JUNOS™ Internet Software
for M-series and T-series Routing Platforms

MPLS Network Operations Guide

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

530-012279-01, Revision 3

JUNOS Internet Software for M-series and T-series Routing Platforms MPLS Network Operations Guide
Writer: Merisha Wazna
Editor: Sonia Saruba
Covers and template design: Edmonds Design

Thanks to Tom Van Meter, Peter Moyer, and Joe Sorecelli for their help with the development of this book, and Craig Pierantozzi for his review comments.

Revision History
31 March 2005—Revision 1.
13 June 2005—Revision 2.
10 April—Revision 3.

The information in this document is current as of the date listed in the revision history.

Year 2000 Notice

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

Software License

The terms and conditions for using this software are described in the software license contained in the acknowledgment to your purchase order or, to the extent applicable, to any reseller agreement or end-user purchase agreement executed between you and Juniper Networks. By using this software, you indicate that you understand and agree to be bound by those terms and conditions.

Generally speaking, the software license restricts the manner in which you are permitted to use the software and may contain prohibitions against certain uses. The software license may state conditions under which the license is automatically terminated. You should consult the license for further details.

For complete product documentation, please see the Juniper Networks Web site at www.juniper.net/techpubs.

End User License Agreement

READ THIS END USER LICENSE AGREEMENT ("AGREEMENT") BEFORE DOWNLOADING, INSTALLING, OR USING THE SOFTWARE. BY DOWNLOADING, INSTALLING, OR USING THE SOFTWARE OR OTHERWISE EXPRESSING YOUR AGREEMENT TO THE TERMS CONTAINED HEREIN, YOU (AS CUSTOMER OR IF YOU ARE NOT THE CUSTOMER, AS A REPRESENTATIVE/AGENT AUTHORIZED TO BIND THE CUSTOMER) CONSENT TO BE BOUND BY THIS AGREEMENT. IF YOU DO NOT OR CANNOT AGREE TO THE TERMS CONTAINED HEREIN, THEN (A) DO NOT DOWNLOAD, INSTALL, OR USE THE SOFTWARE, AND (B) YOU MAY CONTACT JUNIPER NETWORKS REGARDING LICENSE TERMS.

1. The Parties. The parties to this Agreement are Juniper Networks, Inc. and its subsidiaries (collectively "Juniper"), and the person or organization that originally purchased from Juniper or an authorized Juniper reseller the applicable license(s) for use of the Software ("Customer") (collectively, the "Parties").

2. The Software. In this Agreement, "Software" means the program modules and features of the Juniper or Juniper-supplied software, and updates and releases of such software, for which Customer has paid the applicable license or support fees to Juniper or an authorized Juniper reseller. "Embedded Software" means Software which Juniper has embedded in the Juniper equipment.

3. License Grant. Subject to payment of the applicable fees and the limitations and restrictions set forth herein, Juniper grants to Customer a non-exclusive and non-transferable license, without right to sublicense, to use the Software, in executable form only, subject to the following use restrictions:

a. Customer shall use the Embedded Software solely as embedded in, and for execution on, Juniper equipment originally purchased by Customer from Juniper or an authorized Juniper reseller.

b. Customer shall use the Software on a single hardware chassis having a single processing unit, or as many chassis or processing units for which Customer has paid the applicable license fees; provided, however, with respect to the Steel-Belted Radius or Odyssey Access Client software only, Customer shall use such Software on a single computer containing a single physical random access memory space and containing any number of processors. Use of the Steel-Belted Radius software on multiple computers requires multiple licenses, regardless of whether such computers are physically contained on a single chassis.

c. Product purchase documents, paper or electronic user documentation, and/or the particular licenses purchased by Customer may specify limits to Customer's use of the Software. Such limits may restrict use to a maximum number of seats, registered endpoints, concurrent users, sessions, calls, connections, subscribers, clusters, nodes, realms, devices, links, ports or transactions, or require the purchase of separate licenses to use particular features, functionalities, services, applications, operations, or capabilities, or provide throughput, performance, configuration, bandwidth, interface, processing, temporal, or geographical limits. In addition, such limits may restrict the use of the Software to managing certain kinds of networks or require the Software to be used only in conjunction with other specific Software. Customer's use of the Software shall be subject to all such limitations and purchase of all applicable licenses.

d. For any trial copy of the Software, Customer's right to use the Software expires 30 days after download, installation or use of the Software. Customer may operate the Software after the 30-day trial period only if Customer pays for a license to do so. Customer may not extend or create an additional trial period by re-installing the Software after the 30-day trial period.

e. The Global Enterprise Edition of the Steel-Belted Radius software may be used by Customer only to manage access to Customer's enterprise network. Specifically, service provider customers are expressly prohibited from using the Global Enterprise Edition of the Steel-Belted Radius software to support any commercial network access services.

The foregoing license is not transferable or assignable by Customer. No license is granted herein to any user who did not originally purchase the applicable license(s) for the Software from Juniper or an authorized Juniper reseller.

4. Use Prohibitions. Notwithstanding the foregoing, the license provided herein does not permit the Customer to, and Customer agrees not to and shall not: (a) modify, unbundle, reverse engineer, or create derivative works based on the Software; (b) make unauthorized copies of the Software (except as necessary for backup purposes); (c) rent, sell, transfer, or grant any rights in and to any copy of the Software, in any form, to any third party; (d) remove any proprietary notices, labels, or marks on or in any copy of the Software or any product in which the Software is embedded; (e) distribute any copy of the Software to any third party, including as may be embedded in Juniper equipment sold in the secondhand market; (f) use any 'locked' or key-restricted feature, function, service, application, operation, or capability without first purchasing the applicable license(s) and obtaining a valid key from Juniper, even if such feature, function, service, application, operation, or capability is enabled without a key; (g) distribute any key for the Software provided by Juniper to any third party; (h) use the Software in any manner that extends or is broader than the uses purchased by Customer from Juniper or an authorized Juniper reseller; (i) use the Embedded Software on non-Juniper equipment; (j) use the Software (or make it available for use) on Juniper equipment that the Customer did not originally purchase from Juniper or an authorized Juniper reseller; (k) disclose the results of testing or benchmarking of the Software to any third party without the prior written consent of Juniper; or (l) use the Software in any manner other than as expressly provided herein.

5. Audit. Customer shall maintain accurate records as necessary to verify compliance with this Agreement. Upon request by Juniper, Customer shall furnish such records to Juniper and certify its compliance with this Agreement.

6. Confidentiality. The Parties agree that aspects of the Software and associated documentation are the confidential property of Juniper. As such, Customer shall exercise all reasonable commercial efforts to maintain the Software and associated documentation in confidence, which at a minimum includes restricting access to the Software to Customer employees and contractors having a need to use the Software for Customer's internal business purposes.

7. Ownership. Juniper and Juniper's licensors, respectively, retain ownership of all right, title, and interest (including copyright) in and to the Software, associated documentation, and all copies of the Software. Nothing in this Agreement constitutes a transfer or conveyance of any right, title, or interest in the Software or associated documentation, or a sale of the Software, associated documentation, or copies of the Software.

8. Warranty, Limitation of Liability, Disclaimer of Warranty. The warranty applicable to the Software shall be as set forth in the warranty statement that accompanies the Software (the "Warranty Statement"). Nothing in this Agreement shall give rise to any obligation to support the Software. Support services may be purchased separately. Any such support shall be governed by a separate, written support services agreement. TO THE MAXIMUM EXTENT PERMITTED BY LAW, JUNIPER SHALL NOT BE LIABLE FOR ANY LOST PROFITS, LOSS OF DATA, OR COSTS OR PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, OR FOR ANY SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES ARISING OUT OF THIS AGREEMENT, THE SOFTWARE, OR ANY JUNIPER OR JUNIPER-SUPPLIED SOFTWARE. IN NO EVENT SHALL JUNIPER BE LIABLE FOR DAMAGES ARISING FROM UNAUTHORIZED OR IMPROPER USE OF ANY JUNIPER OR JUNIPER-SUPPLIED SOFTWARE. EXCEPT AS EXPRESSLY PROVIDED IN THE WARRANTY STATEMENT TO THE EXTENT PERMITTED BY LAW, JUNIPER DISCLAIMS ANY AND ALL WARRANTIES IN AND TO THE SOFTWARE (WHETHER EXPRESS, IMPLIED, STATUTORY, OR OTHERWISE), INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR NONINFRINGEMENT. IN NO EVENT DOES JUNIPER WARRANT THAT THE SOFTWARE, OR ANY EQUIPMENT OR NETWORK RUNNING THE SOFTWARE, WILL OPERATE WITHOUT ERROR OR INTERRUPTION, OR WILL BE FREE OF VULNERABILITY TO INTRUSION OR ATTACK. In no event shall Juniper's or its suppliers' or licensors' liability to Customer, whether in contract, tort (including negligence), breach of warranty, or otherwise, exceed the price paid by Customer for the Software that gave rise to the claim, or if the Software is embedded in another Juniper product, the price paid by Customer for such other product. Customer acknowledges and agrees that Juniper has set its prices and entered into this Agreement in reliance upon the disclaimers of warranty and the limitations of liability set forth herein, that the same reflect an allocation of risk between the Parties (including the risk that a contract remedy may fail of its essential purpose and cause consequential loss), and that the same form an essential basis of the bargain between the Parties.

9. Termination. Any breach of this Agreement or failure by Customer to pay any applicable fees due shall result in automatic termination of the license granted herein. Upon such termination, Customer shall destroy or return to Juniper all copies of the Software and related documentation in Customer's possession or control.

10. Taxes. All license fees for the Software are exclusive of taxes, withholdings, duties, or levies (collectively "Taxes"). Customer shall be responsible for paying Taxes arising from the purchase of the license, or importation or use of the Software.

11. Export. Customer agrees to comply with all applicable export laws and restrictions and regulations of any United States and any applicable foreign agency or authority, and not to export or re-export the Software or any direct product thereof in violation of any such restrictions, laws or regulations, or without all necessary approvals. Customer shall be liable for any such violations. The version of the Software supplied to Customer may contain encryption or other capabilities restricting Customer's ability to export the Software without an export license.

12. Commercial Computer Software. The Software is "commercial computer software" and is provided with restricted rights. Use, duplication, or disclosure by the United States government is subject to restrictions set forth in this Agreement and as provided in DFARS 227.7201 through 227.7202-4, FAR 12.212, FAR 27.405(b)(2), FAR 52.227-19, or FAR 52.227-14(ALT III) as applicable.

13. Interface Information. To the extent required by applicable law, and at Customer's written request, Juniper shall provide Customer with the interface information needed to achieve interoperability between the Software and another independently created program, on payment of applicable fee, if any. Customer shall observe strict obligations of confidentiality with respect to such information and shall use such information in compliance with any applicable terms and conditions upon which Juniper makes such information available.

14. Third Party Software. Any licensor of Juniper whose software is embedded in the Software and any supplier of Juniper whose products or technology are embedded in (or services are accessed by) the Software shall be a third party beneficiary with respect to this Agreement, and such licensor or vendor shall have the right to enforce this Agreement in its own name as if it were Juniper. In addition, certain third party software may be provided with the Software and is subject to the accompanying license(s), if any, of its respective owner(s). To the extent portions of the Software are distributed under and subject to open source licenses obligating Juniper to make the source code for such portions publicly available (such as the GNU General Public License ("GPL") or the GNU Library General Public License ("LGPL")), Juniper will make such source code portions (including Juniper modifications, as appropriate) available upon request for a period of up to three years from the date of distribution. Such request can be made in writing to Juniper Networks, Inc., 1194 N. Mathilda Ave., Sunnyvale, CA 94089, ATTN: General Counsel. You may obtain a copy of the GPL at http://www.gnu.org/licenses/gpl.html, and a copy of the LGPL at http://www.gnu.org/licenses/lgpl.html.

15. Miscellaneous. This Agreement shall be governed by the laws of the State of California without reference to its conflicts of laws principles. The provisions of the U.N. Convention for the International Sale of Goods shall not apply to this Agreement. For any disputes arising under this Agreement, the Parties hereby consent to the personal and exclusive jurisdiction of, and venue in, the state and federal courts within Santa Clara County, California. This Agreement constitutes the entire and sole agreement between Juniper and the Customer with respect to the Software, and supersedes all prior and contemporaneous agreements relating to the Software, whether oral or written (including any inconsistent terms contained in a purchase order), except that the terms of a separate written agreement executed by an authorized Juniper representative and Customer shall govern to the extent such terms are inconsistent or conflict with terms contained herein. No modification to this Agreement nor any waiver of any rights hereunder shall be effective unless expressly assented to in writing by the party to be charged. If any portion of this Agreement is held invalid, the Parties agree that such invalidity shall not affect the validity of the remainder of this Agreement. This Agreement and associated documentation has been written in the English language, and the Parties agree that the English version will govern. (For Canada: Les parties aux présentés confirment leur volonté que cette convention de même que tous les documents y compris tout avis qui s'y rattaché, soient redigés en langue anglaise. (Translation: The parties confirm that this Agreement and all related documentation is and will be in the English language)).

Abbreviated Table of Contents

Table of Contents

Part 3 Appendix

Part 4 Index

About This Guide

This preface provides the following guidelines for using the *JUNOS Internet Software for J-series, M-series, and T-series Routing Platforms MPLS Network Operations Guide* and related Juniper Networks, Inc., technical documents:

Objectives

This manual provides operational information helpful in monitoring router components and isolating potential problems. This manual is not directly related to any particular release of the JUNOS Internet software.

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

Audience

This guide is designed for network administrators who are configuring and monitoring a Juniper Networks M-series or T-series routing platform in an MPLS network environment.

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

Personnel operating the equipment must be trained and competent; must not conduct themselves in a careless, willfully negligent, or hostile manner; and must abide by the instructions provided by the documentation.

Chapter Organization

Most chapters in this manual consist of a checklist at the beginning of the chapter listing the tasks and commands for monitoring the interface. The tasks and commands are then explained in step-by-step procedures.

Each step-by-step procedure consists of some or all of the following parts:

- Purpose—Describes what is affected if this task is not performed or what is accomplished with this task.
- What Is... —Describes a component (usually hardware).
- Step(s) To Take—Lists the steps in the task.
- Action—Describes an action to perform in order to complete the step.
- Sample Output—Presents sample output relevant to the procedure.

- What It Means—Describes or summarizes what is presented in the sample output.
- Symptom/Indications—Describes a problem with the software or hardware.
- See Also—Lists other topics related to this task.
- Alternative Actions—Describes other commands or ways of doing the task.
- Syntax—Describes the full syntax of the command or configuration statement. For an explanation of how to read the syntax statements, see "Documentation Conventions" on page xv.

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 CLI User Guide*.

Documentation Conventions

Table 1 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.

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

Table 2: Text and Syntax Conventions (1 of 2)

Convention	Element	Example
Bold sans serif typeface	Represents text that you type.	To enter configuration mode, type the configure command: user@host> **configure**
`Fixed-width typeface`	Represents output on the terminal screen.	`user@host> show chassis alarms` `No alarms currently active`
Italic typeface	■ 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 System Basics Configuration Guide* ■ RFC 1997, *BGP Communities Attribute*
Italic sans serif typeface	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*
Sans serif typeface	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*]

Table 2: Text and Syntax Conventions (2 of 2)

Convention	Element	Example

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 typeface	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**.

Related Juniper Networks Documentation

Table 3 lists the books included in the *Network Operations Guide* series.

Table 3: JUNOS Internet Software Network Operations Guides

Book	Description
JUNOS Internet Software for M-series and T-series Routing Platforms Network Operations Guides	
Baseline	Describes the most basic tasks for running a network using Juniper Networks products. Tasks include upgrading and reinstalling JUNOS software, 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 routers in the network, and using the layered MPLS troubleshooting model to investigate problems with an MPLS network.
Hardware	Describes tasks for monitoring M-series and T-series routing platforms.

Table lists the software and hardware guides and release notes for Juniper Networks J-series, M-series, and T-series routing platforms and describes the contents of each document..

Table 4: Technical Documentation for J-series, M-series, and T-series Routing Platforms (1 of 3)

Document	Description
JUNOS Internet Software for J-series, M-series, and T-series Routing Platforms Configuration Guides	
Class of Service	Provides an overview of the class-of-service (CoS) functions of the JUNOS software and describes how to configure CoS features, including configuring multiple forwarding classes for transmitting packets, defining which packets are placed into each output queue, scheduling the transmission service level for each queue, and managing congestion through the random early detection (RED) algorithm.
CLI User Guide	Describes how to use the JUNOS command-line interface (CLI) to configure, monitor, and manage Juniper Networks routing platforms. This material was formerly covered in *JUNOS System Basics Configuration Guide.*
Feature Guide	Provides a detailed explanation and configuration examples for several of the most complex features in the JUNOS software.
JUNOS-FIPS	(M-series and T-series routing platforms only) Provides an overview of JUNOS-FIPS 140-2 concepts and describes how to install and configure the JUNOS-FIPS software. Describes FIPS-related commands and how to configure, authorize, and zeroize the Adaptive Services (AS) II FIPS Physical Interface Card (PIC).
MPLS Applications	Provides an overview of traffic engineering concepts and describes how to configure traffic engineering protocols.
Multicast Protocols	Provides an overview of multicast concepts and describes how to configure multicast routing protocols.
Network Interfaces	Provides an overview of the network interface functions of the JUNOS software and describes how to configure the network interfaces on the routing platform.
Network Management	Provides an overview of network management concepts and describes how to configure various network management features, such as SNMP and accounting options.
Policy Framework	Provides an overview of policy concepts and describes how to configure routing policy, firewall filters, forwarding options, and cflowd.
Routing Protocols	Provides an overview of routing concepts and describes how to configure routing, routing instances, and unicast routing protocols.
Services Interfaces	Provides an overview of the services interfaces functions of the JUNOS software and describes how to configure the services interfaces on the routing platform.
Software Installation and Upgrade Guide	Provides a description of JUNOS software components and packaging, and includes detailed information about how to initially configure, reinstall, and upgrade the JUNOS system software. This material was formerly covered in *JUNOS System Basics Configuration Guide*.
System Basics	Describes Juniper Networks routing platforms, and provides information about how to configure basic system parameters, supported protocols and software processes, authentication, and a variety of utilities for managing your router on the network.
VPNs	Provides an overview and describes how to configure Layer 2 and Layer 3 virtual private networks (VPNs), virtual private LAN service (VPLS), and Layer 2 circuits. Provides configuration examples.

Table 4: Technical Documentation for J-series, M-series, and T-series Routing Platforms (2 of 3)

Document	Description
JUNOS References	
Hierarchy and RFC Reference	Describes the JUNOS configuration mode commands. Provides a hierarchy reference that displays each level of a configuration hierarchy, and includes all possible configuration statements that can be used at that level. This material was formerly covered in *JUNOS System Basics Configuration Guide*.
Interfaces Command Reference	Describes the JUNOS software operational mode commands you use to monitor and troubleshoot interfaces.
Routing Protocols and Policies Command Reference	Describes the JUNOS software operational mode commands you use to monitor and troubleshoot routing protocols and policies, including firewall filters.
System Basics and Services Command Reference	Describes the JUNOS software operational mode commands you use to monitor and troubleshoot system basics, including commands for real-time monitoring and route (or path) tracing, system software management, and chassis management. Also describes commands for monitoring and troubleshooting services such as CoS, IP Security (IPSec), stateful firewalls, flow collection, and flow monitoring.
System Log Messages Reference	Describes how to access and interpret system log messages generated by JUNOS software modules and provides a reference page for each message.
J-Web User Guide	
J-Web Interface User Guide	Describes how to use the J-Web GUI to configure, monitor, and manage Juniper Networks routing platforms.
JUNOS API and Scripting Documentation	
JUNOScript API Guide	Describes how to use the JUNOScript application programming interface (API) to monitor and configure Juniper Networks routing platforms.
JUNOS XML API Configuration Reference	Provides reference pages for the configuration tag elements in the JUNOS XML API.
JUNOS XML API Operational Reference	Provides reference pages for the operational tag elements in the JUNOS XML API.
JUNOS Configuration and Diagnostic Automation Guide	Provides an overview, instructions for using, and examples of the commit script and self-diagnosis features of the JUNOS software. This guide explains how to enforce custom configuration rules defined in scripts that run at commit time, how to use commit script macros to provide simplified aliases for frequently used configuration statements, and how to configure diagnostic event policies and actions associated with each policy.
NETCONF API Guide	Describes how to use the NETCONF API to monitor and configure Juniper Networks routing platforms.
JUNOS Comprehensive Index and Glossary	
Comprehensive Index and Glossary	Provides a complete index of all JUNOS software books, the *JUNOScript API Guide*, and the *NETCONF API Guide*. Also provides a comprehensive glossary.
JUNOScope Documentation	
JUNOScope Software User Guide	Describes the JUNOScope software 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.
J-series Services Router Documentation	
J-series Services Router Getting Started Guide	Provides an overview, basic instructions, and specifications for J-series Services Routers. The guide explains how to prepare your site for installation, unpack and install the router and its components, install licenses, and establish basic connectivity.
J-series Services Router Basic LAN and WAN Access Configuration Guide	Explains how to configure the interfaces on J-series Services Routers for basic IP routing with standard routing protocols, ISDN backup, and digital subscriber line (DSL) connections.

Table 4: Technical Documentation for J-series, M-series, and T-series Routing Platforms (3 of 3)

Document	Description
J-series Services Router Advanced WAN Access Configuration Guide	Explains how to configure J-series Services Routers in virtual private networks (VPNs) and multicast networks, configure data link switching (DLSw) services, and apply routing techniques such as policies, stateless and stateful firewall filters, IP Security (IPSec) tunnels, and class-of-service (CoS) classification for safer, more efficient routing.
J-series Services Router Administration Guide	Shows how to manage users and operations, monitor network performance, upgrade software, and diagnose common problems on J-series Services Routers.
M-series and T-series 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 PICs. Each platform has its own PIC guide.
Release Notes	
JUNOS Release Notes	Summarize new features and known problems for a particular software release, provide corrections and updates to published JUNOS, JUNOScript, 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 the supported PICs, and summarize known problems with the hardware and accompanying software. Each platform has its own release notes.
JUNOScope Software Release Notes	Contain corrections and updates to the published JUNOScope manual, provide information that might have been omitted from the manual, and describe upgrade and downgrade procedures.
J-series Services Router Release Notes	Briefly describe the J-series Services Router features, identify known hardware problems, and provide upgrade and downgrade instructions.

Documentation Feedback

We encourage you to provide feedback, comments, and suggestions so that we can improve the documentation. Send your comments to techpubs-comments@juniper.net, or fill out the documentation feedback form at http://www.juniper.net/techpubs/docbug/docbugreport.html. If you are using e-mail, be sure to include the following information with your comments:

- Document name
- Document part number
- Page number
- Software release version

Requesting Support

For technical support, open a support case using the Case Manager link at http://www.juniper.net/support/ or call 1-888-314-JTAC (from the United States, Canada, or Mexico) or 1-408-745-9500 (from elsewhere).

Part 1

Monitoring an MPLS Network

This part describes how to configure an example network with Multiprotocol Label Switching (MPLS), verify the correct configuration of both MPLS and the Resource Reservation Protocol (RSVP), and display the status and statistics of MPLS running on all routers in the network.

This part also includes the operational mode commands and steps you use in determining status and statistics information useful in diagnosing problem situations, determining whether RSVP path messages are being sent and received, and verifying the availability and valid use of a label-switched path (LSP) in the network. The information is covered in the following chapters:

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. (See Table 5.)

Table 5: Checklist for Verifying a Network Configured with MPLS

Verifying a Network Configured with MPLS Tasks	Command or Action
Configuring MPLS on Your Network on page 6	
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	
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 14	[edit] edit interfaces set *type-fpc/pic/port* unit *number* family iso show commit
d. Verify That IS-IS Adjacencies Are Established on page 15	show isis adjacency

Verifying a Network Configured with MPLS Tasks	Command or Action
3. Configure OSPF as the IGP on page 16	
a. Enable OSPF on Routers in Your Network on page 17	[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 19	show ospf neighbor
4. Set Up BGP on Routers in Your Network on page 21	
a. Define the Local Autonomous System on page 22	[edit] edit routing-options set autonomous-system *as-number* show commit
b. Configure BGP Neighbor Connections on page 23	[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 24	[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 26	show bgp summary
5. Enable MPLS and RSVP on page 28	
a. Enable MPLS and RSVP on Routers on page 28	[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

Verifying a Network Configured with MPLS Tasks	Command or Action
b. Enable MPLS on Transit Interfaces on page 29	[edit] edit interfaces set *type-fpc/pic/port* unit *number* family mpls show commit
6. Establish an LSP in Your Network on page 30	
a. Configure the LSP on page 30	[edit] edit protocols mpls set label-switched-path *lsp-path-name* to *address* show commit
b. Verify the LSP on page 32	show mpls lsp extensive
Example Configurations for an MPLS Topology on page 34	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

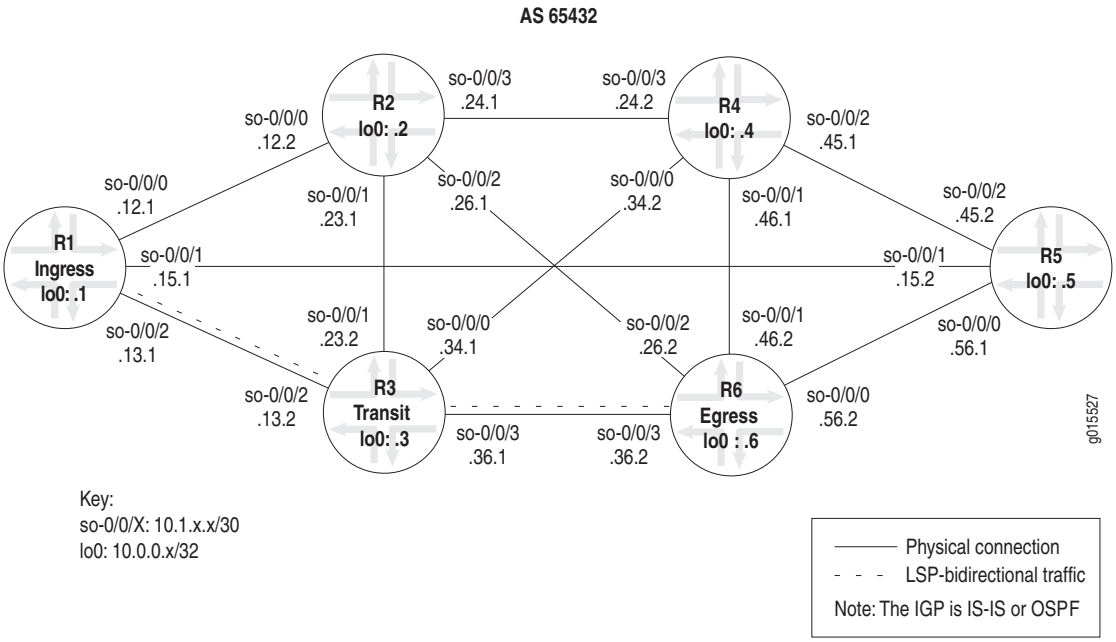
In addition, you must configure a label-switched path (LSP) from the ingress router to the egress router. For more information on ingress and egress routers, see the *JUNOS MPLS Applications Configuration Guide*.

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 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 software. The example network in Figure 1 focuses on CSPF LSPs.

Figure 1 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 6 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 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 34 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.

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 28 as appropriate on other routers until all routers and interfaces are enabled for MPLS.

Steps To Take 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 16
4. Set Up BGP on Routers in Your Network on page 21
5. Enable MPLS and RSVP on page 28
6. Establish an LSP in Your Network on page 30

Step 1: 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
```

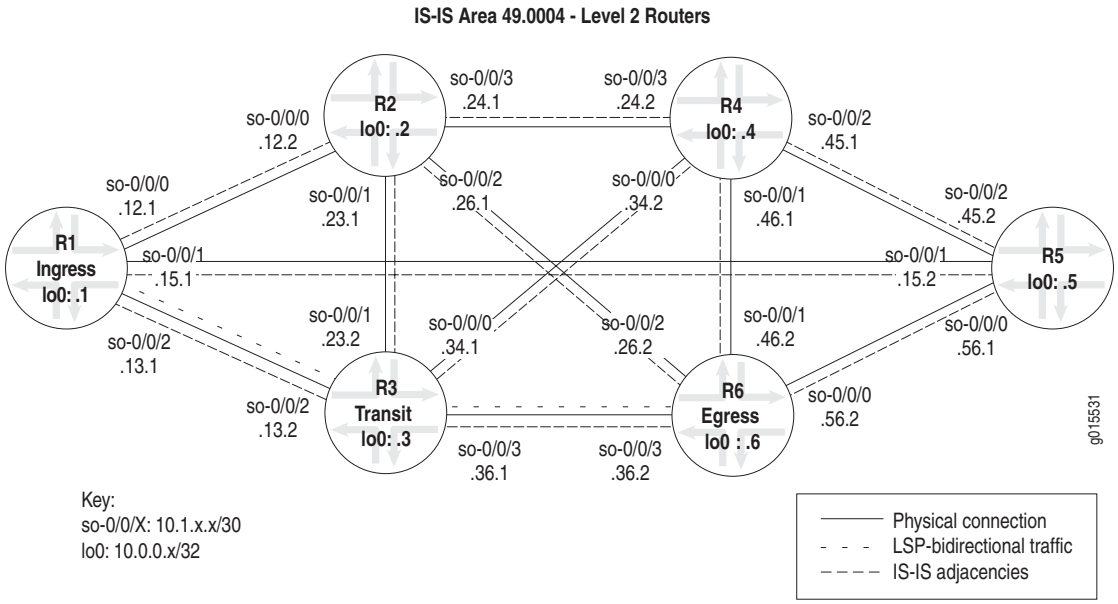
What It Means The sample output shows an interface configured with an IP address. The IP address is assigned when you configure the protocol family. In this instance, the IP address is included in the inet family. The family statement identifies which protocol packets are accepted into the interfaces. For example, valid IP packets are dropped if the interface is not configured with the family inet statement.

For more information on interface addressing, see the *JUNOS Network Interfaces Configuration Guide*.

Step 2: Configure IS-IS as the IGP

Purpose 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 16.

Figure 2: IS-IS Network Topology



The IS-IS IGP in the MPLS network in Figure 2 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 14 as appropriate on other routers until all routers and interfaces establish IS-IS adjacencies.

Steps To Take 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 14
4. Verify That IS-IS Adjacencies Are Established on page 15

1. 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;
}
```

What It Means

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 6 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.

2. 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
```

What It Means

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 6 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*.

3. 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
```

What It Means The sample output shows that the interface so-0/0/2 is configured with IS-IS.

4. 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 command-line interface (CLI) operational mode command:

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

Sample Output

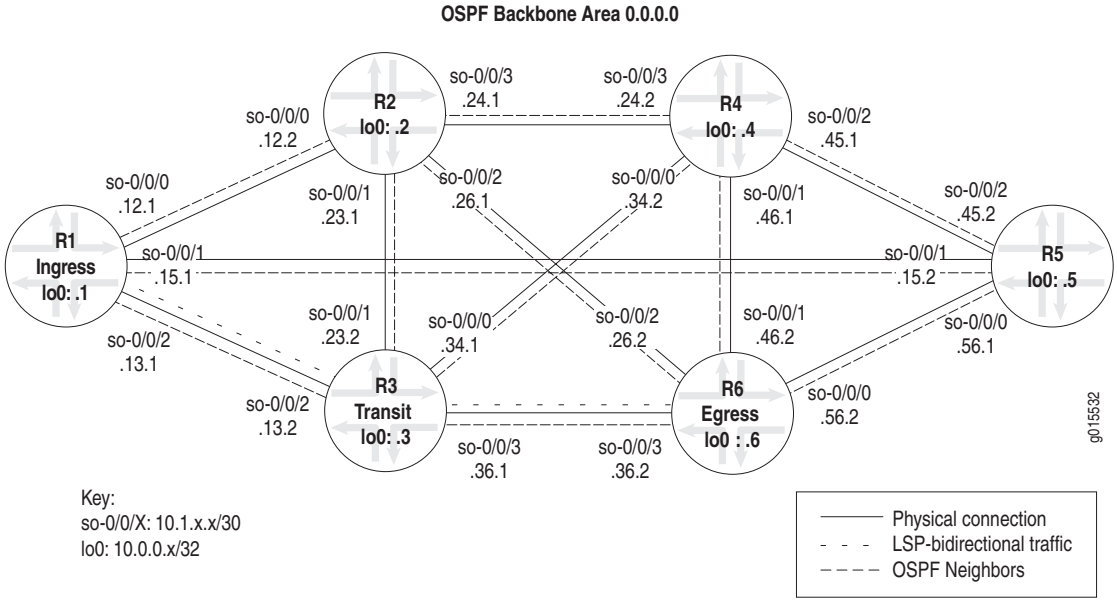
```
user@R1> show isis adjacency
Interface             System         L State       Hold (secs) SNPA
so-0/0/0.0            R2             2 Up                   25
so-0/0/1.0            R5             2 Up                   23
so-0/0/2.0            R3             2 Up                   20

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
```

What It Means The sample output from the ingress, transit, and egress routers shows that all routers in the network shown in Figure 1 on page 6 have formed IS-IS adjacencies.

Step 3: Configure OSPF as the IGP

Purpose 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 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.

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

1. Enable OSPF on Routers in Your Network on page 17
2. Verify That OSPF Neighbors Are Established on page 19

1. 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
```

What It Means 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.

2. 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 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
```

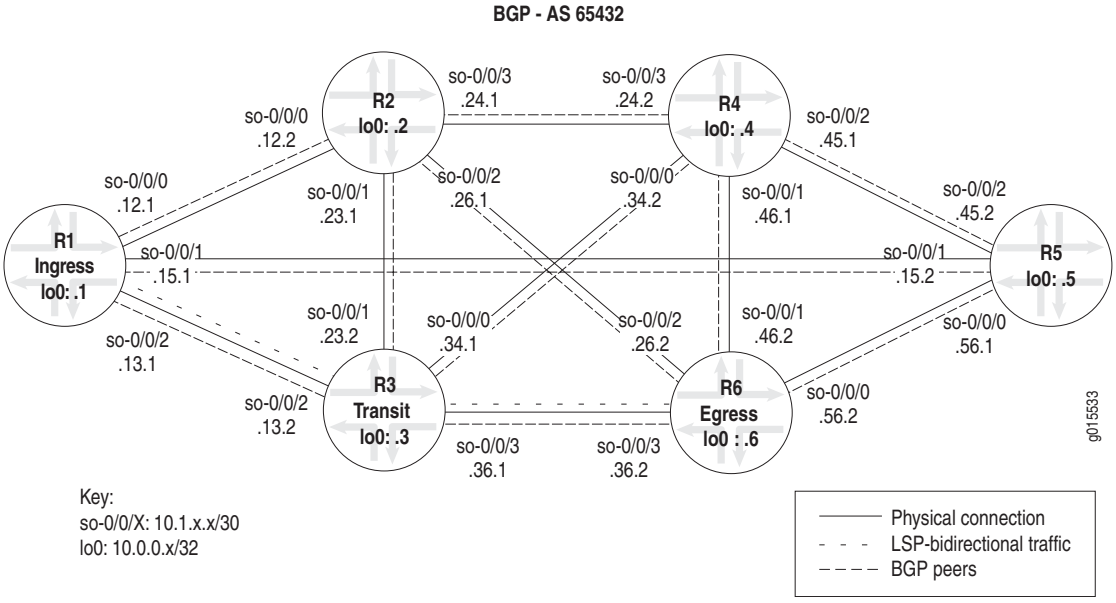
What It Means The sample output from the ingress, transit, and egress routers shows that all routers in the network shown in Figure 1 on page 6 have formed OSPF neighbor adjacencies.

Step 4: Set Up BGP on Routers in Your Network

Purpose 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 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 22 through Step 3, "Configure a Simple Routing Policy" on page 24 as appropriate on other routers until all routers are set up with BGP.

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

1. Define the Local Autonomous System on page 22
2. Configure BGP Neighbor Connections on page 23
3. Configure a Simple Routing Policy on page 24
4. Verify That BGP Sessions Are Up on page 26

1. 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 21, 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
```

What It Means The output shows that router R1 resides in AS 65432. All other routers in the example network shown in Figure 4 on page 21 also reside in AS 65432.

2. 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 21, 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
```

What It Means 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.

3. 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 21, 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
```

What It Means 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.

4. 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 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
```

What It Means The sample output from the ingress, transit, and egress routers shows that all routers in the network shown in Figure 4 on page 21 have BGP peers established and sessions up.

Step 5: Enable MPLS and RSVP

Purpose You can enable MPLS and RSVP throughout the rest of the network by repeating Step 1, "Enable MPLS and RSVP on Routers" on page 28 and Step 2, "Enable MPLS on Transit Interfaces" on page 29 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 this chapter to have the MPLS protocol running on your network.

Steps To Take

1. Enable MPLS and RSVP on Routers on page 28
2. Enable MPLS on Transit Interfaces on page 29

1. 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
```

What It Means 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 6 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.

2. Enable MPLS on Transit 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 chapter 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
```

What It Means 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.

Step 6: Establish an LSP in Your Network

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

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

1. Configure the LSP on page 30.
2. Verify the LSP on page 32.

1. 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;
}
```

What It Means

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 software. The example network shown in Figure 1 on page 6 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 6, 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.

2. 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
```

What It Means 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 "Determining the LSP State" on page 59.

Example Configurations for an MPLS Topology

Purpose The configurations in this section are for the six routers in the example network illustrated in Figure 1 on page 6.

Action To display the configuration of a router, use the following JUNOS 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;
        }
    }
}
```

What It Means Sample Outputs 1 through 6 show the configurations of all six routers in the example network illustrated in Figure 1 on page 6. 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. (See Table 6.)

Table 6: Checklist for Checking the MPLS and RSVP Configuration

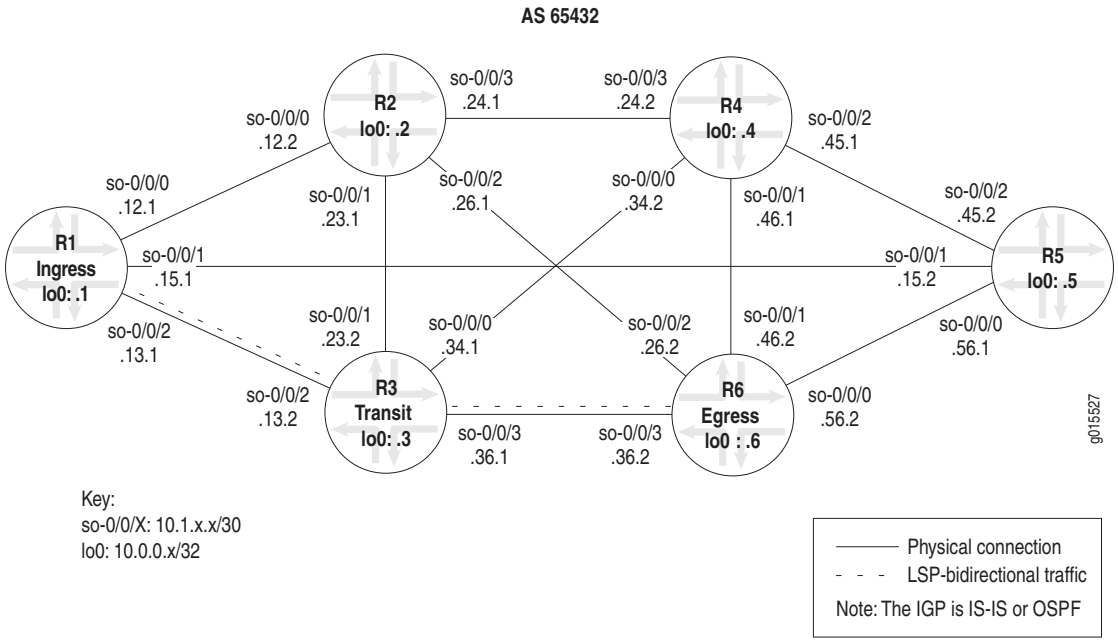
Checking the MPLS and RSVP Configuration Tasks	Command or Action
Verifying the MPLS Configuration on page 46	
1. Verify MPLS Interfaces on page 47	show mpls interface
2. Verify the RSVP Protocol on page 49	show rsvp version
3. Verify RSVP Interfaces on page 50	show rsvp interface
4. Verify Protocol Families on page 52	show interfaces terse
5. Verify MPLS Labels on page 55	
a. Use the traceroute Command to Verify MPLS Labels on page 55	traceroute *host-name* or *ip-address-of-remote-host*
b. Use the ping Command to Verify MPLS Labels on page 56	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

Purpose 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 illustrates the network with the example configurations used in this chapter. For more details about the router configurations in this network, see "Configuring MPLS on a Network" on page 3.

Figure 5: MPLS Network Topology



Steps To Take To verify the MPLS configuration, follow these steps:

1. Verify MPLS Interfaces on page 47
2. Verify the RSVP Protocol on page 49
3. Verify RSVP Interfaces on page 50
4. Verify Protocol Families on page 52
5. Verify MPLS Labels on page 55

Step 1: 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 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 46.

```
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
```

What It Means

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 46. 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 52.

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 a Network” on page 3.

Step 2: 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 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
```

What It Means 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 46.

Step 3: 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 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
```

What It Means

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 a Network” on page 3.

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

Step 4: 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 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
```

What It Means

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 46 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 a Network" on page 3.

Step 5: Verify MPLS Labels

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

Steps To Take 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 55
2. Use the ping Command to Verify MPLS Labels on page 56

1. Use the traceroute Command to Verify MPLS Labels

Action To verify MPLS labels, enter the following JUNOS 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
```

What It Means 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 software 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 software 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).

2. 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 46, 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
```

What It Means

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. (See Table 7.)

Table 7: Checklist for Determining the LSP State

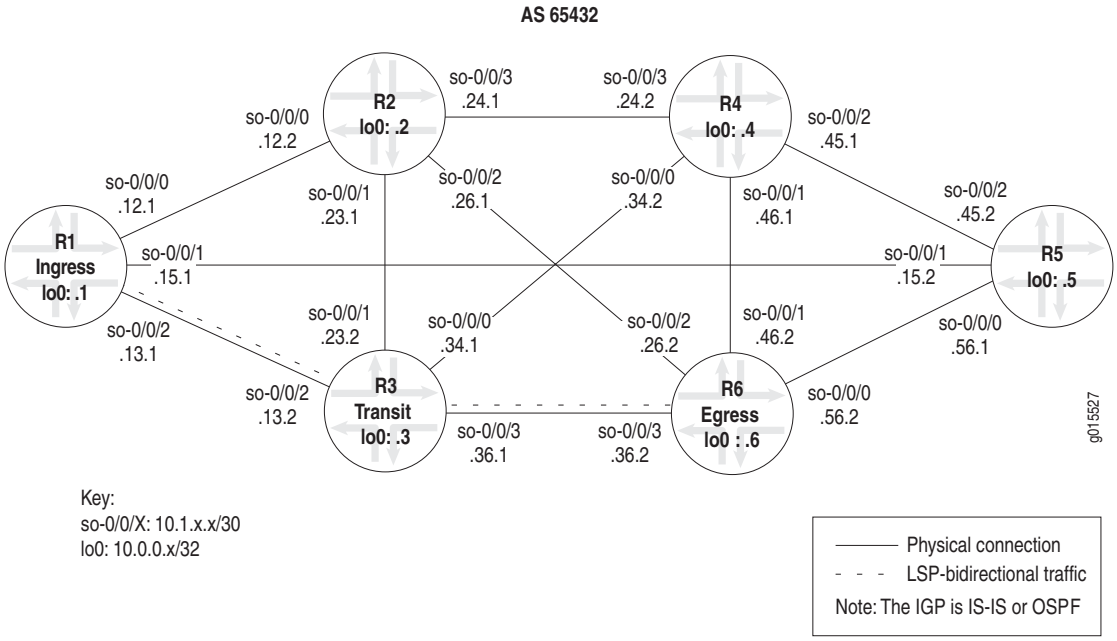
Determining the LSP State Tasks	Command or Action
Determining LSP Status on page 60	
1. Check the Status of the LSP on page 60	show mpls lsp
2. Display Extensive Status About the LSP on page 61	show mpls lsp extensive
Determining LSP Statistics on page 66	show rsvp session detail

Determining LSP Status

Purpose 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 illustrates the network topology used in this chapter. For more details about the router configurations in this network, see “Configuring MPLS on a Network” on page 3.

Figure 6: MPLS Network Topology



Steps To Take To determine the LSP state, follow these steps:

1. Check the Status of the LSP on page 60
2. Display Extensive Status About the LSP on page 61

Step 1: Check the Status of the LSP

Action To determine the LSP status, on the ingress router, enter the following JUNOS 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     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
```

What It Means 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 "Working with the Layered MPLS Troubleshooting Model" on page 85.

Step 2: 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 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
```

What It Means 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 “Working with the Layered MPLS Troubleshooting Model” on page 85.

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 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
```

What It Means 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. (See Table 8.)

Table 8: Checklist for Verifying RSVP Signal Processing

Verifying RSVP Signal Processing Tasks	Command or Action
Checking That RSVP Path Messages Are Sent and Received on page 70	show rsvp statistics
Examining the History Log on page 72	show mpls lsp extensive
Determining the Current RSVP Neighbor State on page 73	show rsvp neighbor
Enabling RSVP Traceoptions on page 74	[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 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
```

What It Means 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 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...]
```

What It Means 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 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
```

What It Means 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
```

What It Means 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 9: 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. (See Table 10.)

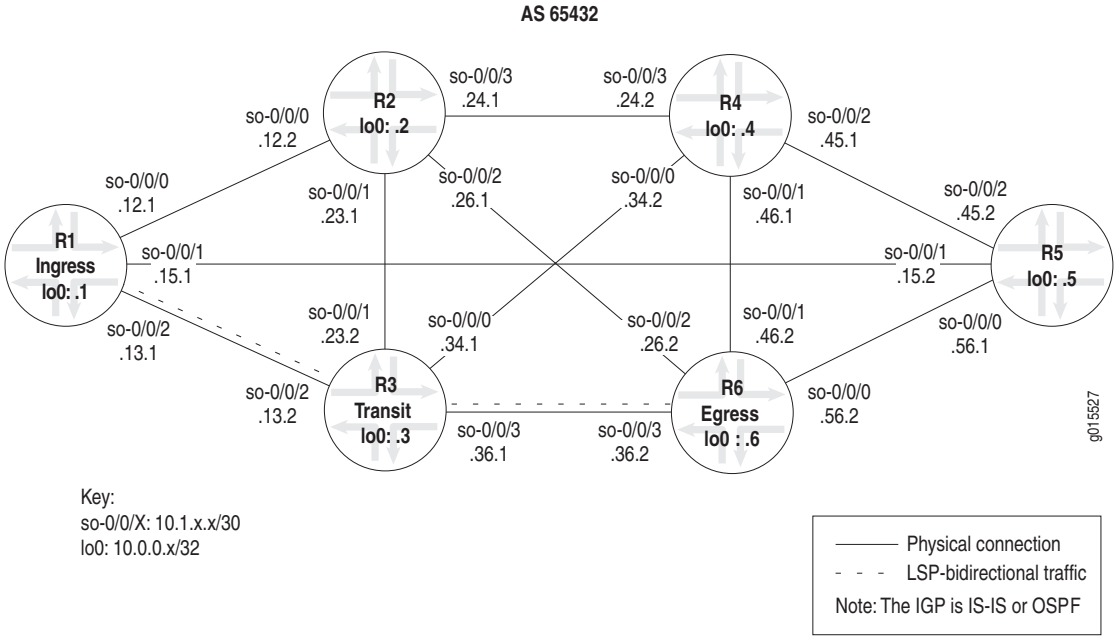
Table 10: Checklist for Verifying LSP Use

Verifying LSP Use Tasks	Command or Action
Verifying LSP Use in Your Network on page 78	
Verifying an LSP on the Ingress Router on page 79	show route table inet.3
Verifying an LSP on a Transit Router on page 80	show route table mpls.0

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 describes the example network used in this chapter.

Figure 7: MPLS Topology for Verifying LSP Use



The MPLS network in Figure 7 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 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 “Configuring MPLS on a Network” on page 3.

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

1. Verifying an LSP on the Ingress Router on page 79
2. Verifying an LSP on a Transit Router on page 80

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 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
```

What It Means 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 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
```

What It Means 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 11 lists the various label range allocations for incoming labels.

Table 11: 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
100,000 through 1,048,575	Reserved for dynamic label assignment

Part 2

Working with Problems on Your Network

The layered Multiprotocol Label Switching (MPLS) troubleshooting model is a disciplined approach to investigating problems with an MPLS network. Part 2 describes and illustrates the layers in the model, and the commands you can use to structure your investigation.

An example MPLS network topology is broken at various points in the network to illustrate problems at different layers of the network. The problems presented are not inclusive and only serve to illustrate one possible process of investigation into the different model layers.

The following information is covered:

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. (See Table 12.) The chapter also includes the example network used throughout the book to illustrate various problems that can occur in an MPLS network.

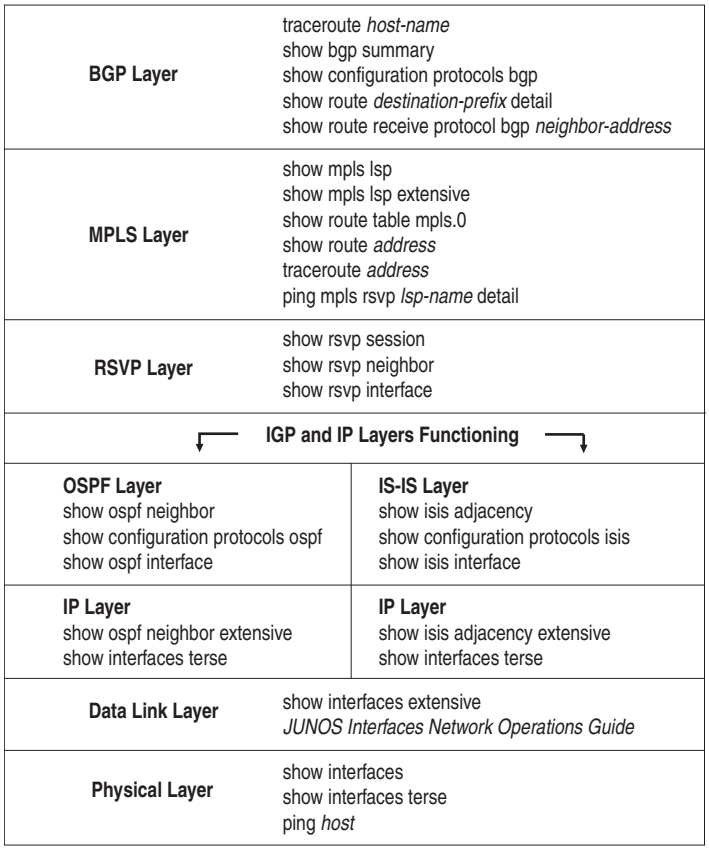
Table 12: Checklist for Working with the Layered MPLS Troubleshooting Model

Working with the Layered MPLS Troubleshooting Model Tasks	Command or Action
Understanding the Layered MPLS Troubleshooting Model on page 86	show mpls lsp show mpls lsp extensive show mpls lsp name *name* show mpls lsp name *name* extensive

Understanding the Layered MPLS Troubleshooting Model

Purpose The layered MPLS troubleshooting model is a disciplined approach to investigating problems with an MPLS network. Figure 8 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.

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 “Verifying the Physical Layer” on page 93.

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 102 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 IP and IGP Layers" on page 113.

- 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 IP and IGP Layers" on page 113.

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.

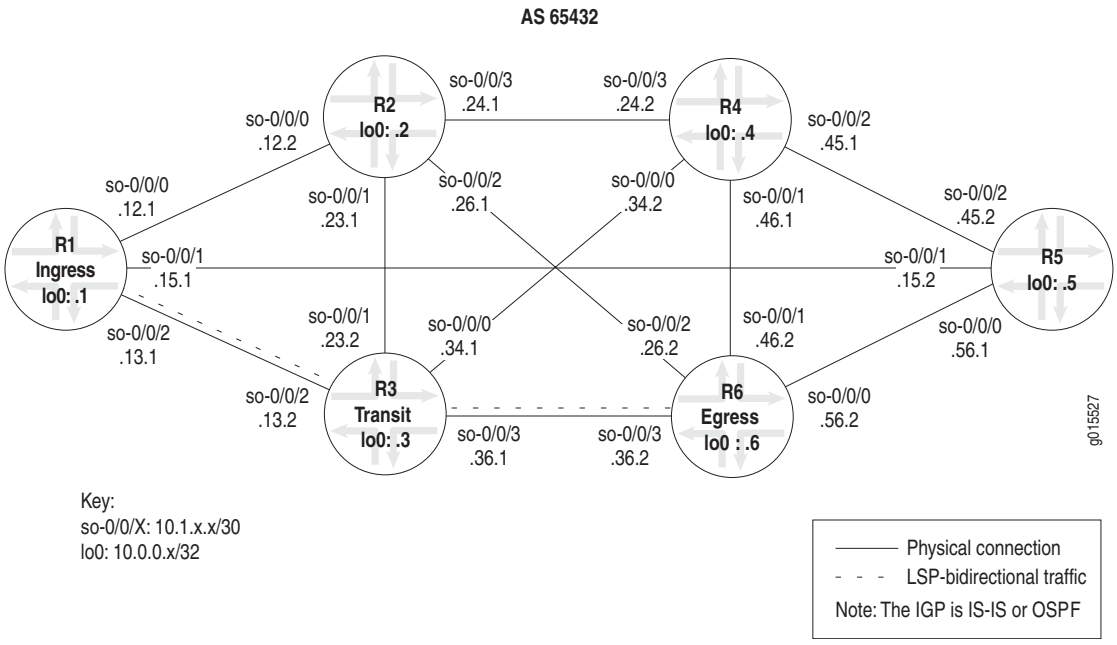
- When you investigate the MPLS layer, you are checking whether the LSP is up and functioning correctly. To check the MPLS layer, enter the show mpls lsp, show mpls lsp extensive, show route table mpls.0, show route *address*, traceroute *address*, and ping mpls rsvp *lsp-name* detail commands. If there 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 179.

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 illustrates the basic network topology used in all the chapters in Part 2.

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 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
```

What It Means 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 “Determining the LSP State” on page 59. For more information on the availability and valid use of an LSP, see “Verifying LSP Use” on page 77.

In the chapters from “Verifying the Physical Layer” on page 93 through “Checking the MPLS Layer” on page 161, the network topology is broken at different layers of the network to 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 model layers.

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. (See Table 13.)

Table 13: Checklist for Verifying the Physical Layer

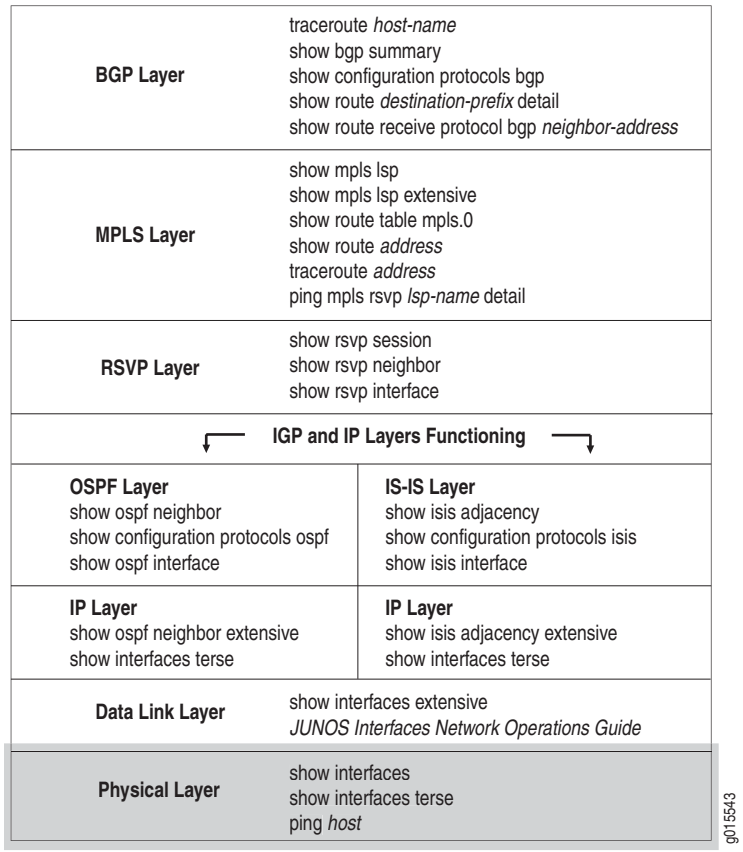
Verifying the Physical Layer Tasks	Command or Action
Verifying the Physical Layer on page 94	
1. Verify the LSP on page 96	show mpls lsp extensive
2. Verify Router Connection on page 97	ping *host*
3. Verify Interfaces on page 98	show interfaces terse show configuration interfaces *type-fpc/pic/port*
4. Take Appropriate Action on page 98	The following sequence of commands addresses the specific problem described in this section: [edit interfaces *type-fpc/pic/port*] set family mpls show commit
5. Verify the LSP Again on page 99	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 illustrates the physical layer of the layered MPLS model.

Figure 10: Verifying the Physical Layer

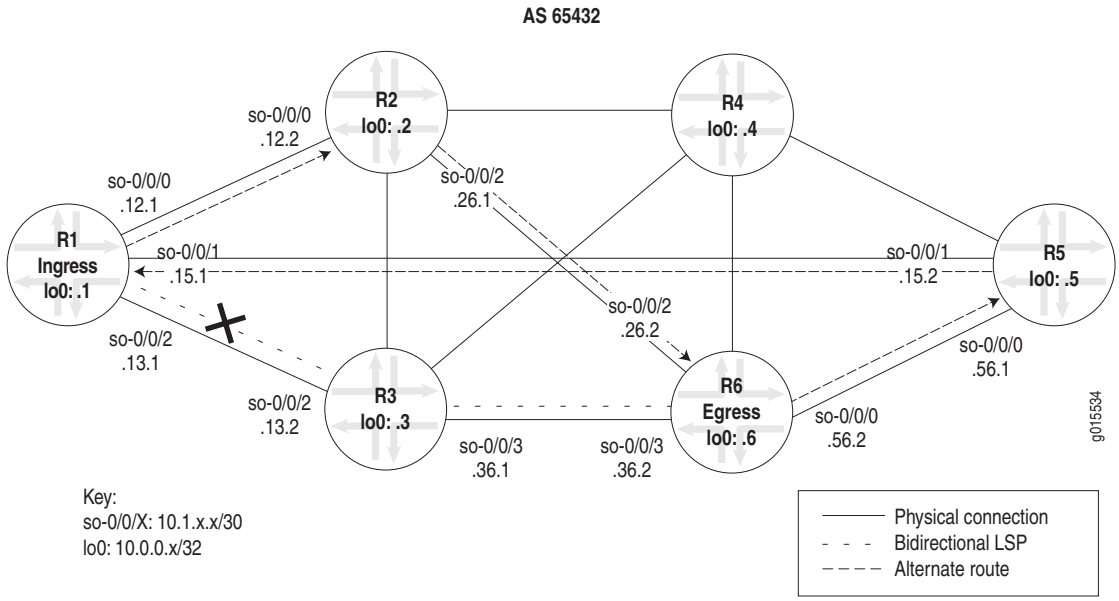


With this layer, you must ensure that the routers are connected, and that the interfaces are up and configured correctly on the ingress, egress, and transit routers.

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

Figure 11 illustrates the MPLS network and the problem described in this chapter.

Figure 11: MPLS Network Broken at the Physical Layer



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

Steps To Take To check the physical layer, follow these steps:

1. Verify the LSP on page 96
2. Verify Router Connection on page 97
3. Verify Interfaces on page 98
4. Take Appropriate Action on page 98
5. Verify the LSP Again on page 99

Step 1: 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
```

What It Means 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 through R5 to R1.

Step 2: Verify Router Connection

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
```

What It Means 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.

Step 3: Verify Interfaces

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
}
```

What It Means 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.

Step 4: Take Appropriate Action

Purpose 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.

Action 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
```

What It Means 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.

Step 5: Verify the LSP Again

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;
```

What It Means

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. (See Table 14.)

Table 14: Checklist for Checking the Data Link Layer

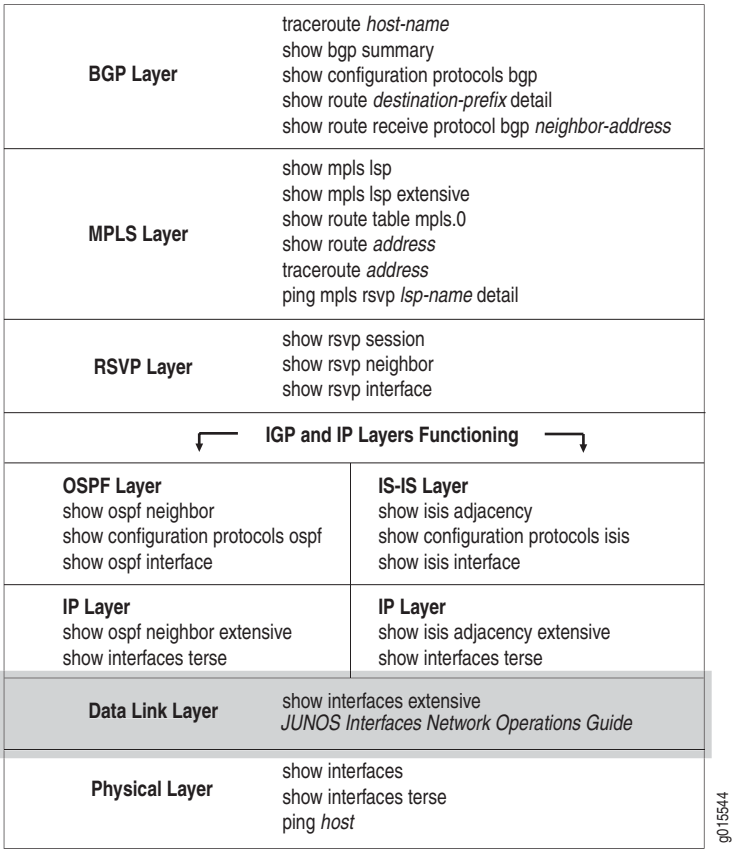
Checking the Data Link Layer Tasks	Command or Action
Checking the Data Link Layer on page 102	
1. Verify the LSP on page 104	show mpls lsp extensive
2. Verify Interfaces on page 105	show interfaces *type-fpc/pic/port* extensive show interfaces *type-fpc/pic/port*
3. Take Appropriate Action on page 108	The following sequence of commands addresses the specific problem described in this section: [edit interfaces *type-fpc/pic/port*] show delete encapsulation show commit
4. Verify the LSP Again on page 109	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 illustrates the data link layer of the layered MPLS model.

Figure 12: Checking the Data Link Layer

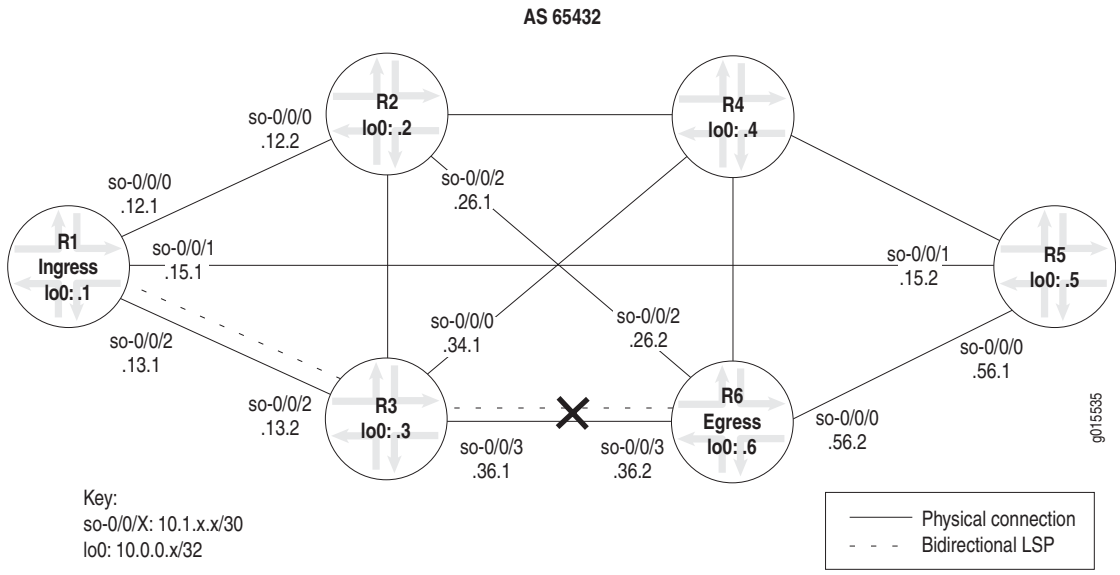


With this layer, you must check the encapsulation mode, for example, Point-to-Point Protocol (PPP) or Cisco High-level Data Link Control (HDLC); PPP options, for example, header encapsulation; frame check sequence (FCS) size; and whether keepalive frames are enabled or disabled. Also, check the ingress,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

If the network is not functioning at this layer, the LSP does not work as configured.

Figure 13 illustrates the MPLS network used in this chapter.

Figure 13: MPLS Network Broken at the Data Link Layer



The network shown in Figure 13 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 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.

Steps To Take To check the data link layer, follow these steps:

1. Verify the LSP on page 104
2. Verify Interfaces on page 105
3. Take Appropriate Action on page 108
4. Verify the LSP Again on page 109

Step 1: 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
```

What It Means 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 103, 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.

Step 2: Verify Interfaces

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

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.

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 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
```

What It Means 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.

Step 3: Take Appropriate Action

Purpose 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.

Action 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
```

Sample 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
```

What It Means 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.

Step 4: Verify the LSP Again

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;
```

What It Means 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. (See Table 15.)

Table 15: Checklist for Verifying the IP and IGP Layers

Verifying the IP and IGP Layer Tasks	Command or Action
Verifying the IP and IGP Layers on page 115	
Verifying the IP Layer on page 117	
1. Verify the LSP on page 118	show mpls lsp extensive
2. Verify IP Addressing on page 119	show interfaces terse
3. Verify Neighbors or Adjacencies at the IP Layer on page 120	show ospf neighbor extensive show isis adjacency extensive
4. Take Appropriate Action on page 123	The following sequence of commands addresses the specific problem described in this section: [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 124	show mpls lsp extensive
Verifying the OSPF Protocol on page 128	
1. Verify the LSP on page 129	show mpls lsp extensive
2. Verify OSPF Interfaces on page 131	show ospf interface
3. Verify OSPF Neighbors on page 133	show ospf neighbor
4. Verify the OSPF Protocol Configuration on page 133	show configuration protocols ospf
5. Take Appropriate Action on page 134	The following sequence of commands addresses the specific problem described in this section: [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

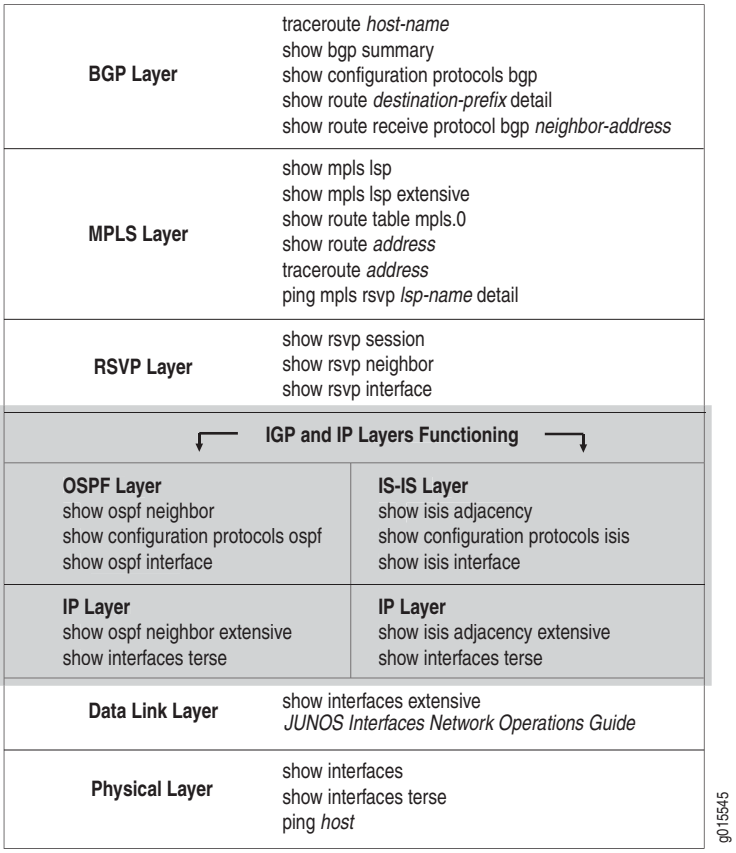
Verifying the IP and IGP Layer Tasks	Command or Action
6. Verify the LSP Again on page 136	show mpls lsp extensive
Verifying the IS-IS Protocol on page 139	
1. Verify the LSP on page 140	show mpls lsp extensive
2. Verify IS-IS Adjacencies and Interfaces on page 141	show isis adjacency show isis interface
3. Verify the IS-IS Configuration on page 142	show configuration protocols isis
4. Take Appropriate Action on page 143	The following sequence of commands addresses the specific problem described in this section: 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 144	show mpls lsp extensive

Verifying the IP and IGP Layers

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 or data link layers. Continue investigating the problem at the IP and IGP layers of the network.

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

Figure 14: IP and IGP Layers



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.

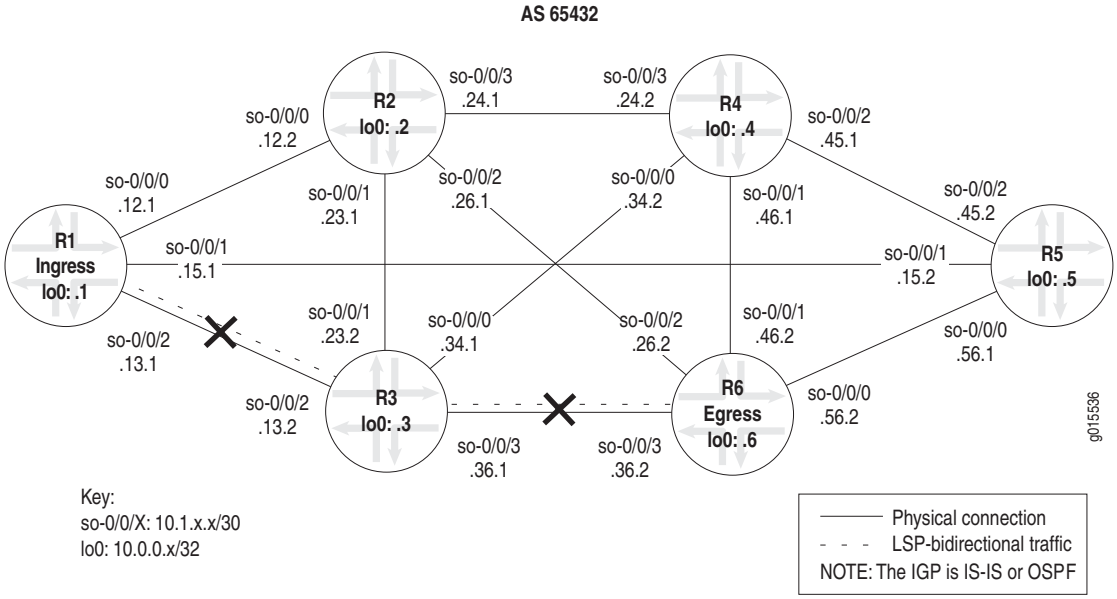
- If the IS-IS protocol is configured, it doesn't matter whether you check IS-IS or IP first because both protocols are independent of each other. Verify that IS-IS adjacencies are up, and that the interfaces and IS-IS protocol are configured correctly.

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 illustrates the MPLS network used in this chapter.

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



The network shown in Figure 15 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 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.

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

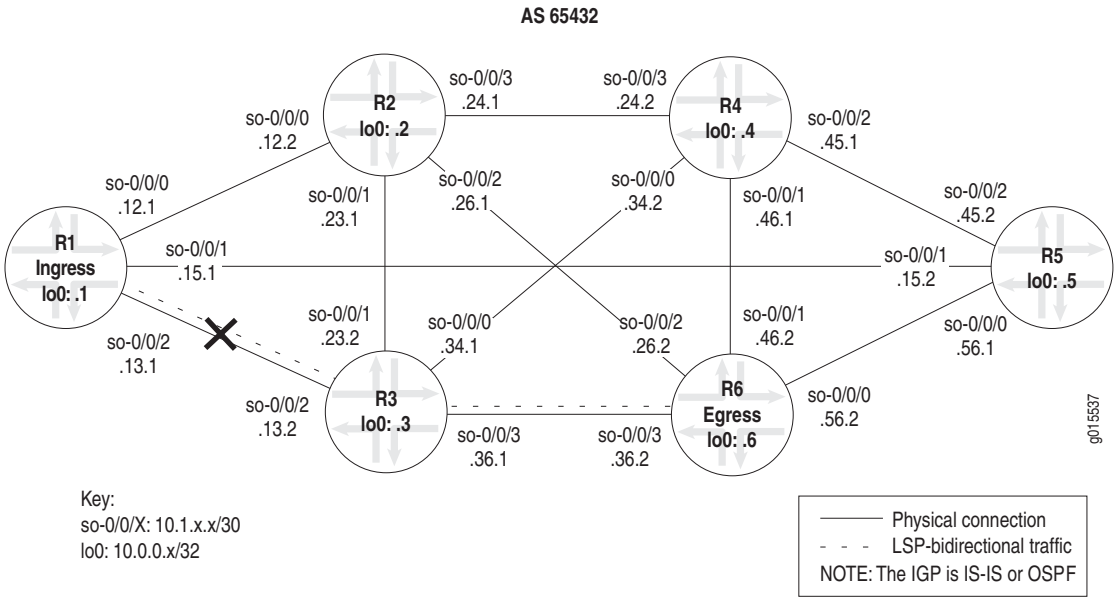
1. Verifying the IP Layer on page 117
2. Verifying the OSPF Protocol on page 128
3. Verifying the IS-IS Protocol on page 139

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 indicates where the LSP is broken because of the incorrect configuration of an IP address on ingress router R1.

Steps To Take To check the IP layer, follow these steps:

1. Verify the LSP on page 118
2. Verify IP Addressing on page 119
3. Verify Neighbors or Adjacencies at the IP Layer on page 120

4. Take Appropriate Action on page 123

5. Verify the LSP Again on page 136

Step 1: 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 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
```

What It Means 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.

Step 2: 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
```

What It Means 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.

Step 3: Verify Neighbors or Adjacencies at the IP Layer

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
```

What It Means 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.

Step 4: Take Appropriate Action

Purpose 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.

Action 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
```

What It Means 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 116, and the possibility that the LSP might come up.

Step 5: Verify the LSP Again

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
```

What It Means 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.

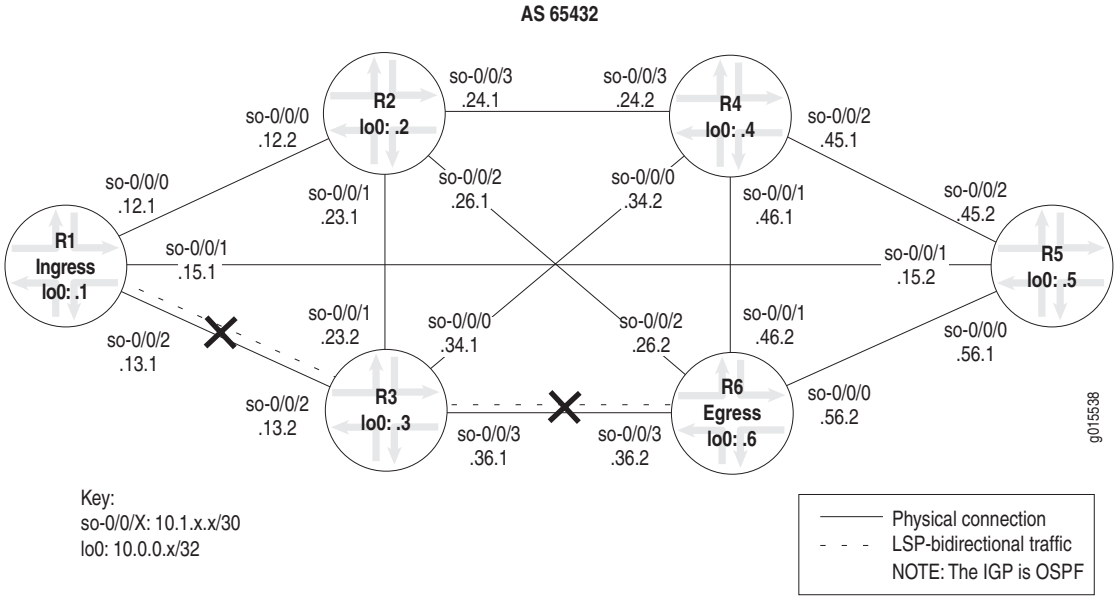
Sample Output 2 from transit router R3 shows that there are two transit LSP sessions, one from R1 to R6 and the other from R6 to R1. Both LSPs are up.

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



The crosses shown in Figure 17 indicate where the LSP is not working because of problems with the OSPF protocol configuration. The OSPF protocol is configured with a RID but without the loopback (lo0) interface, and traffic engineering is missing from the transit router (R3).

Steps To Take

1. Verify the LSP on page 129
2. Verify OSPF Interfaces on page 131
3. Verify OSPF Neighbors on page 133
4. Verify the OSPF Protocol Configuration on page 133
5. Take Appropriate Action on page 134
6. Verify the LSP Again on page 136

Step 1: Verify the LSP

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
```

What It Means 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.

Step 2: 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
```

What It Means

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.

Step 3: 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
```

What It Means 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.

Step 4: 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
}
```

What It Means 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.

Step 5: Take Appropriate Action

Purpose 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).

Action 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
```

What It Means

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*.

Step 6: Verify the LSP Again

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
```

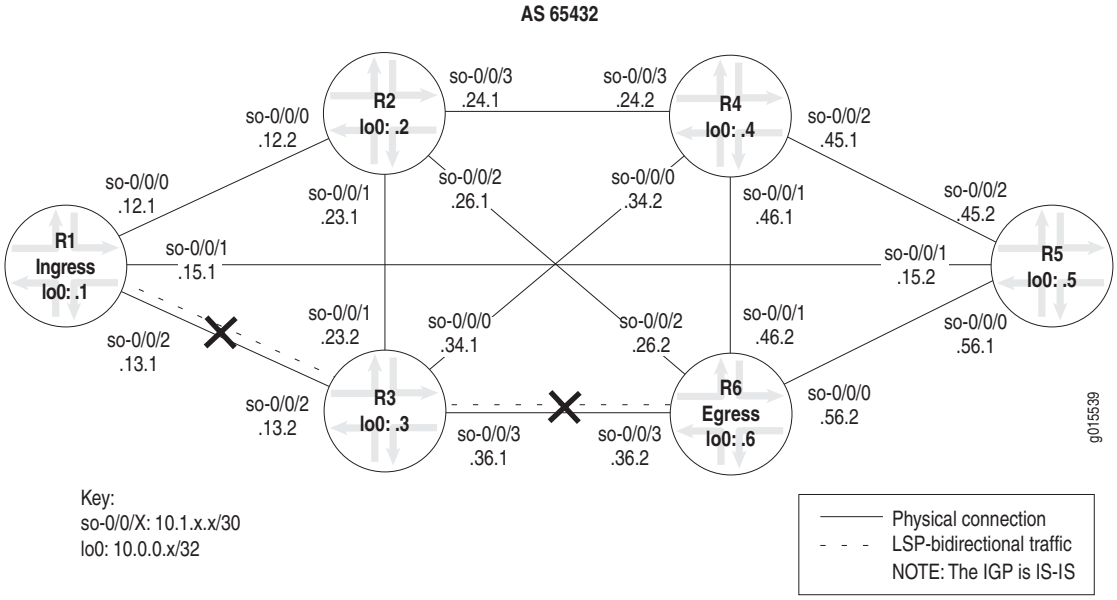
What It Means The sample output from ingress router R1 and egress router R6 shows that the LSP is now traversing the network along the expected path, from R1 through R3 to R6, and the reverse LSP, from R6 through R3 to R1. In addition, the sample output from transit router R3 shows that there are two 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 117.

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



The crosses in Figure 18 indicate where the LSP is not working because IS-IS levels are mismatched.

Steps To Take To check the IS-IS protocol, follow these steps:

1. Verify the LSP on page 140
2. Verify IS-IS Adjacencies and Interfaces on page 141
3. Verify the IS-IS Configuration on page 142
4. Take Appropriate Action on page 143
5. Verify the LSP Again on page 144

Step 1: Verify the LSP

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
```

What It Means 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.

Step 2: 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
```

What It Means 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 116, 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.

Step 3: 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
```

What It Means 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.

Step 4: Take Appropriate Action

Action 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.

Action 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
```

What It Means The sample output shows that the configuration error on egress router R6 has been corrected and IS-IS adjacencies are now established.

Step 5: Verify the LSP Again

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
```

What It Means

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. (See Table 16.)

Table 16: Checklist for Checking the RSVP Layer

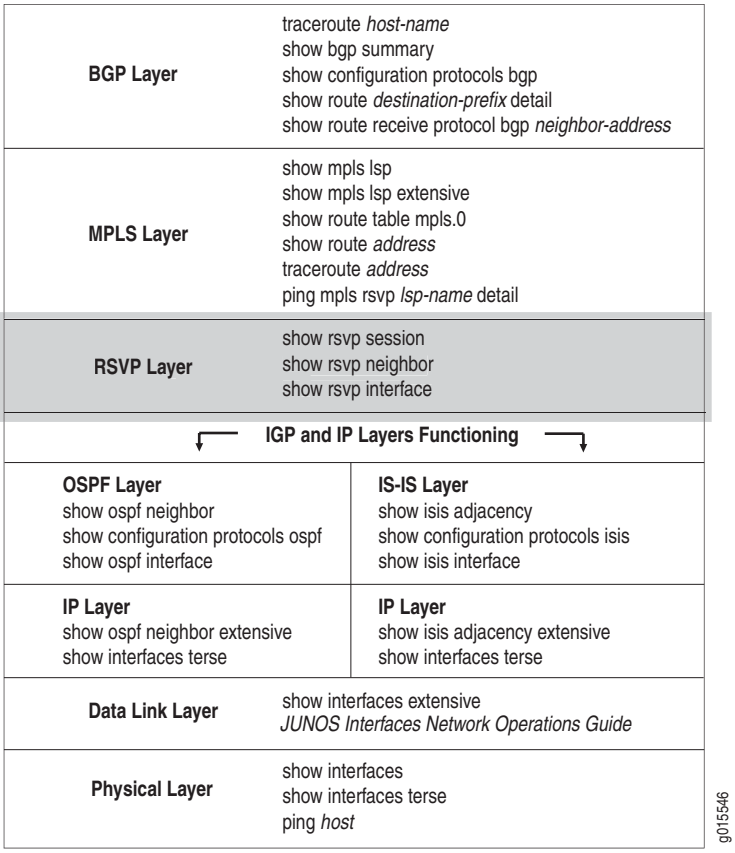
Checking the RSVP Layer Tasks	Command or Action
Checking the RSVP Layer on page 148	
1. Verify the LSP on page 150	show mpls lsp extensive
2. Verify RSVP Sessions on page 151	show rsvp session
3. Verify RSVP Neighbors on page 153	show rsvp neighbor
4. Verify RSVP Interfaces on page 154	show rsvp interface
5. Verify the RSVP Protocol Configuration on page 155	show configuration protocols rsvp
6. Take Appropriate Action on page 156	The following sequence of commands addresses the specific problem described in this section: [edit] edit protocols rsvp [edit protocols rsvp] show set interface *type-fpc/pic/port* show commit
7. Verify the LSP Again on page 157	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 illustrates the RSVP layer of the layered MPLS model.

Figure 19: Checking the RSVP Layer

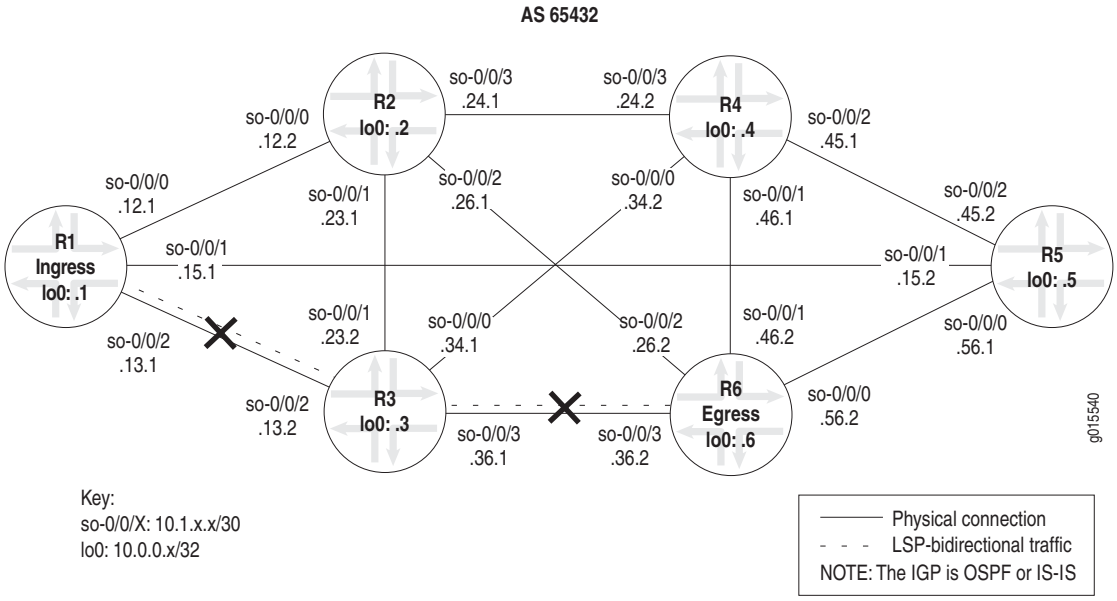


With this layer, you check that dynamic RSVP signaling is occurring as expected, neighbors are connected, and interfaces are configured correctly for RSVP. Check the ingress, egress, and transit routers.

If the network is not functioning at this layer, the LSP does not work as configured.

Figure 20 illustrates the MPLS network used in this chapter.

Figure 20: MPLS Network Broken at the RSVP Layer



The network shown in Figure 20 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 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, a configuration error on transit router R3 prevents the LSP from traversing the network as expected.

Steps To Take To check the RSVP layer, follow these steps:

1. Verify the LSP on page 150
2. Verify RSVP Sessions on page 151
3. Verify RSVP Neighbors on page 153
4. Verify RSVP Interfaces on page 154
5. Verify the RSVP Protocol Configuration on page 155
6. Take Appropriate Action on page 156
7. Verify the LSP Again on page 157

Step 1: 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
```

What It Means 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.

Step 2: 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
```

What It Means

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 153.

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.

Step 3: 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
```

What It Means 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 154.

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.

Step 4: 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

```
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
```

What It Means 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.

Step 5: 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;
}
```

What It Means 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.

Step 6: Take Appropriate Action

Purpose 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.

Action 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
```

What It Means 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.

Step 7: Verify the LSP Again

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
```

What It Means 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. (See Table 17.)

Table 17: Checklist for Checking the MPLS Layer

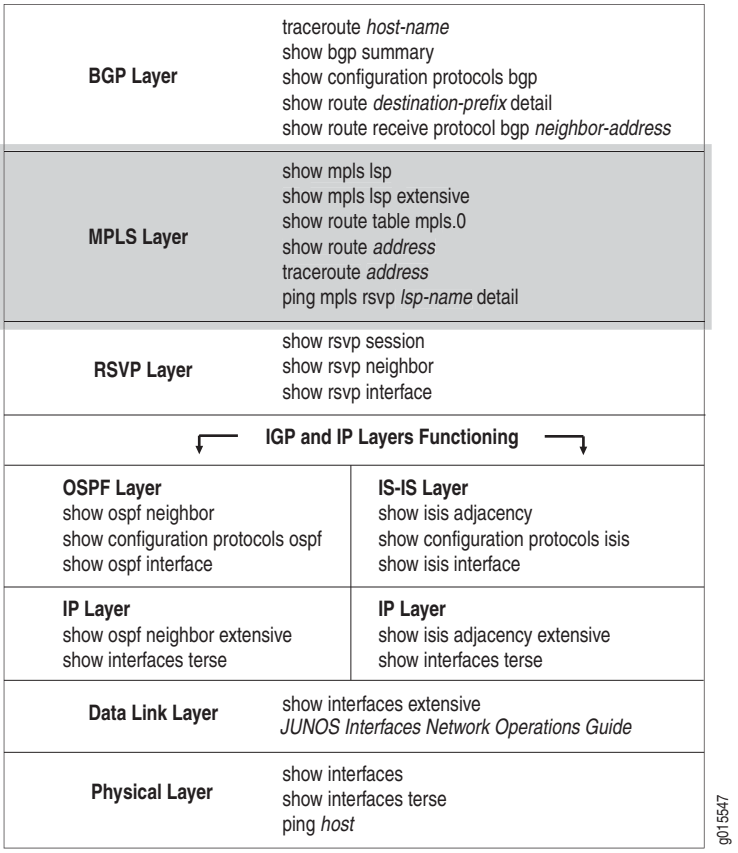
Checking the MPLS Layer Tasks	Command or Action
Checking the MPLS Layer on page 162	
1. Verify the LSP on page 164	show mpls lsp show mpls lsp extensive show mpls lsp name *name* show mpls lsp name *name* extensive
2. Verify the LSP Route on the Transit Router on page 166	show route table mpls.0
3. Verify the LSP Route on the Ingress Router on page 168	show route *destination*
4. Verify MPLS Labels with the traceroute Command on page 169	traceroute *hostname*
5. Verify MPLS Labels with the ping Command on page 170	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 171	show configuration protocols mpls show configuration interfaces
7. Take Appropriate Action on page 173	The following sequence of commands addresses the specific problem described in this section: edit edit protocols mpls [edit protocols mpls] show activate interface so-0/0/3.0 show commit
8. Verify the LSP Again on page 174	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 illustrates the MPLS layer of the layered MPLS model.

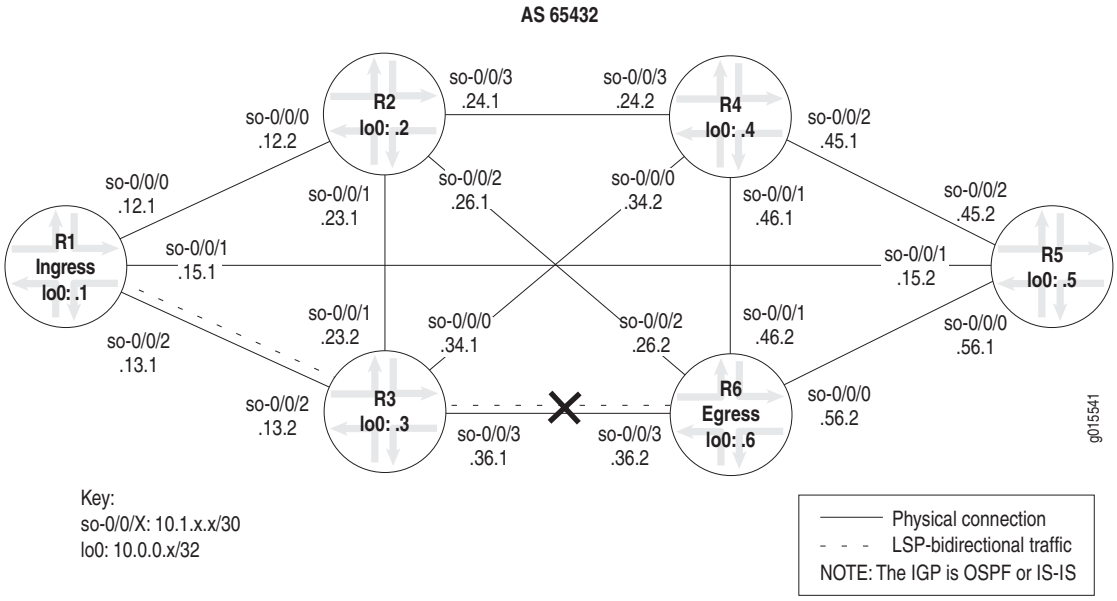
Figure 21: Checking the MPLS Layer



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 illustrates the MPLS network used in this chapter.

Figure 22: MPLS Network Broken at the MPLS Layer



The network shown in Figure 22 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 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, a configuration error on egress router R6 prevents the LSP from traversing the network as expected.

Steps To Take To check the MPLS layer, follow these steps:

1. Verify the LSP on page 164
2. Verify the LSP Route on the Transit Router on page 166
3. Verify the LSP Route on the Ingress Router on page 168
4. Verify MPLS Labels with the traceroute Command on page 169
5. Verify MPLS Labels with the ping Command on page 170
6. Verify the MPLS Configuration on page 171
7. Take Appropriate Action on page 173
8. Verify the LSP Again on page 174

Step 1: 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
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
```

What It Means

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 163. However, in a large network with many LSPs configured, the results would be quite different between the two commands.

Step 2: 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
```

What It Means

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 “Verifying LSP Use” on page 77.

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*.

Step 3: 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
```

What It Means 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 163.

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.

Step 4: 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
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)  0.866 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
```

What It Means 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 163) to reach the BGP next-hop LSP egress address. The JUNOS software 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.

Step 5: 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
```

What It Means 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.

Step 6: 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;
        }
    }
}
```

What It Means 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).

Step 7: Take Appropriate Action

Purpose 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.

Action 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
```

What It Means 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.

Step 8: Verify the LSP Again

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
```

What It Means 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. (See Table 18.)

Table 18: Checklist for Checking the BGP Layer

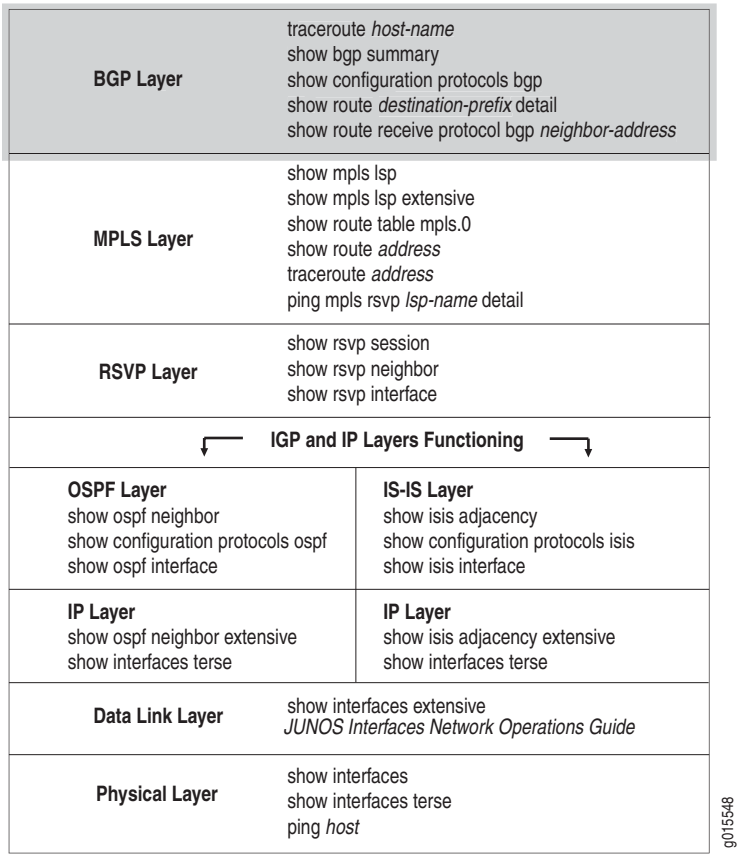
Checking the BGP Layer Tasks	Command or Action
Checking the BPG Layer on page 180	
1. Check That BGP Traffic Is Using the LSP on page 182	traceroute *hostname*
2. Check BGP Sessions on page 182	show bgp summary
3. Verify the BGP Configuration on page 183	show configuration
4. Examine BGP Routes on page 189	show route *destination-prefix* detail
5. Verify Received BGP Routes on page 190	show route receive protocol bgp *neighbor-address*
6. Take Appropriate Action on page 191	The following sequence of commands addresses the specific problem described in this section: [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
7. Check That BGP Traffic Is Using the LSP Again on page 192	traceroute *hostname*

Checking the BPG 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 illustrates the BGP layer of the layered MPLS model.

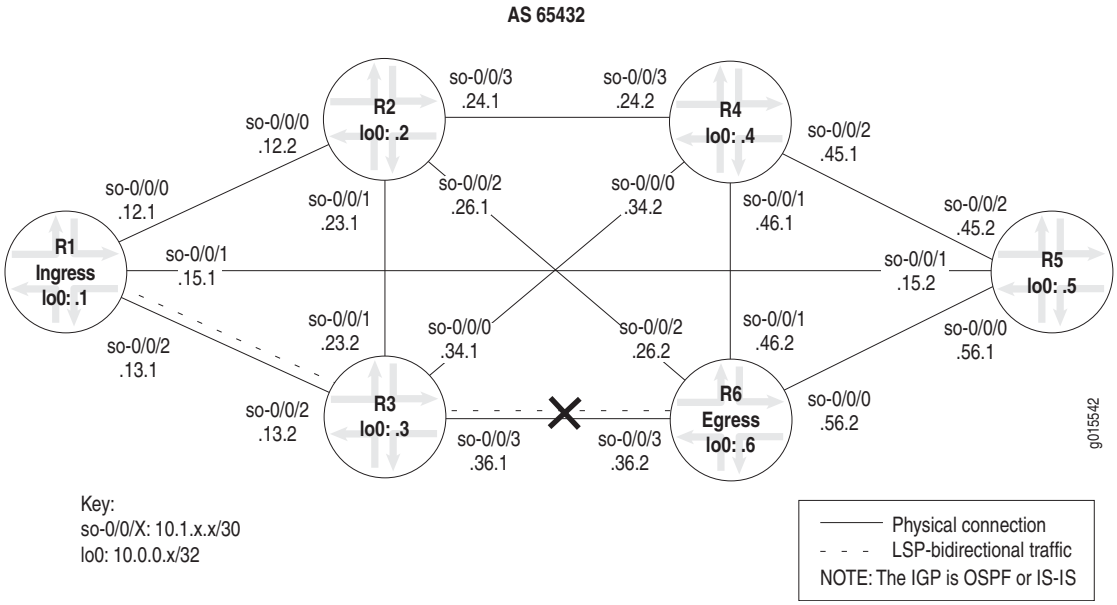
Figure 23: Checking the BGP Layer



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 illustrates the MPLS network used in this chapter.

Figure 24: MPLS Network Broken at the BGP Layer



The network shown in Figure 24 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 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.

Steps To Take To check the BGP layer, follow these steps:

1. Check That BGP Traffic Is Using the LSP on page 182
2. Check BGP Sessions on page 182
3. Verify the BGP Configuration on page 183
4. Examine BGP Routes on page 189
5. Verify Received BGP Routes on page 190
6. Take Appropriate Action on page 191
7. Check That BGP Traffic Is Using the LSP Again on page 192

Step 1: 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 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
```

What It Means 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 181) to reach the BGP next-hop LSP egress address for R6 and R1. The JUNOS software default is to use LSPs for BGP traffic when the BGP next hop equals the LSP egress address.

Step 2: 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 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
```

What It Means 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 183.

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 191. 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 190.

Step 3: 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 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;
        }
    }
}
```

What It Means 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.

Step 4: 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 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
```

What It Means 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.

Step 5: 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 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)
```

What It Means 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 191.

Step 6: Take Appropriate Action

Purpose 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.

Action 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
```

What It Means 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.

Step 7: Check That BGP Traffic Is Using the LSP Again

Action To verify that BGP traffic is using the LSP, enter the following JUNOS 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
```

What It Means 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 software 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 software 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 182.

Part 3
Appendix

Command-Line Interface Overview

This chapter provides an overview of the JUNOS software command-line interface (CLI). For more detailed information about using the JUNOS software CLI, see the *JUNOS System Basics Configuration Guide* and the *JUNOS System Basics and Services Command Reference*.

The CLI is the interface to the software that you use whenever you access the router—whether from the console or through a remote network connection. The CLI, which automatically starts after the router finishes booting, provides commands that you use to perform various tasks, including configuring the JUNOS software, and monitoring and troubleshooting the software, network connectivity, and the router hardware.

The CLI has two modes:

CLI Operational Mode

In operational mode you enter commands to monitor and troubleshoot the software, network connectivity, and the router by entering commands. When you log in to the router and the CLI starts, you are at the top level of the CLI operational mode. At this level, there are several broad groups of CLI commands (see Table 19).

Table 19: CLI Operational Mode Top-Level Commands

Command	Description
clear	Clear statistics and protocol database information. Syntax: clear (arp | bgp | chassis | firewall | igmp | interfaces | isis | ldp | log | mpls | msdp | multicast | ospf | pim | rip | route | rsvp | snmp | system | vrrp)
configure	Enter CLI configuration mode. Alternative commands: configure exclusive | configure private
file	Perform file manipulation operations, such as copy, delete, list, rename, and show. Syntax: file (compare | copy | delete | list | rename | show)
help	Provide help information. Syntax: help (reference | topic)
monitor	Monitor a log file or interface traffic in real time. Syntax: monitor (start | stop | interface | list | traffic)
mtrace	Display trace information about a multicast path from a source to a receiver. Syntax: mtrace (from-source | to-gateway | monitor)
ping	Try to connect to a remote target.
pipe	Filter the output of an operational mode or configuration mode command. Syntax: | (compare | count | display <detail | inheritance | xml> | except pattern | find pattern | hold | match pattern | no-more | resolve <full-names> | save *filename* | trim columns)
quit	Exit from the CLI to a UNIX shell.
request	Make system-level requests, such as stop or reboot the router, load software packages, and back up the router's file systems. Syntax: request system (reboot | halt | software | snapshot)
restart	Restart the router software processes. Syntax: restart (fpc | interface-control | mib-process | routing | sampling | sfm | snmp | soft)
set	Set CLI properties, the router's date and time, and the craft interface display text. Syntax: set (chassis | cli | date)
show	Show information about all aspects of the software, including interfaces and routing protocols. Syntax: (aps | arp | as-path | bgp | chassis | cli | configuration | connections | dvmrp | firewall | host | igmp | interfaces | isis | ldp | log | mpls | msdpl | multicast | ntp | ospf | pfe | pim | policy | ripl | route | rsvp | sap | snmp | system | task | ted | version | vrrp)
ssh	Open a secure shell to another host.
start	Start a software process. Syntax: start shell
telnet	Start a telnet session to another host.
test	Run various diagnostic debugging commands. Syntax: test (configuration | interface | msdp | policy)
traceroute	Trace the route to a remote host.

:

Using the CLI Operational Mode

This section describes how to use the CLI operational mode. You can do the following:

- Entering the CLI Operational Mode on page 197
- Getting Help on Commands at a Hierarchy Level on page 197
- Getting Help about Commands on page 198
- Having the CLI Complete Commands on page 199
- Using CLI Command Completion on page 200
- Displaying CLI Command History on page 200

Entering the CLI Operational Mode

To enter the JUNOS software CLI, use the following command:

```
% cli
```

You are in the CLI when you see the > prompt, which is preceded by a string that defaults to the name of the user and the name of the router. For example:

```
user@host>
```

Getting Help on Commands at a Hierarchy Level

The CLI provides context-sensitive help at every level of the command hierarchy. The help information tells you which commands are available at the current level in the hierarchy and provides a brief description of each.

To get help while in the CLI, type ?. You do not need to press Enter after typing the question mark. You have the following options:

- If you type the question mark at the command-line prompt, the CLI lists the available commands and options.
- If you type the question mark after entering the complete name of a command or command option, the CLI lists the available commands and options, then redisplays the command names and options that you typed.
- If you type the question mark in the middle of a command name, the CLI lists possible command completions that match the letters you have entered so far, then redisplays the letters that you typed.

Getting Help about Commands

To get help about operational mode CLI commands, you can do the following:

Listing Top-Level Operational Mode CLI Commands

To list all available commands at the top level of the CLI operational mode, use the following command (see Table 19):

```
user@host> ?

Possible completions:
  clear                Clear information in the system
  configure            Manipulate software configuration information
  file                 Perform file operations
  help                 Provide help information
  mtrace               Trace mtrace packets from source to receiver.
  monitor              Real-time debugging
  ping                 Ping a remote target
  quit                 Exit the management session
  request              Make system-level requests
  restart              Restart a software process
  set                  Set CLI properties, date, time, craft display text
  show                 Show information about the system
  ssh                  Open a secure shell to another host
  start                Start a software process
  telnet               Telnet to another host
  test                 Diagnostic debugging commands
  traceroute           Trace the route to a remote host
user@host>
```

Listing CLI Commands That Start with a Particular Letter

To list all commands that start with the letter **c**, use the following CLI command:

```
user@host> c?

Possible completions:
  clear                Clear information in the system
  configure            Manipulate software configuration information
user@host> c
```

Listing All Available Commands of a Particular Type

To list all available clear commands, use the following CLI command:

```
user@host> clear ?

Possible completions:
  arp                  Clear address-resolution information
  bgp                  Clear BGP information
  chassis              Clear chassis information
  firewall             Clear firewall counters
  igmp                 Clear IGMP information
  interfaces           Clear interface information
  ilmi                 Clear ILMI statistics information
  isis                 Clear IS-IS information
  ldp                  Clear LDP information
  log                  Clear contents of a log file
  mpls                 Clear MPLS information
  msdp                 Clear MSDP information
  multicast            Clear Multicast information
  ospf                 Clear OSPF information
  pim                  Clear PIM information
  rip                  Clear RIP information
  route                Clear routing table information
  rsvp                 Clear RSVP information
  snmp                 Clear SNMP information
  system               Clear system status
  vrrp                 Clear VRRP statistics information
user@host> clear
```

Having the CLI Complete Commands

You do not always have to remember or type the full command or option name for the CLI to recognize it. To display all possible command or option completions, type the partial command followed by a question mark.

To complete a command or option that you have partially typed, press the Tab key or the spacebar. If the partially typed letters begin a string that uniquely identifies a command, the complete command name appears. Otherwise, a beep indicates that you have entered an ambiguous command, and the possible completions are displayed.

Command completion also applies to other strings, such as filenames and usernames. To display all possible values, type a partial string followed by a question mark. However, to complete these strings, press the Tab key; pressing the space bar does not work.

Using CLI Command Completion

To complete the show interfaces command, do the following:

user@host> **show in<Spacebar>**terfaces **<Enter>**

```
Physical interface: at-0/1/0, Enabled, Physical link is Up
  Interface index: 11, SNMP ifIndex: 65
  Link-level type: ATM-PVC, MTU: 4482, Clocking: Internal, SONET mode
  Speed: OC12, Loopback: None, Payload scrambler: Enabled
  Device flags   : Present Running
  Link flags     : 0x01
[...Output truncated...]
```

To display a list of all log files whose names start with the string "messages," and then display the contents of one of the files, do the following:

user@host> **show log mes?**

```
Possible completions:
  <filename>                     Log file to display
  messages                       Size: 1417052, Last changed: Mar  3 00:33
  messages.0.gz                  Size: 145575, Last changed: Mar  3 00:00
  messages.1.gz                  Size: 134253, Last changed: Mar  2 23:00
  messages.10.gz                 Size: 137022, Last changed: Mar  2 14:00
  messages.2.gr                  Size: 137112, Last changed: Mar  2 22:00
  messages.3.gz                  Size: 121633, Last changed: Mar  2 21:00
  messages.4.gz                  Size: 135715, Last changed: Mar  2 20:00
  messages.5.gz                  Size: 137504, Last changed: Mar  2 19:00
  messages.6.gz                  Size: 134591, Last changed: Mar  2 18:00
  messages.7.gz                  Size: 132670, Last changed: Mar  2 17:00
  messages.8.gz                  Size: 136596, Last changed: Mar  2 16:00
  messages.9.gz                  Size: 136210, Last changed: Mar  2 15:00

user@host> show log mes<Tab>sages.4<Tab>.gz<Enter>
Jan 15 21:00:00 myhost newsyslog[1381]: logfile turned over
[...Output truncated...]
```

Displaying CLI Command History

You can display a list of recent commands that you issued. To display the command history, use the show cli history command:

user@host> **show cli history**

```
03-03 01:00:50 -- show cli history
03-03 01:01:12 -- show interfaces terse
03-03 01:01:22 -- show interfaces lo0
03-03 01:01:44 -- show bgp next-hop-database
03-03 01:01:51 -- show cli history
```

By default, this command displays the last 100 commands issued in the CLI. Specify a number with the command to display that number of recent commands. For example:

user@host> **show cli history 3**

```
01:01:44 -- show bgp next-hop-database
01:01:51 -- show cli history
01:02:51 -- show cli history 3
```

CLI Configuration Mode

In configuration mode, you configure the JUNOS software by creating a hierarchy of configuration statements by using the CLI or by creating a text (ASCII) file that contains the statement hierarchy. (The statement hierarchy is identical in both the CLI and text configuration file.) You can configure all properties of the JUNOS software, including interfaces, general routing information, routing protocols, and user access, as well as several system hardware properties. When you have finished entering the configuration statements, you commit them, which activates the configuration on the router.

Table 20 explains each CLI configuration mode command. The commands are organized alphabetically.

Table 20: CLI Configuration Mode Commands

Command	Description
activate	Remove the **inactive:** tag from a statement, effectively reading the statement or identifier to the configuration. Statements or identifiers that have been activated take effect when you next issue the **commit** command. Syntax: **activate** (*statement* | *identifier*)
annotate	Add comments to a configuration. You can add comments only at the current hierarchy level. Syntax: **annotate** *statement* "*comment-string*"
commit	Commit the set of changes to the database and cause the changes to take operational effect. Syntax: **commit** << at <*string*>> <and-quit> <check> <confirmed <*minutes*>> <synchronize>
copy	Make a copy of an existing statement in the configuration. Syntax: **copy** *existing-statement* **to** *new-statement*
deactivate	Add the **inactive:** tag to a statement, effectively commenting out the statement or identifier from the configuration. Statements or identifiers marked as inactive do not take effect when you issue the **commit** command. Syntax: **deactivate** (*statement* | *identifier*)
delete	Delete a statement or identifier. All subordinate statements and identifiers contained within the specified statement path are deleted with it. Syntax: **delete** <*statement-path*> <*identifier*>
edit	Move inside the specified statement hierarchy. If the statement does not exist, it is created. Syntax: **edit** *statement-path*
exit	Exit the current level of the statement hierarchy, returning to the level prior to the last edit command, or exit from configuration mode. The **quit** and **exit** commands are synonyms. Syntax: **exit** <*configuration-mode*>
help	Display help about available configuration statements. Syntax: **help** (apropos | topic | reference) <*string*>
insert	Insert an identifier into an existing hierarchy. Syntax: **insert** <*statement-path*> *identifier1* (before | after) *identifier2*
load	Load a configuration from an ASCII configuration file or from terminal input. Your current location in the configuration hierarchy is ignored when the load operation occurs. Syntax: **load** (replace | merge | override) (*filename* | *terminal*)

Command	Description
quit	Exit the current level of the statement hierarchy, returning to the level prior to the last edit command, or exit from configuration mode. The **quit** and **exit** commands are synonyms. Syntax: **quit** <*configuration-mode*>
rename	Rename an existing configuration statement or identifier. Syntax: **rename** <*statement-path*> *identifier1* **to** *identifier2*
rollback	Return to a previously committed configuration. The software saves the last 10 committed configurations, including the rollback number, date, time, and name of the user who issued the commit configuration command. The currently operational JUNOS software configuration is stored in the file **juniper.conf**, and the last three committed configurations are stored in the files **juniper.conf.1**, **juniper.conf.2**, and **juniper.conf.3**. These four files are located in the directory **/config**, which is on the router's flash drive. The remaining six previous committed configurations, the files **juniper.conf.4** through **juniper.conf.9**, are stored in the directory **/var/db/config**, which is on the router's hard disk. Syntax: **rollback** <*number*>
run	Run a top-level CLI command without exiting from configuration mode. Syntax: **run** *command*
save	Save the configuration to an ASCII file. The contents of the current level of the statement hierarchy (and below) are saved, along with the statement hierarchy containing it. This allows a section of the configuration to be saved, while fully specifying the statement hierarchy. Syntax: **save** *filename*
set	Create a statement hierarchy and set identifier values. This is similar to **edit** except that your current level in the hierarchy does not change. Syntax: **set** <*statement-path*> *identifier*
show	Display the current configuration. Syntax: **show** <*statement-path*> <*identifier*>
status	Display the users currently editing the configuration.
top	Return to the top level of configuration command mode, which is indicated by the **[edit]** banner. Syntax: **top** <*configuration-command*>
up	Move up one level in the statement hierarchy. Syntax: **up** <*number*> <*configuration-command*>
update	Update a private database.

:

Configuration Statements and Identifiers

You configure all router properties by including statements in the configuration. A statement consists of a keyword, which is fixed text, and, optionally, an identifier. An identifier is an identifying name that you define, such as the name of an interface, or a username, which allows you and the CLI to discriminate among a collection of statements.

The following list shows the statements available at the top level of the configuration mode (that is, the trunk of the hierarchy tree). Table 21 on page 204 describes each statement.

```
user@host# set ?
Possible completions:
> accounting-options     Accounting data configuration
+ apply-groups           Groups from which to inherit configuration data
> chassis                Chassis configuration
> class-of-service       Class-of-service configuration
> firewall               Define a firewall configuration
> forwarding-options     Configure options to control packet sampling
> groups                 Configuration groups
> interfaces             Interface configuration
> policy-options         Routing policy option configuration
> protocols              Routing protocol configuration
> routing-instances      Routing instance configuration
> routing-options        Protocol-independent routing option configuration
> snmp                   Simple Network Management Protocol
> system                 System parameters
```

An angle bracket (>) before the statement name indicates that it is a container statement and you can define other statements at levels below it.

If there is no angle bracket (>) before the statement name, the statement is a leaf statement; you cannot define other statements at hierarchy levels below it.

A plus sign (+) before the statement name indicates that it can contain a set of values. To specify a set, include the values in brackets. For example:

```
[edit]
user@host# set policy-options community my-as1-transit members [65535:10
65535:11]
```

In some statements, you can include an identifier. For some identifiers, such as interface names, you must specify the identifier in a precise format. For example, the interface name so-0/0/0 refers to a SONET/SDH interface that is on the Flexible PIC Concentrator (FPC) in slot 0, in the first Physical Interface Card (PIC) location, and in the first port on the PIC. For other identifiers, such as interface descriptive text, policy, and firewall term names, you can specify any name, including special characters, spaces, and tabs.

You must enclose in quotation marks (double quotes) identifiers and any strings that include the following characters: space tab ( ) [ ] { } ! @ # $ % ^ & | ' = ?

Table 21 describes each top-level CLI configuration mode statement.

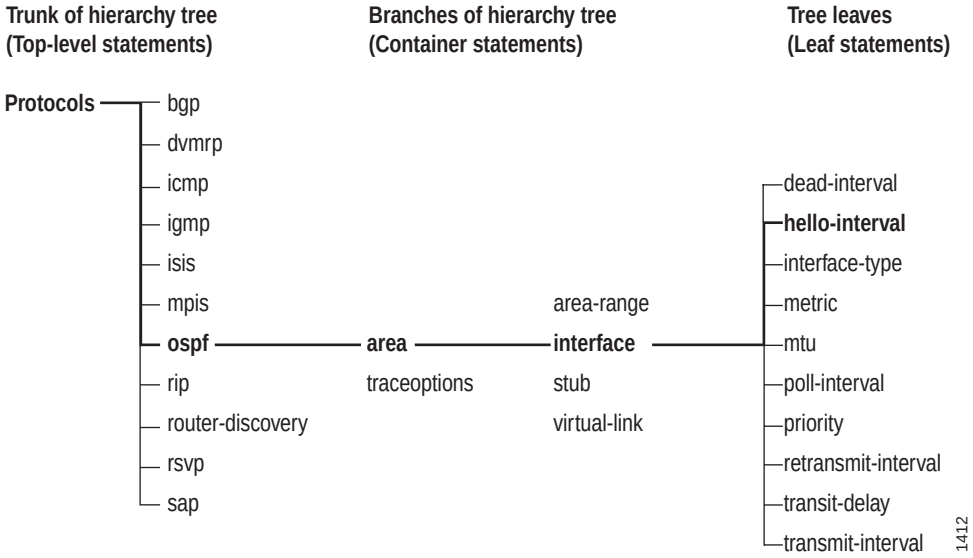
Table 21: Configuration Mode Top-Level Statements

Statement	Description
accounting-options	Configure accounting statistics data collection for interfaces and firewall filters. For information about the statements in this hierarchy, see the *JUNOS Network Management Configuration Guide*.
chassis	Configure properties of the router chassis, including the clock source, conditions that activate alarms, and SONET/SDH framing and concatenation properties. For information about the statements in this hierarchy, see the *JUNOS System Basics Configuration Guide*.
class-of-service	Configure class-of-service parameters. For information about the statements in this hierarchy, see the *JUNOS Class of Service Configuration Guide*.
firewall	Define filters that select packets based on their contents. For information about the statements in this hierarchy, see the *JUNOS Policy Framework Configuration Guide*.
forwarding-options	Define forwarding options, including traffic sampling options. For information about the statements in this hierarchy, see the *JUNOS Network Interfaces Configuration Guide*.
groups	Configure configuration groups. For information about statements in this hierarchy, see *JUNOS System Basics Configuration Guide*.
interfaces	Configure interface information, such as encapsulation, interfaces, virtual channel identifiers (VCIs), and data-link channel identifiers (DLCIs). For information about the statements in this hierarchy, see the *JUNOS Network Interfaces Configuration Guide*.
policy-options	Define routing policies, which allow you to filter and set properties in incoming and outgoing routes. For information about the statements in this hierarchy, see the *JUNOS Routing Protocols Configuration Guide*.
protocols	Configure routing protocols, including Border Gateway Protocol (BGP), Intermediate System-to-Intermediate System (IS-IS), Open Shortest Path First (OSPF), Routing Information Protocol (RIP), Multiprotocol Label Switching (MPLS), Label Distribution Protocol (LDP), and Resource Reservation Protocol (RSVP). For information about the statements in this hierarchy, see the chapters that discuss how to configure the individual routing protocols in the *JUNOS Routing Protocols Configuration Guide* and the *JUNOS MPLS Applications Configuration Guide*.
routing-instances	Configure multiple routing instances. For information about the statements in this hierarchy, see the *JUNOS Routing Protocols Configuration Guide*.
routing-options	Configure protocol-independent routing options, such as static routes, autonomous system (AS) numbers, confederation members, and global tracing (debugging) operations to log. For information about the statements in this hierarchy, see the *JUNOS Routing Protocols Configuration Guide*.
snmp	Configure Simple Network Management Protocol (SNMP) community strings, interfaces, traps, and notifications. For information about the statements in this hierarchy, see the *JUNOS Network Management Configuration Guide*.
system	Configure systemwide properties, including the hostname, domain name, Domain Name System (DNS) server, user logins and permissions, mappings between hostnames and addresses, and software processes.

Configuration Statement Hierarchy

The JUNOS software configuration consists of a hierarchy of *statements*. There are two types of statements: *container statements*, which are statements that contain other statements, and *leaf statements*, which do not contain other statements (see Figure 25). All of the container and leaf statements together form the *configuration hierarchy*.

Figure 25: Configuration Mode Hierarchy of Statements



Each statement at the top level of the configuration hierarchy resides at the trunk (or root level) of a hierarchy tree. The top-level statements are container statements, containing other statements that form the tree branches. The leaf statements are the leaves of the hierarchy tree. An individual hierarchy of statements, which starts at the trunk of the hierarchy tree, is called a *statement path*. Figure 25 illustrates the hierarchy tree, showing a statement path for the portion of the protocol configuration hierarchy that configures the hello interval on an interface in an OSPF area.

The protocols statement is a top-level statement at the trunk of the configuration tree. The ospf, area, and interface statements are all subordinate container statements of a higher statement (they are branches of the hierarchy tree), and the hello-interval statement is a leaf on the tree, which, in this case, contains a data value: the length of the hello interval in seconds.

The CLI represents the statement path shown in Figure 25 on page 205as [protocols ospf area *area-number* interface *interface-name*], and displays the configuration as follows:

```
protocols {
    ospf {
        area 0.0.0.0 {
            interface so-0/0/0 {
                hello-interval 5;
            }
            interface so-0/0/1 {
                hello-interval 5;
            }
        }
    }
}
```

The CLI indents each level in the hierarchy to indicate each statement's relative position in the hierarchy and generally sets off each level with braces, using an open brace at the beginning of each hierarchy level and a closing brace at the end. If the statement at a hierarchy level is empty, the braces are not printed. Each leaf statement ends with a semicolon. If the hierarchy does not extend as far as a leaf statement, the last statement in the hierarchy ends with a semicolon.

The CLI uses this indented representation when it displays the current system configuration, and you use this format when creating ASCII files that contain the software configuration. However, the format of ASCII configuration files is not as strict as the CLI output of the configuration. Although the braces and semicolons are required, the indentation and use of new lines, as shown above, are not required in ASCII configuration files.

Using the CLI Configuration Mode

This section describes how to use the CLI configuration mode. You can do the following:

Entering Configuration Mode

If many users enter configuration mode at the same time, everyone can make configuration changes and commit all changes. If one user enters configuration mode when another user is also in configuration mode, a message indicates who the user is and what portion of the configuration that user is viewing or editing. To enter configuration mode, use the following CLI command:

user@host> **configure**

```
Entering configuration mode
Current configuration users:
    root terminal p3 (pid 1088) on since 1999-05-13 01:03:27 EDT
        [edit interfaces so-3/0/0 unit 0 family inet]
The configuration has been changed but not committed
```

- If, when you enter configuration mode, the configuration contains changes that have not been committed, a message appears:

  user@host> **configure**

  ```
  Entering configuration mode
  The configuration has been changed but not committed
  ```

- If, while in configuration mode, you try to make a change while the configuration is locked by another user, a message indicates that the configuration database is locked, who the user is, and what portion of the configuration the user is viewing or editing:

  user@host# **set system host-name ipswitch**

  ```
  error: configuration database locked by:
      user2 terminal d0 (pid 1828) on since 19:47:58 EDT, idle 00:02:11
          exclusive [edit protocols]
  ```

- If you enter configuration mode with the configure exclusive command, you lock the candidate configuration for as long as you remain in configuration mode, allowing you to make changes without interference from other users. If another user is also in configuration mode and has the configuration locked, a message indicates who the user is and what portion of the configuration the user is viewing or editing:

  user@host> **configure exclusive**

  ```
  Entering configuration mode
  Users currently editing the configuration:
      root terminal p3 (pid 1088) on since 2000-10-30 19:47:58 EDT, idle
  00:00:44
      exclusive [edit interfaces so-3/0/0 unit 0 family inet]
  ```

Exiting Configuration Mode

To exit configuration mode, use the exit configuration-mode configuration mode command from any level or use the exit command from the top level. If you try to exit from configuration mode using the exit command and the configuration contains changes that have not been committed, you see a message and prompt:

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

```
The configuration has been changed but not committed
Exit with uncommitted changes? [yes,no] (yes) <Enter>
Exiting configuration mode
user@host>
```

To exit with uncommitted changes without having to respond to a prompt, use the exit configuration-mode command.

Moving Among Levels of the Hierarchy

The CLI commands in Table 22 help you navigate the levels of the configuration statement hierarchy.

Table 22: CLI Configuration Mode Navigation Commands

Command	Description
edit	To move down through an existing configuration command hierarchy, or to create a hierarchy and move down to that level, use the edit configuration mode command, specifying the hierarchy level at which you want to be.
exit	To move up the hierarchy, use the exit configuration mode command. This command is, in effect, the opposite of the edit command.
up	To move up the hierarchy one level at a time, use the up configuration mode command.
top	To move directly to the top level, use the top configuration mode command.

Displaying the Current Configuration

You can display the following information about the current configuration:

Displaying the Configuration at the Current Hierarchy Level

To display the configuration at the current hierarchy level or at the specified level, use the show configuration mode command.

user@host> **show** <*statement-path*>

The configuration statements appear in a fixed order. The CLI indents each level in the hierarchy to indicate each statement's relative position in the hierarchy and generally sets off each level with braces, using an open brace at the beginning of each hierarchy level and a closing brace at the end. If the statement at a hierarchy level is empty, the braces are not printed. Each leaf statement ends with a semicolon. If the hierarchy does not extend as far as a leaf statement, the last statement in the hierarchy ends with a semicolon. Interfaces appear alphabetically by type, and then in numerical order by slot number, PIC number, and port number.

Displaying the Last Committed Current Configuration

You also can use the CLI operational mode show configuration command to display the last committed current configuration, which is the configuration currently running on the router:

user@host> **show configuration**

Displaying Users Currently Editing the Configuration

To display the users currently editing the configuration, use the status configuration mode command:

user@host# **status**

```
Current configuration users:
  user terminal p0 (pid 518) on since 2002-03-12 18:24:27 PST
      [edit protocols]
```

The system displays who is editing the configuration (user), how the user is logged in (terminal p0), the date and time the user logged in (2002-03-12 18:24:27 PST), and what level of the hierarchy the user is editing ([edit protocols]).

Modifying the Configuration

To configure the router or to modify an existing router configuration, you add statements to the configuration. For each statement hierarchy, you create the hierarchy starting with a statement at the top level and continuing with statements that move progressively lower in the hierarchy.

To modify the hierarchy, you use two configuration mode commands:

- set—Creates a statement hierarchy and sets identifier values. After you issue a set command, you remain at the same level in the hierarchy. The set command has the following syntax:

  set <*statement-path*> *statement* <*identifier*>

  statement-path is the hierarchy to the configuration statement and the statement itself. If you have already moved to the statement's hierarchy level, you omit this. *statement* is the configuration statement itself. *identifier* is a string that identifies an instance of a statement.

- edit—Moves to a particular hierarchy level. If that hierarchy level does not exist, the edit command creates it and then moves to it. The edit command has the following syntax:

  edit <*statement-path*> *statement* <*identifier*>

Removing a Statement

To delete a statement or identifier, use the delete configuration mode command. Deleting a statement or an identifier effectively "unconfigures" the functionality associated with that statement or identifier, returning that functionality to its default condition. When you delete a statement, the statement and all its subordinate statements and identifiers are removed from the configuration.

delete <*statement-path*> <*identifier*>

To delete the entire hierarchy starting at the current hierarchy level, do not specify a statement or an identifier in the delete command:

```
[edit]
user@host# delete

Delete everything under this level? [yes, no] (no) ?
    Possible completions:
        no          Don't delete everything under this level
        yes         Delete everything under this level
Delete everything under this level? [yes, no] (no)
```

Running Operational Mode CLI Commands from Configuration

:

Mode

To display the output of an operational mode show or other command while configuring the software, you can execute a single operational mode command by issuing the run configuration mode command and specifying the operational mode command:

```
[edit]
user@host# run operational-mode-command
```

Displaying Configuration Mode Command History

To display a list of the recent commands you issued while in configuration mode, use the run show cli history command. By default, this command displays the last 100 commands issued in the CLI.

```
user@host# run show cli history

12:40:08 -- show
12:40:17 -- edit protocols
12:40:27 -- set isis
12:40:29 -- edit isis
12:40:40 -- run show cli history
```

Committing a Configuration

To commit a configuration, you can do the following:

- Saving Configuration Changes and Activating the Configuration on page 211
- Saving Configuration Changes, Activating the Configuration, and Exiting Configuration Mode on page 212

Saving Configuration Changes and Activating the Configuration

To save software configuration changes to the configuration database and activate the configuration on the router, use the commit configuration mode command:

```
user@host# commit

commit complete
```

The configuration is checked for syntax errors. If the syntax is correct, the configuration is activated and becomes the current, operational router configuration. If the configuration contains syntax errors, a message indicates the location of the error and the configuration is not activated. You must correct the error before recommitting the configuration.

Saving Configuration Changes, Activating the Configuration, and Exiting Configuration Mode

To save software configuration changes, activate the configuration on the router, and exit configuration mode, use the commit and-quit configuration mode command. This command succeeds only if the configuration contains no errors.

```
[edit]
user@host# commit and-quit

commit complete
exiting configuration mode
user@host>
```

Saving a Configuration to a File

To save the configuration to a text (ASCII) file so that you can edit it with a text editor of your choice, use the save configuration mode command. By default, the configuration is saved to that file in your home directory, which is on the flash disk.

```
[edit]
user@host# save filename
```

Returning to a Previously Committed Configuration

To return to a previously committed configuration, you can do the following:

- Returning to the Most Recent Committed Configuration on page 212
- Activating the Configuration You Loaded on page 213
- Returning to a Configuration Prior to the Most Recently Committed One on page 213
- Displaying Previous Configurations on page 213

Returning to the Most Recent Committed Configuration

To return to the most recently committed configuration and load it into configuration mode without activating it, use the rollback configuration mode command:

```
[edit]
user@host# rollback

load complete
```

Activating the Configuration You Loaded

To activate the configuration that you loaded, use the commit command:

```
[edit]
user@host# rollback
load complete
[edit]
user@host# commit
```

Returning to a Configuration Prior to the Most Recently Committed One

To return to a configuration prior to the most recently committed one, include the number in the rollback command. *number* can be a number in the range 0 through 9. The most recently saved configuration is number 0 (which is the default configuration to which the system returns), and the oldest saved configuration is number 9.

```
[edit]
user@host# rollback number
load complete
```

Displaying Previous Configurations

To display previous configurations, including the rollback number, date, time, the name of the user who committed changes, and the method of commit, use the rollback ? command.

```
[edit]
user@host# rollback ?

Possible completions:
<[Enter]> Execute this command
<number> Numeric argument
0 2001-02-27 12:52:10 PST by abc via cli
1 2001-02-26 14:47:42 PST by cde via cli
2 2001-02-14 21:55:45 PST by fgh via cli
3 2001-02-10 16:11:30 PST by hij via cli
4 2001-02-10 16:02:35 PST by klm via cli
|   Pipe through a command
[edit]
```

Getting Help about Statements

In configuration mode, you can use the help command to display help based on a text string contained in a statement name. This command displays help for statements at the current hierarchy level and below.

```
user@host# help  string
```

You can also display help based on a text string contained in a statement name using the help topic and help reference commands. The help topic command displays usage guidelines for the statement, whereas the help reference command displays summary information about the statement.

```
user@host# help topic string
user@host# help reference string
```

If you do not type an option for a statement that requires one, a message indicates the type of information expected. In this example, you need to type an area number to complete the command:

```
[edit]
user@host# set protocols ospf area<Enter>

syntax error, expecting <identifier>.
```

In this example, you need to type a value for the hello interval to complete the command:

```
[edit]
user@host# set protocols ospf area 45 interface so-0/0/0
                hello-interval<Enter>

syntax error, expecting <data>
```

If you have omitted a required statement at a particular hierarchy level, when you attempt to move from that hierarchy level or when you issue the show command in configuration mode, a message indicates which statement is missing. For example:

```
[edit protocols pim interface so-0/0/0]
user@host# top
Warning: missing mandatory statement: 'mode'
[edit]
user@host# show
protocols {
    pim {
        interface so-0/0/0 {
            priority 4;
            version 2;
            # Warning: missing mandatory statement(s): 'mode'
        }
    }
}
```

Part 4
Index

■ Index on page 217

Index

D

E

F

G

H

I

K

L

M

N

O

P

Q

R

S

T

U