0, Down 0

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

Transit LSP: 2 sessions

10.0.0.1
  From: 10.0.0.6, LSPstate: Up, ActiveRoute: 1
  LSPname: R6-to-R1, LSPpath: Primary
  Suggested label received: -, Suggested label sent: -
  Recovery label received: -, Recovery label sent: 3
  Resv style: 1 FF, Label in: 100672, Label out: 3
  Time left:  152, Since: Wed Oct 27 15:16:39 2004
  Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
```

```
  Port number: sender 1 receiver 39092 protocol 0
  PATH rcvfrom: 10.1.36.2 (so-0/0/3.0) 7 pkts
  Adspec: received MTU 1500 sent MTU 1500
  PATH sentto: 10.1.13.1 (so-0/0/2.0) 7 pkts
  RESV rcvfrom: 10.1.13.1 (so-0/0/2.0) 7 pkts
  Explct route: 10.1.13.1
  Record route: 10.1.36.2 <self> 10.1.13.1

10.0.0.6
  From: 10.0.0.1, LSPstate: Up, ActiveRoute: 1
  LSPname: R1-to-R6, LSPpath: Primary
  Suggested label received: -, Suggested label sent: -
  Recovery label received: -, Recovery label sent: 3
  Resv style: 1 FF, Label in: 100656, Label out: 3
  Time left:  129, Since: Wed Oct 27 14:53:14 2004
  Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
  Port number: sender 1 receiver 47977 protocol 0
  PATH rcvfrom: 10.1.13.1 (so-0/0/2.0) 40 pkts
  Adspec: received MTU 1500 sent MTU 1500
  PATH sentto: 10.1.36.2 (so-0/0/3.0) 7 pkts
  RESV rcvfrom: 10.1.36.2 (so-0/0/3.0) 7 pkts
  Record route: 10.1.13.1 <self> 10.1.36.2
Total 2 displayed, Up 2, Down 0
```

Sample Output 3

```
user@R6> show mpls lsp extensive
Ingress LSP: 1 sessions

10.0.0.1
  From: 10.0.0.6, State: Up,  ActiveRoute: 1 ,  LSPname: R6-to-R1
  ActivePath:  (primary)
  LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
 *Primary                    State: Up
    Computed ERO (S [L] denotes strict [loose] hops): (CSPF metric: 20)
 10.1.36.1 S 10.1.13.1 S
   Received RRO (ProtectionFlag 1=Available 2=InUse 4=B/W 8=Node 10=SoftPreempt):

         10.1.36.1 10.1.13.1
    6 Oct 27 15:22:06 Selected as active path
    5 Oct 27 15:22:06 Record Route:  10.1.36.1 10.1.13.1
    4 Oct 27 15:22:06 Up
    3 Oct 27 15:22:06 Originate Call
    2 Oct 27 15:22:06 CSPF: computation result accepted
    1 Oct 27 15:21:36 CSPF failed: no route toward 10.0.0.1[50 times]
  Created: Wed Oct 27 14:57:45 2004
Total 1 displayed, Up 1, Down 0

Egress LSP: 1 sessions

10.0.0.6
  From: 10.0.0.1, LSPstate: Up, ActiveRoute: 0
  LSPname: R1-to-R6, 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:  119, Since: Wed Oct 27 15:21:43 2004
  Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
  Port number: sender 1 receiver 47977 protocol 0
  PATH rcvfrom: 10.1.36.1 (so-0/0/3.0) 7 pkts
  Adspec: received MTU 1500
  PATH sentto: localclient
```

```
  RESV rcvfrom: localclient
  Record route: 10.1.13.1 10.1.36.1 <self>
Total 1 displayed, Up 1, Down 0

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

Meaning Sample Output 1 from ingress router **R1** shows that LSP **R1-to-R6** has an active route to **R6** and the state is up.

Sample Output 2 from transit router **R3** shows that there are two transit LSP sessions, one from **R1** to **R6** and the other from **R6** to **R1**. Both LSPs are up.

Sample Output 3 from egress router **R6** shows that the LSP is up and the active route is the primary route. The LSP is now traversing the network along the expected path, from **R1** through **R3** to **R6**, and the reverse LSP, from **R6** through **R3** to **R1**.

CHAPTER 11

Checking the MPLS Layer

This chapter describes how to check the Multiprotocol Label Switching (MPLS) layer of the layered MPLS model.

Checklist for Checking the MPLS Layer

Problem This checklist provides the steps and commands for checking the Multiprotocol Label Switching (MPLS) layer of the layered MPLS model. The checklist provides links to an overview of the MPLS layer and more detailed information about the commands used to investigate the problem.

Table 19 on page 151 provides commands for checking the MPLS layer.

Solution

Table 19: Checklist for Checking the MPLS Layer

Tasks	Command or Action
"Checking the MPLS Layer" on page 152	
1. Verify the LSP on page 154	**show mpls lsp** **show mpls lsp extensive** **show mpls lsp name *name*** **show mpls lsp name *name* extensive**
2. Verify the LSP Route on the Transit Router on page 157	**show route table mpls.0**
3. Verify the LSP Route on the Ingress Router on page 158	**show route *destination***
4. Verify MPLS Labels with the traceroute Command on page 159	**traceroute *hostname***

Table 19: Checklist for Checking the MPLS Layer *(continued)*

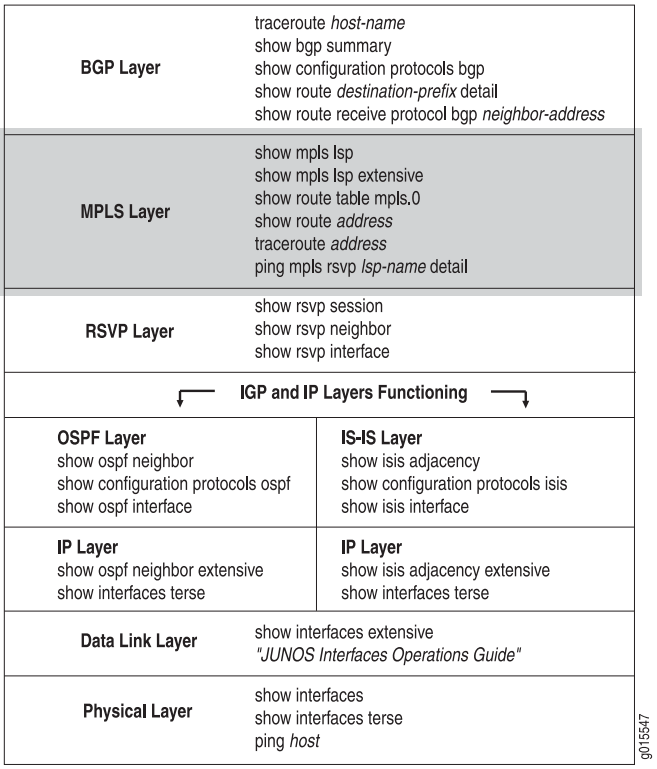
Tasks	Command or Action
5. Verify MPLS Labels with the ping Command on page 160	On the egress router: **[edit]** **edit interfaces lo0 unit *number*** **[edit interfaces lo0 unit *number*]** **set family inet address 127.0.0.1/32** **show** **commit** On the ingress router: **ping mpls rsvp *lsp-name* detail**
6. Verify the MPLS Configuration on page 161	**show configuration protocols mpls** **show configuration interfaces**
7. Take Appropriate Action on page 163	The following sequence of commands addresses the specific problem described in this topic: **edit** **edit protocols mpls** **[edit protocols mpls]** **show** **activate interface so-0/0/3.0** **show** **commit**
8. Verify the LSP Again on page 164	**show mpls lsp extensive**

Checking the MPLS Layer

Purpose After you have configured the label-switched path (LSP), issued the **show mpls lsp** command, and determined that there is an error, you might find that the error is not in the physical, data link, Internet Protocol (IP), interior gateway protocol (IGP), or Resource Reservation Protocol (RSVP) layers. Continue investigating the problem at the MPLS layer of the network.

Figure 21 on page 153 illustrates the MPLS layer of the layered MPLS model.

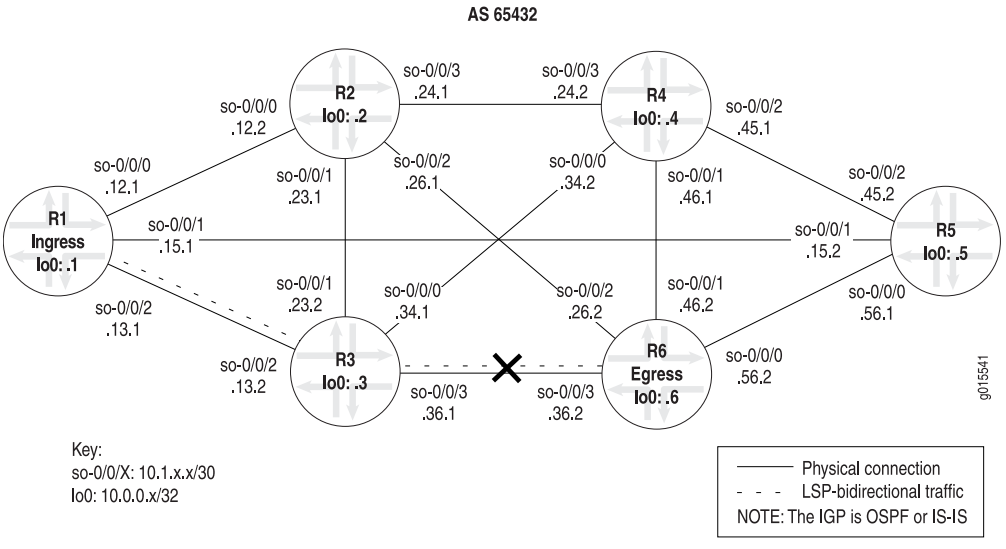
Figure 21: Checking the MPLS Layer



With the MPLS layer, you check whether the LSP is up and functioning correctly. If the network is not functioning at this layer, the LSP does not work as configured.

Figure 22 on page 153 illustrates the MPLS network used in this topic.

Figure 22: MPLS Network Broken at the MPLS Layer



The network shown in Figure 22 on page 153 is a fully meshed configuration where every directly connected interface can receive and send packets to every other similar interface.

The LSP in this network is configured to run from ingress router **R1**, through transit router **R3**, to egress router **R6**. In addition, a reverse LSP is configured to run from **R6** through **R3** to **R1**, creating bidirectional traffic.

However, in this example, the reverse LSP is down without a path from **R6** to **R1**.

The cross shown in Figure 22 on page 153 indicates where the LSP is broken. Some possible reasons the LSP is broken might include an incorrectly configured MPLS protocol, or interfaces that are incorrectly configured for MPLS.

In the network shown in Figure 22 on page 153, a configuration error on egress router **R6** prevents the LSP from traversing the network as expected.

To check the MPLS layer, follow these steps:

1. Verify the LSP on page 154
2. Verify the LSP Route on the Transit Router on page 157
3. Verify the LSP Route on the Ingress Router on page 158
4. Verify MPLS Labels with the traceroute Command on page 159
5. Verify MPLS Labels with the ping Command on page 160
6. Verify the MPLS Configuration on page 161
7. Take Appropriate Action on page 163
8. Verify the LSP Again on page 164

Verify the LSP

Purpose Typically, you use the **show mpls lsp extensive** command to verify the LSP. However for quick verification of the LSP state, use the **show mpls lsp** command. If the LSP is down, use the **extensive** option (**show mpls lsp extensive)** as a follow-up. If your network has numerous LSPs, you might consider specifying the name of the LSP, using the **name** option (**show mpls lsp name** *name* or **show mpls lsp name** *name* **extensive).**

Action To verify that the LSP is up, enter some or all of the following commands from the ingress router:

```
user@host> show mpls lsp
user@host> show mpls lsp extensive
user@host> show mpls lsp name name
user@host> show mpls lsp name name extensive
```

Sample Output 1

```
user@R1> show mpls lsp
Ingress LSP: 1 sessions
To              From            State Rt ActivePath       P     LSPname
10.0.0.6        10.0.0.1        Dn     0 -                       R1-to-R6
Total 1 displayed, Up 0,  Down 1

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

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

```
user@R3> show mpls lsp
Ingress LSP: 0 sessions
Total 0 displayed, Up 0, Down 0

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

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

user@R6> show mpls lsp
Ingress LSP: 1 sessions
To              From            State Rt ActivePath       P     LSPname
10.0.0.1        10.0.0.6        Dn     0 -                       R6-to-R1
Total 1 displayed, Up 0,  Down 1

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

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

Sample Output 2

```
user@R1> show mpls lsp extensive
Ingress LSP: 1 sessions

10.0.0.6
  From: 10.0.0.1, State: Dn, ActiveRoute: 0, LSPname: R1-to-R6
  ActivePath: (none)
  LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
  Primary                   State: Dn
    Will be enqueued for recomputation in 22 second(s).
    1 Nov  2 14:43:38  CSPF failed: no route toward 10.0.0.6 [175 times]
  Created: Tue Nov  2 13:18:39 2004
Total 1 displayed, Up 0, Down 1

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

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

user@R3> show mpls lsp extensive
Ingress LSP: 0 sessions
Total 0 displayed, Up 0, Down 0

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

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

user@R6> show mpls lsp extensive
Ingress LSP: 1 sessions

10.0.0.1
  From: 10.0.0.6, State: Dn, ActiveRoute: 0, LSPname: R6-to-R1
  ActivePath: (none)
  LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
  Primary                   State: Dn
```

```
    Will be enqueued for recomputation in 13 second(s).
    1 Nov  2 14:38:12  CSPF failed: no route toward 10.0.0.1 [177 times]
  Created: Tue Nov  2 13:12:22 2004
Total 1 displayed, Up 0, Down 1

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

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

Sample Output 3

```
user@R1> show mpls lsp name R1-to-R6
Ingress LSP: 1 sessions
To              From            State Rt ActivePath       P     LSPname
10.0.0.6        10.0.0.1        Dn     0 -                      R1-to-R6
Total 1 displayed, Up 0, Down 1

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

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

Sample Output 4

```
user@R1> show mpls lsp name R1-to-R6 extensive
Ingress LSP: 1 sessions

10.0.0.6
  From: 10.0.0.1, State: Dn, ActiveRoute: 0, LSPname: R1-to-R6
  ActivePath: (none)
  LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
  Primary                   State: Dn
    Will be enqueued for recomputation in 10 second(s).
    1 Nov  2 14:51:53 CSPF failed: no route toward 10.0.0.6[192 times]
  Created: Tue Nov  2 13:18:39 2004
Total 1 displayed, Up 0, Down 1

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

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

Meaning

Sample Output 1 shows a brief description of the state of the LSP for the ingress, transit, and egress routers. Output from ingress router **R1** and egress router **R6** shows that both LSPs are down, **R1-to-R6** and **R6-toR1**. With the configured LSPs on **R1** and **R6**, we would expect egress LSP sessions on both **R1** and **R6**. In addition, transit router **R3** has no transit sessions.

Sample Output 2 shows all information about the LSPs, including all past state history and the reason why an LSP failed. Output from **R1** and **R6** indicates that there is no route to the destination because the Constrained Shortest Path First (CSPF) algorithm failed.

Sample Outputs 3 and 4 show examples of the output for the **show mpls lsp name** command with the **extensive** option. In this instance, the output is very similar to the **show mpls lsp** command because only one LSP is configured in the example network in Figure

22 on page 153. However, in a large network with many LSPs configured, the results would be quite different between the two commands.

Verify the LSP Route on the Transit Router

Purpose If the LSP is up, the LSP route should appear in the **mpls.0** routing table. MPLS maintains an MPLS path routing table (**mpls.0**), which contains a list of the next label-switched router in each LSP. This routing table is used on transit routers to route packets to the next router along an LSP. If routes are not present in the output for the transit router, check the MPLS protocol configuration on the ingress and egress routers.

Action To verify the LSP route on the transit router, enter the following command from the transit router:

```
user@host> show route table mpls.0
```

Sample Output 1

```
user@R3> show route table mpls.0
mpls.0: 3 destinations, 3 routes (3 active, 0 holddown, 0 hidden)
+ = Active Route, - = Last Active, * = Both
0                  *[MPLS/0] 16w2d 21:52:40, metric 1
                      Receive
1                  *[MPLS/0] 16w2d 21:52:40, metric 1
                      Receive
2                  *[MPLS/0] 16w2d 21:52:40, metric 1
                      Receive
```

Sample Output 2

```
user@R3> show route table mpls.0
mpls.0: 7 destinations, 7 routes (7 active, 0 holddown, 0 hidden)
+ = Active Route, - = Last Active, * = Both
0                  *[MPLS/0] 16w2d 22:26:08, metric 1
                      Receive
1                  *[MPLS/0] 16w2d 22:26:08, metric 1
                      Receive
2                  *[MPLS/0] 16w2d 22:26:08, metric 1
                      Receive
100864             *[RSVP/7] 00:07:23, metric 1
                    > via so-0/0/2.0, label-switched-path R6-to-R1
100864(S=0)        *[RSVP/7] 00:07:23, metric 1
                    > via so-0/0/2.0, label-switched-path R6-to-R1
100880             *[RSVP/7] 00:07:01, metric 1
                    > via so-0/0/3.0, label-switched-path R1-to-R6
100880(S=0)        *[RSVP/7] 00:07:01, metric 1
                    > via so-0/0/3.0, label-switched-path R1-to-R6
```

Meaning Sample Output 1 from transit router **R3** shows three route entries in the form of MPLS label entries. These MPLS labels are reserved MPLS labels defined in RFC 3032, and are always present in the **mpls.0** routing table, regardless of the state of the LSP. The incoming labels assigned by RSVP to the upstream neighbor are missing from the output, indicating that the LSP is down. For more information on MPLS label entries, see “Checklist for Verifying LSP Use” on page 69.

In contrast, Sample Output 2 shows the MPLS labels and routes for a correctly configured LSP. The three reserved MPLS labels are present, and the four other entries represent the incoming labels assigned by RSVP to the upstream neighbor. These four entries represent two routes. There are two entries per route because the stack values in the

MPLS header may be different. For each route, the second entry **100864 (S=0)** and **100880 (S=0)** indicates that the stack depth is not 1, and additional label values are included in the packet. In contrast, the first entry, **100864** and **100880** has an inferred S=1 value which indicates a stack depth of 1 and makes each label the last label in that particular packet. The dual entries indicate that this is the penultimate router. For more information on MPLS label stacking, see RFC 3032, *MPLS Label Stack Encoding*.

Verify the LSP Route on the Ingress Router

Purpose Check whether the LSP route is included in the active entries in the **inet.3** routing table for the specified address.

Action To verify the LSP route, enter the following command from the ingress router:

user@host> **show route** ***destination***

Sample Output 1

```
user@R1> show route 10.0.0.6
inet.0 : 27 destinations, 27 routes (27 active, 0 holddown, 0 hidden)
+ = Active Route, - = Last Active, * = Both
10.0.0.6/32        *[IS-IS/18] 6d 01:41:37, metric 20
                      to 10.1.12.2 via so-0/0/0.0
                    > to 10.1.15.2 via so-0/0/1.0
                      to 10.1.13.2 via so-0/0/2.0

user@R6> show route 10.0.0.1

inet.0 : 28 destinations, 28 routes (28 active, 0 holddown, 0 hidden)
+ = Active Route, - = Last Active, * = Both
10.0.0.1/32        *[IS-IS/18] 5d 01:01:38, metric 20
                      to 10.1.56.1 via so-0/0/0.0
                    > to 10.1.26.1 via so-0/0/2.0
                      to 10.1.36.1 via so-0/0/3.0
```

Sample Output 2

```
user@R1> show route 10.0.0.6
inet.0: 28 destinations, 28 routes (27 active, 0 holddown, 1 hidden)
+ = Active Route, - = Last Active, * = Both

10.0.0.6/32        *[IS-IS/18] 6d 02:13:42, metric 20
                      to 10.1.12.2 via so-0/0/0.0
                    > to 10.1.15.2 via so-0/0/1.0
                      to 10.1.13.2 via so-0/0/2.0

inet.3 : 1 destinations, 1 routes (1 active, 0 holddown, 0 hidden)
+ = Active Route, - = Last Active, * = Both

10.0.0.6/32        *[RSVP/7] 00:08:07, metric 20
                    > via so-0/0/2.0,  label-switched-path R1-to-R6

user@R6> show route 10.0.0.1

inet.0: 29 destinations, 29 routes (28 active, 0 holddown, 1 hidden)
+ = Active Route, - = Last Active, * = Both

10.0.0.1/32        *[IS-IS/18] 5d 01:34:03, metric 20
                      to 10.1.56.1 via so-0/0/0.0
                    > to 10.1.26.1 via so-0/0/2.0
                      to 10.1.36.1 via so-0/0/3.0
```

```
inet.3 : 1 destinations, 1 routes (1 active, 0 holddown, 0 hidden)
+ = Active Route, - = Last Active, * = Both

10.0.0.1/32        *[RSVP/7] 00:10:39, metric 20
                    >  via so-0/0/3.0, label-switched-path R6-to-R1
```

Meaning Sample Output 1 shows entries in the **inet.0** routing table only. The **inet.3** routing table is missing from the output because the LSP is not working. The **inet.0** routing table is used by interior gateway protocols (IGPs) and Border Gateway Protocol (BGP) to store routing information. In this case, the IGP is Intermediate System-to-Intermediate System (IS-IS). For more information on the **inet.0** routing table, see the *Junos MPLS Applications Configuration Guide*.

If the LSP was working, we would expect to see entries that include the LSP in the **inet.3** routing table. The **inet.3** routing table is used on ingress routers to route BGP packets to the destination egress router. BGP uses the **inet.3** routing table on the ingress router to help resolve next-hop addresses. BGP is configured in the example network shown in Figure 22 on page 153.

Sample Output 2 shows output you should receive when the LSP is up. The output shows both the **inet.0** and **inet.3** routing tables, indicating that LSPs **R1-to-R6** and **R6-to-R1** are available.

Verify MPLS Labels with the traceroute Command

Purpose Display the route packets take to a BGP destination where the BGP next hop for that route is the LSP egress address. By default, BGP uses the **inet.0** and the **inet.3** routing tables to resolve the next-hop address. When the next-hop address of the BGP route is not the router ID of the egress router, traffic is mapped to IGP routes, not to the LSP. Use the **traceroute** command as a debugging tool to determine whether the LSP is being used to forward traffic.

Action To verify MPLS labels, enter the following command from the ingress router:

```
user@host> traceroute hostname
```

Sample Output 1

```
user@R1> traceroute 100.100.6.1
traceroute to 100.100.6.1 (100.100.6.1), 30 hops max, 40 byte packets
 1  10.1.12.2 (10.1.12.2)  0.627 ms  0.561 ms  0.520 ms
 2  10.1.26.2 (10.1.26.2)  0.570 ms !N  0.558 ms !N  4.879 ms !N

user@R6> traceroute 100.100.1.1
traceroute to 100.100.1.1 (100.100.1.1), 30 hops max, 40 byte packets
 1  10.1.26.1 (10.1.26.1)  0.630 ms  0.545 ms  0.488 ms
 2  10.1.12.1 (10.1.12.1)  0.551 ms !N  0.557 ms !N  0.526 ms !N
```

Sample Output 2

```
user@R1> traceroute 100.100.6.1
 to 100.100.6.1 (100.100.6.1), 30 hops max, 40 byte packets
 1  10.1.13.2 (10.1.13.2)  0.866 ms  0.746 ms  0.724 ms
      MPLS Label=100912 CoS=0 TTL=1 S=1
 2  10.1.36.2 (10.1.36.2)  0.577 ms !N  0.597 ms !N  0.546 ms !N

user@R6> traceroute 100.100.1.1
traceroute to 100.100.1.1 (100.100.1.1), 30 hops max, 40 byte packets
 1  10.1.36.1 (10.1.36.1)  0.802 ms  0.716 ms  0.688 ms
```

```
        MPLS Label=100896 CoS=0 TTL=1 S=1
 2  10.1.13.1 (10.1.13.1)  0.570 ms !N  0.568 ms !N  0.546 ms !N
```

Meaning Sample Output 1 shows that BGP traffic is not using the LSP, consequently MPLS labels do not appear in the output. Instead of using the LSP, BGP traffic is using the IGP (IS-IS, in the example network in Figure 22 on page 153) to reach the BGP next-hop LSP egress address. The Junos OS default behavior uses LSPs for BGP traffic when the BGP next hop equals the LSP egress address.

Sample Output 2 is an example of output for a correctly configured LSP. The output shows MPLS labels, indicating that BGP traffic is using the LSP to reach the BGP next hop.

Verify MPLS Labels with the ping Command

Purpose When you ping a specific LSP, you check that echo requests are sent over the LSP as MPLS packets. On the egress router (the router receiving the MPLS echo packets), you must configure the address **127.0.0.1/32** on its loopback (**lo0**) interface. If this is not configured, the egress router does not have this forwarding entry and therefore simply drops the incoming MPLS pings and replies with "ICMP host unreachable" messages.

Action To verify MPLS labels, follow these steps:

1. On the egress router, in configuration mode, go to the following hierarchy level:

   ```
   [edit]
   user@host# edit interfaces lo0 unit number
   ```

   For example:

   ```
   [edit]
   user@R6# edit interfaces lo0.0
   ```

2. Configure the loopback (**lo0**) interface with the following IP address:

   ```
   [edit interfaces lo0 unit number]
   user@host# set family inet address 127.0.0.1/32
   ```

3. Verify the configuration:

   ```
   user@host# show
   ```

   ```
   user@host# commit
   ```

4. On the ingress router, in operational mode, enter the following command to ping the egress router:

   ```
   user@host> ping mpls rsvp lsp-name detail
   ```

   For example:

   ```
   user@R1> ping mpls rsvp R1-to-R6 detail
   ```

Sample Output 1

```
user@R1> ping mpls rsvp R1-to-R6 detail
LSP R1-to-R6 - LSP has no active path, exiting.
```



```
user@R6> ping mpls rsvp R6-to-R1 detail
LSP R6-to-R1 - LSP has no active path, exiting.
```

Sample Output 2

```
user@R1> traceroute 10.0.0.6
traceroute to 10.0.0.6 (10.0.0.6), 30 hops max, 40 byte packets
 1  10.1.15.2 (10.1.15.2)  0.708 ms  0.613 ms  0.576 ms
 2  10.0.0.6 (10.0.0.6)  0.763 ms  0.708 ms  0.700 ms

user@R1> ping mpls rsvp R1-to-R6 detail
Request for seq 1, to interface 69, label 100880
Reply for seq 1, return code: Egress-ok
Request for seq 2, to interface 69, label 100880
Reply for seq 2, return code: Egress-ok
Request for seq 3, to interface 69, label 100880
Reply for seq 3, return code: Egress-ok
Request for seq 4, to interface 69, label 100880
Reply for seq 4, return code: Egress-ok
Request for seq 5, to interface 69, label 100880
Reply for seq 5, return code: Egress-ok

--- lsping statistics ---
5 packets transmitted, 5 packets received, 0% packet loss

user@R6> ping mpls rsvp R6-to-R1 detail
Request for seq 1, to interface 70, label 100864
Reply for seq 1, return code: Egress-ok
Request for seq 2, to interface 70, label 100864
Reply for seq 2, return code: Egress-ok
Request for seq 3, to interface 70, label 100864
Reply for seq 3, return code: Egress-ok
Request for seq 4, to interface 70, label 100864
Reply for seq 4, return code: Egress-ok
Request for seq 5, to interface 70, label 100864
Reply for seq 5, return code: Egress-ok

--- lsping statistics ---
5 packets transmitted, 5 packets received, 0% packet loss
```

Meaning Sample Output 1 shows that the LSP does not have an active path to forward echo requests, indicating that the LSP is down.

Sample Output 2 is an example of output you should receive when the LSP is up and forwarding packets.

Verify the MPLS Configuration

Purpose After you have checked the transit and ingress routers, used the **traceroute** command to verify the BGP next hop, and used the **ping** command to verify the active path, you can check for problems with the MPLS configuration at the [**edit protocols mpls**] and [**edit interfaces**] hierarchy levels.

Action To verify the MPLS configuration, enter the following commands from the ingress, transit, and egress routers:

```
user@host> show configuration protocols mpls
user@host> show configuration interfaces
```

Sample Output 1

```
user@R1> show configuration protocols mpls
label-switched-path R1-to-R6 {
    to 10.0.0.6;
}
inactive: interface so-0/0/0.0;
inactive: interface so-0/0/1.0;
interface so-0/0/2.0;
interface fxp0.0 {
    disable;
}

user@R3> show configuration protocols mpls
interface fxp0.0 {
    disable;
}
inactive: interface so-0/0/0.0;
inactive: interface so-0/0/1.0;
interface so-0/0/2.0;
interface so-0/0/3.0;

user@R6> show configuration protocols mpls
label-switched-path R6-to-R1 {
    to 10.0.0.1;
}
inactive: interface so-0/0/0.0;
inactive: interface so-0/0/1.0;
inactive: interface so-0/0/2.0;
inactive: interface so-0/0/3.0; <<< Incorrectly configured
```

Sample Output 2

```
user@R6> show configuration interfaces
so-0/0/0 {
    unit 0 {
        family inet {
            address 10.1.56.2/30;
        }
        family iso;
        family mpls;
    }
}
so-0/0/1 {
    unit 0 {
        family inet {
            address 10.1.46.2/30;
        }
        family iso;
        family mpls;
    }
}
so-0/0/2 {
    unit 0 {
        family inet {
            address 10.1.26.2/30;
        }
        family iso;
        family mpls;
    }
}
so-0/0/3 {
    unit 0 {
        family inet {
            address 10.1.36.2/30;
```

```
        }
        family iso;
        family mpls;
    }
}
}
fxp0 {
    unit 0 {
        family inet {
            address 192.168.70.148/21;
        }
    }
}
lo0 {
    unit 0 {
        family inet {
            address 10.0.0.6/32;
            address 127.0.0.1/32;
        }
        family iso {
            address 49.0003.1000.0000.0006.00;
        }
    }
}
```

Meaning Sample Output 1 from the ingress, transit, and egress routers shows that the configuration of interfaces on egress router **R6** is incorrect. Interface **so-0/0/3.0** is included as inactive at the [**edit protocols mpls**] hierarchy level, when it should be active because it is the interface through which the LSP travels.

Sample Output 2 shows that interfaces are correctly configured for MPLS on egress router **R6**. The interfaces are also correctly configured on the ingress and transit routers (not shown).

Take Appropriate Action

Problem Depending on the error you encountered in your investigation, you must take the appropriate action to correct the problem. In this example, an interface is incorrectly configured at the [**edit protocols mpls**] hierarchy level on egress router **R6.**

Solution To correct the error in this example, follow these steps:

1. Activate the interface in the MPLS protocol configuration on egress router **R6**:

   ```
   user@R6> edit
   user@R6# edit protocols mpls
   [edit protocols mpls]
   user@R6# show
   user@R6# activate interface so-0/0/3.0
   ```

2. Verify and commit the configuration:

   ```
   [edit protocols mpls]
   user@R6# show
   user@R6# commit
   ```

Sample Output

```
user@R6> edit
Entering configuration mode
```

```
[edit]
user@R6# edit protocols mpls

[edit protocols mpls]
user@R6# show
label-switched-path R6-to-R1 {
    to 10.0.0.1;
}
inactive: interface so-0/0/0.0;
inactive: interface so-0/0/1.0;
inactive: interface so-0/0/2.0;
inactive: interface so-0/0/3.0; <<< Incorrectly configured interface

[edit protocols mpls]
user@R6#  activate interface so-0/0/3

[edit protocols mpls]
user@R6# show
label-switched-path R6-to-R1 {
    to 10.0.0.1;
}
inactive: interface so-0/0/0.0;
inactive: interface so-0/0/1.0;
inactive: interface so-0/0/2.0;
interface so-0/0/3.0; <<< Correctly configured interface

[edit protocols mpls]
user@R6# commit
commit complete
```

Meaning The sample output shows that the incorrectly configured interface **so-0/0/3.0** on egress router **R6** is now activated at the [**edit protocols mpls**] hierarchy level. The LSP can now come up.

Verify the LSP Again

Purpose After taking the appropriate action to correct the error, the LSP needs to be checked again to confirm that the problem in the BGP layer has been resolved.

Action To verify the LSP again, enter the following command from the ingress, transit, and egress routers:

```
user@host>  show mpls lsp extensive
```

Sample Output

```
user@R1> show mpls lsp extensive
Ingress LSP: 1 sessions

10.0.0.6
  From: 10.0.0.1,  State: Up , ActiveRoute: 1 , LSPname: R1-to-R6
  ActivePath:  (primary)
  LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
 *Primary                   State: Up
    Computed ERO (S [L] denotes strict [loose] hops): (CSPF metric: 20)
 10.1.13.2 S 10.1.36.2 S
   Received RRO (ProtectionFlag 1=Available 2=InUse 4=B/W 8=Node 10=SoftPreempt):
```

```
          10.1.13.2 10.1.36.2
    6 Nov  2 15:48:52 Selected as active path
    5 Nov  2 15:48:52 Record Route:  10.1.13.2 10.1.36.2
    4 Nov  2 15:48:52 Up
    3 Nov  2 15:48:52 Originate Call
    2 Nov  2 15:48:52 CSPF: computation result accepted
    1 Nov  2 15:48:22 CSPF failed: no route toward 10.0.0.6[308 times]
  Created: Tue Nov  2 13:18:39 2004
Total 1 displayed, Up 1, Down 0

Egress LSP: 1 sessions

10.0.0.1
  From: 10.0.0.6,  LSPstate: Up , ActiveRoute: 0
   LSPname: R6-to-R1 , 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:  159, Since: Tue Nov  2 15:48:30 2004
  Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
  Port number: sender 1 receiver 39106 protocol 0
  PATH rcvfrom: 10.1.13.2 (so-0/0/2.0) 10 pkts
  Adspec: received MTU 1500
  PATH sentto: localclient
  RESV rcvfrom: localclient
  Record route: 10.1.36.2 10.1.13.2 <self>
Total 1 displayed, Up 1, Down 0

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

user@R3> show mpls lsp extensive
Ingress LSP: 0 sessions
Total 0 displayed, Up 0, Down 0

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

Transit LSP: 2 sessions

10.0.0.1
  From: 10.0.0.6, LSPstate: Up, ActiveRoute: 1
  LSPname: R6-to-R1, LSPpath: Primary
  Suggested label received: -, Suggested label sent: -
  Recovery label received: -, Recovery label sent: 3
  Resv style: 1 FF, Label in: 100864, Label out: 3
  Time left:  123, Since: Tue Nov  2 15:35:41 2004
  Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
  Port number: sender 1 receiver 39106 protocol 0
  PATH rcvfrom: 10.1.36.2 (so-0/0/3.0) 10 pkts
  Adspec: received MTU 1500 sent MTU 1500
  PATH sentto: 10.1.13.1 (so-0/0/2.0) 10 pkts
  RESV rcvfrom: 10.1.13.1 (so-0/0/2.0) 10 pkts
  Explct route: 10.1.13.1
  Record route: 10.1.36.2 <self> 10.1.13.1

10.0.0.6
  From: 10.0.0.1, LSPstate: Up, ActiveRoute: 1
  LSPname: R1-to-R6, LSPpath: Primary
  Suggested label received: -, Suggested label sent: -
  Recovery label received: -, Recovery label sent: 3
```

```
  Resv style: 1 FF, Label in: 100880, Label out: 3
  Time left:  145, Since: Tue Nov  2 15:36:03 2004
  Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
  Port number: sender 1 receiver 48015 protocol 0
  PATH rcvfrom: 10.1.13.1 (so-0/0/2.0) 10 pkts
  Adspec: received MTU 1500 sent MTU 1500
  PATH sentto: 10.1.36.2 (so-0/0/3.0) 10 pkts
  RESV rcvfrom: 10.1.36.2 (so-0/0/3.0) 10 pkts
  Explct route: 10.1.36.2
  Record route: 10.1.13.1 <self> 10.1.36.2
Total 2 displayed, Up 2, Down 0

user@R6> show mpls lsp extensive
Ingress LSP: 1 sessions

10.0.0.1
  From: 10.0.0.6,  State: Up, ActiveRoute: 1, LSPname: R6-to-R1
  ActivePath:  (primary)
  LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
 *Primary                    State: Up
    Computed ERO (S [L] denotes strict [loose] hops): (CSPF metric: 20)
 10.1.36.1 S 10.1.13.1 S
   Received RRO (ProtectionFlag 1=Available 2=InUse 4=B/W 8=Node 10=SoftPreempt):

         10.1.36.1 10.1.13.1
    6 Nov  2 15:41:44 Selected as active path
    5 Nov  2 15:41:44 Record Route:  10.1.36.1 10.1.13.1
    4 Nov  2 15:41:44 Up
    3 Nov  2 15:41:44 Originate Call
    2 Nov  2 15:41:44 CSPF: computation result accepted
    1 Nov  2 15:41:14 CSPF failed: no route toward 10.0.0.1[306 times]
  Created: Tue Nov  2 13:12:21 2004
Total 1 displayed, Up 1, Down 0

Egress LSP: 1 sessions

10.0.0.6
  From: 10.0.0.1,  LSPstate: Up,  ActiveRoute: 0
   LSPname: R1-to-R6 , 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: Tue Nov  2 15:42:06 2004
  Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
  Port number: sender 1 receiver 48015 protocol 0
  PATH rcvfrom: 10.1.36.1 (so-0/0/3.0) 11 pkts
  Adspec: received MTU 1500
  PATH sentto: localclient
  RESV rcvfrom: localclient
  Record route: 10.1.13.1 10.1.36.1 <self>
Total 1 displayed, Up 1, Down 0

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

Meaning Sample Output 1 from ingress router **R1** shows that LSP **R1-to-R6** has an active route to **R6** and the state is up.

Sample Output 2 from transit router **R3** shows that there are two transit LSP sessions, one from **R1** to **R6** and the other from **R6** to **R1**. Both LSPs are up.

Sample Output 3 from egress router **R6** shows that the LSP is up and the active route is the primary route. The LSP is now traversing the network along the expected path, from **R1** through **R3** to **R6**, and the reverse LSP, from **R6** through **R3** to **R1**.

CHAPTER 12

Checking the BGP Layer

This chapter describes how to check the Border Gateway Protocol (BGP) layer of the layered Multiprotocol Label Switching (MPLS) model.

Checklist for Checking the BGP Layer

Problem This checklist provides the steps and commands for checking the BGP configuration of the Multiprotocol Label Switching (MPLS) network. The checklist provides links to an overview of the BGP configuration and more detailed information about the commands used to configure BGP. (See Table 20 on page 169.)

Solution

Table 20: Checklist for Checking the BGP Layer

Tasks	Command or Action
"Checking the BGP Layer" on page 170	
1. Check That BGP Traffic Is Using the LSP on page 171	**traceroute** *hostname*
2. Check BGP Sessions on page 172	**show bgp summary**
3. Verify the BGP Configuration on page 173	**show configuration**
4. Examine BGP Routes on page 178	**show route** *destination-prefix* **detail**
5. Verify Received BGP Routes on page 179	**show route receive protocol bgp** *neighbor-address*
6. Take Appropriate Action on page 180	The following sequence of commands addresses the specific problem described in this topic: **[edit]** **edit protocols bgp** **[edit protocols bgp]** **show** **set local-address 10.0.0.1** **delete group internal neighbor 10.1.36.2** **show** **commit**

Table 20: Checklist for Checking the BGP Layer *(continued)*

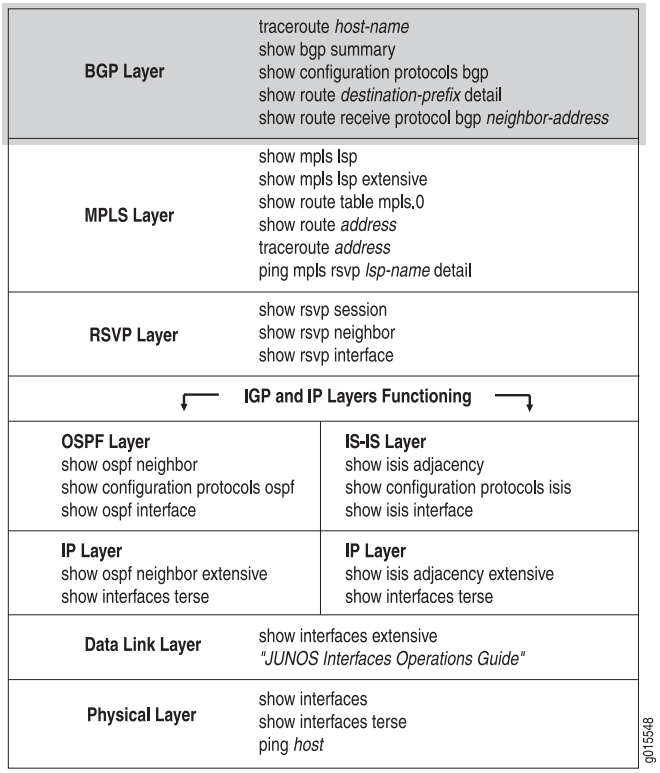
Tasks	Command or Action
7. Check That BGP Traffic Is Using the LSP Again on page 181	**traceroute** ***hostname***

Checking the BGP Layer

Purpose After you have configured the label-switched path (LSP) and determined that it is up, and configured BGP and determined that sessions are established, ensure that BGP is using the LSP to forward traffic.

Figure 23 on page 170 illustrates the BGP layer of the layered MPLS model.

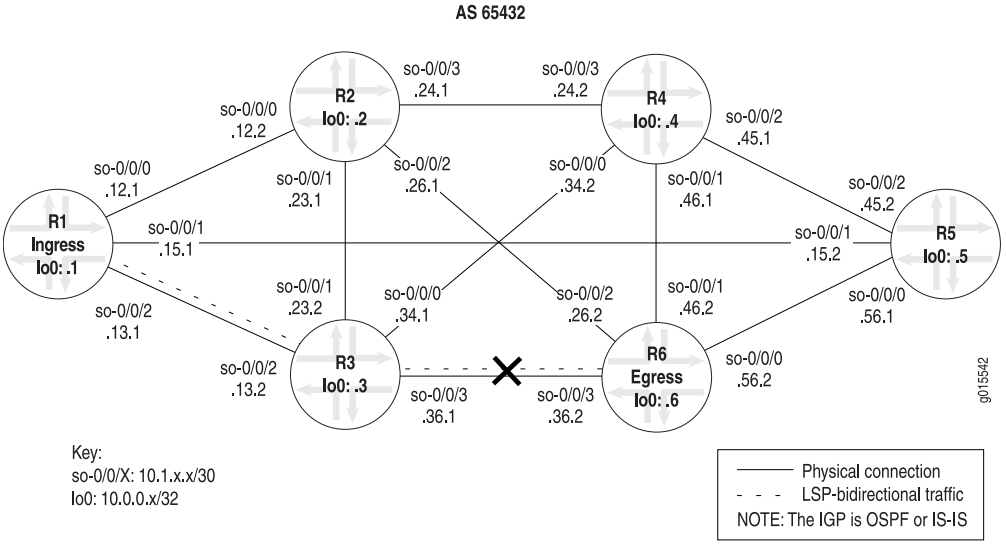
Figure 23: Checking the BGP Layer



When you check the BGP layer, you verify that the route is present and active, and more importantly, you ensure that the next hop is the LSP. There is no point in checking the BGP layer unless the LSP is established, because BGP uses the MPLS LSP to forward traffic. If the network is not functioning at the BGP layer, the LSP does not work as configured.

Figure 24 on page 171 illustrates the MPLS network used in this topic.

Figure 24: MPLS Network Broken at the BGP Layer



The network shown in Figure 24 on page 171 is a fully meshed configuration where every directly connected interface can receive and send packets to every other similar interface. The LSP in this network is configured to run from ingress router **R1**, through transit router **R3**, to egress router **R6**. In addition, a reverse LSP is configured to run from **R6** through **R3** to **R1**, creating bidirectional traffic.

The cross shown in Figure 24 on page 171 indicates where BGP is not being used to forward traffic through the LSP. Possible reasons for the LSP not working correctly are that the destination IP address of the LSP does not equal the BGP next hop or that BGP is not configured properly.

To check the BGP layer, follow these steps:

1. Check That BGP Traffic Is Using the LSP on page 171
2. Check BGP Sessions on page 172
3. Verify the BGP Configuration on page 173
4. Examine BGP Routes on page 178
5. Verify Received BGP Routes on page 179
6. Take Appropriate Action on page 180
7. Check That BGP Traffic Is Using the LSP Again on page 181

Check That BGP Traffic Is Using the LSP

Purpose At this level of the troubleshooting model, BGP and the LSP may be up, however BGP traffic might not be using the LSP to forward traffic.

Action To verify that BGP traffic is using the LSP, enter the following Junos OS command-line interface (CLI) operational mode command from the ingress router:

user@host> **traceroute** ***hostname***

Sample Output

```
user@R1> traceroute 100.100.6.1
traceroute to 100.100.6.1 (100.100.6.1), 30 hops max, 40 byte packets
 1  10.1.13.2 (10.1.13.2)  0.653 ms  0.590 ms  0.543 ms
 2  10.1.36.2 (10.1.36.2)  0.553 ms !N  0.552 ms !N  0.537 ms !N

user@R6> traceroute 100.100.1.1
traceroute to 100.100.1.1 (100.100.1.1), 30 hops max, 40 byte packets
 1  10.1.36.1 (10.1.36.1)  0.660 ms  0.551 ms  0.526 ms
 2  10.1.13.1 (10.1.13.1)  0.568 ms !N  0.553 ms !N  0.536 ms !N
```

Meaning The sample output shows that BGP traffic is not using the LSP, consequently MPLS labels do not appear in the output. Instead of using the LSP, BGP traffic is using the interior gateway protocol (IGP) (IS-IS or OSPF, in the example network shown in Figure 24 on page 171) to reach the BGP next-hop LSP egress address for **R6** and **R1**. The Junos OS default is to use LSPs for BGP traffic when the BGP next hop equals the LSP egress address.

Check BGP Sessions

Purpose Display summary information about BGP and its neighbors to determine if routes are received from peers in the autonomous system (AS). When a BGP session is established, the peers are exchanging update messages.

Action To check that BGP sessions are up, enter the following Junos OS CLI operational mode command from the ingress router:

```
user@host> show bgp summary
```

Sample Output 1

```
user@R1> show bgp summary
Groups: 1 Peers: 6   Down peers: 1
Table          Tot Paths  Act Paths Suppressed    History Damp State    Pending
inet.0                 1          1          0          0          0          0
Peer              AS      InPkt     OutPkt    OutQ   Flaps Last Up/Dwn
State|#Active/Received/Damped...
10.0.0.2        65432      11257      11259       0       0 3d 21:49:57  0/0/0
                0/0/0
10.0.0.3        65432      11257      11259       0       0 3d 21:49:57 0/0/0
                0/0/0
10.0.0.4        65432      11257      11259       0       0 3d 21:49:57 0/0/0
                0/0/0
10.0.0.5        65432      11257      11260       0       0 3d 21:49:57 0/0/0
                0/0/0
10.0.0.6    65432    4    4572    0    1 3d 21:46:59 Active
10.1.36.2       65432      11252      11257       0       0 3d 21:46:49  1/1/0
                0/0/0
```

Sample Output 2

```
user@R1> show bgp summary
Groups: 1 Peers: 5 Down peers: 0
Table          Tot Paths  Act Paths Suppressed    History Damp State    Pending
inet.0                 1          1          0          0          0          0
Peer              AS      InPkt     OutPkt    OutQ   Flaps Last Up/Dwn
State|#Active/Received/Damped...
10.0.0.2        65432         64         68       0       0       32:18 0/0/0
                0/0/0
10.0.0.3        65432         64         67       0       0       32:02 0/0/0
                0/0/0
10.0.0.4        65432         64         67       0       0       32:10 0/0/0
```

```
                0/0/0
10.0.0.5          65432         64         67        0        0        32:14 0/0/0
                0/0/0
10.0.0.6          65432         38         39        0        1        18:02 1/1/0
                0/0/0
```

Meaning Sample Output 1 shows that one peer (egress router **10.0.0.6**) is not established, as indicated by the **Down Peers: 1** field. The last column (**State|#Active/Received/Damped**) shows that peer **10.0.0.6** is active, indicating that is it not established. All other peers are established as indicated by the number of active, received, and damped routes. For example, **0/0/0** for peer **10.0.0.2** indicates that no BGP routes were active or received in the routing table, and no BGP routes were damped; **1/1/0** for peer **10.1.36.2** indicates that one BGP route was active and received in the routing table, and no BGP routes were damped.

If the output of the **show bgp summary** command of an ingress router shows that a neighbor is down, check the BGP configuration. For information on checking the BGP configuration, see "Verify the BGP Configuration" on page 173.

Sample Output 2 shows output from ingress router **R1** after the BGP configurations on **R1** and **R6** were corrected in "Take Appropriate Action" on page 180. All BGP peers are established and one route is active and received. No BGP routes were damped.

If the output of the **show bgp summary** command shows that a neighbor is up but packets are not being forwarded, check for received routes from the egress router. For information on checking the egress router for received routes, see "Verify Received BGP Routes" on page 179.

Verify the BGP Configuration

Purpose For BGP to run on the router, you must define the local AS number, configure at least one group, and include information about at least one peer in the group (the peer's IP address and AS number). When BGP is part of an MPLS network, you must ensure that the LSP is configured with a destination IP address equal to the BGP next hop in order for BGP routes to be installed with the LSP as the next hop for those routes.

Action To verify the BGP configuration, enter the following Junos OS CLI operational mode command:

```
user@host> show configuration
```

Sample Output 1

```
user@R1> show configuration
[...Output truncated...]
interfaces {
    so-0/0/0 {
        unit 0 {
            family inet {
                address 10.1.12.1/30;
            }
            family iso;
            family mpls;
        }
    }
    so-0/0/1 {
```

```
        unit 0 {
            family inet {
                address 10.1.15.1/30;
            }
            family iso;
            family mpls;
        }
    }
    so-0/0/2 {
        unit 0 {
            family inet {
                address 10.1.13.1/30;
            }
             family iso;
            family mpls;
        }
    }
    fxp0 {
        unit 0 {
            family inet {
                address 192.168.70.143/21;
            }
        }
    }
    lo0 {
        unit 0 {
            family inet {
                address 10.0.0.1/32;
            }
             family iso {
                address 49.0004.1000.0000.0001.00;
            }
        }
    }
}
routing-options {
    [...Output truncated...]
         route 100.100.1.0/24 reject;
    }
     router-id 10.0.0.1;
     autonomous-system 65432;
}
protocols {
    rsvp {
        interface so-0/0/0.0;
        interface so-0/0/1.0;
        interface so-0/0/2.0;
        interface fxp0.0 {
            disable;
        }
    }
    mpls {
        label-switched-path R1-to-R6 {
            to  10.0.0.6; <<< destination address of the LSP
        }
        inactive: interface so-0/0/0.0;
        inactive: interface so-0/0/1.0;
        interface so-0/0/2.0;
        interface fxp0.0 {
            disable;
        }
```

```
        }
        bgp {
            export send-statics; <<< missing local-address statement
             group internal {
                type internal;
                neighbor 10.0.0.2;
                neighbor 10.0.0.5;
                neighbor 10.0.0.4;
                neighbor 10.0.0.6;
                neighbor 10.0.0.3;
                neighbor 10.1.36.2; <<< incorrect interface address
            }
        }
        isis {
            level 1 disable;
            interface so-0/0/0.0;
            interface so-0/0/1.0;
            interface so-0/0/2.0;
            interface all {
                level 2 metric 10;
            }
            interface fxp0.0 {
                disable;
            }
            interface lo0.0 {
                passive;
            }
        }
        ospf {
            traffic-engineering;
            area 0.0.0.0 {
                interface so-0/0/0.0;
                interface so-0/0/1.0;
                interface so-0/0/2.0;
                interface lo0.0; {
                    passive
                }
            }
        }
    }
    policy-options {
        policy-statement send-statics {
            term statics {
                from {
                    route-filter 100.100.1.0/24 exact;
                }
                then accept;
            }
        }
    }
```

Sample Output 2

```
user@R6> show configuration
[...Output truncated...]
interfaces {
    so-0/0/0 {
        unit 0 {
            family inet {
                address 10.1.56.2/30;
            }
            family iso;
            family mpls;
```

```
        }
    }
    so-0/0/1 {
        unit 0 {
            family inet {
                address 10.1.46.2/30;
            }
            family iso;
            family mpls;
        }
    }
    so-0/0/2 {
        unit 0 {
            family inet {
                address 10.1.26.2/30;
            }
            family iso;
            family mpls;
        }
    }
    so-0/0/3 {
        unit 0 {
            family inet {
                address 10.1.36.2/30;
            }
             family iso;
            family mpls;
        }
    }
    fxp0 {
        unit 0 {
            family inet {
                address 192.168.70.148/21;
            }
        }
    }
    lo0 {
        unit 0 {
            family inet {
                address 10.0.0.6/32;
                address 127.0.0.1/32;
            }
            family iso {
                address 49.0004.1000.0000.0006.00;
            }
        }
    }
}
routing-options {
    [...Output truncated...]
         route 100.100.6.0/24 reject;
    }
     router-id 10.0.0.6;
     autonomous-system 65432;
}
protocols {
    rsvp {
        interface so-0/0/0.0;
        interface so-0/0/1.0;
        interface so-0/0/2.0;
        interface so-0/0/3.0;
```

```
        interface fxp0.0 {
            disable;
        }
    }
    mpls {
        label-switched-path R6-to-R1 {
            to 10.0.0.1; <<< destination address of the reverse LSP
        }
        inactive: interface so-0/0/0.0;
        inactive: interface so-0/0/1.0;
        inactive: interface so-0/0/2.0;
        interface so-0/0/3.0;
    }
    bgp {
        group internal {
            type internal;
            export send-statics; <<< missing local-address statement
             neighbor 10.0.0.2;
            neighbor 10.0.0.3;
            neighbor 10.0.0.4;
            neighbor 10.0.0.5;
            neighbor 10.0.0.1;
            neighbor 10.1.13.1;          <<< incorrect interface address
        }
    }
    isis {
        level 1 disable;
        interface all {
            level 2 metric 10;
        }
        interface fxp0.0 {
            disable;
        }
        interface lo0.0 {
            passive;
        }
    }
    ospf {
        traffic-engineering;
        area 0.0.0.0 {
            interface so-0/0/0.0;
            interface so-0/0/1.0;
            interface so-0/0/2.0;
            interface so-0/0/3.0;
            interface lo0.0 {
                passive;
            }
        }
    }
}
policy-options {
    policy-statement send-statics {
        term statics {
            from {
                route-filter 100.100.6.0/24 exact;
            }
            then accept;
        }
```

```
    }
}
```

Meaning The sample output shows the BGP configurations on ingress router **R1** and egress router **R6**. Both configurations show the local AS (**65432**), one group (**internal**), and six peers configured. The underlying interior gateway protocol is IS-IS, and the relevant interfaces are configured to run IS-IS.

NOTE: In this configuration, the RID is manually configured to avoid any duplicate RID problems, and all interfaces configured with BGP include the **family inet** statement at the [**edit interfaces** *type-fpc/pic/port* **unit** *logical-unit-number*] hierarchy level.

Sample output for ingress router **R1** and egress router **R6** shows that the BGP protocol configuration is missing the **local-address** statement for the internal group. When the **local-address** statement is configured, BGP packets are forwarded from the local router loopback (**lo0**) interface address, which is the address to which BGP peers are peering. If the **local-address** statement is not configured, BGP packets are forwarded from the outgoing interface address, which does not match the address to which BGP peers are peering, and BGP does not come up.

On the ingress router, the IP address (**10.0.0.1**) in the **local-address** statement should be the same as the address configured for the LSP on the egress router (**R6**) in the **to** statement at the [**edit protocols mpls label-switched-path** *lsp-path-name*] hierarchy level. BGP uses this address, which is identical to the LSP address, to forward BGP traffic through the LSP.

In addition, the BGP configuration on **R1** includes two IP addresses for **R6**, an interface address (**10.1.36.2**) and a loopback (**lo0**) interface address (**10.0.0.6**), resulting in the LSP destination address (**10.0.0.6**) not matching the BGP next-hop address (**10.1.36.2**). The BGP configuration on **R6** also includes two IP addresses for **R1**, an interface address (**10.1.13.1**) and a loopback (**lo0**) interface address, resulting in the reverse LSP destination address (**10.0.0.1**) not matching the BGP next-hop address (**10.1.13.1**).

In this instance, because the **local-address** statement is missing in the BGP configurations of both routers and the LSP destination address does not match the BGP next-hop address, BGP is not using the LSP to forward traffic.

Examine BGP Routes

Purpose You can examine the BGP path selection process to determine the single, active path when BGP receives multiple routes to the same destination. In this step, we examine the reverse LSP **R6-to-R1**, making **R6** the ingress router for that LSP.

Action To examine BGP routes and route selection, enter the following Junos OS CLI operational mode command:

```
user@host> show route destination-prefix detail
```

Sample Output 1

```
user@R6> show route 100.100.1.1 detail
inet.0: 30 destinations, 46 routes (29 active, 0 holddown, 1 hidden)
100.100.1.0/24 (1 entry, 1 announced)
        *BGP    Preference: 170/-101
                Source: 10.1.13.1
                Next hop: via so-0/0/3.0, selected
                 Protocol next hop: 10.1.13.1  Indirect next hop: 8671594 304
                State: <Active Int Ext>
                Local AS: 65432 Peer AS: 65432
                Age: 4d 5:15:39         Metric2: 2
                Task: BGP_65432.10.1.13.1+3048
                Announcement bits (2): 0-KRT 4-Resolve inet.0
                AS path: I
                Localpref: 100
                 Router ID: 10.0.0.1
```

Sample Output 2

```
user@R6> show route 100.100.1.1 detail
inet.0: 30 destinations, 46 routes (29 active, 0 holddown, 1 hidden)
100.100.1.0/24 (1 entry, 1 announced)
        *BGP    Preference: 170/-101
                Source: 10.0.0.1
                Next hop: via so-0/0/3.0 weight 1, selected
                 Label-switched-path R6-to-R1
                Label operation: Push 100000
                 Protocol next hop: 10.0.0.1  Indirect next hop: 8671330 301
                State: <Active Int Ext>
                Local AS: 65432 Peer AS: 65432
                Age: 24:35      Metric2: 2
                Task: BGP_65432.10.0.0.1+179
                Announcement bits (2): 0-KRT 4-Resolve inet.0
                AS path: I
                Localpref: 100
                 Router ID: 10.0.0.1
```

Meaning Sample Output 1 shows that the BGP next hop (**10.1.13.1**) does not equal the LSP destination address (**10.0.0.1**) in the **to** statement at the [**edit protocols mpls label-switched-path *label-switched-path-name***] hierarchy level when the BGP configuration of **R6** and **R1** is incorrect.

Sample Output 2, taken after the configurations on R1 and R6 are corrected, shows that the BGP next hop (**10.0.0.1**) and the LSP destination address (**10.0.0.1**) are the same, indicating that BGP can use the LSP to forward BGP traffic.

Verify Received BGP Routes

Purpose Display the routing information received on router **R6**,the ingress router for the reverse LSP **R6-to-R1**.

Action To verify that a particular BGP route is received on the egress router, enter the following Junos OS CLI operational mode command:

user@host> **show route receive protocol bgp *neighbor-address***

Sample Output 1

```
user@R6> show route receive-protocol bgp 10.0.0.1
inet.0: 30 destinations, 46 routes (29 active, 0 holddown, 1 hidden)
<<< missing route
inet.3: 1 destinations, 1 routes (1 active, 0 holddown, 0 hidden)
```

```
iso.0: 1 destinations, 1 routes (1 active, 0 holddown, 0 hidden)

mpls.0: 3 destinations, 3 routes (3 active, 0 holddown, 0 hidden)

__juniper_private1__.inet6.0: 1 destinations, 1 routes (1 active, 0 holddown, 0
hidden)
```

Sample Output 2

```
user@R6> show route receive-protocol bgp 10.0.0.1
inet.0: 30 destinations, 46 routes (29 active, 0 holddown, 1 hidden)
  Prefix                  Nexthop              MED     Lclpref    AS path
* 100.100.1.0/24     10.0.0.1         100    I

inet.3: 1 destinations, 1 routes (1 active, 0 holddown, 0 hidden)

iso.0: 1 destinations, 1 routes (1 active, 0 holddown, 0 hidden)

mpls.0: 3 destinations, 3 routes (3 active, 0 holddown, 0 hidden)

__juniper_private1__.inet6.0: 1 destinations, 1 routes (1 active, 0 holddown, 0
hidden)
```

Meaning Sample Output 1 shows that ingress router **R6** (reverse LSP **R6-to-R1**) does not receive any BGP routes into the **inet.0** routing table when the BGP configurations of **R1** and **R6** are incorrect.

Sample Output 2 shows a BGP route installed in the **inet.0** routing table after the BGP configurations on **R1** and **R6** are corrected using “Take Appropriate Action” on page 180.

Take Appropriate Action

Problem Depending on the error you encountered in your investigation, you must take the appropriate action to correct the problem. In this example, the ingress and egress routers are incorrectly configured for BGP to forward traffic using the LSP.

Solution To correct the errors in this example, follow these steps:

1. On ingress router R1, include the **local-address** statement and delete the incorrect interface address (repeat these steps on egress router R6):

   ```
   [edit]
   user@R1#  edit protocols bgp
   [edit protocols bgp]
   user@R1# show
   user@R1#  set local-address 10.0.0.1
   user@R1#  delete group internal neighbor 10.1.36.2
   ```

2. Verify and commit the configuration:

   ```
   [edit protocols bgp]
   user@R1# show
   user@R1# commit
   ```

Sample Output

```
[edit]
user@R1#  edit protocols bgp

[edit protocols bgp]
```

```
user@R1# show
export send-statics;
group internal {
    type internal;
    neighbor 10.0.0.2;
    neighbor 10.0.0.5;
    neighbor 10.0.0.4;
    neighbor 10.0.0.6;
    neighbor 10.0.0.3;
    neighbor 10.1.36.2;
}

[edit protocols bgp]
user@R1# set local-address 10.0.0.1

[edit protocols bgp]
user@R1#  delete group internal neighbor 10.1.36.2

[edit protocols bgp]
user@R1# show
local-address 10.0.0.1;
export send-statics;
group internal {
    type internal;
    neighbor 10.0.0.2;
    neighbor 10.0.0.5;
    neighbor 10.0.0.4;
    neighbor 10.0.0.6;
    neighbor 10.0.0.3;
}

[edit protocols bgp]
user@R1# commit
commit complete
```

Meaning The sample output shows that the configuration of BGP on ingress router **R1** is now correct. BGP can now forward BGP traffic through the LSP.

Check That BGP Traffic Is Using the LSP Again

Purpose After taking the appropriate action to correct the error, the LSP needs to be checked again to confirm that BGP traffic is using the LSP and that the problem in the BGP layer has been resolved.

Action To verify that BGP traffic is using the LSP, enter the following Junos OS CLI operational mode command from the ingress router:

user@host> **traceroute** ***hostname***

Sample Output

```
user@R1> traceroute 100.100.6.1
traceroute to 100.100.6.1 (100.100.6.1), 30 hops max, 40 byte packets
 1  10.1.13.2 (10.1.13.2)  0.858 ms  0.740 ms  0.714 ms
      MPLS Label=100016 CoS=0 TTL=1 S=1
 2  10.1.36.2 (10.1.36.2)  0.592 ms !N  0.564 ms !N  0.548 ms !N

user@R6> traceroute 100.100.1.1
traceroute to 100.100.1.1 (100.100.1.1), 30 hops max, 40 byte packets
 1  10.1.36.1 (10.1.36.1)  0.817 ms  0.697 ms  0.771 ms
```

```
     MPLS Label=100000 CoS=0 TTL=1 S=1
 2  10.1.13.1 (10.1.13.1)  0.581 ms !N  0.567 ms !N  0.544 ms !N
```

Meaning The sample output shows that MPLS labels are used to forward packets through the LSP. Included in the output is a label value (**MPLS Label=100016**), the time-to-live value (**TTL=1**), and the stack bit value (**S=1**).

The **MPLS Label** field is used to identify the packet to a particular LSP. It is a 20-bit field, with a maximum value of (2^^20-1), approximately 1,000,000.

The time-to-live (TTL) value contains a limit on the number of hops that this MPLS packet can travel through the network (1). It is decremented at each hop, and if the TTL value drops below one, the packet is discarded.

The bottom of the stack bit value (**S=1**) indicates that is the last label in the stack and that this MPLS packet has one label associated with it. The MPLS implementation in the Junos OS supports a stacking depth of 3 on the M-series routers and up to 5 on the T-series routing platforms. For more information on MPLS label stacking, see RFC 3032, *MPLS Label Stack Encoding.*

MPLS labels appear in the sample output because the **traceroute** command is issued to a BGP destination where the BGP next hop for that route is the LSP egress address. The Junos OS by default uses LSPs for BGP traffic when the BGP next hop equals the LSP egress address.

If the BGP next hop does not equal the LSP egress address, the BGP traffic does not use the LSP, and consequently MPLS labels do not appear in the output for the **traceroute** command, as indicated in the sample output in “Check BGP Sessions” on page 172.

PART 3

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