



JUNOS® Software

Routing Protocols Configuration Guide

Release 9.3

Juniper Networks, Inc.

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Part Number: 530-027200-01 , Revision 1

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JUNOS® Software Routing Protocols Configuration Guide,
Release 9.3

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Cover Design: Edmonds Design

Revision History
10 October 2008—Revision 1

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

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Part 1

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About This Guide

This preface provides the following guidelines for using the *JUNOS® Software Routing Protocols Configuration Guide*:

- Objectives on page xxxv
- Audience on page xxxv
- Supported Routing Platforms on page xxxvi
- Using the Indexes on page xxxvi
- Using the Examples in This Manual on page xxxvi
- Documentation Conventions on page xxxviii
- List of Technical Publications on page xl
- Documentation Feedback on page xlvii
- Requesting Technical Support on page xlvii

Objectives

This guide is designed for network administrators who are configuring and monitoring a Juniper Networks J-series, M-series, MX-series, or T-series routing platform.



NOTE: This guide documents Release 9.3 of the JUNOS software. For additional information about the JUNOS software—either corrections to or information that might have been omitted from this guide—see the software release notes at <http://www.juniper.net/>.

Audience

This guide is designed for network administrators who are configuring and monitoring a Juniper Networks M-series, MX-series, T-series, EX-series, or J-series routing platform.

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

- Border Gateway Protocol (BGP)
- 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.

Supported Routing Platforms

For the features described in this manual, the JUNOS software currently supports the following routing platforms:

- J-series
- M-series
- MX-series
- T-series
- EX-series

Using the Indexes

This reference contains two indexes: a complete index that includes topic entries, and an index of statements and commands only.

In the index of statements and commands, an entry refers to a statement summary section only. In the complete index, the entry for a configuration statement or command contains at least two parts:

- The primary entry refers to the statement summary section.
- The secondary entry, *usage guidelines*, refers to the section in a configuration guidelines chapter that describes how to use the statement or command.

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.xml; }
```

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

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

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

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

For more information about the load command, see the *JUNOS CLI User Guide*.

Documentation Conventions

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

Table 1: Notice Icons





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

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

Table 2: Text and Syntax Conventions

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

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

Convention	Description	Examples
Fixed-width text like this	Represents output that appears on the terminal screen.	<code>user@host> show chassis alarms</code> <code>No alarms currently active</code>
<i>Italic text like this</i>	<ul style="list-style-type: none"> Introduces important new terms. Identifies book names. Identifies RFC and Internet draft titles. 	<ul style="list-style-type: none"> A policy <i>term</i> is a named structure that defines match conditions and actions. <i>JUNOS System Basics Configuration Guide</i> RFC 1997, <i>BGP Communities Attribute</i>
<i>Italic text like this</i>	Represents variables (options for which you substitute a value) in commands or configuration statements.	Configure the machine's domain name: [edit] root@# set system domain-name <i>domain-name</i>
Plain text like this	Represents names of configuration statements, commands, files, and directories; IP addresses; configuration hierarchy levels; or labels on routing platform components.	<ul style="list-style-type: none"> To configure a stub area, include the stub statement at the [edit protocols ospf area area-id] hierarchy level. The console port is labeled CONSOLE.
< > (angle brackets)	Enclose optional keywords or variables.	stub <default-metric <i>metric</i> >;
(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 (<i>string1</i> <i>string2</i> <i>string3</i>)
# (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 [<i>community-ids</i>]
Indentation and braces ({ })	Identify a level in the configuration hierarchy.	[edit] routing-options { static { route default { nexthop <i>address</i> ; retain; } } }
; (semicolon)	Identifies a leaf statement at a configuration hierarchy level.	
J-Web GUI Conventions		
Bold text like this	Represents J-Web graphical user interface (GUI) items you click or select.	<ul style="list-style-type: none"> In the Logical Interfaces box, select All Interfaces. To cancel the configuration, click Cancel.

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

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

List of Technical Publications

Table 3 on page xl lists the software and hardware guides and release notes for Juniper Networks J-series, M-series, MX-series, and T-series routing platforms and describes the contents of each document. Table 4 on page xlv lists the books included in the *Network Operations Guide* series. Table 5 on page xlv lists the manuals and release notes supporting JUNOS software with enhanced services. All documents are available at <http://www.juniper.net/techpubs/>.

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

Table 3: Technical Documentation for Supported Routing Platforms

Book	Description
JUNOS Software for Supported Routing Platforms	
<i>Access Privilege</i>	Explains how to configure access privileges in user classes by using permission flags and regular expressions. Lists the permission flags along with their associated command-line interface (CLI) operational mode commands and configuration statements.
<i>Class of Service</i>	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.
<i>CLI User Guide</i>	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 the <i>JUNOS System Basics Configuration Guide</i> .
<i>Feature Guide</i>	Provides a detailed explanation and configuration examples for several of the most complex features in the JUNOS software.
<i>High Availability</i>	Provides an overview of hardware and software resources that ensure a high level of continuous routing platform operation and describes how to configure high availability (HA) features such as nonstop active routing (NSR) and graceful Routing Engine switchover (GRES).
<i>MPLS Applications</i>	Provides an overview of traffic engineering concepts and describes how to configure traffic engineering protocols.

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

Book	Description
<i>Multicast Protocols</i>	Provides an overview of multicast concepts and describes how to configure multicast routing protocols.
<i>Multiplay Solutions</i>	Describes how you can deploy IPTV and voice over IP (VoIP) services in your network.
<i>MX-series Layer 2 Configuration Guide</i>	Provides an overview of the Layer 2 functions of the MX-series routers, including configuring bridging domains, MAC address and VLAN learning and forwarding, and spanning-tree protocols. It also details the routing instance types used by Layer 2 applications. All of this material was formerly covered in the <i>JUNOS Routing Protocols Configuration Guide</i> .
<i>MX-series Solutions Guide</i>	Describes common configuration scenarios for the features supported on the MX-series routers, including basic bridged VLANs with normalized VLAN tags, aggregated Ethernet links, bridge domains, Multiple Spanning Tree Protocol (MSTP), and integrated routing and bridging (IRB).
<i>Network Interfaces</i>	Provides an overview of the network interface functions of the JUNOS software and describes how to configure the network interfaces on the routing platform.
<i>Network Management</i>	Provides an overview of network management concepts and describes how to configure various network management features, such as SNMP and accounting options.
<i>Policy Framework</i>	Provides an overview of policy concepts and describes how to configure routing policy, firewall filters, and forwarding options.
<i>Protected System Domain</i>	Provides an overview of the JCS 1200 platform and the concept of Protected System Domains (PSDs). The JCS 1200 platform, which contains up to 12 Routing Engines running JUNOS software, can be connected to up to three T-series routing platforms. To configure a PSD, you assign any number of Flexible PIC concentrators (FPCs) on a T-series routing platform to a pair of Routing Engines on the JCS 1200 platform. Each PSD has the same capabilities and functionality as a physical router, with its own control plane, forwarding plane, and administration.
<i>Routing Protocols</i>	Provides an overview of routing concepts and describes how to configure routing, routing instances, and unicast routing protocols.
<i>Secure Configuration Guide for Common Criteria and JUNOS-FIPS</i>	Provides an overview of secure Common Criteria and JUNOS-FIPS protocols for the JUNOS software and describes how to install and configure secure Common Criteria and JUNOS-FIPS on a routing platform.
<i>Services Interfaces</i>	Provides an overview of the services interfaces functions of the JUNOS software and describes how to configure the services interfaces on the router.
<i>Software Installation and Upgrade Guide</i>	Describes the JUNOS software components and packaging and explains how to initially configure, reinstall, and upgrade the JUNOS system software. This material was formerly covered in the <i>JUNOS System Basics Configuration Guide</i> .

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

Book	Description
<i>Subscriber Access</i>	Provides an overview of the subscriber access features of the JUNOS software and describes how to configure subscriber access support on the router, including dynamic profiles, class of service, AAA, and access methods.
<i>System Basics</i>	Describes Juniper Networks routing platforms and explains how to configure basic system parameters, supported protocols and software processes, authentication, and a variety of utilities for managing your router on the network.
<i>VPNs</i>	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.
JUNOS References	
<i>Hierarchy and RFC Reference</i>	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 the <i>JUNOS System Basics Configuration Guide</i> .
<i>Interfaces Command Reference</i>	Describes the JUNOS software operational mode commands you use to monitor and troubleshoot interfaces.
<i>Routing Protocols and Policies Command Reference</i>	Describes the JUNOS software operational mode commands you use to monitor and troubleshoot routing policies and protocols, including firewall filters.
<i>System Basics and Services Command Reference</i>	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 class of service (CoS), IP Security (IPsec), stateful firewalls, flow collection, and flow monitoring.
<i>System Log Messages Reference</i>	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	
<i>J-Web Interface User Guide</i>	Describes how to use the J-Web graphical user interface (GUI) to configure, monitor, and manage Juniper Networks routing platforms.
JUNOS API and Scripting Documentation	
<i>JUNOScript API Guide</i>	Describes how to use the JUNOScript application programming interface (API) to monitor and configure Juniper Networks routing platforms.
<i>JUNOS XML API Configuration Reference</i>	Provides reference pages for the configuration tag elements in the JUNOS XML API.

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

Book	Description
<i>JUNOS XML API Operational Reference</i>	Provides reference pages for the operational tag elements in the JUNOS XML API.
<i>NETCONF API Guide</i>	Describes how to use the NETCONF API to monitor and configure Juniper Networks routing platforms.
<i>JUNOS Configuration and Diagnostic Automation Guide</i>	Describes how to use the commit script and self-diagnosis features of the JUNOS software. This guide explains how to enforce custom configuration rules defined in scripts, how to use commit script macros to provide simplified aliases for frequently used configuration statements, and how to configure diagnostic event policies.
Hardware Documentation	
<i>Hardware Guide</i>	Describes how to install, maintain, and troubleshoot routing platforms and components. Each platform has its own hardware guide.
<i>PIC Guide</i>	Describes the routing platform's Physical Interface Cards (PICs). Each platform has its own PIC guide.
<i>DPC Guide</i>	Describes the Dense Port Concentrators (DPCs) for all MX-series routers.
JUNOScope Documentation	
<i>JUNOScope Software User Guide</i>	Describes the JUNOScope software graphical user interface (GUI), how to install and administer the software, and how to use the software to manage routing platform configuration files and monitor routing platform operations.
Advanced Insight Solutions (AIS) Documentation	
<i>Advanced Insight Solutions Guide</i>	Describes the Advanced Insight Manager (AIM) application, which provides a gateway between JUNOS devices and Juniper Support Systems (JSS) for case management and intelligence updates. Explains how to run AI-Scripts on Juniper Networks devices.
J-series Routing Platform Documentation	
<i>Getting Started Guide</i>	Provides an overview, basic instructions, and specifications for J-series routing platforms. The guide explains how to prepare your site for installation, unpack and install the router and its components, install licenses, and establish basic connectivity. Use the <i>Getting Started Guide</i> for your router model.
<i>Basic LAN and WAN Access Configuration Guide</i>	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.
<i>Advanced WAN Access Configuration Guide</i>	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.

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

Book	Description
<i>Administration Guide</i>	Shows how to manage users and operations, monitor network performance, upgrade software, and diagnose common problems on J-series Services Routers.
Release Notes	
<i>JUNOS Release Notes</i>	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.
<i>Hardware Release Notes</i>	Describe the available documentation for the routing platform and summarize known problems with the hardware and accompanying software. Each platform has its own release notes.
<i>JUNOScope Release Notes</i>	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.
<i>AIS Release Notes</i>	Summarize AIS new features and guidelines, identify known and resolved problems, provide information that might have been omitted from the manuals, and provide initial setup, upgrade, and downgrade procedures.
<i>AIS AI-Scripts Release Notes</i>	Summarize AI-Scripts new features, identify known and resolved problems, provide information that might have been omitted from the manuals, and provide instructions for automatic and manual installation, including deleting and rolling back.
<i>J-series Services Router Release Notes</i>	Briefly describe Services Router features, identify known hardware problems, and provide upgrade and downgrade instructions.

Table 4: JUNOS Software Network Operations Guides

Book	Description
<i>Baseline</i>	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.
<i>Interfaces</i>	Describes tasks for monitoring interfaces. Tasks include using loopback testing and locating alarms.
<i>MPLS</i>	Describes tasks for configuring, monitoring, and troubleshooting an example MPLS network. Tasks include verifying the correct configuration of the MPLS and RSVP protocols, displaying the status and statistics of MPLS running on all routing platforms in the network, and using the layered MPLS troubleshooting model to investigate problems with an MPLS network.

Table 4: JUNOS Software Network Operations Guides (continued)

Book	Description
<i>MPLS Log Reference</i>	Describes MPLS status and error messages that appear in the output of the <code>show mpls lsp extensive</code> command. The guide also describes how and when to configure Constrained Shortest Path First (CSPF) and RSVP trace options, and how to examine a CSPF or RSVP failure in a sample network.
<i>MPLS Fast Reroute</i>	Describes operational information helpful in monitoring and troubleshooting an MPLS network configured with fast reroute (FRR) and load balancing.
<i>Hardware</i>	Describes tasks for monitoring M-series and T-series routing platforms.

To configure and operate a J-series Services Router running JUNOS software with enhanced services, you must also use the configuration statements and operational mode commands documented in JUNOS configuration guides and command references. To configure and operate a WX Integrated Services Module, you must also use WX documentation.

Table 5: JUNOS Software with Enhanced Services Documentation

Book	Description
All Platforms	
<i>JUNOS Software Interfaces and Routing Configuration Guide</i>	Explains how to configure J-series interfaces for basic IP routing with standard routing protocols, ISDN service, firewall filters (access control lists), and class-of-service (CoS) traffic classification.
<i>JUNOS Software Security Configuration Guide</i>	Explains how to configure and manage security services such as stateful firewall policies, IP Security (IPsec) virtual private networks (VPNs), firewall screens, Network Address Translation (NAT), Public Key Cryptography, and Application Layer Gateways (ALGs).
<i>JUNOS Software Administration Guide</i>	Shows how to monitor J-series devices and routing operations, firewall and security services, system alarms and events, and network performance. This guide also shows how to administer user authentication and access, upgrade software, and diagnose common problems.
<i>JUNOS Software CLI Reference</i>	Provides the complete JUNOS software with enhanced services configuration hierarchy and describes the configuration statements and operational mode commands not documented in the standard JUNOS manuals.
J-series Only	
<i>JUNOS Software with Enhanced Services Design and Implementation Guide</i>	Provides guidelines and examples for designing and implementing IPsec VPNs, firewalls, and routing on J-series Services Routers running JUNOS software with enhanced services.

Table 5: JUNOS Software with Enhanced Services Documentation (continued)

Book	Description
<i>JUNOS Software with Enhanced Services Quick Start</i>	Explains how to quickly set up a J-series Services Router. This document contains router declarations of conformity.
<i>JUNOS Software with Enhanced Services J-series Services Router Hardware Guide</i>	Provides an overview, basic instructions, and specifications for J-series Services Routers. This guide explains how to prepare a site, unpack and install the router, replace router hardware, and establish basic router connectivity. This guide contains hardware descriptions and specifications.
<i>JUNOS Software with Enhanced Services Migration Guide</i>	Provides instructions for migrating an SSG device running ScreenOS software or a J-series Services Router running the JUNOS software to JUNOS software with enhanced services.
<i>WXC Integrated Services Module Installation and Configuration Guide</i>	Explains how to install and initially configure a WXC Integrated Services Module in a J-series Services Router for application acceleration.
<i>JUNOS Software with Enhanced Services Release Notes</i>	Summarizes new features and known problems for a particular release of JUNOS software with enhanced services on J-series Services Routers, including J-Web interface features and problems. The release notes also contain corrections and updates to the manuals and software upgrade and downgrade instructions for JUNOS software with enhanced services.

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

Book	Description
<i>Interdomain Multicast Routing</i>	Provides background and in-depth analysis of multicast routing using Protocol Independent Multicast sparse mode (PIM SM) and Multicast Source Discovery Protocol (MSDP); details any-source and source-specific multicast delivery models; explores multiprotocol BGP (MBGP) and multicast IS-IS; explains Internet Gateway Management Protocol (IGMP) versions 1, 2, and 3; lists packet formats for IGMP, PIM, and MSDP; and provides a complete glossary of multicast terms.
<i>JUNOS Cookbook</i>	Provides detailed examples of common JUNOS software configuration tasks, such as basic router configuration and file management, security and access control, logging, routing policy, firewalls, routing protocols, MPLS, and VPNs.
<i>MPLS-Enabled Applications</i>	Provides an overview of Multiprotocol Label Switching (MPLS) applications (such as Layer 3 virtual private networks [VPNs], Layer 2 VPNs, virtual private LAN service [VPLS], and pseudowires), explains how to apply MPLS, examines the scaling requirements of equipment at different points in the network, and covers the following topics: point-to-multipoint label switched paths (LSPs), DiffServ-aware traffic engineering, class of service, interdomain traffic engineering, path computation, route target filtering, multicast support for Layer 3 VPNs, and management and troubleshooting of MPLS networks.
<i>OSPF and IS-IS: Choosing an IGP for Large-Scale Networks</i>	Explores the full range of characteristics and capabilities for the two major link-state routing protocols: Open Shortest Path First (OSPF) and IS-IS. Explains architecture, packet types, and addressing; demonstrates how to improve scalability; shows how to design large-scale networks for maximum security and reliability; details protocol extensions for MPLS-based traffic engineering, IPv6, and multipoint-to-multipoint routing; and covers troubleshooting for OSPF and IS-IS networks.

Table 6: Additional Books Available Through <http://www.juniper.net/books> (continued)

Book	Description
<i>Routing Policy and Protocols for Multivendor IP Networks</i>	Provides a brief history of the Internet, explains IP addressing and routing (Routing Information Protocol [RIP], OSPF, IS-IS, and Border Gateway Protocol [BGP]), explores ISP peering and routing policies, and displays configurations for both Juniper Networks and other vendors' routers.
<i>The Complete IS-IS Protocol</i>	Provides the insight and practical solutions necessary to understand the IS-IS protocol and how it works by using a multivendor, real-world approach.

Documentation Feedback

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

- Document name
- Document part number
- Page number
- Software release version (not required for *Network Operations Guides [NOGs]*)

Requesting Technical Support

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

- JTAC policies—For a complete understanding of our JTAC procedures and policies, review the JTAC User Guide located at <http://www.juniper.net/customers/support/downloads/710059.pdf>.
- Product warranties—For product warranty information, visit <http://www.juniper.net/support/warranty/>.
- JTAC Hours of Operation —The JTAC centers have resources available 24 hours a day, 7 days a week, 365 days a year.

Self-Help Online Tools and Resources

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

- Find CSC offerings: <http://www.juniper.net/customers/support/>
- Search for known bugs: <http://www2.juniper.net/kb/>

- Find product documentation: <http://www.juniper.net/techpubs/>
- Find solutions and answer questions using our Knowledge Base:
<http://kb.juniper.net/>
- Download the latest versions of software and review release notes:
<http://www.juniper.net/customers/csc/software/>
- Search technical bulletins for relevant hardware and software notifications:
<https://www.juniper.net/alerts/>
- Join and participate in the Juniper Networks Community Forum:
<http://www.juniper.net/company/communities/>
- Open a case online in the CSC Case Management tool: <http://www.juniper.net/cm/>

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

Opening a Case with JTAC

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

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

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

Part 1

Overview

- Routing Protocols Concepts on page 3
- Complete Routing and Routing Protocol Configuration Statements on page 15

Chapter 1

Routing Protocols Concepts

The JUNOS routing protocol process supports a wide variety of routing protocols, including Intermediate System-to-Intermediate System (IS-IS), Open Shortest Path First (OSPF), Routing Information Protocol (RIP), Routing Information Protocol Next Generation (RIPng), and Border Gateway Protocol (BGP). This chapter explains the general terminology and concepts related to configuring and using the routing protocol process and the routing protocols. For information about configuring the individual routing protocols, see the individual chapter about that protocol.

This chapter discusses the following topics:

- Routing Databases on page 3
- Configuring Interfaces on page 6
- Route Preferences on page 6
- Equal-Cost Paths and Load Sharing on page 10
- IPv6 on page 10

Routing Databases

The JUNOS software maintains two databases for routing information:

- Routing table—Contains all the routing information learned by all routing protocols.
- Forwarding table—Contains the routes actually used to forward packets through the router.

In addition, the interior gateway protocols (IGPs), IS-IS, and OSPF maintain link-state databases.

This section includes the following topics:

- Routing Protocol Databases on page 4
- JUNOS Routing Tables on page 4
- Forwarding Tables on page 5
- How the Routing and Forwarding Tables Are Synchronized on page 5

Routing Protocol Databases

Each IGP routing protocol maintains a database of the routing information it has learned from other routers running the same protocol and uses this information as defined and required by the protocol. IS-IS and OSPF use the routing information they received to maintain link-state databases, which they use to determine which adjacent neighbors are operational and to construct network topology maps.

IS-IS and OSPF use the Dijkstra algorithm, and RIP and RIPv6 use the Bellman-Ford algorithm to determine the best route or routes (if there are multiple equal-cost routes) to reach each destination and install these routes into the JUNOS software routing table.

JUNOS Routing Tables

The JUNOS software routing table is used by the routing protocol process to maintain its database of routing information. In this table, the routing protocol process stores statically configured routes, directly connected interfaces (also called *direct routes* or *interface routes*), and all routing information learned from all routing protocols. The routing protocol process uses this collected routing information to select the *active route* to each destination, which is the route that actually is used to forward packets to that destination.

By default, the JUNOS software maintains three routing tables: one for unicast routes, another for multicast routes, and a third for Multiprotocol Label Switching (MPLS). You can configure additional routing tables to support situations where you need to separate a particular group of routes or where you need greater flexibility in manipulating routing information. In general, most operations can be performed without resorting to the complexity of additional routing tables. However, creating additional routing tables has several specific uses, including importing interface routes into more than one routing table, applying different routing policies when exporting the same route to different peers, and providing greater flexibility with incongruent multicast topologies.

Each routing table is identified by a name, which consists of the protocol family followed by a period and a small, nonnegative integer. The protocol family can be **inet** (Internet), **iso** (ISO), or **mpls** (MPLS). The following names are reserved for the default routing tables maintained by the JUNOS software:

- **inet.0**—Default Internet Protocol version 4 (IPv4) unicast routing table
- **inet6.0**—Default Internet Protocol version 6 (IPv6) unicast routing table
- **instance-name.inet.0**—Unicast routing table for a particular routing instance
- **inet.1**—Multicast forwarding cache
- **inet.2**—Unicast routes used for multicast reverse path forwarding (RPF) lookup
- **inet.3**—MPLS routing table for path information
- **mpls.0**—MPLS routing table for label-switched path (LSP) next hops



NOTE: For clarity, this manual contains general discussions of routing tables as if there were only one table. However, when it is necessary to distinguish among the routing tables, their names are explicitly used.

Forwarding Tables

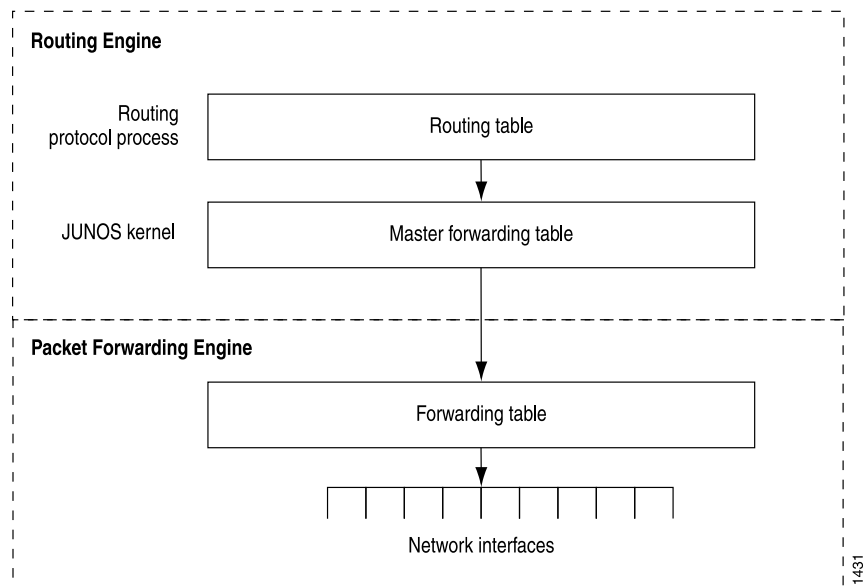
The JUNOS software installs all active routes from the routing table into the forwarding table. The active routes are used to forward packets to their destinations.

The JUNOS kernel maintains a master copy of the forwarding table. It copies the forwarding table to the Packet Forwarding Engine, which is the part of the router responsible for forwarding packets.

How the Routing and Forwarding Tables Are Synchronized

The JUNOS routing protocol process is responsible for synchronizing the routing information between the routing and forwarding tables. To do this, the routing protocol process calculates the active routes from all the routes in the routing table and installs them into the forwarding table. The routing protocol process then copies the forwarding table to the router's Packet Forwarding Engine, the part of the router that forwards packets. Figure 1 on page 5 illustrates how the routing tables are synchronized.

Figure 1: Synchronizing Routing Exchange Between the Routing and Forwarding Tables



Configuring Interfaces

When you configure a protocol on an interface, you must also configure a protocol family on that interface. For information about configuring interfaces, see the *JUNOS Network Interfaces Configuration Guide* and *JUNOS Services Interfaces Configuration Guide*. For information about configuring protocol families, see the individual protocol configuration chapters in this guide.

Route Preferences

For unicast routes, the JUNOS routing protocol process uses the information in its routing table, along with the properties set in the configuration file, to choose an *active route* for each destination. While the JUNOS software might know of many routes to a destination, the active route is the preferred route to that destination and is the one that is installed in the forwarding table and used when actually routing packets.

The routing protocol process generally determines the active route by selecting the route with the lowest preference value. The preference value is an arbitrary value in the range from 0 through 4,294,967,295 ($2^{32} - 1$) that the software uses to rank routes received from different protocols, interfaces, or remote systems.

The preference value is used to select routes to destinations in external autonomous systems (ASs) or routing domains; it has no effect on the selection of routes within an AS (that is, within an IGP). Routes within an AS are selected by the IGP and are based on that protocol's metric or cost value.

This section includes the following topics:

- Alternate and Tiebreaker Preferences on page 6
- How the Active Route Is Determined on page 7
- Multiple Active Routes on page 8
- Default Route Preference Values on page 8

Alternate and Tiebreaker Preferences

The JUNOS software provides support for alternate and tiebreaker preferences, and some of the routing protocols, including BGP and label switching, use these additional preferences. With these protocols, you can specify a primary route preference, **preference**, and a secondary preference, **preference2**, that is used as a tiebreaker. You can also mark route preferences with additional route tiebreaker information by specifying a color, **color**, and a tiebreaker color, **color2**.

The software uses a 4-byte value to represent the route preference value. When using the preference value to select an active route, the software first compares the primary route preference values, choosing the route with the lowest value. If there is a tie and a secondary preference has been configured, the software compares the secondary preference values, choosing the route with the lowest value. The secondary preference values must be included in a set for the preference values to be considered.

How the Active Route Is Determined

For each prefix in the routing table, the routing protocol process selects a single best path, called the active route. The algorithm for determining the active route is as follows:

1. Choose the path with the lowest preference value (routing protocol process preference). Routes that are not eligible to be used for forwarding (for example, because they were rejected by routing policy or because a next hop is inaccessible) have a preference of -1 and are never chosen.
2. For BGP, prefer the path with higher local preference. For non-BGP paths, choose the path with the lowest **preference2** value.
3. If the path includes an AS path:
 - a. Prefer the route with a shorter AS path.

Confederation sequences are considered to have a path length of 0, and AS and confederation sets are considered to have a path length of 1.

- b. Prefer the route with the lower origin code. Routes learned from an IGP have a lower origin code than those learned from an EGP, and both have lower origin codes than incomplete routes (routes whose origin is unknown).
- c. Depending on whether nondeterministic routing table path selection behavior is configured, there are two possible cases:
 - If nondeterministic routing table path selection behavior is not configured (that is, if the **path-selection cisco-nondeterministic** statement is not included in the BGP configuration), for paths with the same neighboring AS numbers at the front of the AS path, prefer the path with the lowest multiple exit discriminator (MED) metric. Confederation AS numbers are not considered when deciding what the neighbor AS number is. When you display the routes in the routing table using the **show route** command, they generally appear in order from most preferred to least preferred. Routes that share the same neighbor AS are grouped together in the command output. Within a group, the best route is listed first and the other routes are marked with the **NotBest** flag in the **State** field of the **show route detail** command.
 - To always compare MEDs whether or not the peer ASs of the compared routes are the same, use the **path-selection (always-compare-med)** statement. For an example, see “Configuring Routing Table Path Selection” on page 671.

If nondeterministic routing table path selection behavior is configured (that is, the **path-selection cisco-nondeterministic** statement is included in the BGP configuration), prefer the path with the lowest MED metric. When you display the routes in the routing table using the **show route** command, they generally appear in order from most preferred to least preferred and are ordered with the best route first, followed by all other routes in order from newest to oldest.

In both cases, confederations are not considered when determining neighboring ASs. Also, in both cases, a missing metric is treated as if a MED were present but zero.

4. Prefer strictly internal paths, which include IGP routes and locally generated routes (static, direct, local, and so forth).
5. Prefer strictly external (EBGP) paths over external paths learned through interior sessions (IBGP).
6. For BGP, prefer the path whose next hop is resolved through the IGP route with the lowest metric.
7. For BGP, prefer the path with the largest number of BGP next hops.
8. For BGP, prefer the route with the lowest IP address value for the BGP router ID. For EBGP only, prefer the current active route when a route is received from different neighboring ASs, by default. To disable this default behavior, specify the `external-router-id` option at the `[edit protocols bgp path-selection]` hierarchy level. For more information, see “Configuring Routing Table Path Selection” on page 671.
9. For BGP, prefer the route with the shortest route reflection cluster list. Routes without a cluster list are considered to have a cluster list of length 0.
10. Prefer the path that was learned from the neighbor with the lowest peer IP address.

Multiple Active Routes

The interior gateway protocols (IGPs) compute equal-cost multipath next hops, and internal BGP (IBGP) picks up these next hops. When there are multiple, equal-cost next hops associated with a route, the routing protocol process installs only one of the next hops in the forwarding path with each route, randomly selecting which next hop to install. For example, if there are 3 equal-cost paths to an exit router and 900 routes leaving through that router, each path ends up with about 300 routes pointing at it. This mechanism provides load distribution among the paths while maintaining packet ordering per destination.

Default Route Preference Values

The JUNOS software routing protocol process assigns a default preference value to each route that the routing table receives. The default value depends on the source of the route. The preference value is a value from 0 through 4,294,967,295 ($2^{32} - 1$), with a lower value indicating a more preferred route. Table 7 on page 8 lists the default preference values.

Table 7: Default Route Preference Values

How Route Is Learned	Default Preference	Statement to Modify Default Preference
Directly connected network	0	–

Table 7: Default Route Preference Values (continued)

How Route Is Learned	Default Preference	Statement to Modify Default Preference
System routes	4	–
Static and Static LSPs	5	static
RSVP-signaled LSPs	7	RSVP preference in the <i>JUNOS MPLS Applications Configuration Guide</i>
LDP-signaled LSPs	9	LDP preference in the <i>JUNOS MPLS Applications Configuration Guide</i>
OSPF internal route	10	OSPF preference
IS-IS Level 1 internal route	15	IS-IS preference
IS-IS Level 2 internal route	18	IS-IS , preference
Redirects	30	–
Kernel	40	–
SNMP	50	–
Router discovery	55	–
RIP	100	RIP preference
RIPng	100	RIPng preference
PIM	105	<i>JUNOS Multicast Protocols Configuration Guide</i>
DVMRP	110	<i>JUNOS Multicast Protocols Configuration Guide</i>
Aggregate	130	aggregate
OSPF AS external routes	150	OSPF external-preference
IS-IS Level 1 external route	160	IS-IS external-preference
IS-IS Level 2 external route	165	IS-IS external-preference
BGP	170	BGP preference, export, import
MSDP	175	<i>JUNOS Multicast Protocols Configuration Guide</i>

In general, the narrower the scope of the statement, the higher precedence its preference value is given, but the smaller the set of routes it affects. To modify the default preference value for routes learned by routing protocols, you generally apply routing policy when configuring the individual routing protocols. You also can modify some preferences with other configuration statements, which are indicated in the

table. For information about defining and applying routing policies, see the *JUNOS Policy Framework Configuration Guide*.

Equal-Cost Paths and Load Sharing

For equal-cost paths, load sharing is based on the BGP next hop. For example, if four prefixes all point to a next hop and there is more than one equal-cost path to that next hop, the routing protocol process uses a hash algorithm to choose the path among the four prefixes. Also, for each prefix, the routing protocol process installs a single forwarding entry pointing along one of the paths. The routing software does not rehash the path taken as prefixes pointing to the next hop come and go, but it does rehash if the number of paths to the next hop changes. Because a prefix is tied to a particular path, packet reordering should not happen. The degree of load sharing improves as the number of prefixes increases.

IPv6

Internet Protocol version 6 (IPv6) is the new version of the Internet Protocol (IP). The Internet Protocol allows numerous nodes on different networks to interoperate seamlessly. Internet Protocol version 4 (IPv4) is currently used in intranets and private networks, as well as the Internet. IPv6 is the successor to IPv4, and is based for the most part on IPv4.

IPv4 has been widely deployed and used to network the Internet today. With the rapid growth of the Internet, enhancements to IPv4 are needed to support the influx of new subscribers, Internet-enabled devices, and applications. IPv6 is designed to enable the global expansion of the Internet.

IPv6 builds upon the functionality of IPv4, providing improvements to addressing, configuration and maintenance, and security.

IPv6 offers the following benefits:

- Expanded addressing capabilities—IPv6 provides a larger address space. IPv6 addresses consist of 128 bits, while IPv4 addresses consist of 32 bits. 128-bit addressing increases the address space by approximately 10^{29} unique addresses, enough to last for the foreseeable future.
- Header format simplification—IPv6 packet header format is designed to be efficient. IPv6 standardizes the size of the packet header to 40 bytes, divided into 8 fields.
- Improved support for extensions and options—Extension headers carry Internet-layer information and have a standard size and structure.
- Flow labeling capability—Flow labels provide consistent handling of packets belonging to the same flow.
- Improved privacy and security—IPv6 supports extensions for authentication and data integrity, which enhance privacy and security.

This section discusses the following topics:

- IPv6 Standards on page 11
- IPv6 Packet Headers on page 11
- IPv6 Addressing on page 12

IPv6 Standards

IPv6 is defined in the following documents:

- RFC 1981, *Path MTU Discovery for IP version 6*
- RFC 2373, *IP Version 6 Addressing Architecture*
- RFC 2460, *Internet Protocol, Version 6 (IPv6)*
- RFC 2461, *Neighbor Discovery for IP Version 6*
- RFC 2462, *IPv6 Stateless Address Auto configuration*
- RFC 2463, *Internet Control Message Protocol (ICMPv6) for the Internet Protocol Version 6*
- RFC 2464, *Transmission of IPv6 Packets over Ethernet Networks*
- RFC 2472, *IP Version 6 over PPP*
- RFC 2474, *Definition of the Differentiated Services Field (DS Field) in the IPv4 and IPv6 Headers*
- RFC 2675, *IPv6 Jumbo grams*
- RFC 2767, *Dual Stack Hosts using the "Bump-In-the-Stack" Technique (BIS)*
- RFC 2878, *PPP Bridging Control Protocol*
- RFC 2893, *Transition Mechanisms for IPv6 Hosts and Routers*
- Internet draft draft-ietf-dhc-dhcpv6-16.txt, *Dynamic Host Configuration Protocol for IPv6* (expires May 2001)
- Internet draft draft-kato-bgp-ipv6-link-local-00.txt, *BGP4 + Peering Using IPv6 Link-local Address* (expires April 2002)
- Internet draft draft-ietf-idr-flow-spec-00.txt, *Dissemination of Flow Specification Rules*

To access Internet Requests for Comments (RFCs) and drafts, see <http://www.ietf.org>.

IPv6 Packet Headers

IPv6 headers are different from IPv4 headers.

This section discusses the following topics that provide background information about IPv6 headers:

- Header Structure on page 12
- Extension Headers on page 12

Header Structure

IPv6 packet headers contain many of the fields found in IPv4 packet headers; some of these fields have been modified from IPv4. The 40-byte IPv6 header consists of the following 8 fields:

- Traffic class—Class-of-service (CoS) priority of the packet. Previously the type-of-service (ToS) field in IPv4. However, the semantics of this field (for example, DiffServ code points) are identical to IPv4.
- Destination address—Final destination node address for the packet.
- Flow label—Packet flows requiring a specific CoS. The flow label identifies all packets belonging to a specific flow, and routers can identify these packets and handle them in a similar fashion.
- Hop limit—Maximum number of hops allowed. Previously the time-to-live (TTL) field in IPv4.
- Next header—Next extension header to examine. Previously the protocol field in IPv4.
- Payload length—Length of the IPv6 payload. Previously the total length field in IPv4.
- Source address—Address of the source node sending the packet.
- Version—Version of the Internet Protocol.

Extension Headers

In IPv6, *extension headers* are used to encode optional Internet-layer information.

Extension headers are placed between the IPv6 header and the upper layer header in a packet.

Extension headers are chained together using the next header field in the IPv6 header. The next header field indicates to the router which extension header to expect next. If there are no more extension headers, the next header field indicates the upper layer header (TCP header, User Datagram Protocol [UDP] header, ICMPv6 header, an encapsulated IP packet, or other items).

IPv6 Addressing

IPv6 uses a 128-bit addressing model. This creates a much larger address space than IPv4 addresses, which are made up of 32 bits. IPv6 addresses also contain a scope field that categorizes what types of applications are suitable for the address. IPv6 does not support broadcast addresses, but instead uses multicast addresses to serve this role. In addition, IPv6 also defines a new type of address called *anycast*.

This section discusses the following topics that provide background information about IPv6 addressing:

- Address Representation on page 13
- Address Types on page 13

- Address Scope on page 13
- Address Structure on page 14

Address Representation

IPv6 addresses consist of 8 groups of 16-bit hexadecimal values separated by colons (:). The IPv6 address format is as follows:

aaaa:aaaa:aaaa:aaaa:aaaa:aaaa:aaaa:aaaa

aaaa is a 16-bit hexadecimal value, and *a* is a 4-bit hexadecimal value. Following is an example of an actual IPv6 address:

3FFE:0000:0000:0001:0200:F8FF:FE75:50DF

You can omit the leading zeros, as shown:

3FFE:0:0:1:200:F8FF:FE75:50DF

You can compress 16-bit groups of zeros to "::", as shown here, but only once per address:

3FFE::1:200:F8FF:FE75:50DF

Address Types

There are three types of IPv6 addresses:

- Unicast—For a single interface.
- Multicast—For a set of interfaces on the same physical medium. A packet is sent to all of the interfaces associated with the address.
- Anycast—For a set of interfaces on different physical mediums. A packet is sent to only one of the interfaces associated with this address, not to all the interfaces.

Address Scope

IPv6 addresses have *scope*, which identifies the application suitable for the address. Unicast and multicast addresses support scoping.

Unicast addresses support two types of scope: *global* scope and *local* scope. There are two types of local scope: *link-local* addresses and *site-local* addresses. Link-local unicast addresses are used within a single network link. The first ten bits of the prefix identify the address as a link-local address. Link-local addresses cannot be used outside a network link. Site-local unicast addresses are used within a site or intranet. A site consists of multiple network links, and site-local addresses identify nodes inside the intranet. Site-local addresses cannot be used outside the site.

Multicast addresses support 16 different types of scope, including node, link, site, organization, and global scope. A 4-bit field in the prefix identifies the scope.

Address Structure

Unicast addresses identify a single interface. The address consists of n bits for the prefix, and $128 - n$ bits for the interface ID.

Multicast addresses identify a set of interfaces. The address is made up of the first 8 bits of all ones, a 4-bit flags field, a 4-bit scope field, and a 112-bit group ID:

11111111 | *flags* | *scope* | *group ID*

The first octet of ones identifies the address as a multicast address. The flags field identifies whether the multicast address is a well-known address or a transient multicast address. The scope field identifies the scope of the multicast address. The 112-bit group ID identifies the multicast group.

Similar to multicast addresses, anycast addresses identify a set of interfaces. However, packets are sent to only one of the interfaces, not to all interfaces. Anycast addresses are allocated from the normal unicast address space and cannot be distinguished from a unicast address in format. Therefore, each member of an anycast group must be configured to recognize certain addresses as anycast addresses.

Chapter 2

Complete Routing and Routing Protocol Configuration Statements

This chapter shows the complete configuration statement hierarchy for the portions of the configuration discussed in this manual, listing all possible configuration statements and showing their level in the configuration hierarchy. When you are configuring the JUNOS software, your current hierarchy level is shown in the banner on the line preceding the `user@host#` prompt.

For a list of the complete configuration statement hierarchy, see the *JUNOS Hierarchy and RFC Reference*.

This chapter is organized as follows:

- [edit logical-systems] Hierarchy Level on page 15
- [edit protocols] Hierarchy Level on page 16
- [edit routing-instances] Hierarchy Level on page 30
- [edit routing-options] Hierarchy Level on page 35

[edit logical-systems] Hierarchy Level

The following lists the statements that can be included at the [edit logical-systems] hierarchy level and are also documented in this manual.

```
logical-systems {  
  logical-system-name {  
    protocols {  
      bgp {  
        bgp-configuration;  
      }  
      isis {  
        isis-configuration;  
      }  
      ospf {  
        ospf-configuration;  
      }  
      ospf3 {  
        ospf3-configuration;  
      }  
      rip {  
        rip-configuration;  
      }  
    }  
  }  
}
```

```

    }
    ripng {
        ripng-configuration;
    }
    router-advertisement {
        router-advertisement-configuration;
    }
    router-discovery {
        router-discovery-configuration;
    }
}
routing-instances {
    routing-instance-name {
        routing-instance-configuration;
    }
}
routing-options {
    routing-option-configuration;
}
}
}

```

[edit protocols] Hierarchy Level

The following statements can also be included at the [edit logical-systems *logical-system-name*] hierarchy level.

```

protocols {
}

BGP  bgp {
    accept-remote-nexthop;
    advertise-external <conditional>;
    advertise-inactive;
    advertise-peer-as;
    authentication-algorithm algorithm;
    authentication-key key;
    authentication-key-chain key-chain;
    cluster cluster-identifier;
    damping;
    description text-description;
    disable;
    export [ policy-names ];
    family {
        (iso-vpn | inet | inet6 | inet-vpn | inet6-vpn | l2-vpn) {
            (any | multicast | unicast | signaling) {
                prefix-limit {
                    maximum number;
                    teardown <percentage> <idle-timeout (forever | minutes)>;
                }
                rib-group group-name;
            }
        }
        labeled-unicast {
            aggregate-label {
                community community-name;
            }
        }
    }
}

```



```

    }
    explicit-null {
        connected-only;
    }
    prefix-limit {
        maximum number;
        teardown <percentage> <idle-timeout (forever | minutes)>;
    }
    resolve-vpn;
    rib inet.3;
    rib-group group-name;
}
}
route-target {
    advertise-default;
    external-paths number;
    prefix-limit {
        maximum number;
        teardown <percentage> <idle-timeout (forever | minutes)>;
    }
}
}
signaling {
    prefix-limit {
        maximum number;
        teardown <percentage> <idle-timeout (forever | minutes)>;
    }
}
}
graceful-restart {
    disable;
    restart-time seconds;
    stale-routes-time seconds;
}
hold-time seconds;
import [ policy-names ];
include-mp-next-hop;
ipsec-sa ipsec-sa;
keep (all | none);
local-address address;
local-as autonomous-system <private>;
local-preference local-preference;
log-updown;
metric-out (metric | minimum-igp <offset> | igp <offset>);
multihop {
    <ttl-value>;
    no-nexthop-change;
}
no-advertise-peer-as;
no-aggregator-id;
no-client-reflect;
out-delay seconds;
passive;
path-selection {
    (cisco-non-deterministic | always-compare-med | external-router-id);
    med-plus-igp {
        igp-multiplier number;
    }
}

```

```

        med-multiplier number;
    }
}
peer-as autonomous-system;
preference preference;
remove-private;
tcp-mss segment-size;
traceoptions {
    file name <size size> <files number> <world-readable | no-world-readable>;
    flag flag <flag-modifier> <disable>;
}
vpn-apply-export;
group group-name {
    accept-remote-nexthop;
    advertise-external <conditional>;
    advertise-inactive;
    advertise-peer-as;
    [ network/mask-length ];
    as-override;
    authentication-algorithm algorithm;
    authentication-key key;
    authentication-key-chain key-chain;
    bfd-liveness-detection {
        detection-time {
            threshold milliseconds;
        }
        holddown-interval milliseconds;
        minimum-interval milliseconds;
        minimum-receive-interval milliseconds;
        multiplier number;
        no-adaptation;
        transmit-interval {
            threshold milliseconds;
            minimum-interval milliseconds;
        }
    }
    version (1 | automatic);
}
cluster cluster-identifier;
damping;
description text-description;
export [ policy-names ];
family {
    (iso-vpn | inet | inet6 | inet-vpn | inet6-vpn | l2-vpn) {
        (any | multicast | unicast | signaling) {
            explicit-null {
                connected-only;
            }
            prefix-limit {
                maximum number;
                teardown <percentage> <idle-timeout (forever | minutes)>;
            }
            rib-group group-name;
        }
        flow {
            no-validate policy-name;
        }
    }
}

```

```

        labeled-unicast {
            prefix-limit {
                maximum number;
                teardown <percentage> <idle-timeout (forever | minutes)>;
            }
            resolve-vpn;
            rib inet.3;
            rib-group group-name;
        }
    }
    route-target {
        advertise-default;
        external-paths number;
        prefix-limit {
            maximum number;
            teardown <percentage> <idle-timeout (forever | minutes)>;
        }
    }
    signaling {
        prefix-limit {
            maximum number;
            teardown <percentage> <idle-timeout (forever | minutes)>;
        }
    }
}
graceful-restart {
    disable;
    restart-time seconds;
    stale-routes-time seconds;
}
hold-time seconds;
import [ policy-names ];
ipsec-sa ipsec-sa;
keep (all | none);
local-address address;
local-as autonomous-system <private>;
local-preference local-preference;
log-updown;
metric-out (metric | minimum-igp <offset> | igp <offset>);
mtu-discovery;
multihop <ttl-value>;
multipath {
    multiple-as;
}
no-advertise-peer-as;
no-aggregator-id;
no-client-reflect;
out-delay seconds;
passive;
peer-as autonomous-system;
preference preference;
remove-private;
tcp-mss segment-size;
traceoptions {
    file name <size size> <files number> <world-readable | no-world-readable>;
    flag flag <flag-modifier> <disable>;
}

```

```

}
type type;
vpn-apply-export;
neighbor address {
  accept-remote-nexthop;
  advertise-external <conditional>;
  advertise-inactive;
  advertise-peer-as;
  as-override;
  authentication-algorithm algorithm;
  authentication-key key;
  authentication-key-chain key-chain;
  bfd-liveness-detection {
    detection-time {
      threshold milliseconds;
    }
    minimum-interval milliseconds;
    minimum-receive-interval milliseconds;
    multiplier number;
    no-adaptation;
    transmit-interval {
      threshold milliseconds;
      minimum-interval milliseconds;
    }
    version (1 | automatic);
  }
}
cluster cluster-identifier;
damping;
description text-description;
export [ policy-names ];
family {
  (iso-vpn | inet | inet6 | inet-vpn | inet6-vpn | l2-vpn) {
    (any | multicast | unicast | signaling) {
      explicit-null {
        connected-only;
      }
      prefix-limit {
        maximum number;
        teardown <percentage> <idle-timeout (forever | minutes)>;
      }
      rib-group group-name;
    }
    flow {
      no-validate policy-name;
    }
    labeled-unicast {
      prefix-limit {
        maximum number;
        teardown <percentage> <idle-timeout (forever | minutes)>;
      }
      resolve-vpn;
      rib inet.3;
      rib-group group-name;
    }
  }
}
route-target {

```

```

        advertise-default;
        external-paths number;
        prefix-limit {
            maximum number;
            teardown <percentage> <idle-timeout (forever | minutes)>;
        }
    }
    signaling {
        prefix-limit {
            maximum number;
            teardown <percentage> <idle-timeout (forever | minutes)>;
        }
    }
}
graceful-restart {
    disable;
    restart-time seconds;
    stale-routes-time seconds;
}
hold-time seconds;
import [ policy-names ];
ipsec-sa ipsec-sa;
keep (all | none);
local-address address;
local-as autonomous-system <private>;
local-interface interface-name;
local-preference local-preference;
log-updown;
metric-out (metric | minimum-igp <offset> | igp <offset>);
mtu-discovery;
multihop <ttl-value>;
multipath {
    multiple-as;
}
no-advertise-peer-as;
no-aggregator-id;
no-client-reflect;
out-delay seconds;
passive;
peer-as autonomous-system;
preference preference;
remove-private;
tcp-mss segment-size;
traceoptions {
    file name <size size> <files number> <world-readable | no-world-readable>;
    flag flag <flag-modifier> <disable>;
}
vpn-apply-export;
}
}
}

```

ES-IS esis {
 disable;
 graceful-restart {

```

        disable;
        restart-duration seconds;
    }
    preference preference;
    interface (interface-name | all) {
        disable;
        hello-interval seconds;
        esct seconds;
    }
    traceoptions {
        file name <size size> <files number> <(world-readable | no-world-readable)>;
        flag flag <flag-modifier> <disable>;
    }
}

```

IS-IS

```

isis {
    clns-routing;
    disable;
    export [ policy-names ];
    ignore-attached-bit;
    graceful-restart {
        disable;
        helper-disable;
        restart-duration seconds;
    }
    label-switched-path name level level metric metric;
    level level-number {
        authentication-key key;
        authentication-type authentication;
        external-preference preference;
        ipv6-multicast-metric number;
        no-csnp-authentication;
        no-hello-authentication;
        no-psnp-authentication;
        preference preference;
        prefix-export-limit number;
        wide-metrics-only;
    }
    loose-authentication-check;
    lsp-lifetime seconds;
    max-areas;
    no-adjacency-holddown;
    no-authentication-check;
    no-ipv4-routing;
    no-ipv6-routing;
    overload {
        advertise-high-metrics;
        timeout seconds;
    }
    reference-bandwidth reference-bandwidth;
    rib-group {
        inet group-name;
        inet6 group-name;
    }
    spf-options {

```

```

    delay milliseconds;
    holddown milliseconds;
    rapid-runs number;
}
topologies {
    ipv4-multicast;
    ipv6-unicast;
}
traceoptions {
    file name <size size> <files number> <world-readable | no-world-readable>;
    flag flag <flag-modifier> <disable>;
}
traffic-engineering {
    disable;
    family inet {
        shortcuts <ignore-lsp-metrics> {
            multicast-rpf-routes;
        }
    }
    family inet6 {
        shortcuts;
    }
}
interface (all | interface-name) {
    disable;
    bfd-liveness-detection {
        detection-time {
            threshold milliseconds;
        }
        minimum-interval milliseconds;
        minimum-receive-interval milliseconds;
        multiplier number;
        no-adaptation;
        transmit-interval {
            threshold milliseconds;
            minimum-interval milliseconds;
        }
        version (1 | automatic);
    }
    checksum;
    csnp-interval (seconds | disable);
    hello-padding (adaptive | loose | strict);
    ldp-synchronization {
        disable;
        hold-time seconds;
    }
    lsp-interval milliseconds;
    mesh-group (value | blocked);
    no-ipv4-multicast;
    no-ipv6-multicast;
    no-ipv6-unicast;
    no-unicast-topology;
    passive;
    point-to-point;
    level level-number {
        disable;
    }
}

```

```

        hello-authentication-key key;
        hello-authentication-type authentication;
        hello-interval seconds;
        hold-time seconds;
        ipv4-multicast-metric number;
        ipv6-multicast-metric number;
        ipv6-unicast-metric number;
        metric metric;
        passive;
        priority number;
        te-metric metric;
    }
}

```

```

OSPF  ospf {
        disable;
        export [ policy-names ];
        external-preference preference;
        graceful-restart {
            disable;
            helper-disable;
            notify-duration seconds;
            restart-duration seconds;
        }
        import [ policy-names ];
        no-nssa-abr;
        overload {
            timeout seconds;
        }
        preference preference;
        reference-bandwidth reference-bandwidth;
        rib-group group-name;
        sham-link {
            local address;
        }
        spf-options {
            delay milliseconds;
            holddown milliseconds;
            rapid-runs milliseconds;
        }
        traffic-engineering {
            accept-unnumbered-interfaces;
            multicast-rpf-routes;
            no-topology;
            shortcuts {
                ignore-lsp-metrics;
                lsp-metric-into-summary;
            }
        }
        traceoptions {
            file name <size size> <files number> <(world-readable | no-world-readable)>;
            flag flag <flag-modifier> <disable>;
        }
        area area-id {

```



```

area-range network/mask-length <restrict> <exact> <override-metric metric>;
interface interface-name {
    demand-circuit;
    disable;
    bfd-liveness-detection {
        detection-time {
            threshold milliseconds;
        }
        minimum-interval milliseconds;
        minimum-receive-interval milliseconds;
        multiplier number;
        no-adaptation;
        transmit-interval {
            threshold milliseconds;
            minimum-interval milliseconds;
        }
        version (1 | automatic);
    }
    ipsec-sa <sa-name>;
}
authentication {
    md5 key-id {
        key [ key-values ];
    }
    simple-password key-id;
}
dead-interval seconds;
hello-interval seconds;
interface-type type;
ldp-synchronization {
    disable;
    hold-time seconds;
}
metric metric;
neighbor address <eligible>;
network-summary-export [ policy-names ];
network-summary-import [ policy-names ];
passive;
poll-interval seconds;
priority number;
retransmit-interval seconds;
te-metric metric;
transit-delay seconds;
}
label-switched-path name metric metric;
nssa {
    area-range network/mask-length <restrict> <exact> <override-metric metric>;
    default-lsa {
        default-metric metric;
        metric-type type;
        type-7;
    }
    (no-summaries | summaries);
}
peer-interface interface-name {
    disable;

```

```

        dead-interval seconds;
        hello-interval seconds;
        retransmit-interval seconds;
        transit-delay seconds;
    }
    sham-link-remote address {
        ipsec-sa <sa-name>;
    }
    demand-circuit;
    metric metric;
}
stub <default-metric metric> <(no-summaries | summaries)>;
virtual-link neighbor-id router-id transit-area area-id {
    disable;
    ipsec-sa <sa-name>;
}
authentication {
    md5 key-id;
    simple-password key-id;
}
dead-interval seconds;
hello-interval seconds;
retransmit-interval seconds;
transit-delay seconds;

```

OSPFv3

```

ospf3 {
    disable;
    export [ policy-names ];
    external-preference preference;
    import [ policy-names ];
    overload {
        timeout seconds;
    }
    preference preference;
    reference-bandwidth reference-bandwidth;
    rib-group group-name;
    spf-options {
        delay milliseconds;
        holddown milliseconds;
        rapid-runs number;
    }
    traceoptions {
        file name <size size> <files number> <world-readable | no-world-readable>;
        flag flag <flag-modifier> <disable>;
    }
    area area-id {
        area-range network/mask-length <restrict> <exact> <override-metric metric>;
        interface interface-name {
            disable;
            dead-interval seconds;
            hello-interval seconds;
            ipsec-sa name;
            metric metric;
            neighbor address <eligible>;
            passive;

```

```

        priority number;
        retransmit-interval seconds;
        transit-delay seconds;
    }
    inter-area-prefix-export [policy-names ];
    inter-area-prefix-import [ policy-names ];
    nssa {
        area-range network/mask-length <restrict> <exact> <override-metric metric>;
        default-lsa {
            default-metric metric;
            metric-type type;
            type-7;
        }
        (no-summaries | summaries);
    }
    stub <default-metric metric> <(no-summaries | summaries)>;
    virtual-link neighbor-id router-id transit-area area-id {
        disable;
        dead-interval seconds;
        hello-interval seconds;
        ipsec-sa name;
        retransmit-interval seconds;
        transit-delay seconds;
    }
}

```

RIP

```

rip {
    any-sender;
    authentication-key password;
    authentication-type type;
    (check-zero | no-check-zero);
    graceful-restart {
        disable;
        restart-time seconds;
    }
    holddown seconds;
    import [ policy-names ];
    message-size number;
    metric-in metric;
    receive receive-options;
    rib-group group-name;
    route-timeout seconds;
    send send-options;
    update-interval seconds;
    traceoptions {
        file name <size size> <files number> <(world-readable | no-world-readable)>;
        flag flag <flag-modifier> <disable>;
    }
    group group-name {
        bfd-liveness-detection {
            detection-time {
                threshold milliseconds;
            }
            minimum-interval milliseconds;
        }
    }
}

```

```

        minimum-receive-interval milliseconds;
        multiplier number;
        no-adaptation;
        transmit-interval {
            threshold milliseconds;
            minimum-interval milliseconds;
        }
        version (0 | 1 | automatic);
    }
    export [ policy-names ];
    metric-out metric;
    preference preference;
    route-timeout seconds;
    update-interval seconds;
    neighbor neighbor-name {
        authentication-key password;
        authentication-type type;
        bfd-liveness-detection {
            detection-time {
                threshold milliseconds;
            }
            minimum-interval milliseconds;
            minimum-receive-interval milliseconds;
            transmit-interval {
                threshold milliseconds;
                minimum-interval milliseconds;
            }
            multiplier number;
            version (1 | automatic);
        }
        (check-zero | no-check-zero);
        import [ policy-names ];
        message-size number;
        metric-in metric;
        receive receive-options;
        route-timeout seconds;
        send send-options;
        update-interval seconds;
    }
}

```

```

RIPng  ripng {
    graceful-restart {
        disable;
        restart-time seconds;
    }
    holddown seconds;
    import [ policy-names ];
    metric-in metric;
    receive <none>;
    route-timeout seconds;
    send <none>;
    update-interval seconds;
    traceoptions {

```

```

    file name <size size> <files number> <(world-readable | no-world-readable)>;
    flag flag <flag-modifier> <disable>;
  }
group group-name {
  export [ policy-names ];
  metric-out metric;
  preference number;
  route-timeout seconds;
  update-interval seconds;
  neighbor neighbor-name {
    import [ policy-names ];
    metric-in metric;
    receive <none>;
    route-timeout seconds;
    send <none>;
    update-interval seconds;
  }
}

```

Router Advertisement

```

router-advertisement {
  interface interface-name {
    current-hop-limit number;
    default-lifetime seconds;
    (managed-configuration | no-managed-configuration);
    max-advertisement-interval seconds;
    min-advertisement-interval seconds;
    (other-stateful-configuration | no-other-stateful-configuration);
    prefix prefix {
      (autonomous | no-autonomous);
      (on-link | no-on-link);
      preferred-lifetime seconds;
      valid-lifetime seconds;
    }
    reachable-time milliseconds;
    retransmit-timer milliseconds;
    traceoptions {
      file name <size size> <files number> <(world-readable | no-world-readable)>;
      flag flag <detail> <disable>;
    }
  }
}

```

Router Discovery

```

router-discovery {
  disable;
  traceoptions {
    file name <size size> <files number> <(world-readable | no-world-readable)>;
    flag flag <detail> <disable>;
  }
  interface interface-name {
    min-advertisement-interval seconds;
    max-advertisement-interval seconds;
    lifetime seconds;
  }
  address address {

```

```

        (advertise | ignore);
        (broadcast | multicast);
        (priority number | ineligible);
    }
}

Secure Neighbor  
Discovery    neighbor-discovery {
    secure {
        security-level {
            (default | secure-messages-only);
        }
        cryptographic-address {
            key-length number;
            key-pair pathname;
        }
        timestamp {
            clock-drift number;
            known-peer-window seconds;
            new-peer-window seconds;
        }
        traceoptions {
            file filename <match> <size size> <files number> <world-readable |
            no-world-readable>;
            flag flag;
            no-remote-trace <file filename> <flag flag>;
        }
    }
}

```

[edit routing-instances] Hierarchy Level

The following statements can also be included at the [edit logical-systems *logical-system-name*] hierarchy level.



NOTE: The virtual-switch instance type is not supported at the [edit logical-systems *logical-system-name*] hierarchy level. For more detailed information about configuring a virtual switch on MX-series routers, see the *JUNOS MX-series Layer 2 Configuration Guide*.

```

routing-instances {
    routing-instance-name {
        bridge-domains bridge-domain-name {
            domain-type bridge;
            <vlan-id (all | none | number)>;
            <vlan-tags outer number inner number>;
            <routing-interface routing-interface-name>;
            interface interface-name;
            bridge-options {
                interface-mac-linit limit;
                mac-statistics;
                mac-table-size limit;
            }
        }
    }
}

```

```

        no-mac-learning;
        static-mac mac-address;
    }
}
description text;
forwarding-options;
interface interface-name;
instance-type (forwarding | layer2-control | l2vpn | no-forwarding | virtual-router |
    virtual-switch | vpls | vrf);
no-vrf-advertise;
route-distinguisher (as-number:number | ip-address:number);
vrf-import [ policy-names ];
vrf-export [ policy-names ];
vrf-table-label;
vrf-target {
    export community-name;
    import community-name;
}
protocols {
    bgp {
        bgp-configuration;
    }
    isis {
        isis-configuration;
    }
    l2vpn {
        l2vpn-configuration;
    }
    ldp {
        ldp-configuration;
    }
    msdp {
        msdp-configuration;
    }
    ospf {
        domain-id domain-id;
        domain-vpn-tag number;
        route-type-community (vendor | iana);
        ospf-configuration;
    }
    ospf 3 {
        domain-id domain-id;
        domain-vpn-tag number;
        route-type-community (vendor | iana);
        ospf3-configuration;
    }
    pim {
        pim-configuration;
    }
    rip {
        rip-configuration;
    }
    vpls {
        vpls-configuration;
    }
}

```

```

routing-options {
  aggregate {
    defaults {
      ... aggregate-options ...
    }
    route destination-prefix {
      policy policy-name;
      ... aggregate-options ...
    }
  }
}
auto-export {
  (disable | enable);
  family {
    inet {
      flow {
        (disable | enable);
        rib-group rib-group;
      }
      multicast {
        (disable | enable);
        rib-group rib-group;
      }
      unicast {
        (disable | enable);
        rib-group rib-group;
      }
    }
  }
}
traceoptions {
  file name <size size> <files number> <(world-readable | no-world-readable)>;
  flag flag <flag-modifier> <disable>;
}
}
autonomous-system autonomous-system <loops number> {
  independent-domain;
}
confederation confederation-autonomous-systems
members autonomous-system;
dynamic-tunnels tunnel-name {
  destination-prefix prefix;
  source-address address;
  tunnel-type type-of-tunnel;
}
fate-sharing {
  group group-name;
  cost value;
  from address {
    to address;
  }
  flow {
    route name {
      match {
        match-conditions;
      }
      then {
        actions;
      }
    }
  }
}

```



```

    }
  }
  validation {
    traceoptions {
      file name <size size> <files number> <(world-readable |
        no-world-readable)>;
      flag flag <flag-modifier> <disable>;
    }
  }
  generate {
    defaults {
      generate-options;
    }
    route destination-prefix {
      policy policy-name;
      generate-options;
    }
  }
  instance-export [ policy-names ];
  instance-import [ policy-names ];
  interface-routes {
    family (inet | inet6) {
      export {
        lan;
        point-to-point;
      }
    }
    rib-group group-name;
  }
  martians {
    destination-prefix match-type <allow>;
  }
  maximum-paths path-limit <log-only | threshold value log-interval seconds>;
  maximum-prefixes prefix-limit <log-only | threshold value log-interval seconds>;
  multicast {
    forwarding-cache {
      threshold (suppress | reuse) value value;
    }
    interface interface-name {
      enable;
    }
    scope scope-name {
      interface interface-name;
      prefix destination-prefix;
    }
    scope-policy policy-name;
    ssm-groups {
      addresses;
    }
  }
  options {
    syslog (level level | upto level);
  }
  resolution {
    rib routing-table-name {
      import [ policy-names ];

```

```

        resolution-ribs [ routing-table-names ];
    }
}
rib routing-table-name {
    aggregate {
        defaults {
            ... aggregate-options ...
        }
        route destination-prefix {
            policy policy-name;
            ... aggregate-options ...
        }
    }
    filter {
        input filter-name;
    }
    generate {
        defaults {
            generate-options;
        }
        route destination-prefix {
            policy policy-name;
            generate-options;
        }
    }
    martians {
        destination-prefix match-type <allow>;
    }
    static {
        defaults {
            static-options;
        }
        passive group-name;
        route destination-prefix {
            lsp-next-hop {
                metric metric;
                preference preference;
            }
            next-hop;
            p2mp-lsp-next-hop {
                metric metric;
                preference preference;
            }
            qualified-next-hop address {
                interface interface-name;
                metric metric;
                preference preference;
            }
            static-options;
        }
    }
}
passive {
    group-name {
        import-policy [ policy-names ];
        import-rib [ group-names ];
    }
}

```

```

    export-rib group-name;
}
}
route-distinguisher-id address;
route-record;
router-id address;
static {
    defaults {
        static-options;
    }
    rib-group group-name;
    route destination-prefix {
        bfd-liveness-detection {
            detection-time {
                threshold milliseconds;
            }
            local-address ip-address;
            minimum-interval milliseconds;
            minimum-receive-interval milliseconds;
            minimum-receive-ttl milliseconds;
            transmit-interval {
                threshold milliseconds;
                minimum-interval milliseconds;
            }
            multiplier number;
            version (1 | automatic);
        }
        lsp-next-hop {
            metric metric;
            preference preference;
        }
        next-hop;
        qualified-next-hop address {
            interface interface-name;
            metric metric;
            preference preference;
        }
        static-options;
    }
}
}
traceoptions {
    file name <size size> <files number> <(world-readable | no-world-readable)>;
    flag flag <flag-modifier> <disable>;
}
}
}
}
}
```

[edit routing-options] Hierarchy Level

The following statements can also be included at the [edit logical-systems *logical-system-name*] hierarchy level.

```
routing-options {
```

```

aggregate {
  defaults {
    ... aggregate-options ...
  }
  route destination-prefix {
    policy policy-name;
    ... aggregate-options ...
  }
}
auto-export {
  (disable | enable);
  family {
    inet {
      flow {
        (disable | enable);
        rib-group rib-group;
      }
      multicast {
        (disable | enable);
        rib-group rib-group;
      }
      unicast {
        (disable | enable);
        rib-group rib-group;
      }
    }
  }
}
traceoptions {
  file filename <size size> <files number> <world-readable | no-world-readable>;
  flag flag <flag-modifier> <disable>;
}
}
autonomous-system autonomous-system <loops number>;
confederation confederation-autonomous-system members autonomous-system;
dynamic-tunnels tunnel-name {
  destination-prefix prefix;
  source-address address;
  tunnel-type tunnel-type;
}
fate-sharing {
  group group-name;
  cost value;
  from address {
    to address;
  }
}
flow {
  route name {
    match {
      match-conditions;
    }
    then {
      actions;
    }
  }
}
validation {

```

```

traceoptions {
    file filename <size size> <files number>
        <(world-readable | no-world-readable)>;
    flag flag <flag-modifier> <disable>;
}
}
forwarding-table {
    export [ policy-names ];
    (indirect-next-hop | no-indirect-next-hop);
    unicast-reverse-path (active-paths | feasible-paths);
}
generate {
    defaults {
        generate-options;
    }
    route destination-prefix {
        policy policy-name;
        generate-options;
    }
}
graceful-restart {
    disable;
    restart-duration seconds;
}
instance-export [ policy-names ];
instance-import [ policy-names ];
interface-routes {
    family (inet | inet6) {
        export {
            lan;
            point-to-point;
        }
    }
    rib-group group-name;
}
martians {
    destination-prefix match-type <allow>;
}
maximum-paths path-limit <log-only | threshold value log-interval seconds>;
maximum-prefixes prefix-limit <log-only | threshold value log-interval seconds>;
multicast {
    forwarding-cache {
        threshold (suppress | reuse) value value;
    }
    interface interface-name {
        enable;
    }
    scope scope-name {
        interface interface-name;
        prefix destination-prefix;
    }
    scope-policy policy-name;
    ssm-groups {
        address;
    }
}
}

```

```

options {
    syslog (level level | upto level);
}
ppm {
    delegate-processing;
}
resolution {
    rib routing-table-name {
        import [ policy-names ];
        resolution-ribs [ routing-table-names ];
    }
}
rib routing-table-name {
    aggregate {
        defaults {
            ... aggregate-options ...
        }
        rib-group group-name;
        route destination-prefix {
            policy policy-name;
            ... aggregate-options ...
        }
    }
    filter {
        input filter-name;
    }
    generate {
        defaults {
            generate-options;
        }
        route destination-prefix {
            policy policy-name;
            generate-options;
        }
    }
}
martians {
    destination-prefix match-type <allow>;
}
static {
    defaults {
        static-options;
    }
    rib-group group-name;
    route destination-prefix {
        lsp-next-hop {
            metric metric;
            preference preference;
        }
        next-hop;
        qualified-next-hop address {
            interface interface-name;
            metric metric;
            preference preference;
        }
    }
    static-options;
}

```

```

    }
  }
  rib-groups {
    group-name {
      import-policy [ policy-names ];
      import-rib [ group-names ];
      export-rib group-name;
    }
  }
  route-distinguisher-id address;
  route-record;
  router-id address;
  static {
    defaults {
      static-options;
    }
    rib-group group-name;
    route destination-prefix {
      bfd-liveness-detection {
        detection-time {
          threshold milliseconds;
        }
        holddown-interval milliseconds;
        local-address ip-address;
        minimum-interval milliseconds;
        minimum-receive-interval milliseconds;
        minimum-receive-ttl number;
        multiplier number;
        neighbor address;
        no-adaptation;
        transmit-interval {
          threshold milliseconds;
          minimum-interval milliseconds;
        }
        version (1 | automatic);
      }
      lsp-next-hop {
        metric metric;
        preference preference;
      }
      next-hop;
      p2mp-lsp-next-hop {
        metric metric;
        preference preference;
      }
      qualified-next-hop (address | interface-name) {
        interface interface-name;
        metric metric;
        preference preference;
      }
      source-routing {
        (ip | ipv6);
      }
      static-options;
    }
  }
}

```

```
topologies {  
  (inet | inet6) {  
    topology name;  
  }  
}  
traceoptions {  
  file name <size size> <files number>  
    <world-readable | no-world-readable>;  
  flag flag <flag-modifier> <disable>;  
}  
}
```


Part 2

Protocol-Independent Routing Properties

- Protocol-Independent Routing Properties Overview on page 43
- Configuring Routing Tables and Routes on page 49
- Configuring Other Protocol-Independent Routing Properties on page 101
- Logical System Overview on page 125
- Summary of Protocol-Independent Routing Properties Configuration Statements on page 131

Chapter 3

Protocol-Independent Routing Properties Overview

Protocol-independent routing properties affect system-wide routing operations. For the most part, these properties are independent of any routing protocols. The protocol-independent routing properties allow you to do the following:

- Add routing table entries, including static routes, aggregated (coalesced) routes, generated routes (routes of last resort), and martian routes (routes to ignore).
- Create additional routing tables and routing table groups.
- Set the autonomous system (AS) number of the router for use by the Border Gateway Protocol (BGP).
- Set the router ID, which is used by BGP and Open Shortest Path First (OSPF) to identify the router from which a packet originated.
- Define BGP confederation members for use by BGP.
- Configure multicast administrative scoping.
- Configure how much system logging information to log for the routing protocol process.
- Configure system-wide tracing (debugging) to track standard and unusual routing operations and record this information in a log file.

This chapter discusses the following topics related to understanding and configuring protocol-independent routing properties:

- Protocol-Independent Routing Properties Configuration Statements on page 43
- Minimum Protocol-Independent Routing Properties Configuration on page 47

Protocol-Independent Routing Properties Configuration Statements

To configure protocol-independent routing properties, you include the following statements at the [edit routing-options] hierarchy level:

```
routing-options {  
  aggregate {  
    defaults {  
      ... aggregate-options ...  
    }  
    route destination-prefix {
```

```

        policy policy-name;
        ... aggregate-options ...
    }
}
auto-export {
    (disable | enable);
    family {
        inet {
            multicast {
                (disable | enable);
                rib-group rib-group;
            }
            unicast {
                (disable | enable);
                rib-group rib-group;
            }
        }
    }
}
traceoptions {
    file name <size size> <files number> <world-readable | no-world-readable>;
    flag flag <flag-modifier> <disable>;
}
}
autonomous-system autonomous-system <loops number>;
confederation confederation-autonomous-system members autonomous-system;
dynamic-tunnels tunnel-name {
    destination-prefix prefix;
    source-address address;
    tunnel-type type-of-tunnel;
}
fate-sharing {
    group group-name;
    cost value;
    from address {
        to address;
    }
}
forwarding-table {
    export [ policy-names ];
    (indirect-next-hop | no-indirect-next-hop);
    unicast-reverse-path (active-paths | feasible-paths);
}
generate {
    defaults {
        generate-options;
    }
    route destination-prefix {
        policy policy-name;
        generate-options;
    }
}
instance-export [ policy-names ];
instance-import [ policy-names ];
interface-routes {
    export {
        lan;

```

```

        point-to-point;
    }
    rib-group group-name;
}
martians {
    destination-prefix match-type <allow>;
}
maximum-paths route-limit <log-only | threshold value>;
multicast {
    forwarding-cache {
        threshold (suppress | reuse) value value;
    }
    interface interface-name;
    scope scope-name {
        interface [ interface-names ];
        prefix destination-prefix;
    }
    ssm-groups {
        address;
    }
}
ppm {
    delegate-processing;
}
resolution {
    rib routing-table-name {
        import [ policy-names ]
        resolution-ribs [ routing-table-names ];
    }
}
rib routing-table-name {
    aggregate {
        defaults {
            ... aggregate-options ...
        }
        route destination-prefix {
            policy policy-name;
            ... aggregate-options ...
        }
    }
}
generate {
    defaults {
        generate-options;
    }
    route destination-prefix {
        policy policy-name;
        generate-options;
    }
}
martians {
    destination-prefix match-type <allow>;
}
source-routing {
    (ip | ipv6);
}
static {

```

```

    defaults {
        static-options;
    }
    rib-group group-name;
    route destination-prefix {
        bfd-liveness-detection {
            detection-time {
                threshold milliseconds;
            }
            <local-address ip-address>;
            minimum-interval milliseconds;
            minimum-receive-interval milliseconds;
            minimum-receive-ttl number;
            multiplier number;
            neighbor address;
            no-adaptation;
            transmit-interval {
                threshold milliseconds;
                minimum-interval milliseconds;
            }
            version (1 | automatic);
        }
        lsp-next-hop {
            metric metric;
            preference preference;
        }
        next-hop;
        p2mp-lsp-next-hop {
            metric metric;
            preference preference;
        }
        qualified-next-hop {
            interface interface-name;
            metric metric;
            preference preference;
        }
        static-options;
    }
}

rib-groups {
    group-name {
        import-policy [ policy-names ];
        import-rib [ group-names ];
        export-rib group-name;
    }
}

route-record;
router-id address;
static {
    defaults {
        static-options;
    }
    rib-group group-name;
    route destination-prefix {
        bfd-liveness-detection {

```

```

    detection-time {
        threshold milliseconds;
    }
    <local-address ip-address>;
    minimum-interval milliseconds;
    minimum-receive-interval milliseconds;
    minimum-receive-ttl number;
    multiplier number;
    neighbor address;
    no-adaptation;
    transmit-interval {
        threshold milliseconds;
        minimum-interval milliseconds;
    }
    version (1 | automatic);
}
lsp-next-hop {
    metric metric;
    preference preference;
}
next-hop;
qualified-next-hop {
    interface interface-name;
    metric metric;
    preference preference;
}
static-options;
}
}
traceoptions {
    file name <size size> <files number> <world-readable | no-world-readable>;
    flag flag <flag-modifier> <disable>;
}
}

```

Minimum Protocol-Independent Routing Properties Configuration

All statements that configure protocol-independent routing properties are optional and do not have to be included in the configuration for the router to operate. However, if you are configuring BGP, you must configure an AS number and a router identifier. For OSPF, the router uses the IP address configured on the loopback interface (lo0) as the router identifier. If no IP address is configured on the loopback interface, the router uses the highest IP address for the router identifier.

Chapter 4

Configuring Routing Tables and Routes

This chapter discusses how to perform the following tasks for configuring routing tables and routes:

- Creating Routing Tables on page 49
- Configuring Static Routes on page 51
- Configuring Aggregate Routes on page 78
- Configuring Generated Routes on page 86
- Configuring Martian Addresses on page 93
- Configuring a Flow Route on page 95
- Applying a Filter to a Forwarding Table on page 99

Creating Routing Tables

The JUNOS software can maintain one or more routing tables, thus allowing the software to store route information learned from different protocols separately. For example, it is common for the routing software to maintain unicast routes and multicast routes in different routing tables. You also might have policy considerations that would lead you to create separate routing tables to manage the propagation of routing information.

Creating routing tables is optional. If you do not create any, the JUNOS software uses its default routing tables, which are **inet.0** for Internet Protocol version 4 (IPv4) unicast routes, **inet6.0** for Internet Protocol version 6 (IPv6) unicast routes, **inet.1** for the IPv4 multicast forwarding cache, and **inet.3** for IPv4 Multiprotocol Label Switching (MPLS). If the Multiprotocol Border Gateway Protocol (MBGP) is enabled, **inet.2** is used for Subsequent Address Family Indicator (SAFI) 2 routes. If you configure a routing instance, the JUNOS software creates the default unicast routing table **instance-name.inet.0**. If you configure a flow route, the JUNOS software creates the flow routing table **instance-name.inetflow.0**.

If you want to add static, aggregate, generated, or martian routes only to the default IPv4 unicast routing table (**inet.0**), you do not have to create any routing tables because, by default, these routes are added to **inet.0**. You can add these routes just by including the **static**, **aggregate**, **generate**, and **martians** statements. For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

To explicitly create a routing table, include the **rib** statement:

```

rib routing-table-name {
  static {
    defaults {
      static-options;
    }
    rib-group group-name;
    route destination-prefix {
      lsp-next-hop lsp-name {
        metric metric;
        preference preference;
      }
      next-hop;
      p2mp-lsp-next-hop {
        metric metric;
        preference preference;
      }
      qualified-next-hop address {
        metric metric;
        preference preference;
      }
    }
    static-options;
  }
}
aggregate {
  defaults {
    ... aggregate-options ...
  }
  route destination-prefix {
    policy policy-name;
    ... aggregate-options ...
  }
}
generate {
  defaults {
    generate-options;
  }
  route destination-prefix {
    policy policy-name;
    generate-options;
  }
}
martians {
  destination-prefix match-type <allow>;
}
}

```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

The routing table name, *routing-table-name*, includes the protocol family, optionally followed by a period and a number. The protocol family can be *inet* for the IPv4 family, *inet6* for the IPv6 family, or *iso* for the International Standards Organization (ISO) protocol family. The number represents the routing instance. The first instance is 0.

Example: Creating Routing Tables

Create the IPv4 routing table `inet.4` and add a static route to it:

```
[edit]
routing-options {
  rib inet.4 {
    static {
      route 140.122.0.0/16 next-hop 192.168.0.10;
    }
  }
}
```

Configure the primary IPv6 routing table `inet6.0` and add a static route to it:

```
[edit routing-options]
rib inet6.0 {
  static {
    route 8:1::1/128 next-hop 8:3::1;
  }
}
```

Configuring Static Routes

The router uses dynamic routes to learn how to reach network destinations. Dynamic routes are determined from the information exchanged by the routing protocols and, as the name implies, the routes might change as network conditions change and these changes are discovered by the routing protocols. You can configure static (nonchanging) routes to some network destinations. The router uses static routes when it does not have a route to a destination that has a better (lower) preference value, when it cannot determine the route to a destination, or when it is forwarding unroutable packets.

A static route is installed in the routing table only when the route is active; that is, the list of next-hop routers configured for that route contains at least one next hop on an operational interface.

You can add the same routes to more than one routing table.

To configure static routes in the default IPv4 routing table (`inet.0`), include the `static` statement:

```
static {
  defaults {
    static-options;
  }
  rib-group group-name;
  route destination-prefix {
    bfd-liveness-detection {
      detection-time {
        threshold milliseconds;
      }
    }
    <local-address ip-address>;
    minimum-interval milliseconds;
  }
}
```

```

        minimum-receive-interval milliseconds;
        multiplier number;
        neighbor address;
        minimum-receive-ttl number;
        no-adaptation;
        transmit-interval {
            threshold milliseconds;
            minimum-interval milliseconds;
        }
        version (1 | automatic);
    }
    lsp-next-hop lsp-name {
        metric metric;
        preference preference;
    }
    next-hop address;
    next-hop options;
    p2mp-lsp-next-hop {
        metric metric;
        preference preference;
    }
    qualified-next-hop address {
        metric metric;
        preference preference;
    }
    static-options;
}

```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

To configure static routes in one of the other routing tables, to explicitly configure static routes in the default IPv4 route table (inet.0), or to explicitly configure static routes in the primary IPv6 routing table (inet6.0), include the **static** statement:

```

rib routing-table-name {
    static {
        defaults {
            static-options;
        }
        rib-group group-name;
        route destination-prefix {
            bfd-liveness-detection {
                detection-time {
                    threshold milliseconds;
                }
            }
            <local-address ip-address>;
            minimum-interval milliseconds;
            minimum-receive-interval milliseconds;
            minimum-receive-ttl number;
            multiplier number;
            neighbor address;
            no-adaptation;
            transmit-interval {

```

```

        threshold milliseconds;
        minimum-interval milliseconds;
    }
    version (1 | automatic);
}
lsp-next-hop lsp-name {
    metric metric;
    preference preference;
}
next-hop address;
next-hop options;
p2mp-lsp-next-hop {
    metric metric;
    preference preference;
}
qualified-next-hop address {
    metric metric;
    preference preference;
}
static-options;
}
}
}

```



NOTE: You cannot configure static routes for the IPv4 multicast routing table (*inet.1*) or the IPv6 multicast routing table (*inet6.1*).

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

The **static** statement consists of two parts:

- **defaults**—Specify global static route options. These options only set default attributes inherited by all newly created static routes. These are treated as global defaults and apply to all the static routes you configure in the **static** statement. This part of the **static** statement is optional.



NOTE: Specifying the global static route options does not create default routes. These options only set default attributes inherited by all newly created static routes.

- **route**—Configure individual static routes. In this part of the **static** statement, you optionally can configure static route options. These options apply to the individual destination only and override any options you configured in the **defaults** part of the **static** statement.

The following sections explain how to configure static routes:

- Specifying the Destination of the Static Route on page 54
- Specifying the Next Hop of the Static Route on page 54
- Specifying an Independent Preference for a Static Route on page 55

- Specifying an LSP as the Next Hop for a Static Route on page 59
- Installing a Static Route into More than One Routing Table on page 60
- Configuring a Connectionless Network Services Static Route on page 60
- Specifying Static Route Options on page 62
- Configuring a Default Route on page 75
- Propagating Static Routes into Routing Protocols on page 75
- Examples: Configuring Static Routes on page 76

Specifying the Destination of the Static Route

When you configure an individual static route in the **route** part of the **static** statement, specify the destination of the route (in **route destination-prefix**) in one of the following ways:

- *network/mask-length*, where *network* is the network portion of the IP address and *mask-length* is the destination prefix length.
- **default** if this is the default route to the destination. This is equivalent to specifying an IP address of 0.0.0.0/0.

Specifying the Next Hop of the Static Route

When you configure an individual static route in the **route** part of the **static** statement, specify how to reach the destination (in **next-hop**) in one of the following ways:

- **next-hop address**—IPv4 or IPv6 address of the next hop to the destination, specified as:
 - IPv4 or IPv6 address of the next hop
 - Interface name (for point-to-point interfaces only)
 - *address* or *interface-name* to specify an IP address of a multipoint interface or an interface name of a point-to-point interface.



NOTE: If an interface becomes unavailable, all configured static routes on that interface are withdrawn from the routing table.

- **next-table routing-table-name**—Name of the next routing table to the destination.



NOTE: Within a routing instance, you cannot configure a static route with the `next-table inet.0` statement if any static route in the main routing instance is already configured with the `next-table` statement to point to the `inet.0` routing table of the routing instance. For example, if you configure on the main routing instance a static route 192.168.88.88/32 with `next-table test.inet.0` and the routing instance `test` is also configured with a static route 192.168.88.88/32 `next-table inet.0`, the configuration commit fails. Instead, you must configure a rib group both on the main instance and on the routing instance, which enables you to install the static route into both routing tables. For more information, see “Installing a Static Route into More than One Routing Table” on page 60.

- **reject**—Do not forward packets addressed to this destination. Instead, drop the packets, send ICMP (or ICMPv6) unreachable messages to the packets’ originators, and install a reject route for this destination into the routing table.
- **discard**—Do not forward packets addressed to this destination. Instead, drop the packets, do not send ICMP (or ICMPv6) unreachable messages to the packets’ originators, and install a reject route for this destination into the routing table.
- **receive**—Cause packets to the destination to be received by the local router.

Specifying an Independent Preference for a Static Route

Configuring independent preferences allows you to configure multiple static routes with different preferences and metrics to the same destination. The static route with the best preference, metric, and reachable next hop is chosen as the active route. This feature allows you to specify preference and metric on a next-hop basis using the `qualified-next-hop` statement.



NOTE: The `preference` and `metric` options configured by means of this statement only apply to the qualified next hops. The qualified next hop preference and metric override the route preference and metric (for that specific qualified next hop), similar to how the route preference overrides the default preference and metric (for that specific route).

To specify an independent preference for a static route on a point-to-point interface or on an Ethernet interface, include the following statements:

```
qualified-next-hop address {
  interface interface-name;
  metric metric;
  preference preference;
}
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Specify a next-hop interface by including the `qualified-next-hop` option. Specifying a next-hop interface is useful when you are creating a route to an IPv6 link-local next-hop address (which is a link-only scope address and is specific only to an

interface). The preference value can be a number from 0 through 4,294,967,295 ($2^{32} - 1$). A lower number indicates a more preferred route. The metric value can be a number from 0 through 4,294,967,295 ($2^{32} - 1$).

You can configure static routes on an unnumbered Ethernet interface by using the **qualified-next-hop** option to specify the unnumbered interface as the next-hop interface for a configured static route.

To configure an unnumbered Ethernet interface as the next-hop interface for a static route and to specify independent preferences, include the following statements:

```
qualified-next-hop interface-name {
    metric metric;
    preference preference;
}
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Keep the following points in mind when you configure static routes for unnumbered Ethernet interfaces:

- The prefix length of the static route must be 32.
- The router uses the Address Resolution Protocol (ARP) to resolve the media access control (MAC) address of the destination interface.

For information about how to configure an unnumbered Ethernet interface, see the *JUNOS Network Interfaces Configuration Guide*.



NOTE: The **qualified-next-hop** statement is mutually exclusive with all other types of next hops, except for **next-hop address**. Therefore, you cannot configure **next-hop reject**, **next-hop discard**, and **next-hop receive** with **qualified-next-hop** for the same destination.

For sample configurations, see the following sections:

- Example: Configuring Independent Preferences for an IPv4 Static Route on page 56
- Example: Configuring Independent Preferences for an IPv6 Static Route on page 57
- Example: Configuring Independent Preferences for an Unnumbered Ethernet Interface on page 58

Example: Configuring Independent Preferences for an IPv4 Static Route

The following example configures:

- A static route to 0.0.0.0/8 with a next hop through 192.168.1.254, with a metric of 10 and preference of 10.

- A static route to 10.0.0.0/8 with a next hop through 192.168.1.254, with a metric of 6 and preference of 5.
- A static route to 10.0.0.0/8 with a next hop through 192.168.1.2, with a metric of 6 and preference of 7.

```
[edit]
routing-options {
  static {
    defaults {
      metric 10;
      preference 10;
    }
    route 0.0.0.0/8 {
      next-hop 192.168.1.254 {
        retain;
        no-readvertise;
      }
      route 10.0.0.0/8 {
        next-hop [192.168.1.2];
        qualified-next-hop 192.168.1.254 {
          preference 5;
        }
        metric 6;
        preference 7;
      }
    }
  }
}
```

Example: Configuring Independent Preferences for an IPv6 Static Route

Configure the following qualified next hops:

- A static route to fec0:1:1:4::/64 with a next hop through fec0:1:1:2::1, with a metric 10 and preference 10.
- A static route to fec0:1:1:5::/64 with a next hop through fec0:1:1:2::2, with a metric 6 and preference 5.
- A static route to fec0:1:1:5::/64 with a next hop through fec0:1:1:2::3, with a metric 6 and preference 7.

```
[edit]
routing-options {
  rib inet6.0 {
    static {
      defaults {
        metric 10;
        preference 10;
      }
      route fec0:1:1:4::/64 {
        next-hop fec0:1:1:2::1 {
          retain;
          no-readvertise;
        }
      }
    }
  }
}
```

```

        route fec0:1:1:5::/64 {
            next-hop fec0:1:1:2::3;
            qualified-next-hop fec0:1:1:2::2 {
                preference 5;
            }
            metric 6;
            preference 7;
        }
    }
}

```

Example: Configuring Independent Preferences for an Unnumbered Ethernet Interface

The following example configures two things:

- An unnumbered Ethernet interface `ge-0/0/0`, which borrows an IP address from donor interface `lo0`.
- A static route to `7.7.7.1/32` with a next hop through unnumbered interface `ge-0/0/0.0` with a metric of 5 and preference of 6.

```

interfaces {
    lo0 {
        unit 0 {
            family inet {
                address 5.5.5.1/32;
                address 6.6.6.1/32;
            }
        }
    }
}
interfaces
ge-0/0/0 {
    unit 0 {
        family inet {
            unnumbered-address lo0.0;
        }
    }
}
routing-options {
    static {
        route 7.7.7.1/32 {
            qualified next-hop ge-0/0/0.0 {
                metric 5;
                preference 6;
            }
        }
    }
}

```

Specifying an LSP as the Next Hop for a Static Route

Static routes can be configured with a next hop that is a label-switched path (LSP). This is useful when implementing filter-based forwarding. You can specify an LSP as the next hop and assign an independent preference and metric to this next hop.

To specify an LSP as the next hop for a static route, include the following statements:

```
lsp-next-hop lsp-name {
    metric metric;
    preference preference;
}
```



NOTE: The preference and metric configured by means of the `lsp-next-hop` statement only apply to the LSP next hops. The LSP next-hop preference and metric override the route preference and metric (for that specific LSP next hop), similar to how the route preference overrides the default preference and metric (for that specific route).

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

The **preference** value can be a number in the range from 0 through 4,294,967,295 ($2^{32} - 1$) with a lower number indicating a more preferred route. The **metric** value can be a number in the range from 0 through 4,294,967,295 ($2^{32} - 1$).



NOTE: The `lsp-next-hop` statement is mutually exclusive with all other types of next hops, except for `next-hop address` and `qualified-next-hop`. Therefore, you cannot configure `next-hop reject`, `next-hop discard`, `next-hop receive`, and `next-table` with `lsp-next-hop` for the same destination.

To specify a point-to-multipoint LSP as the next hop for a static route, include the following statements:

```
p2mp-lsp-next-hop {
    interface interface-name;
    metric metric;
    preference preference;
}
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Enable the qualified next-hop address on the interface by specifying the **interface** option. The **preference** value can be a number from 0 through 4,294,967,295 ($2^{32} - 1$). A lower number indicates a more preferred route. The **metric** value can be a number from 0 through 4,294,967,295 ($2^{32} - 1$).

Installing a Static Route into More than One Routing Table

You can install a static route into more than one routing table. For example, you might want a simple configuration that allows you to install a static route into the default routing table `inet.0`, as well as a second routing table `inet.2`. Instead of configuring the same static route for each routing table, you can use routing table groups to insert the route into multiple tables. To create a routing table group, include the `rib-group` statement.

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

To install the routing table into a configured routing table group, include the `import-rib` statement:

```
rib-group group-name {
    import-rib [ routing-table-names ];
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

The first routing table you list in the `import-rib` statement must be the one you configured in the `rib-group` statement.

Examples: Installing a Static Route into More than One Routing Table

Install an IPv4 static route into `inet.0` and `inet.2`:

```
[edit routing-options rib table1.inet.0 static]
rib-group groupA;
[edit routing-options rib-groups]
groupA {
    import-rib [table1.inet.0 inet.0 inet.2];
}
```

Install an IPv6 static route into the `inet6.0` and `inet6.2` routing tables:

```
[edit routing-options rib table1.inet6.0 static]
rib-group groupA;
[edit routing-options rib-groups]
groupA {
    import-rib [table1.inet6.0 inet6.0 inet6.2];
}
```

Configuring a Connectionless Network Services Static Route

Connectionless Network Services (CLNS) is an ISO Layer 3 protocol that uses network service access point (NSAP) reachability information instead of IPv4 prefixes. You can configure a static route for CLNS networks.



NOTE: CLNS is supported for J-series Services Routers only.

To configure a CLNS static route, include the following statements:

```
rib (iso.0 | instance-name.iso.0)
static {
    route nsap-prefix {
        next-hop (interface-name | iso-net);
        qualified-next-hop (interface-name | iso-net) {
            metric metric;
            preference preference;
        }
    }
}
```

For a list of hierarchy levels at which you can configure these statements, see the CLNS statement summary sections in the *J-series Services Router Advanced WAN Access Configuration Guide*.

Specify the `iso.0` routing table option to configure a primary instance CLNS static route. Specify the `instance-name.iso.0` routing table option to configure CLNS static route for a particular routing instance. Specify the `route nsap-prefix` statement to configure the destination for the CLNS static route. Specify the `next-hop (interface-name | iso-net)` statement to configure the next hop, specified as an ISO network entity title (NET) or interface name. Specify the `qualified-next-hop (interface-name | iso-net)` statement to configure the qualified next hop, specified as an ISO network entity title or interface name.

Example: Configuring a Static CLNS Route

Configure a static CLNS route with an NSAP of 47.0005.80ff.f800.0000.ffff.ffff:

```
[edit]
routing-options {
    rib iso.0 {
        static {
            iso-route 47.0005.80ff.f800.0000.ffff.ffff next-hop
                47.0005.80ff.f800.0000.0108.0001.1921.6800.4212;
            iso-route 47.0005.80ff.f800.0000.0108.0001.1921.6800.4212 next-hop
                t1-0/2/2.0;
            iso-route 47.0005.80ff.f800.0000.eee {
                qualified-next-hop 47.0005.80ff.f800.0000.0108.0001.1921.6800.4002
                {
                    preference 20;
                    metric 10;
                }
            }
        }
    }
}
```

For information on CLNS, see “Configuring Support for Connectionless Network Services” on page 324 and the *J-series Services Router Advanced WAN Access Configuration Guide*.

Specifying Static Route Options

In the **defaults** and **route** parts of the **static** statement, you can specify *static-options*, which define additional information about static routes that is included with the route when it is installed in the routing table. All static options are optional. Static options that you specify in the **defaults** part of the **static** statement are treated as global defaults and apply to all the static routes you configure in the **static** statement. Static options that you specify in the **route** part of the **static** statement override any global static options and apply to that destination only.

To configure static route options for IPv4 static routes, include one or more options in the **defaults** or **route** part of the **static** statement. Each of these options is explained in the sections that follow.

```

routing-options {
  static {
    defaults {
      (active | passive);
      as-path <as-path> <origin (egp | igp | incomplete)> <atomic-aggregate>
        <aggregator as-number in-address>;
      community [ community-ids ];
      (install | no-install);
      metric metric <type type>;
      (preference | preference2 | color | color2) preference <type type>;
      (readvertise | no-readvertise);
      (retain | no-retain);
      tag string;
    }
    rib-group group-name;
    route destination-prefix {
      (active | passive);
      as-path <as-path> <origin (egp | igp | incomplete)> <atomic-aggregate>
        <aggregator as-number in-address>;
      bfd-liveness-detection {
        detection-time {
          threshold milliseconds;
        }
        local-address ip-address;
        minimum-interval milliseconds;
        minimum-receive-interval milliseconds;
        minimum-receive-ttl number;
        multiplier number;
        neighbor address;
        no-adaptation;
        transmit-interval {
          threshold milliseconds;
          minimum-interval milliseconds
        }
        version (1 | automatic);
      }
    }
  }
}

```

```

        community [ community-ids ];
        (install | no-install);
        metric metric <type type>;
        (preference | preference2 | color | color2) preference <type type>;
        (readvertise | no-readvertise);
        resolve;
        (retain | no-retain);
        tag string;
    }
}

```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

To configure static route options for IPv6 static routes, include one or more options in the **defaults** or **route** part of the **static** statement. Each of these options is explained in the sections that follow.

```

rib inet6.0 {
    static {
        defaults {
            (active | passive);
            as-path <as-path> <origin (egp | igp | incomplete)> <atomic-aggregate>
              <aggregator as-number in-address>;
            community [ community-ids ];
            (install | no-install);
            metric metric <type type>;
            (preference | preference2 | color | color2) preference <type type>;
            (readvertise | no-readvertise);
            resolve;
            (no-retain | retain);
        }
        rib-group group-name;
        route destination-prefix {
            (active | passive);
            as-path <as-path> <origin (egp | igp | incomplete)> <atomic-aggregate>
              <aggregator as-number in-address>;
            bfd-liveness-detection {
                detection-time {
                    threshold milliseconds;
                }
                local-address ip-address;
                minimum-interval milliseconds;
                minimum-receive-interval milliseconds;
                minimum-receive-ttl number;
                multiplier number;
                neighbor address;
                no-adaptation;
                transmit-interval {
                    threshold milliseconds;
                    minimum-interval milliseconds;
                }
                version (1 | automatic);
            }
        }
    }
}

```

```

        community [ community-ids ];
        (install | no-install);
        metric metric <type type>;
        (preference | preference2 | color | color2) preference <type type>;
        (readvertise | no-readvertise);
        resolve;
        (retain | no-retain);
    }
}

```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

The following sections explain how to specify static route options:

- Specifying the Route Metric on page 64
- Specifying the Route Preference on page 65
- Specifying Community Information on page 65
- Specifying the AS Path on page 66
- Specifying the OSPF Tag on page 67
- Specifying Whether a Route Is Installed in the Forwarding Table on page 67
- Specifying Whether the Route Is Permanently Installed in the Forwarding Table on page 68
- Specifying Whether Inactive Routes Are Removed from the Routing or Forwarding Table on page 69
- Specifying When the Route Can Be Readvertised on page 70
- Specifying When the Route Can Be Resolved to a Prefix That Is Not Directly Connected on page 70
- Configuring Bidirectional Forwarding Detection on page 71

Specifying the Route Metric

To associate a metric value with an IPv4 route, include the **metric** statement:

```

static (defaults | route) {
    metric metric <type type>;
}

```

To associate a metric value with an IPv6 route, include the **metric** statement:

```

rib inet6.0 static (defaults | route) {
    metric metric <type type>;
}

```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

In the **type** option, you can specify the type of route. For OSPF, when routes are exported to OSPF, type 1 routes are advertised in type 1 externals, and routes of

any other type are advertised in type 2 externals. Note that if a qualified-next-hop metric value is configured, this value will override the route metric.

Specifying the Route Preference

By default, static routes have a preference value of 5. To modify the default preference value, specify a primary preference value (**preference**). You also can specify a secondary preference value (**preference2**) and colors, which are even finer-grained preference values (**color** and **color2**). To do this for IPv4 static routes, include one or more of the following statements:

```
static (defaults | route) {
    (preference | preference2 | color | color2) preference <type type>;
}
```

To do this for IPv6 static routes, include one or more of the following statements:

```
rib inet6.0 static (defaults | route) {
    (preference | preference2 | color | color2) preference <type type>;
}
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

The preference value can be a number in the range from 0 through 4,294,967,295 ($2^{32} - 1$) with a lower number indicating a more preferred route. For more information about preference values, see “Route Preferences” on page 6. Note that if a qualified-next-hop preference value is configured, this value will override the route preference.

In the **type** option, you can specify the type of route.

Specifying Community Information

By default, no Border Gateway Protocol (BGP) community information is associated with static routes. To associate community information with IPv4 routes, include the **community** statement:

```
static (defaults | route) {
    community [ community-ids ];
}
```

To associate community information with IPv6 routes, include the **community** statement:

```
rib inet6.0 static (defaults | route) {
    community [ community-ids ];
}
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

community-ids is one or more community identifiers for either communities or extended communities.

The format for community identifiers is:

as-number:community-value

as-number is the autonomous system (AS) number and can be a value in the range from 1 through 65,534. *community-value* is the community identifier and can be a number in the range from 0 through 65,535.

You also can specify *community-ids* as one of the following well-known community names, which are defined in RFC 1997:

- **no-export**—Routes containing this community name are not advertised outside a BGP confederation boundary.
- **no-advertise**—Routes containing this community name are not advertised to other BGP peers.
- **no-export-subconfed**—Routes containing this community name are not advertised to external BGP peers, including peers in other members' ASs inside a BGP confederation.

You can also explicitly exclude BGP community information with a static route using the **none** option. Include **none** when configuring an individual route in the **route** portion of the **static** statement to override a **community** option specified in the **defaults** portion of the statement.



NOTE: Extended community attributes are not supported at the [edit routing-options] hierarchy level. You must configure extended communities at the [edit policy-options] hierarchy level. For information about configuring extended communities information, see the “Configuring the Extended Communities Attribute” section in the *JUNOS Policy Framework Configuration Guide*.

Specifying the AS Path

By default, no AS path information is associated with static routes. To associate AS path information with IPv4 routes, include the **as-path** statement:

```
static (defaults | route) {
  as-path <as-path> <origin (egp | igp | incomplete)> <atomic-aggregate> <aggregator
    as-number in-address>;
}
```

To associate AS path information with IPv6 routes, include the **as-path** statement:

```
rib inet6.0 static (defaults | route) {
  as-path <as-path> <origin (egp | igp | incomplete)> <atomic-aggregate> <aggregator
    as-number in-address>;
}
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

as-path is the AS path to include with the route. It can include a combination of individual AS path numbers and AS sets. Enclose sets in brackets ([]). The first AS number in the path represents the AS immediately adjacent to the local AS. Each subsequent number represents an AS that is progressively farther from the local AS, heading toward the origin of the path.

Beginning with JUNOS Release 9.1, the range that you can configure for the AS number has been extended to provide BGP support for 4-byte AS numbers as defined in RFC 4893, *BGP Support for Four-octet AS Number Space*. You can now configure a number from 1 through 4,294,967,295. The JUNOS software continues to support 2-byte AS numbers.

You also can specify the AS path using the BGP origin attribute, which indicates the origin of the AS path information:

- **igp**—Path information originated within the local AS.
- **egp**—Path information originated in another AS.
- **incomplete**—Path information learned by some other means.

To attach the BGP **ATOMIC_AGGREGATE** path attribute to the static route, specify the **atomic-aggregate** statement. This path attribute indicates that the local system selected a less specific route rather than a more specific route.

To attach the BGP **AGGREGATOR** path attribute to the static route, specify the **aggregator** statement. When using this statement, you must specify the last AS number that formed the static route (encoded as two octets), followed by the IP address of the BGP system that formed the static route.

Specifying the OSPF Tag

By default, no OSPF tag strings are associated with static routes. You can specify an OSPF tag string by including the **tag** statement:

```
static (defaults | route) {
    tag string;
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Specifying Whether a Route Is Installed in the Forwarding Table

By default, the JUNOS software installs all active static routes into the forwarding table. To configure the software not to install active IPv4 static routes into the forwarding table, include the **no-install** statement:

```
static (defaults | route) {
    no-install;
}
```

To configure the software not to install active IPv6 static routes into the forwarding table, include the **no-install** statement:

```

rib inet6.0 static (defaults | route) {
    no-install;
}

```

Even if you configure a route so it is not installed in the forwarding table, the route is still eligible to be exported from the routing table to other protocols. To explicitly install IPv4 routes into the forwarding table, include the **install** statement. Include this statement when configuring an individual route in the **route** portion of the **static** statement to override a **no-install** option specified in the **defaults** portion of the statement.

```

static (defaults | route) {
    install;
}

```

To explicitly install IPv6 routes into the forwarding table, include the **install** statement. Include this statement when configuring an individual route in the **route** portion of the **static** statement to override a **no-install** statement specified in the **defaults** portion of the statement.

```

rib inet6.0 static (defaults | route) {
    install;
}

```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Specifying Whether the Route Is Permanently Installed in the Forwarding Table

By default, statically configured routes are deleted from the forwarding table when the routing protocol process shuts down normally. To have an IPv4 static route remain in the forwarding table, include the **retain** statement. Doing this greatly reduces the time required to restart a system that has a large number of routes in its routing table.

```

static (defaults | route) {
    retain;
}

```

To have an IPv6 static route remain in the forwarding table, include the **retain** statement. Doing this greatly reduces the time required to restart a system that has a large number of routes in its routing table.

```

rib inet6.0 static (defaults | route) {
    retain;
}

```

To explicitly specify that IPv4 routes be deleted from the forwarding table, include the **no-retain** statement. Include this statement when configuring an individual route in the **route** portion of the **static** statement to override a **retain** option specified in the **defaults** portion of the statement.

```

static (defaults | route) {

```

```

    no-retain;
}

```

To explicitly specify that IPv6 routes be deleted from the forwarding table, include the **no-retain** statement. Include this statement when configuring an individual route in the **route** portion of the **static** statement to override a **retain** statement specified in the **defaults** portion of the statement.

```

rib inet6.0 static (defaults | route) {
    no-retain;
}

```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Specifying Whether Inactive Routes Are Removed from the Routing or Forwarding Table

Static routes are only removed from the routing table if the next hop becomes unreachable. This can occur if the local or neighbor interface goes down. To have an IPv4 static route remain installed in the routing and forwarding tables, include the **passive** statement:

```

static (defaults | route) {
    passive;
}

```

To have an IPv6 static route remain installed in the routing and forwarding tables, include the **passive** statement:

```

rib inet6.0 static (defaults | route) {
    passive;
}

```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Routes that have been configured to remain continually installed in the routing and forwarding tables are marked with **reject** next hops when they are inactive.

To explicitly remove IPv4 static routes when they become inactive, include the **active** statement. Include this statement when configuring an individual route in the **route** portion of the **static** statement to override a **passive** option specified in the **defaults** portion of the statement.

```

static (defaults | route) {
    active;
}

```

To explicitly remove IPv6 static routes when they become inactive, include the **active** statement. Include this statement when configuring an individual route in the **route** portion of the **static** statement to override a **passive** statement specified in the **defaults** portion of the statement.

```
rib inet6.0 static (defaults | route) {
    active;
}
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Specifying When the Route Can Be Readvertised

By default, static routes are eligible to be readvertised (that is, exported) by dynamic routing protocols. To mark an IPv4 static route as being ineligible for readvertisement, include the **no-readvertise** statement:

```
static (defaults | route) {
    no-readvertise;
}
```

To mark an IPv6 static route as being ineligible for readvertisement, include the **no-readvertise** statement:

```
rib inet6.0 static (defaults | route) {
    no-readvertise;
}
```

To explicitly readvertise IPv4 static routes, include the **readvertise** statement. Include the **readvertise** statement when configuring an individual route in the **route** portion of the **static** statement to override a **no-readvertise** statement specified in the **defaults** portion of the statement.

```
static (defaults | route) {
    readvertise;
}
```

To explicitly readvertise IPv6 static routes, include the **readvertise** statement. Include the **readvertise** statement when configuring an individual route in the **route** portion of the **static** statement to override a **no-readvertise** option specified in the **defaults** portion of the statement.

```
rib inet6.0 static (defaults | route) {
    readvertise;
}
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Specifying When the Route Can Be Resolved to a Prefix That Is Not Directly Connected

By default, static routes can point only to a directly connected next hop. You can configure an IPv4 route to a prefix that is not directly connected by resolving the route through the **inet.0** and **inet.3** routing tables. To configure an IPv4 static route to a prefix that is not a directly connected next hop, include the **resolve** statement:

```
static (defaults | route) {
```

```

    resolve;
}

```

You can configure an IPv6 route to a prefix that is not directly connected by resolving the route through the `inet6.0` routing table. To configure an IPv6 static route to a prefix that is not a directly connected next hop, include the `resolve` statement:

```

rib inet6.0 static (defaults | route) {
    resolve;
}

```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Configuring Bidirectional Forwarding Detection

The Bidirectional Forwarding Detection (BFD) protocol is a simple hello mechanism that detects failures in a network. Hello packets are sent at a specified, regular interval. A neighbor failure is detected when the router stops receiving a reply after a specified interval. BFD works with a wide variety of network environments and topologies. The failure detection timers for BFD have shorter time limits than the failure detection mechanisms of static routes, providing faster detection. These timers are also adaptive. For example, a timer can adapt to a higher value if an adjacency fails, or a neighbor can negotiate a higher value than the one configured. By default, BFD is supported on single-hop static routes. Beginning with JUNOS Release 8.2, BFD also supports multihop static routes.

To enable failure detection, include the `bfd-liveness-detection` statement:

```

static route destination-prefix {
    bfd-liveness-detection {
        detection-time {
            threshold milliseconds;
        }
        local-address ip-address;
        minimum-interval milliseconds;
        minimum-receive-interval milliseconds;
        minimum-receive-ttl number;
        multiplier number;
        neighbor address;
        no-adaptation;
        transmit-interval {
            threshold milliseconds;
            minimum-interval milliseconds;
        }
        version (1 | automatic);
    }
}

```

Beginning with JUNOS Release 9.1, the BFD protocol is supported for IPv6 static routes. Global unicast and link-local IPv6 addresses are supported for static routes. The BFD protocol is not supported on multicast or anycast IPv6 addresses. For IPv6, the BFD protocol supports only static routes and beginning with JUNOS Release 9.3, OSPF3. IPv6 for BFD is not supported for any other protocol. To configure the BFD

protocol for IPv6 static routes, include the **bfd-liveness-detection** statement at the [edit routing-options rib inet6.0 static route *destination-prefix*] hierarchy level.

Beginning with JUNOS Release 8.5, you can configure a hold-down interval to specify how long the BFD session must remain up before state change notification is sent. To specify the hold-down interval, include the **holddown-interval** statement:

```
static route destination-prefix {
  bfd-liveness-detection {
    holddown-interval milliseconds;
  }
}
```

You can configure a number in the range from 0 through 255,000 milliseconds, and the default is 0. If the BFD session goes down and then comes back up during the hold-down interval, the timer is restarted.



NOTE: If a single BFD session includes multiple static routes, the hold-down interval with the highest value is used.

To specify the minimum transmit and receive intervals for failure detection, include the **minimum-interval** statement:

```
static route destination-prefix {
  bfd-liveness-detection {
    minimum-interval milliseconds;
  }
}
```

This value represents the minimum interval at which the local router transmits hello intervals as well as the minimum interval that the router expects to receive a reply from a neighbor with which it has established a BFD session. You can configure a number in the range from 1 through 255,000 milliseconds. You can also specify the minimum transmit and receive intervals separately.

To specify only the minimum receive interval for failure detection, include the **minimum-receive-interval** statement:

```
static route destination-prefix {
  bfd-liveness-detection {
    minimum-receive-interval milliseconds;
  }
}
```

This value represents the minimum interval at which the local router expects to receive a reply from a neighbor with which it has established a BFD session. You can configure a number in the range from 1 through 255,000 milliseconds.

To specify the number of hello packets not received by the neighbor that causes the originating interface to be declared down, include the **multiplier** statement:

```
static route destination-prefix {
  bfd-liveness-detection {
```



```

        multiplier number;
    }
}

```

The default value is 3. You can configure a number in the range from 1 through 255.

To specify a threshold for detecting the adaptation of the detection time, include the **threshold** statement:

```

static route destination-prefix {
    bfd-liveness-detection {
        detection-time {
            threshold milliseconds;
        }
    }
}

```

When the BFD session detection time adapts to a value equal to or higher than the threshold, a single trap and a system log message are sent. The detection time is based on the multiplier of the **minimum-interval** or the **minimum-receive-interval** value. The threshold must be a higher value than the multiplier for either of these configured values. For example if the **minimum-receive-interval** is 300 ms and the **multiplier** is 3, the total detection time is 900 ms. Therefore, the detection time threshold must have a value higher than 900.

To specify only the minimum transmit interval for failure detection, include the **transmit-interval minimum-interval** statement:

```

static route destination-prefix {
    bfd-liveness-detection {
        transmit-interval {
            minimum-interval milliseconds;
        }
    }
}

```

This value represents the minimum interval at which the local router transmits hello packets to the neighbor with which it has established a BFD session. You can configure a value in the range from 1 through 255,000 milliseconds.

To specify the transmit threshold for detecting the adaptation of the transmit interval, include the **transmit-interval threshold** statement:

```

static route destination-prefix {
    bfd-liveness-detection {
        transmit-interval {
            threshold milliseconds;
        }
    }
}

```

The threshold value must be greater than the transmit interval. When the BFD session detection time adapts to a value higher than the threshold, a single trap and a system log message are sent. The detection time is based on the multiplier of the

minimum-interval or the minimum-receive-interval value. The threshold must be a higher value than the multiplier for either of these configured values.

To specify the BFD version, include the **version** statement:

```
static route destination-prefix {
  bfd-liveness-detection {
    version (1 | automatic);
  }
}
```

The default is to have the version detected automatically.

To include an IP address for the next hop of the BFD session, include the **neighbor** statement:

```
static route destination-prefix {
  next-hop interface-name;
  bfd-liveness-detection {
    neighbor address;
  }
}
```



NOTE: You must configure the **neighbor** statement if the next hop specified is an interface name. If you specify an IP address as the next hop, that address is used as the neighbor address for the BFD session.

Beginning with JUNOS Release 9.0, you can configure BFD sessions not to adapt to changing network conditions. To disable BFD adaptation, include the **no-adaptation** statement:

```
bfd-liveness-detection {
  no-adaptation;
}
```



NOTE: We recommend that you not disable BFD adaptation unless it is preferable not to have BFD adaptation in your network.

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.



NOTE: If BFD is configured only on one end of a static route, the route is removed from the routing table. BFD establishes a session when BFD is configured on both ends of the static route.

BFD is not supported on ISO address families in static routes. BFD does support IS-IS.

If you configure Graceful Routing Engine Switchover (GRES) at the same time as BFD, GRES does not preserve the BFD state information during a failover.

The JUNOS software also supports BFD over multihop static routes. For example, you can configure BFD over a Layer 3 path to provide path integrity over that path. You can limit the number of hops by specifying the time-to-live (TTL).

To configure BFD over multihop static routes, include the following statements:

```
static route destination-prefix {
  bfd-liveness-detection {
    local-address ip-address;
    minimum-receive-ttl number;
  }
}
```

To specify the source address for the multihop static route and to enable multihop BFD support, include the `local-address` statement.

To specify the number of hops, include the `minimum-receive-ttl` statement. You must configure this statement for a multihop BFD session. You can configure a value in the range from 1 through 255. It is optional for a single-hop BFD session. If you configure the `minimum-receive-ttl` statement for a single-hop session, the value must be 255.

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Configuring a Default Route

To configure an IPv4 default route, include the `next-hop address` and `retain` statements:

```
static route default {
  next-hop address;
  retain;
}
```

To configure an IPv6 static route, include the `next-hop address` and `retain` statements:

```
rib inet6.0 static (default | route) {
  next-hop address;
  retain;
}
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Propagating Static Routes into Routing Protocols

A common way to propagate static routes into the various routing protocols is to configure the routes so that the next-hop router is the loopback address (commonly, 127.0.0.1). However, configuring static routes in this way with the JUNOS software (by including a statement such as `route address/mask-length next-hop 127.0.0.1`) does not propagate the static routes, because the forwarding table ignores static routes whose next-hop router is the loopback address. To propagate IPv4 static routes into the routing protocols, include the `discard` statement:

```

rib inet.0 static (defaults | route) {
    discard;
}

```

To propagate IPv6 static routes into the routing protocols, include the **discard** statement:

```

rib inet6.0 static (defaults | route) {
    discard;
}

```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

In this configuration, you use the **discard** option instead of **reject** because **discard** does not send an ICMP (or ICMPv6) unreachable message for each packet that it drops.

Examples: Configuring Static Routes

Configure an IPv4 default route through the next-hop router 192.238.52.33:

```

[edit]
user@host# set routing-options static route 0.0.0.0/0 next-hop 192.238.52.33
[edit]
user@host# show
routing-options {
    static {
        route 0.0.0.0/0 next-hop 192.238.52.33;
    }
}

```

Configure IPv4 static routes that are retained in the forwarding table when the routing software shuts down normally:

```

[edit]
user@host# set routing-options static route 0.0.0.0/0 next-hop 192.168.1.254 retain
[edit]
user@host# set routing-options static route 10.1.1.1/32 next-hop 127.0.0.1 retain
[edit]
user@host# show
routing-options {
    static {
        route 0.0.0.0/0 {
            next-hop 192.168.1.254;
            retain;
        }
        route 10.1.1.1/32 {
            next-hop 127.0.0.1;
            retain;
        }
    }
}

```

Configure an IPv4 static route and have it propagate into the routing protocols. In this example, specify that the route 143.172.0.0/6 next-hop 127.0.0.1 should be discarded.

```
[edit]
user@host# set routing-options static route 143.172.0.0/6 discard
[edit]
user@host# show
routing-options {
  static {
    route 143.172.0.0/6 discard;
  }
}
```

Install an IPv4 static route into both inet.0 and inet.2:

```
[edit]
user@host# set routing-options static rib-group some-group
user@host# set rib-groups some-group import-rib [inet.0 inet.2]
[edit]
user@host# show
routing-options {
  static {
    rib-group some-group;
  }
  rib-groups {
    some-group {
      import-rib [ inet.0 inet.2 ];
    }
  }
}
```

Configure an IPv6 default route through the next-hop router 8:3::1:

```
[edit]
user@host# set routing-options rib inet6.0 static route 0::/0 next-hop 8:3::1
[edit]
user@host# show
routing-options {
  rib inet6.0 static {
    route abcd::/48 next-hop 8:3::1;
  }
}
```

Resolve an IPv6 static route to non-next-hop router 1::/64 using next-hop router 2000::1:

```
[edit]
user@host# set routing-options rib inet6.0 static route 1::/64 next-hop 2000::1
resolve
[edit]
user@host# show route 1::/64
inet6.0: 26 destinations, 27 routes (25 active, 0 holddown, 1 hidden)
+ = Active Route, - = Last Active, * = Both
1::/64 *[Static/5] 00:01:50
> to 8:1::2 via ge-0/1/0.0
```

```

user@host# show route 2000::1
inet6.0: 26 destinations, 27 routes (25 active, 0 holddown, 1 hidden)
+ = Active Route, - = Last Active, * = Both
2000::/126 *[BGP/170] 00:05:32, MED 20, localpref 100
AS path: 2 I
> to 8:1::2 via ge-0/1/0.0

```

Configuring Aggregate Routes

Route aggregation allows you to combine groups of routes with common addresses into a single entry in the routing table. This decreases the size of the routing table as well as the number of route advertisements sent by the router.

An aggregate route becomes active when it has one or more *contributing routes*. A contributing route is an active route that is a more specific match for the aggregate destination. For example, for the aggregate destination **128.100.0.0/16**, routes to **128.100.192.0/19** and **128.100.67.0/24** are contributing routes, but routes to **128.0.0.0/8**, **128.0.0.0/16**, and **128.100.0.0/16** are not.

A route can contribute only to a single aggregate route. However, an active aggregate route can recursively contribute to a less specific matching aggregate route. For example, an aggregate route to the destination **128.100.0.0/16** can contribute to an aggregate route to **128.96.0.0/13**.

When an aggregate route becomes active, it is installed in the routing table with the following information:

- Reject next hop—If a more-specific packet does not match a more-specific route, the packet is rejected and an ICMP unreachable message is sent to the packet's originator.
- Metric value as configured with the **aggregate** statement.
- Preference value that results from the policy filter on the primary contributor, if a filter is specified.
- AS path as configured in the **aggregate** statement, if any. Otherwise, the path is computed by aggregating the paths of all contributing routes.
- Community as configured in the **aggregate** statement, if any is specified.



NOTE: You can configure only one aggregate route for each destination prefix.

To configure aggregate routes in the default routing table (**inet.0**), include the **aggregate** statement:

```

aggregate {
  defaults {
    ... aggregate-options ...
  }
  route destination-prefix {
    policy policy-name;
    ... aggregate-options ...
  }
}

```

```
}
}
```

To configure aggregate routes in one of the other routing tables, or to explicitly configure aggregate routes in the default routing table (`inet.0`), include the **aggregate** statement:

```
rib routing-table-name {
  aggregate {
    defaults {
      ... aggregate-options ...
    }
    route destination-prefix {
      policy policy-name;
      ... aggregate-options ...
    }
  }
}
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.



NOTE: You cannot configure aggregate routes for the IPv4 multicast routing table (`inet.1`) nor the IPv6 multicast routing table (`inet6.1`).

The **aggregate** statement consists of two parts:

- **defaults**—Here you specify global aggregate route options. These are treated as global defaults and apply to all the aggregate routes you configure in the **aggregate** statement. This part of the **aggregate** statement is optional.
- **route**—Here you configure individual aggregate routes. In this part of the **aggregate** statement, you optionally can configure aggregate route options. These options apply to the individual destination only and override any options you configured in the **defaults** part of the **aggregate** statement.

The following sections explain how to configure aggregate routes:

- Specifying the Destination of the Aggregate Route on page 79
- Specifying Aggregate Route Options on page 80
- Specifying Policy with Aggregate Routes on page 85
- Advertising Aggregate Routes on page 86

Specifying the Destination of the Aggregate Route

When you configure an individual aggregate route in the **route** part of the **aggregate** statement, specify the destination of the route (in **route destination-prefix**) in one of the following ways:

- **network/mask-length**, where **network** is the network portion of the IP address and **mask-length** is the destination prefix length.

- default if this is the default route to the destination. This is equivalent to specifying an IP address of 0.0.0.0/0.

Specifying Aggregate Route Options

In the **defaults** and **route** parts of the **aggregate** statement, you can specify *aggregate-options*, which define additional information about aggregate routes that is included with the route when it is installed in the routing table. All aggregate options are optional. Aggregate options that you specify in the **defaults** part of the **aggregate** statement are treated as global defaults and apply to all the aggregate routes you configure in the **aggregate** statement. Aggregate options that you specify in the **route** part of the **aggregate** statement override any global aggregate options and apply to that destination only.

To configure aggregate route options, include one or more of them in the **defaults** or **route** part of the **aggregate** statement:

```
[edit]
routing-options {
  aggregate {
    (defaults | route) {
      (active | passive);
      as-path <as-path> <origin (egp | igp | incomplete)> <atomic-aggregate>
        <aggregator as-number in-address>;
      community [ community-ids ];
      discard;
      (brief | full);
      (metric | metric2 | metric3 | metric4) metric <type type>;
      (preference | preference2 | color | color2) preference <type type>;
      tag string;
    }
  }
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

The following sections explain how to specify aggregate route options:

- Specifying the Route Metric on page 81
- Specifying the Route Preference on page 81
- Specifying a Next Hop for a Route on page 81
- Specifying Community Information on page 82
- Specifying the AS Path on page 83
- Specifying Which AS Numbers to Include in the Aggregate Route on page 84
- Specifying the OSPF Tag on page 84
- Specifying Whether Inactive Routes Are Removed from the Routing or Forwarding Table on page 84

Specifying the Route Metric

You can specify up to four metric values, starting with **metric** (for the first metric value) and continuing with **metric2**, **metric3**, and **metric4** by including one or more of the following statements:

```
aggregate (defaults | route) {
  (metric | metric2 | metric3 | metric4) metric <type type>;
}
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

In the **type** option, you can specify the type of route.

Specifying the Route Preference

By default, aggregate routes have a preference value of 130. If the routing table contains a dynamic route to a destination that has a better (lower) preference value than this, the dynamic route is chosen as the active route and is installed in the forwarding table.

To modify the default preference value, specify a primary preference value (**preference**). You also can specify secondary preference value (**preference2**); and colors, which are even finer-grained preference values (**color** and **color2**). To do this, include one or more of the following statements:

```
aggregate (defaults | route) {
  (preference | preference2 | color | color2) preference <type type>;
}
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

The preference value can be a number in the range from 0 through 4,294,967,295 ($2^{32} - 1$) with a lower number indicating a more preferred route. For more information about preference values, see “Route Preferences” on page 6.

In the **type** option, you can specify the type of route.

Specifying a Next Hop for a Route

By default, when aggregate routes are installed in the routing table, the next hop is configured as a reject route. That is, the packet is rejected and an ICMP unreachable message is sent to the packet’s originator.

When you configure an individual route in the **route** part of the **aggregate** statement, or when you configure the defaults for aggregate routes, you can specify a discard next hop. This means that if a more specific packet does not match a more specific route, the packet is rejected and a reject route for this destination is installed in the routing table, but ICMP unreachable messages are not sent.

Being able to discard next hops allows you to originate a summary route, which is advertisable through dynamic routing protocols, and allows you to discard received traffic that does not match a more specific route than the summary route. To discard next hops, include the **discard** option:

```
discard;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Specifying Community Information

By default, no BGP community information is associated with aggregate routes. To associate community information with the routes, include the **community** option:

```
aggregate (defaults | route) {
  community [ community-ids ];
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement. **community-value** is the community identifier and can be a number in the range from 0 through 65,535.

community-ids is one or more community identifiers for either communities or extended communities.

The format for community identifiers is:

```
as-number:community-value
```

as-number is the AS number and can be a value in the range from 1 through 65,534.

You also can specify **community-ids** for communities as one of the following well-known community names, which are defined in RFC 1997:

- **no-export**—Routes containing this community name are not advertised outside a BGP confederation boundary.
- **no-advertise**—Routes containing this community name are not advertised to other BGP peers.
- **no-export-subconfed**—Routes containing this community name are not advertised to external BGP peers, including peers in other members' ASs inside a BGP confederation.

You can explicitly exclude BGP community information with an aggregate route using the **none** option. Include **none** when configuring an individual route in the **route** portion of the **aggregate** statement to override a **community** option specified in the **defaults** portion of the statement.



NOTE: Extended community attributes are not supported at the [edit routing-options] hierarchy level. You must configure extended communities at the [edit policy-options] hierarchy level. For information about configuring extended communities information, see the “Configuring the Extended Communities Attribute” section in the *JUNOS Policy Framework Configuration Guide*.

Specifying the AS Path

By default, the AS path for aggregate routes is built from the component routes. To manually specify the AS path and associate AS path information with the routes, include the `as-path` option:

```
aggregate (defaults | route) {
  as-path <as-path> <origin (egp | igp | incomplete)> <atomic-aggregate> <aggregator
    as-number in-address>;
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

as-path is the AS path to include with the route. It can include a combination of individual AS path numbers and AS sets. Enclose sets in brackets ([]). The first AS number in the path represents the AS immediately adjacent to the local AS. Each subsequent number represents an AS that is progressively farther from the local AS, heading toward the origin of the path.



NOTE: Beginning with JUNOS Release 9.1, the numeric AS range has been extended to provide BGP support for 4-byte AS numbers, as defined in RFC 4893, *BGP Support for Four-octet AS Number Space*. For the AS number, you can now configure a value from 1 through 4,294,967,295.

You also can specify the AS path using the BGP origin attribute, which indicates the origin of the AS path information:

- **egp**—Path information originated in another AS.
- **igp**—Path information originated within the local AS.
- **incomplete**—Path information was learned by some other means.

To attach the BGP **ATOMIC_AGGREGATE** path attribute to the aggregate route, specify the **atomic-aggregate** option. This path attribute indicates that the local system selected a less specific route rather than a more specific route.

To attach the BGP **AGGREGATOR** path attribute to the aggregate route, specify the **aggregator** option. When using this option, you must specify the last AS number that formed the aggregate route (encoded as two octets), followed by the IP address of the BGP system that formed the aggregate route.

Specifying Which AS Numbers to Include in the Aggregate Route

By default, all AS numbers from all contributing paths are included in the aggregate route's path. To include only the longest common leading sequences from the contributing AS paths, include the **brief** option when configuring the route. If doing this results in AS numbers being omitted from the aggregate route, the BGP **ATOMIC_ATTRIBUTE** path attribute is included with the aggregate route.

```
aggregate (defaults | route) {
    brief;
}
```

To explicitly have all AS numbers from all contributing paths be included in the aggregate route's path, include the **full** option when configuring routes. Include this option when configuring an individual route in the **route** portion of the **aggregate** statement to override a **retain** option specified in the **defaults** portion of the statement.

```
aggregate (defaults | route) {
    full;
}
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Specifying the OSPF Tag

By default, no OSPF tag strings are associated with aggregate routes. You can specify an OSPF tag string by including the **tag** option:

```
aggregate (defaults | route) {
    tag string;
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Specifying Whether Inactive Routes Are Removed from the Routing or Forwarding Table

Static routes are only removed from the routing table if the next hop becomes unreachable. The next hop will become unreachable if there are no contributing routes. To have an aggregate route remain continually installed in the routing and forwarding tables, include the **passive** option when configuring the route:

```
aggregate (defaults | route) {
    passive;
}
```

Routes that have been configured to remain continually installed in the routing and forwarding tables are marked with **reject** next hops when they are inactive.

To explicitly remove aggregate routes when they become inactive, include the **active** option when configuring routes. Include this option when configuring an individual

route in the **route** portion of the **aggregate** statement to override a **retain** option specified in the **defaults** portion of the statement.

```
aggregate (defaults | route) {
    active;
}
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Specifying Policy with Aggregate Routes

You can associate a routing policy when configuring an aggregate route's destination prefix in the **routes** part of the **aggregate** statement. Doing so provides the equivalent of an import routing policy filter for the destination prefix. That is, each potential contributor to an aggregate route, along with any aggregate options, is passed through the policy filter. The policy then can accept or reject the route as a contributor to the aggregate route and, if the contributor is accepted, the policy can modify the default preferences.

The following algorithm is used to compare two aggregate contributing routes in order to determine which one is the primary or preferred contributor:

1. Compare the protocol's **preferences** of the contributing routes. The lower the preference, the better the route. This is similar to the comparison that is done while determining the best route for the routing table.
2. Compare the protocol's **preferences2** of the contributing routes. The lower preference2 value is better. If only one route has **preferences2**, then this route is preferred.
3. The preference values are the same. Proceed with a numerical comparison of the prefix values.
 - a. The primary contributor is the numerically smallest prefix value.
 - b. If the two prefixes are numerically equal, the primary contributor is the route that has the smallest prefix length value.
4. At this point, the two routes are the same. The primary contributor does not change. An additional next hop will be available for the existing primary contributor.

A rejected contributor still can contribute to a less specific aggregate route. If you do not specify a policy filter, all candidate routes contribute to an aggregate route.

To associate a routing policy with an aggregate route, include the **policy** statement when configuring the route:

```
aggregate (defaults | route) {
    policy policy-name;
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Advertising Aggregate Routes

After you have configured aggregate routes, you can have a protocol advertise the routes by configuring a policy that is then exported by a routing protocol.

To configure a protocol to advertise routes, include the **policy-statement** statement:

```
policy-statement advertise-aggregate-routes {
  term first-term {
    from protocol aggregate;
    then accept;
  }
  term second-term {
    then next policy;
  }
}
protocols {
  bgp {
    export advertise-aggregate-routes;
    ...
  }
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Configuring Generated Routes

Generated routes are used as the *route of last resort*. A packet is forwarded to the route of last resort when the routing tables have no information about how to reach that packet's destination. One use of route generation is to generate a default route to use if the routing table contains a route from a peer on a neighboring backbone.

A generated route becomes active when it has one or more *contributing routes*. A contributing route is an active route that is a more specific match for the generated destination. For example, for the destination **128.100.0.0/16**, routes to **128.100.192.0/19** and **128.100.67.0/24** are contributing routes, but routes to **128.0.0.0/8**, **128.0.0.0/16**, and **128.100.0.0/16** are not.

A route can contribute only to a single generated route. However, an active generated route can recursively contribute to a less specific matching generated route. For example, a generated route to the destination **128.100.0.0/16** can contribute to a generated route to **128.96.0.0/13**.

By default, when generated routes are installed in the routing table, the next hop is chosen from the primary contributing route.



NOTE: Currently, you can configure only one generated route for each destination prefix.

To configure generated routes in the default routing table (`inet.0`), include the **generate** statement:

```
generate {
  defaults {
    generate-options;
  }
  route destination-prefix {
    policy policy-name;
    generate-options;
  }
}
```

To configure generated routes in one of the other routing tables, or to explicitly configure generated routes in the default route table (`inet.0`), include the **generate** statement:

```
rib routing-table-name {
  generate {
    defaults {
      generate-options;
    }
    route destination-prefix {
      policy policy-name;
      generate-options;
    }
  }
}
```



NOTE: You cannot configure generated routes for the IPv4 multicast routing table (`inet.1`) or the IPv6 multicast routing table (`inet6.1`).

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

The **generate** statement consists of two parts:

- **defaults**—Here you specify global generated route options. These are treated as global defaults and apply to all the generated routes you configure in the **generate** statement. This part of the **generate** statement is optional.
- **route**—Here you configure individual generated routes. In this part of the **generate** statement, you optionally can configure generated route options. These options apply to the individual destination only and override any options you configured in the **defaults** part of the **generate** statement.

The following sections explain how to configure generated routes:

- Specifying the Destination of a Generated Route on page 88
- Specifying Generated Route Options on page 88
- Specifying Policy with Generated Routes on page 92

Specifying the Destination of a Generated Route

When you configure an individual generated route in the **route** part of the **generate** statement, specify the destination of the route (in **route destination-prefix**) in one of the following ways:

- **network/mask-length**, where *network* is the network portion of the IP address and *mask-length* is the destination prefix length.
- **default** if this is the default route to the destination. This is equivalent to specifying an IP address of 0.0.0.0/0.

Specifying Generated Route Options

In the **defaults** and **route** parts of the **generate** statement, you can specify options that define additional information about generated routes that is included with the route when it is installed in the routing table. All generated options are optional. Generated options that you specify in the **defaults** part of the **generate** statement are treated as global defaults and apply to all the generated routes you configure in the **generate** statement. Generated options that you specify in the **route** part of the **generate** statement override any global generated options and apply to that destination only.

To configure generated route options, include one or more of them in the **defaults** or **route** part of the **generate** statement (for routing instances, include the statement). For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement. Each of these options is explained in the sections that follow.

```
[edit]
routing-options
generate {
  (defaults | route) {
    (active | passive);
    as-path <as-path> <origin (egp | igp | incomplete)> <atomic-aggregate>
      <aggregator as-number in-address>;
    community [ community-ids ];
    discard;
    (brief | full);
    (metric | metric2 | metric3 | metric4) metric <type type>;
    (preference | preference2 | color | color2) preference <type type>;
    tag string;
  }
}
```

The following sections explain how to specify generated route options:

- Specifying the Route Metric on page 89
- Specifying the Route Preference on page 89
- Specifying a Next Hop for a Route on page 89
- Specifying Community Information on page 90

- Specifying the AS Path on page 91
- Specifying the OSPF Tag on page 91
- Specifying Which AS Numbers to Include in the Generated Route on page 92
- Specifying Whether Inactive Routes Are Removed from the Routing or Forwarding Table on page 92

Specifying the Route Metric

You can specify up to four metric values, starting with **metric** (for the first metric value) and continuing with **metric2**, **metric3**, and **metric4**, by including one or more of the following statements:

```
(metric | metric2 | metric3 | metric4) metric < type type>;
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

In the **type** option, you specify the type of route.

Specifying the Route Preference

By default, generated routes have a preference value of 130. If the JUNOS routing table contains a dynamic route to a destination that has a better (lower) preference value than this, the dynamic route is chosen as the active route and is installed in the forwarding table.

To modify the default preference value, specify a primary preference value (**preference**). You also can specify a secondary preference value (**preference2**) and colors, which are even finer-grained preference values (**color** and **color2**). To do this, include one or more of the following statements:

```
(preference | preference2 | color | color2) preference <type type>;
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

The preference value can be a number in the range from 0 through 4,294,967,295 ($2^{32} - 1$) with a lower number indicating a more preferred route. For more information about preference values, see “Route Preferences” on page 6.

In the **type** option, you specify the type of route.

Specifying a Next Hop for a Route

By default, when generated routes are installed in the routing table, the next hop is chosen from the primary contributing route.

When you configure an individual route in the **route** part of the **generate** statement, or when you configure the defaults for generated routes, you can specify a discard next hop. This means that if a more specific packet does not match a more specific route, the packet is rejected and a reject route for this destination is installed in the

routing table, but ICMP unreachable messages are not sent. The discard next-hop feature allows you to originate a summary route, which is advertisable through dynamic routing protocols, and allows you to discard received traffic that does not match a more specific route than the summary route.

For example:

```
[edit routing-options generate route 1.0.0.0/8]
user@host# set discard
```

Specifying Community Information

By default, no BGP community information is associated with generated routes. To associate community information with the routes, include the **community** option:

```
community [ community-ids ];
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

community-ids is one or more community identifiers for either communities or extended communities.

The format for community identifiers is:

```
as-number:community-value
```

as-number is the AS number and can be a value in the range from 1 through 65,534.

You also can specify *community-ids* for communities as one of the following well-known community names, which are defined in RFC 1997:

- **no-advertise**—Routes containing this community name are not advertised to other BGP peers.
- **no-export**—Routes containing this community name are not advertised outside a BGP confederation boundary.
- **no-export-subconfed**—Routes containing this community name are not advertised to external BGP peers, including peers in other members' ASs inside a BGP confederation.

You can explicitly exclude BGP community information with a generated route using the **none** option. Include **none** when configuring an individual route in the **route** portion of the **generate** statement to override a **community** option specified in the **defaults** portion of the statement.



NOTE: Extended community attributes are not supported at the [edit routing-options] hierarchy level. You must configure extended communities at the [edit policy-options] hierarchy level. For information about configuring extended communities, see the “Configuring the Extended Communities Attribute” section in the *JUNOS Policy Framework Configuration Guide*.

Specifying the AS Path

By default, no AS path information is associated with generated routes. To associate AS path information with the routes, include the **as-path** statement:

```
as-path <as-path> <origin (egp | igp | incomplete)> <atomic-aggregate> <aggregator
as-number in-address>;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

as-path is the AS path to include with the route. It can include a combination of individual AS path numbers and AS sets. Enclose sets in brackets ([]). The first AS number in the path represents the AS immediately adjacent to the local AS. Each subsequent number represents an AS that is progressively farther from the local AS, heading toward the origin of the path.



NOTE: Beginning with JUNOS Release 9.1, the numeric AS range has been extended to provide BGP support for 4-byte AS numbers, as defined in RFC 4983, *BGP Support for Four-octet AS Number Space*. For the AS number, you can now configure a number from 1 through 4,294,967,295.

You also can specify the AS path using the BGP origin attribute, which indicates the origin of the AS path information:

- **egp**—Path information originated in another AS.
- **igp**—Path information originated within the local AS.
- **incomplete**—Path information was learned by some other means.

To attach the BGP **ATOMIC_AGGREGATE** path attribute to the generated route, specify the **atomic-aggregate** option. This path attribute indicates that the local system selected a less specific route rather than a more specific route.

To attach the BGP **AGGREGATOR** path attribute to the generated route, specify the **aggregator** option. When using this option, you must specify the last AS number that formed the generated route (encoded as two octets), followed by the IP address of the BGP system that formed the generated route.

Specifying the OSPF Tag

By default, no OSPF tag strings are associated with generated routes. You can specify an OSPF tag string by including the **tag** statement:

```
tag string;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Specifying Which AS Numbers to Include in the Generated Route

By default, all AS numbers from all contributing paths are included in the generated route's path. To include only the longest common leading sequences from the contributing AS paths, include the **brief** statement when configuring the route. If doing this results in AS numbers being omitted from the generated route, the BGP **ATOMIC_ATTRIBUTE** path attribute is included with the generated route.

```
brief;
```

To explicitly have all AS numbers from all contributing paths be included in the generated route's path, include the **full** state when configuring routes. Include this option when configuring an individual route in the **route** portion of the **generate** statement to override a **retain** option specified in the **defaults** portion of the statement.

```
full;
```

For a list of hierarchy levels at which you can configure the **brief** or **full** statement, see the statement summary sections for these statements.

Specifying Whether Inactive Routes Are Removed from the Routing or Forwarding Table

Static routes are only removed from the routing table if the next hop becomes unreachable. The next hop will become unreachable if there are no contributing routes. To have a generated route remain continually installed in the routing and forwarding tables, include the **passive** option when configuring the route:

```
generate (defaults | route) {
    passive;
}
```

Routes that have been configured to remain continually installed in the routing and forwarding tables are marked with reject next hops when they are inactive.

To explicitly remove generated routes when they become inactive, include the **active** option when configuring routes. Include this option when configuring an individual route in the **route** portion of the **generate** statement to override a **retain** option specified in the **defaults** portion of the statement.

```
generate (defaults | route) {
    active;
}
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Specifying Policy with Generated Routes

You optionally can associate a routing policy when configuring a generated route's destination prefix in the **routes** part of the **generate** statement. Doing so provides the equivalent of an import routing policy filter for the destination prefix. That is, each potential contributor to a generated route, along with any generate options, is passed

through the policy filter. The policy can accept or reject the route as a contributor to the generated route and, if the contributor is accepted, the policy can modify the default preferences.

The following algorithm is used to compare two generated contributing routes in order to determine which one is the primary or preferred contributor:

1. Compare the protocol's **preference** of the contributing routes. The lower the preference, the better the route. This is similar to the comparison that is done while determining the best route for the routing table.
2. Compare the protocol's **preference2** of the contributing routes. The lower **preference2** value is better. If only one route has **preference2**, then this route is preferred.
3. The preference values are the same. Proceed with a numerical comparison of the prefixes' values.
 - a. The primary contributor is the numerically smallest prefix value.
 - b. If the two prefixes are numerically equal, the primary contributor is the route that has the smallest prefix length value.

At this point, the two routes are the same. The primary contributor does not change. An additional next hop will be available for the existing primary contributor.

A rejected contributor still can contribute to less specific generated route. If you do not specify a policy filter, all candidate routes contribute to a generated route.

To associate a routing policy with an generated route, include the **policy** statement:

```
policy policy-name;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Configuring Martian Addresses

Martian addresses are host or network addresses about which all routing information is ignored. They commonly are sent by improperly configured systems on the network and have destination addresses that are obviously invalid.

In IPv4, the following are the default martian addresses:

- 0.0.0.0/8
- 127.0.0.0/8
- 128.0.0.0/16
- 191.255.0.0/16
- 192.0.0.0/24
- 223.255.255.0/24
- 240.0.0.0/4

In IPv6, the loopback address, the reserved and unassigned prefixes from RFC 2373, and the link-local unicast prefix are the default martian addresses.

The following sections explain how to configure martian routes:

- Adding Martian Addresses on page 94
- Deleting Martian Addresses on page 95

Adding Martian Addresses

To add martian addresses to the list of default martian addresses in the default IPv4 routing table (`inet.0`), include the `martians` statement:

```
martians {
  destination-prefix match-type;
}
```

To add martian addresses to the list of default martian addresses in other routing tables, or to explicitly add martian addresses to the list of default martian addresses in the primary IPv6 routing table (`inet6.0`), include the `martians` statement:

```
rib inet6.0 {
  martians {
    destination-prefix match-type;
  }
}
```

To add martian addresses to the list of default martian addresses in any other routing tables, or to explicitly add martian addresses to the list of default martian addresses in the default routing table (`inet.0`), include the `martians` statement:

```
rib routing-table-name {
  martians {
    destination-prefix match-type;
  }
}
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

In *destination-prefix*, specify the routing destination in one of the following ways:

- **default**—If this is the default route to the destination. This is equivalent to specifying the IP address 0.0.0.0/0.
- **network/mask-length**—*network* is the network portion of the IP address and *mask-length* is the destination prefix length.

In *match-type*, specify the type of match to apply to the destination prefix. For more information about match types, see the *JUNOS Policy Framework Configuration Guide*.

Deleting Martian Addresses

To delete a martian address from within a range of martian addresses, include the **allow** option in the **martians** statement. This option removes an exact prefix that is within a range of addresses that has been specified to be martian addresses.

To delete a martian address from the default routing table (**inet.0**), include the **martians** statement:

```
martians {
    destination-prefix match-type allow;
}
```

To delete a martian address from other routing tables, or to explicitly delete a martian address from the primary IPv6 routing table (**inet6.0**), include the **martians** statement:

```
rib inet6.0 {
    martians {
        destination-prefix match-type allow;
    }
}
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Configuring a Flow Route

A flow route is an aggregation of match conditions for IP packets. Flow routes are propagated through the network using flow-specification network-layer reachability information (NLRI) messages and installed into the flow routing table *instance-name.inetflow.0*. Packets can travel through flow routes only if specific match conditions are met.

Flow routes and firewall filters are similar in that they filter packets based on their components and perform an action on the packets that match. Flow routes provide traffic filtering and rate-limiting capabilities much like firewall filters. In addition, you can propagate flow routes across different autonomous systems.

To configure a flow route, include the **flow** statement:

```
flow {
    route name {
        match {
            match-conditions;
        }
        then {
            actions;
        }
    }
    validation {
        traceoptions {
            file name <size size> <files number> <world-readable | no-world-readable>;
            flag flag <flag-modifier> <disable>;
        }
    }
}
```

```
    }
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Flow routes are propagated by BGP through flow-specification NLRI messages. You must enable BGP to propagate these NLRIs. For more information on configuring BGP, see “BGP Configuration Guidelines” on page 641.

The following sections describe the specified tasks:

- Configuring the Match Condition on page 96
- Configuring the Action on page 98
- Validating Flow Routes on page 98

Configuring the Match Condition

You specify conditions that the packet must match before the action in the **then** statement is taken for a flow route. All conditions in the **from** statement must match for the action to be taken. The order in which you specify match conditions is not important, because a packet must match all the conditions in a term for a match to occur.

To configure a match condition, include the **match** statement at the [edit routing-options flow] hierarchy level:

```
[edit routing-options flow]
match {
    match-conditions;
}
```

Table 8 on page 96 describes the flow route match conditions.

Table 8: Flow Route Match Conditions

Match Condition	Description
<i>destination prefix</i>	IP destination address field.
<i>destination-port number</i>	<p>TCP or User Datagram Protocol (UDP) destination port field. You cannot specify both the port and destination-port match conditions in the same term.</p> <p>In place of the numeric value, you can specify one of the following text synonyms (the port numbers are also listed): afs (1483), bgp (179), biff (512), bootpc (68), bootps (67), cmd (514), cvspserver (2401), dhcp (67), domain (53), eklogin (2105), ekshell (2106), exec (512), finger (79), ftp (21), ftp-data (20), http (80), https (443), ident (113), imap (143), kerberos-sec (88), klogin (543), kpasswd (761), krb-prop (754), krbupdate (760), kshell (544), ldap (389), login (513), mobileip-agent (434), mobiliip-mn (435), msdp (639), netbios-dgm (138), netbios-ns (137), netbios-ssn (139), nfsd (2049), nnntp (119), ntalk (518), ntp (123), pop3 (110), pptp (1723), printer (515), radacct (1813), radius (1812), rip (520), rkinit (2108), smtp (25), snmp (161), snmptrap (162), snpp (444), socks (1080), ssh (22), sunrpc (111), syslog (514), tacacs-ds (65), talk (517), telnet (23), tftp (69), timed (525), who (513), xmcp (177), zephyr-clt (2103), or zephyr-hm (2104).</p>

Table 8: Flow Route Match Conditions (*continued*)

Match Condition	Description
<i>dscp number</i>	<p>Differentiated Services code point (DSCP). The DiffServ protocol uses the type-of-service (ToS) byte in the IP header. The most significant six bits of this byte form the DSCP.</p> <p>You can specify DSCP in hexadecimal or decimal form.</p>
<i>fragment type</i>	<p>Fragment type field. The keywords are grouped by the fragment type with which they are associated:</p> <ul style="list-style-type: none"> ■ dont-fragment ■ first-fragment ■ is-fragment ■ last-fragment ■ not-a-fragment
<i>icmp-code number</i>	<p>ICMP code field. This value or keyword provides more specific information than <i>icmp-type</i>. Because the value's meaning depends upon the associated <i>icmp-type</i> value, you must specify <i>icmp-type</i> along with <i>icmp-code</i>.</p> <p>In place of the numeric value, you can specify one of the following text synonyms (the field values are also listed). The keywords are grouped by the ICMP type with which they are associated:</p> <ul style="list-style-type: none"> ■ parameter-problem: ip-header-bad (0), required-option-missing (1) ■ redirect: redirect-for-host (1), redirect-for-network (0), redirect-for-tos-and-host (3), redirect-for-tos-and-net (2) ■ time-exceeded: ttl-eq-zero-during-reassembly (1), ttl-eq-zero-during-transit (0) ■ unreachable: communication-prohibited-by-filtering (13), destination-host-prohibited (10), destination-host-unknown (7), destination-network-prohibited (9), destination-network-unknown (6), fragmentation-needed (4), host-precedence-violation (14), host-unreachable (1), host-unreachable-for-TOS (12), network-unreachable (0), network-unreachable-for-TOS (11), port-unreachable (3), precedence-cutoff-in-effect (15), protocol-unreachable (2), source-host-isolated (8), source-route-failed (5)
<i>icmp-type number</i>	<p>ICMP packet type field. Normally, you specify this match in conjunction with the <i>protocol</i> match statement to determine which protocol is being used on the port.</p> <p>In place of the numeric value, you can specify one of the following text synonyms (the field values are also listed): echo-reply (0), echo-request (8), info-reply (16), info-request (15), mask-request (17), mask-reply (18), parameter-problem (12), redirect (5), router-advertisement (9), router-solicit (10), source-quench (4), time-exceeded (11), timestamp (13), timestamp-reply (14), or unreachable (3).</p>
<i>packet-length number</i>	Total IP packet length.
<i>port number</i>	<p>TCP or UDP source or destination port field. You cannot specify both the <i>port</i> match and either the <i>destination-port</i> or <i>source-port</i> match condition in the same term.</p> <p>In place of the numeric value, you can specify one of the text synonyms listed under <i>destination-port</i>.</p>
<i>protocol number</i>	<p>IP protocol field. In place of the numeric value, you can specify one of the following text synonyms (the field values are also listed): ah (8), esp (50), gre (47), icmp (1), igmp (2), ipip (4), ipv6 (41), ospf (89), pim (103), rsvp (46), tcp (6), or udp (17).</p>
<i>source prefix</i>	IP source address field.

Table 8: Flow Route Match Conditions (*continued*)

Match Condition	Description
source-port <i>number</i>	TCP or UDP source port field. You cannot specify the port and source-port match conditions in the same term. In place of the numeric field, you can specify one of the text synonyms listed under destination-port .
tcp-flag <i>type</i>	TCP header format.

Configuring the Action

You can specify the action to take if the packet matches the conditions you have configured in the flow route. To configure an action, include the **then** statement at the [edit routing-options flow] hierarchy level:

```
[edit routing-options flow]
then {
    action;
}
```

Table 9 on page 98 describes the flow route actions.

Table 9: Flow Route Action Modifiers

Action or Action Modifier	Description
Actions	
accept	Accept a packet. This is the default.
discard	Discard a packet silently, without sending an Internet Control Message Protocol (ICMP) message.
community	Replace any communities in the route with the specified communities.
next-term	Continue to the next match condition for evaluation.
routing-instance <i>extended-community</i>	Specify a routing instance to which packets are forwarded.
rate-limit <i>rate</i>	Limit the bandwidth on the flow route.
sample	Sample the traffic on the flow route.

Validating Flow Routes

Flow routes are installed into the flow routing table only if they have been validated using the validation procedure. The Routing Engine does the validation before installing routes into the flow routing table.

Flow routes received using the BGP NLRI messages are validated before they are installed into the flow primary instance routing table `instance.inetflow.0`. The validation procedure is described in the draft-ietf-idr-flow-spec-00.txt, *Dissemination of Flow Specification Rules*. You can bypass the validation process and use your own specific import policy.

To trace validation operations, include the `validation` statement at the `[edit routing-options flow]` hierarchy level:

```
[edit routing-options flow]
validation {
  traceoptions {
    file name <size size> <files number> <world-readable | no-world-readable>;
    flag flag <flag-modifier> <disable>;
  }
}
```

Applying a Filter to a Forwarding Table

To apply an input filter to a forwarding table, include the `input` statement:

```
rib routing-table-name {
  filter {
    input filter-name;
  }
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.



NOTE: Forwarding table filtering is not supported on the interfaces you configure as tunnel sources. Input filters affect only the transit packets exiting the tunnel.

Forwarding table filtering is not supported with the flow routes configuration.

For more information about forwarding table filters, see the *JUNOS Policy Framework Configuration Guide*.

Chapter 5

Configuring Other Protocol-Independent Routing Properties

This chapter discusses how to perform the following tasks for configuring other protocol-independent routing properties:

- Configuring the AS Number on page 102
- Configuring the Router Identifier on page 103
- Configuring AS Confederation Members on page 103
- Configuring Route Recording for Flow Aggregation on page 104
- Creating Routing Table Groups on page 104
- Configuring How Interface Routes Are Imported into Routing Tables on page 106
- Configuring Multicast Scoping on page 107
- Enabling Multicast on an Interface on page 108
- Configuring Additional Source-Specific Multicast Groups on page 108
- Configuring Multicast Forwarding Cache Limits on page 109
- Configuring Per-Packet Load Balancing on page 109
- Configuring Unicast Reverse-Path-Forwarding Check on page 112
- Configuring Graceful Restart on page 113
- Configuring a Route Distinguisher on page 114
- Configuring a Dynamic Tunnel on page 114
- Configuring Logging for the Routing Protocol Process on page 116
- Configuring Route Resolution on page 116
- Enabling an Indirect Next Hop on page 117
- Enabling Nonstop Routing on page 118
- Tracing Global Routing Protocol Operations on page 119
- Enabling Distributed Periodic Packet Management on page 121
- Enabling Source Routing on page 122
- Configuring a Timer to Delay Multiple Exit Discriminator IGP Updates on page 122

Configuring the AS Number

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

ASs are identified by a number that is assigned by the Network Information Center (NIC) in the United States (<http://www.isi.edu>). Beginning with JUNOS Release 9.1, you can configure a number from 1 through 4,294,967,295 in plain-number format. The range has been extended to provide BGP support for 4-byte AS numbers, as defined in RFC 4893, *BGP Support for Four-octet AS Number Space*. The JUNOS software continues to support 2-byte AS numbers.

Beginning with JUNOS Release 9.2, you can also configure a 4-byte AS number using the AS-dot notation format of two integer values joined by a period: *< 16-bit high-order value in decimal > . < 16-bit low-order value in decimal > .* For example, the 4-byte AS number of 65,546 in plain-number format is represented as 1.10 in the AS-dot notation format. In AS-dot notation format, you can specify a value for AS number from 0.0 through 65535.65535.

If you are using BGP on the router, you must configure an AS number.

To configure the router's AS number, include the **autonomous-system** statement:

```
autonomous-system autonomous-system <loops number>;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

To specify the maximum number of times that this AS number can appear in an AS path, include the **loops** option. You can specify a value in the range from 1 through 10. The default value is 1.

The AS path attribute is modified when a route is advertised to an EBGp peer. Each time a route is advertised to an EBGp peer, the local router prepends its AS number to the existing path attribute, and a value of 1 is added to the AS number. The default loop value of 1 means that an AS number can appear in an AS path only one time. That is, when the local router advertises an AS path to an EBGp peer, that peer cannot advertise that AS path to another EBGp peer. To ensure that the AS path can be advertised by the peer that receives the route to another EBGp peer, specify a **loops** value of 2.



NOTE: When you specify the same AS number in more than one routing instance on the local router, you must configure the same number of loops for the AS number in each instance. For example, if you configure a value of 3 for the **loops** statement in a VPN routing and forwarding (VRF) routing instance that uses the same AS number as that of the master instance, you must also configure a value of 3 loops for the AS number in the master instance.

Use the **independent-domain** option if the **loops** statement must be enabled only on a subset of routing instances. For more information about configuring an independent AS domain, see “Configuring an Independent AS Domain” on page 251.

Configuring the Router Identifier

The router identifier is used by BGP and Open Shortest Path First (OSPF) to identify the router from which a packet originated. The router identifier usually is the IP address of the local router. If you do not configure a router identifier, the IP address of the first interface to come online is used. This is usually the loopback interface. Otherwise, the first hardware interface with an IP address is used.

To configure the router identifier, include the **router-id** statement:

```
router-id address;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.



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

Configuring AS Confederation Members

If you administer multiple ASs that contain a very large number of BGP systems, you can group them into one or more *confederations*. Each confederation is identified by its own AS number, which is called a *confederation AS number*. To external ASs, a confederation appears to be a single AS. Thus, the internal topology of the ASs making up the confederation is hidden.

The BGP path attributes **NEXT_HOP**, **LOCAL_PREF**, and **MULTI_EXIT_DISC**, which normally are restricted to a single AS, are allowed to be propagated throughout the ASs that are members of the same confederation.

Because each confederation is treated as if it were a single AS, you can apply the same routing policy to all the ASs that make up the confederation.

Grouping ASs into confederations reduces the number of BGP connections required to interconnect ASs.

If you are using BGP, you can enable the local router to participate as a member of an AS confederation. To do this, include the **confederation** statement:

```
confederation confederation-autonomous-system members [ autonomous-systems ];
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Specify the AS confederation identifier, along with the AS numbers that are members of the confederation.

Note that peer adjacencies will not form if two BGP neighbors disagree about whether an adjacency falls within a particular confederation.

Configuring Route Recording for Flow Aggregation

Before you can perform flow aggregation, the routing protocol process must export the AS path and routing information to the sampling process. To do this, include the **route-record** statement:

```
route-record;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

For more information about flow aggregation and sampling, see the *JUNOS Network Interfaces Configuration Guide*.

Creating Routing Table Groups

You can group together one or more routing tables to form a *routing table group*. Within a group, a routing protocol can import routes into all the routing tables in the group and can export routes from a single routing table.

To create a routing table group, include the **rib-groups** statement:

```
rib-groups group-name {
  import-policy [ policy-names ];
  import-rib [ routing-table-names ];
  export-rib routing-table-name;
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

The routing table group can have any name you choose (specified in *group-name*). If the group name you specify is not created explicitly, as described in “Configuring Other Protocol-Independent Routing Properties” on page 101, you can create it by naming it in the **rib-groups** statement.

Each routing table group must contain one or more routing tables that the JUNOS software uses when importing routes (specified in the **import-rib** statement). The first

routing table you specify is the *primary routing table*, and any additional routing tables are the *secondary routing tables*.

The primary routing table determines the address family of the routing table group. To configure an Internet Protocol version 4 (IPv4) routing table group, specify `inet.0` as the primary routing table. To configure an Internet Protocol version 6 (IPv6) routing table group, specify `inet6.0` as the primary routing table. If you configure an IPv6 routing table group, the primary and all secondary routing tables must be IPv6 routing tables (`inet6.x`). You cannot have `inet` and `inet6` routing tables in the same `import-rib` statement.

Each routing table group optionally can contain one routing table group that the JUNOS software uses when exporting routes to the routing protocols (specified in the `export-rib` statement).

If you have configured a routing table, configure the OSPF primary instance at the `[edit protocols ospf]` hierarchy level with the statements needed for your network so that routes are installed in `inet.0` and in the forwarding table. Make sure to include the routing table group. For more information, see “Configuring Multiple Instances of OSPF” on page 226.

After specifying the routing table from which to import routes, you can apply one or more policies to control which routes will be installed in the routing table group. To apply a policy to routes being imported into the routing table group, include the `import-policy` statement:

```
rib-groups group-name {
  import-policy [ policy-names ];
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Examples: Creating Routing Table Groups

Create an IPv4 routing table group so that interface routes are installed into two routing tables, `inet.0` and `inet.2`:

```
[edit]
routing-options {
  interface-routes {
    rib-group if-rg;
  }
  rib-groups if-rg {
    import-rib [ inet.0 inet.2 ];
  }
}
```

Create an IPv6 routing table group so that interface routes are installed into two routing tables, `inet6.0` and `inet6.2`:

```
[edit]
routing-options {
  interface-routes {
```

```

        rib-group inet6 if-rg;
    }
    rib-groups if-rg {
        import-rib [ inet6.0 inet6.2 ];
    }
}

```

Configuring How Interface Routes Are Imported into Routing Tables

By default, IPv4 interface routes (also called direct routes) are imported into routing table `inet.0`, and IPv6 interface routes are imported into routing table `inet6.0`. If you are configuring alternate routing tables for use by some routing protocols, it might be necessary to import the interface routes into the alternate routing tables. To define the routing tables into which interface routes are imported, you create a routing table group and associate it with the router's interfaces.

To associate an IPv4 routing table group with the router's interfaces and specify which routing table groups interface routes are imported into, include the `interface-routes` statement:

```

interface-routes {
    rib-group group-name;
}

```

To associate an IPv6 routing table group with an interface, include the `interface-routes` statement at the `[edit routing-options]` hierarchy level:

```

interface-routes {
    rib-group inet6 group-name;
}

```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

To create the routing table groups, include the `passive` statement at the `[edit routing-options]` hierarchy level. For configuration information, see “Creating Routing Table Groups” on page 104.

If you have configured a routing table, configure the OSPF primary instance at the `[edit protocols ospf]` hierarchy level with the statements needed for your network so that routes are installed in `inet.0` and in the forwarding table. Make sure to include the routing table group. For more information, see “Configuring Multiple Instances of OSPF” on page 226.

To export local routes, include the `export` statement:

```

export {
    lan;
    point-to-point;
}

```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

To export LAN routes, include the `lan` option. To export point-to-point routes, include the `point-to-point` option.

Only local routes on point-to-point interfaces configured with a destination address are exportable.

Configuring Multicast Scoping

To configure multicast address scoping, include the following statements:

```
multicast {
  scope scope-name {
    interface [ interface-names ];
    prefix destination-prefix;
  }
  scoping-policy policy-name;
}
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Specify a name for the scope, its address range, and the router interfaces on which you are configuring scoping.

You can apply a multicast scoping policy to the routing table. To apply a scoping policy, include the `scoping-policy` statement at the `[edit routing-options multicast]` hierarchy level. For more information on configuring a scoping policy, see the *JUNOS Policy Framework Configuration Guide*.

Example: Configuring Multicast Scoping

Configure multicast scoping by creating four scopes: local, organization, engineering, and marketing.

Configure the local scope on a Fast Ethernet interface. Configure the organization scope on a Fast Ethernet and a SONET/SDH interface. Configure the engineering and marketing scopes on two SONET/SDH interfaces.

```
[edit]
routing-options {
  multicast {
    scope local {
      prefix 239.255.0.0/16;
      fe-0/1/0.0;
    }
    scope organization {
      prefix 239.192.0.0/14;
      interface [ fe-0/1/0.0 so-0/0/0.0 ];
    }
    scope engineering {
      prefix 239.255.255.0/24;
      interface [ so-0/0/1.0 so-0/0/2.0 ];
    }
  }
}
```

```

scope marketing {
    prefix 239.255.254.0/24;
    interface [ so-0/0/1.0 so-0/0/2.0 ];
}
}

```

Enabling Multicast on an Interface

By default, multicast packets are forwarded by enabling Protocol Independent Multicast (PIM) on an interface. PIM adds multicast routes into the routing table.

You can also configure multicast packets to be forwarded over a static route, such as a static route associated with an LSP next hop. Multicast packets are accepted on an interface and forwarded over a static route in the forwarding table. This is useful when you want to enable multicast traffic on a specific interface without configuring PIM on the interface.

To enable multicast traffic on an interface, include the **interface** statement:

```
interface interface-name;
```

To disable multicast traffic on an interface, include the **disable** statement:

```
interface interface-name {
    disable;
}
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary section for these statements.



NOTE: You cannot enable multicast traffic on an interface and configure PIM on the same interface simultaneously.



NOTE: Static routes must be configured before you can enable multicast on an interface. Configuring the **interface** statement alone does not install any routes into the routing table. This feature relies on the static route configuration.

Configuring Additional Source-Specific Multicast Groups

IGMPv3 supports Source Specific Multicast (SSM) groups. By utilizing inclusion lists, only sources that are specified send to the SSM group. By default, the SSM group multicast address is limited to the IP address range 232.0.0.0 to 232.255.255.255. You can configure additional SSM groups. Shared tree delivery is prohibited on SSM groups.

To configure additional SSM groups, include the **ssm-groups** statement:

```
ssm-groups {
```

```

    address;
}

```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Configuring Multicast Forwarding Cache Limits

To configure multicast forwarding cache limits, include the following routing option statements:

```

multicast {
  forwarding-cache {
    threshold suppress value <reuse value>;
  }
}

```

You can include these statements at the following hierarchy levels:

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

For an overview of logical systems and a detailed example of logical system configuration, see the logical systems chapter of the *JUNOS Feature Guide*.

By default, there are no limits on the number of multicast forwarding cache entries.

Specify a value for the threshold at which to suppress new multicast forwarding cache entries and an optional reuse value for the threshold at which the router will begin to create new multicast forwarding cache entries. The range for both is from 1 through 200,000. If configured, the reuse value should be less than the suppression threshold value. The suppression value is mandatory. If you do not specify the optional reuse value, then the number of multicast forwarding cache entries is limited to the suppression value. A new entry is created as soon as the number of multicast forwarding cache entries falls below the suppression value.

For information about supported standards for multicast scoping, see the *JUNOS Multicast Protocols Configuration Guide*.

Configuring Per-Packet Load Balancing

For the active route, when there are multiple equal-cost paths to the same destination, by default, the JUNOS software chooses in a random fashion one of the next-hop addresses to install into the forwarding table. Whenever the set of next hops for a destination changes in any way, the next-hop address is chosen again, also in a random fashion.

You can configure the JUNOS software so that, for the active route, all next-hop addresses for a destination are installed in the forwarding table. This is called per-packet load balancing. You can use load balancing to spread traffic across multiple paths between routers. The behavior of the per-packet load-balancing function varies according to the version of the Internet Protocol ASIC in the router.

On routers with an Internet Processor I ASIC, when per-packet load balancing is configured, traffic between routers with multiple paths is spread in a random fashion across the available interfaces. The forwarding table balances the traffic headed to a destination, transmitting packets in round-robin fashion among the multiple next hops (up to a maximum of eight equal-cost load-balanced paths). The traffic is load-balanced on a per-packet basis.



NOTE: Per-packet load distribution uses a hashing algorithm that distributes packets over equal-cost links. The algorithm is designed to distribute packets to prevent any single link from being saturated. However, per-packet load balancing offers no guarantee of equal distribution of traffic over equal-cost links, nor does it guarantee that increasing the number of Internet flows will create a better hash distribution.

On routers with the Internet Processor II ASIC and T-series Internet Processor II ASIC, when per-packet load balancing is configured, traffic between routers with multiple paths is divided into individual traffic flows (up to a maximum of 16 equal-cost load-balanced paths). Packets for each individual flow are kept on a single interface. To recognize individual flows in the transit traffic, the router examines each of the following:

- Source IP address
- Destination IP address
- Protocol
- Source port number
- Destination port number
- Source interface index
- Type of service (ToS)

The router recognizes packets in which all of these parameters are identical, and it ensures that these packets are sent out through the same interface. This prevents problems that might otherwise occur with packets arriving at their destination out of their original sequence.

The following steps show how to configure per-packet load balancing:

1. Define a load-balancing routing policy by including one or more **policy-statement** statements at the [edit **policy-options**] hierarchy level, defining an action of **load-balance per-packet**:

```

policy-statement policy-name {
  from {
    match-conditions;
    route-filter destination-prefix match-type <actions>;
    prefix-list name;
  }
  then {
    load-balance per-packet;
  }
}

```

2. Apply the policy to routes exported from the routing table to the forwarding table. To do this, include the **export** statement:

```
export policy-name;
```



NOTE: You cannot apply the export policy to VRF routing instances.

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.



NOTE: Specify all next-hops of that route, if more than one exists, when allocating a label corresponding to a route that is being advertised.



NOTE: Configure the forwarding-options hash key for MPLS to include the IP payload.

Examples: Configuring Per-Packet Load Balancing

Perform per-packet load balancing for all routes:

```
[edit]
policy-options {
  policy-statement load-balancing-policy {
    then {
      load-balance per-packet;
    }
  }
}
routing-options {
  forwarding-table {
    export load-balancing-policy;
  }
}
```

Perform per-packet load balancing for only a limited set of routes:

```
[edit]
policy-options {
  policy-statement load-balancing-policy {
    from {
      route-filter 192.168.10/24 orlonger;
      route-filter 9.114/16 orlonger;
    }
    then {
      load-balance per-packet;
    }
  }
}
routing-options {
```

```

    forwarding-table {
        export load-balancing-policy;
    }
}

```

Configuring Unicast Reverse-Path-Forwarding Check

IP spoofing can occur during a denial-of-service (DoS) attack. IP spoofing allows an intruder to pass IP packets to a destination as genuine traffic, when in fact the packets are not actually meant for the destination. This type of spoofing is harmful because it consumes the destination's resources.

Unicast reverse-path-forwarding (RPF) check is a tool to reduce forwarding of IP packets that may be spoofing an address. A unicast RPF check performs a route table lookup on an IP packet's source address, and checks the incoming interface. The router determines whether the packet is arriving from a path that the sender would use to reach the destination. If the packet is from a valid path, the router forwards the packet to the destination address. If it is not from a valid path, the router discards the packet. Unicast RPF is supported for the IPv4 and IPv6 protocol families, as well as for the virtual private network (VPN) address family.

To control the operation of unicast RPF check, include the **unicast-reverse-path** statement:

```
unicast-reverse-path (active-paths | feasible-paths);
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

To consider only active paths during the unicast RPF check, include the **active-paths** option. To consider all feasible paths during the unicast RPF check, include the **feasible-paths** option.



NOTE: Reverse-path forwarding is not supported on the interfaces you configure as tunnel sources. This affects only the transit packets exiting the tunnel.

You must enable unicast RPF check on an interface. To do so, include the **rpf-check** statement:

```
rpf-check <fail-filter filter-name>;
```

You can include this statement at the following hierarchy levels:

- [edit interfaces *interface-name* unit *logical-unit-number* family (inet | inet6)]
- [edit logical-systems *logical-system-name* interfaces *interface-name* unit *logical-unit-number* family (inet | inet6)]

For more information about configuring unicast RPF on an interface, see the *JUNOS Network Interfaces Configuration Guide*.

Example: Configuring Unicast RPF

Configure unicast RPF strict mode, and apply a fail filter that allows the interface to accept BOOTP packets and DHCP packets. The filter accepts all packets with a source address of 0.0.0.0 and a destination address of 255.255.255.255.

```
[edit firewall]
filter rpf-special-case-dhcp-bootp {
  term allow-dhcp-bootp {
    from {
      source-address {
        0.0.0.0/32;
      }
      address {
        255.255.255.255/32;
      }
    }
    then {
      count rpf-dhcp-bootp-traffic;
      accept;
    }
  }
  term default {
    then {
      log;
      reject;
    }
  }
}
[edit]
interfaces {
  so-0/0/0 {
    unit 0 {
      family inet {
        rpf-check fail-filter rpf-special-case-dhcp-bootp;
      }
    }
  }
}
```

Configuring Graceful Restart

Graceful restart allows a router undergoing a restart to inform its adjacent neighbors and peers of its condition. The restarting router requests a grace period from the neighbor or peer, which can then cooperate with the restarting router. With a graceful restart, the restarting router can still forward traffic during the restart period, and convergence in the network is not disrupted. The restart is not visible to the rest of the network, and the restarting router is not removed from the network topology.

The graceful restart request occurs only if the following conditions are met:

- The network topology is stable.
- The neighbor or peer cooperates.

- The restarting router is not already cooperating with another restart already in progress.
- The grace period does not expire.

Graceful restart is disabled by default. You must configure graceful restart at the `[edit routing-options]` hierarchy level to enable the feature for Layer 2 and Layer 3 VPNs.

To enable graceful restart, include the `graceful-restart` statement:

```
graceful-restart {
  disable;
  restart-duration seconds;
}
```

To disable graceful restart, include the `disable` statement. To configure a time period for complete restart, include the `restart-duration` statement. You can specify a number between 120 and 900.

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

For a detailed example of a graceful restart configuration, see the *JUNOS High Availability Configuration Guide*.

Configuring a Route Distinguisher

If the route distinguisher ID is configured, the routing process automatically generates a type 1 route distinguisher for VPN routing and forwarding (VRF) and Layer 2 VPN instances. If a route distinguisher is explicitly configured under the routing instances stanza, then that configured route distinguisher will be used.

To configure a route distinguisher identifier globally, include the `route-distinguisher-id` statement:

```
route-distinguisher-id address;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

For more information about VPNs, see the *JUNOS VPNs Configuration Guide*.

Configuring a Dynamic Tunnel

A VPN that travels through a non-MPLS network requires a generic routing encapsulation (GRE) tunnel. This tunnel can be either a static tunnel or a dynamic tunnel. A static tunnel is configured manually between two provider edge (PE) routers. A dynamic tunnel is configured using BGP route resolution.

When a router receives a VPN route that resolves over a BGP next hop that does not have an MPLS path, a GRE tunnel can be created dynamically, allowing the VPN

traffic to be forwarded to that route. Formerly, GRE tunnels had to be established manually. Only GRE IPv4 tunnels are supported.

To configure a dynamic tunnel between two PE routers, include the **dynamic-tunnels** statement:

```
dynamic-tunnels tunnel-name {
  destination-networks prefix;
  source-address address;
  tunnel-type type;
}
```

You can include this statement at the following hierarchy levels:

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

Specify the IPv4 prefix range (for example, **10/8** or **11.1/16**) for the destination network by including the **destination-networks** statement. Only tunnels within the specified IPv4 prefix range can be created.

```
destination-networks prefix;
```

You can include this statement at the following hierarchy levels:

- [edit routing-options dynamic-tunnels *tunnel-name*]
- [edit logical-systems *logical-system-name* routing-options dynamic-tunnels *tunnel-name*]

Specify the source address for the GRE tunnels by including the **source-address** statement. The source address specifies the address used as the source for the local tunnel endpoint. It can be any local address on the router (typically the router ID or the loopback address).

```
source-address address;
```

You can include this statement at the following hierarchy levels:

- [edit routing-options dynamic-tunnels *tunnel-name*]
- [edit logical-systems *logical-system-name* routing-options dynamic-tunnels *tunnel-name*]

Specify the type of tunnel to be dynamically created by including the **tunnel-type** statement. The only currently valid value is **gre** (for GRE tunnels).

```
tunnel-type type;
```

You can include this statement at the following hierarchy levels:

- [edit routing-options dynamic-tunnels *tunnel-name*]
- [edit logical-systems *logical-system-name* routing-options dynamic-tunnels *tunnel-name*]

Configuring Logging for the Routing Protocol Process

To control how much information the routing protocol process should log, include the **options** statement.

Include the following form of the statement to log messages for a particular severity level and all higher levels:

```
routing-options {
  options syslog upto level;
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.



NOTE: System logging frequently deals with processes logged at the **info** or **notice** severity level. Make sure that your regular system logging configurations include the **info** or **notice** levels.

Examples: Configuring Logging for the Routing Protocol Process

Configure the router to log messages of all severities:

```
[edit]
user@host# set routing-options options syslog upto emergency
[edit]
user@host# show
routing-options {
  options syslog upto emergency;
}
```

Configure the router to log only alert-level and critical-level messages:

```
[edit]
user@host# set routing-options options syslog alert critical
[edit]
user@host# show
routing-options {
  options syslog alert critical;
}
```

Configuring Route Resolution

You can configure a routing table to accept routes from specific routing tables. You can also configure a routing table to use specific import policies to produce a route resolution table to resolve routes.

To configure route resolution, include the **resolution** statement:

```
resolution {
  rib routing-table-name {
```

```

import [ policy-names ];
resolution-ribs [ routing-table-names ];
}

```

To specify the name of the routing table to modify, include the `rib routing-table-name` statement. To specify one or more import policies to use for route resolution, include the `import [policy-names]` statement. To specify one or more routing tables to use for route resolution, include the `resolution-ribs [routing-table-names]` statement.

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

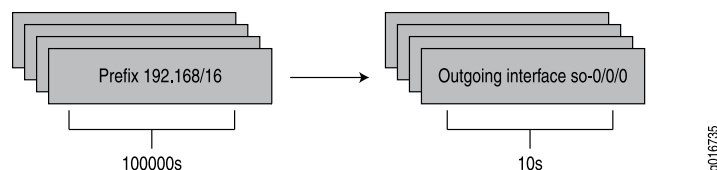
Enabling an Indirect Next Hop

JUNOS software supports the concept of an indirect next hop for all routing protocols that support indirectly connected next hops, also known as third-party next hops.

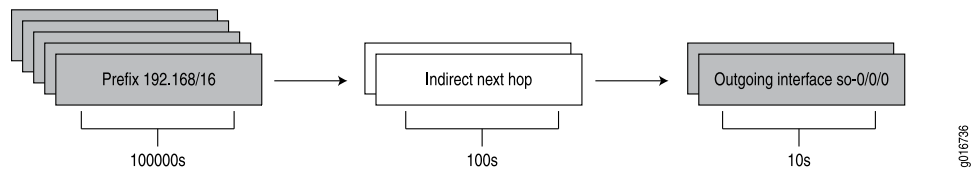
Because routing protocols such as internal BGP can send routing information about indirectly connected routes, the JUNOS software relies on routes from intra-AS routing protocols (OSPF, IS-IS, RIP, and static) to resolve the best directly connected next hop. The Routing Engine performs the task of route resolution to determine the best directly connected next hop and install the route to the Packet Forwarding Engine.

By default, the JUNOS software does not maintain the route for indirect next hop to forwarding next-hop binding on the Packet Forwarding Engine forwarding table. As a result, when a rerouting event occurs, potentially thousands of route to forwarding next-hop bindings must be updated, which increases the route convergence time. Figure 2 on page 117 illustrates the route to forwarding next-hop bindings with indirect next hop disabled.

Figure 2: Route to Forwarding Next-Hop Bindings



You can enable the JUNOS software to maintain the indirect next hop to forwarding next-hop binding on the Packet Forwarding Engine forwarding table. As a result, fewer route to forwarding next-hop bindings need to be updated, which improves the route convergence time. Figure 3 on page 118 illustrates the route to forwarding next-hop bindings with indirect next hop enabled.

Figure 3: Route to Forwarding Indirect Next-Hop Bindings

To enable indirectly connected next hops, include the `indirect-next-hop` statement:

```
indirect-next-hop;
```



NOTE: When virtual private LAN service (VPLS) is configured in the router, the `indirect-next-hop` statement is not supported at the `[edit routing-options forwarding-table]` hierarchy level.

To disable indirectly connected next hops, include the `no-indirect-next-hop` statement:

```
no-indirect-next-hop;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Enabling Nonstop Routing

Nonstop routing (NSR) allows a routing platform with redundant Routing Engines to switch over from a primary Routing Engine to a backup Routing Engine without alerting peer nodes that a change has occurred. Nonstop routing uses the same infrastructure as graceful Routing Engine switchover (GRES) to preserve interface and kernel information. However, nonstop routing also saves routing protocol information by running the routing protocol process (rpd) on the backup Routing Engine. By saving this additional information, nonstop routing is self-contained and does not rely on helper routers to assist the routing platform in restoring routing protocol information. As a result of this enhanced functionality, nonstop routing is a natural replacement for graceful restart protocol extensions.

If the kernel on the master Routing Engine stops operating, the master Routing Engine experiences a hardware failure, or the administrator initiates a manual switchover, mastership switches to the backup Routing Engine. To use nonstop routing, you must first enable GRES on your routing platform. For more information about how to configure GRES, see the *JUNOS High Availability Configuration Guide*.

To enable nonstop routing, include the `nonstop-routing` statement at the `[edit routing-options]` hierarchy level.

```
[edit routing-options]
nonstop-routing;
```



NOTE: You cannot configure nonstop routing and graceful restart protocol extensions simultaneously. To ensure proper operation, include either the **nonstop-routing** statement or the **graceful-restart** statement at the hierarchy level, but not both statements at the same time.

For more detailed information about nonstop routing, see the *JUNOS High Availability Configuration Guide*.

Tracing Global Routing Protocol Operations

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, configure tracing when configuring that protocol.

For a general discussion about tracing and the precedence of multiple tracing operations, see the *JUNOS System Basics Configuration Guide*.

To configure global routing protocol tracing flags, include the **traceoptions** statement:

```
traceoptions {
  file name <size size> <files number> <world-readable | no-world-readable>;
  flag flag <flag-modifier> <disable>;
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

You can specify the following global routing protocol tracing flags:

- **all**—Trace all tracing operations.
- **condition-manager**—Trace condition manager events.
- **config-internal**—Trace configuration internals.
- **general**—Trace all normal operations and routing table changes (a combination of the normal and route trace operations).
- **normal**—Trace all normal operations.
- **nsr-synchronization**—Trace nonstop-routing synchronization events.
- **parse**—Trace configuration parsing.
- **policy**—Trace policy operations and actions.
- **regex-parse**—Trace regular-expression parsing.
- **route**—Trace routing table changes.
- **state**—Trace state transitions.
- **task**—Trace interface transactions and processing.
- **timer**—Trace timer usage.

You can specify the following tracing flag modifiers:

- **detail**—Provide detailed trace information.
- **receive**—Trace only packets being received.
- **send**—Trace only packets being transmitted.



NOTE: Use the trace flags **detail** and **all** with caution. These flags may cause the CPU to become very busy.

The flags in a **traceoptions flag** statement are identifiers. When you use the **set** command to configure a flag, any flags that might already be set are not modified. In the following example, setting the **csn** tracing flag has no effect on the already configured **detail** flag. Use the **delete** command to delete a particular flag.

```
[edit protocols isis]
user@host# show
traceoptions {
    flag csn detail;
}
[edit protocols isis]
user@host# set traceoptions flag csn
[edit protocols isis]
user@host# show
traceoptions {
    flag csn detail;
}
user@host# delete traceoptions flag detail
[edit protocols isis]
user@host# show
traceoptions {
    flag csn;
}
```

Examples: Tracing Global Routing Protocol Operations

Log all globally traceable operations, saving the output in up to 10 files that are up to 10 MB in size:

```
[edit]
routing-options {
    traceoptions {
        file routing size 10m files 10;
        flag all;
    }
}
```

Log all unusual or abnormal traceable operations:

```
[edit]
routing-options {
    traceoptions {
```



```

        file routing size 10m files 10;
        flag all;
        flag normal disable;
    }
}

```

Log changes that occur in the JUNOS software routing table:

```

[edit]
routing-options {
  traceoptions {
    file routing size 10m files 10;
    flag route;
  }
}

```

Enabling Distributed Periodic Packet Management

Periodic packet management (PPM) runs on the Routing Engine by default. You can now configure the router to run PPM on the Packet Forwarding Engine as well as on the Routing Engine. PPM is responsible for periodic transmission of packets on behalf of its various client processes, such as Bidirectional Forwarding Detection (BFD). PPM also receives packets on behalf of client processes. By default, PPM handles time-sensitive periodic processing and performs such processes as the gathering of statistics and the sending of process-specific packets. When you enable distributed PPM to run on the Packet Forwarding Engine, it continues to run on the Routing Engine as well. Distributing PPM to the Packet Forwarding Engine allows you to run such processes as BFD on the Packet Forwarding Engine. To enable distributed PPM, include the `ppm` statement:

```

ppm {
  delegate-processing;
}

```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.



NOTE: Distributed PPM is supported only on the M120, M320, MX-series, T-series, and TX Matrix routing platforms.

The following types of sessions are not supported by distributed PPM:

- Protocols other than BFD
- Multihop BFD session
- BFD session over a label-switched path
- Any protocol session that does not explicitly specify that the adjacency and periodic sends must be distributed
- Sessions over aggregated Ethernet interfaces and integrated routing and bridging interfaces

In addition, on the M120 routing platform, when Forwarding Engine Board (FEB) redundancy is configured and a FEB fails over, PPM sessions do not automatically switch over to the newly active FEB. For more information about FEB redundancy, see the *JUNOS System Basics Configuration Guide*.

Enabling Source Routing

Starting in JUNOS 8.2 for IPv6 and JUNOS 8.5 for IPv4, source routing is disabled by default on J-series, M-series, MX-series, and T-series routers. To enable source routing, include the **source-routing** statement:



NOTE: We recommend that you not use source routing.

```
source-routing {  
  (ip | ipv6);  
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Configuring a Timer to Delay Multiple Exit Discriminator IGP Updates

You can configure a timer to delay update of the multiple-exit discriminator (MED) path attribute calculated for BGP groups or peers that have been configured with the **metric-out igp** statement. If the MED changes before the timer expires because of a change in the IGP metric associated with the route next hop, the BGP peer sends an update only if the MED is lower than the previously advertised value or another attribute associated with the route has changed, or if the BGP peer is responding to a refresh route request.

To configure an interval to delay MED IGP updates, include the **med-igp-update-interval** statement:

```
med-igp-update-interval minutes;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary sections for this statement.

The default interval is 10 minutes. The interval that you can configure is in the range from 10 through 600.

You must separately configure the BGP group or peer that you want to delay sending MED IGP updates for the configured interval. For more information, see “Configuring the Multiple Exit Discriminator Metric” on page 663.



NOTE: If you have nonstop routing enabled and a switchover occurs, the delayed MED updates might be advertised as soon as the switchover occurs. For more detailed information about nonstop routing, see the *JUNOS High Availability Configuration Guide*.

Chapter 6

Logical System Overview

You can partition a single physical router into multiple logical devices that perform independent routing tasks. Because logical systems perform a subset of the tasks once handled by the physical router, logical systems offer an effective way to maximize the use of a single router.



NOTE: Beginning with JUNOS software Release 9.3, the logical router feature has been renamed logical system. All configuration statements, operational commands, **show** command outputs, error messages, log messages, and SNMP MIB objects that contain the string `logical-router` or `logical-routers` have been changed to `logical-system` and `logical-systems`, respectively.

This chapter discusses the following topics related to understanding and configuring logical system properties:

- Overview on page 125
- Logical System Configuration Statements on page 127
- Minimum Logical System Configuration on page 127
- Logical System Configuration Guidelines on page 129
- Configuring a Logical System on page 129
- Logical System Configuration Statement on page 130

Overview

Logical systems perform a subset of the actions of a physical router and have their own unique routing tables, interfaces, policies, and routing instances. A set of logical systems within a single router can handle the functions previously performed by several small routers.

The following are supported on logical systems:

- Open Shortest Path First (OSPF), Intermediate System-to-Intermediate System (IS-IS), Routing Information Protocol (RIP), RIP next generation (RIPng), Border Gateway Protocol (BGP), Resource Reservation Protocol (RSVP), Label Distribution Protocol (LDP), static routes, various multicast protocols, and IP version 4 (IPv4) and version 6 (IPv6) are supported at the `[edit logical-systems protocols]` hierarchy level.
- Basic Multiprotocol Label Switching (MPLS) for core provider router functionality is supported at the `[edit logical-systems protocols mpls]` hierarchy level.
- All policy-related statements available at the `[edit policy-options]` hierarchy level are supported at the `[edit logical-systems policy-options]` hierarchy level.
- Most routing options statements available at the `[edit routing-options]` hierarchy level are supported at the `[edit logical-systems routing-options]` hierarchy level. Only the `route-record` statement is not supported at the `[edit logical-systems routing-options]` hierarchy level.
- Graceful Routing Engine switchover (GRES) is supported.
- You can assign most interface types to a logical system, including SONET interfaces, Ethernet interfaces, Asynchronous Transfer Mode (ATM) interfaces, ATM2 interfaces, Channelized Q Performance Processor (QPP) interfaces, aggregated interfaces, link services interfaces, and multilink services interfaces.
- Source class usage, destination class usage, unicast reverse path forwarding, class of service, firewall filters, class-based forwarding, and policy-based accounting work with logical systems when you configure these features on the physical router.
- Multicast protocols, such as Protocol Independent Multicast (PIM) and Distance Vector Multicast Routing Protocol (DVMRP) are supported at the `[edit logical-systems logical-system-name protocols]` hierarchy level. Rendezvous point (RP) and source designated router (DR) functionality for multicast protocols within a logical system is also supported.
- The Bidirectional Forwarding Protocol (BFD) is supported.

The following restrictions apply to logical systems:

- You can configure a maximum of 15 logical systems on one physical router.
- The router has only one configuration file, which contains configuration information for the physical router and all associated logical systems. Master users can access the full configuration. However, logical system users can access only the portion of the configuration related to their particular logical system.
- All configuration commits performed by a logical system user are treated as `commit private`. For more information on the `commit private` command, see the *JUNOS System Basics Configuration Guide*.
- If a logical system experiences an interruption of its routing protocol process (rpd), the core dump output is saved in a file in the following location: `/var/tmp/rpd_logical-system-name.core-tarball.number.tgz`. Likewise, if you issue the `restart routing` command in a logical system, only the routing protocol process (rpd) for the logical system is restarted.

- If you configure trace options for a logical system, the output log file is stored in the following location: `/var/tmp/logical-system-name`.
- The following Physical Interface Cards (PICs) are not supported with logical systems: Adaptive Services PIC, ES PIC, Monitoring Services PIC, and Monitoring Services II PIC.
- Sampling, port mirroring, IP Security (IPsec), and Generalized MPLS (GMPLS) are not supported.
- Label-switched path (LSP) ping and traceroute for autonomous system (AS) number lookup are not supported.
- If you configure multiple logical systems, you can configure a VPLS routing instance only for the first logical system configured at the `[edit logical-systems logical-system-name routing-instances instance-name protocols vpls]` hierarchy level.

Logical Systems and Virtual Routers

A virtual router is not the same as a logical system. A virtual router is a type of simplified routing instance that has a single routing table. A logical system is a partition of a physical router and can contain multiple routing instances and routing tables. For example, a logical system can contain multiple virtual router routing instances.

Logical System Configuration Statements

To configure logical system properties, you include statements at the `[edit logical-systems logical-system-name]` hierarchy level:

```
[edit]
logical-systems logical-system-name {
  interfaces interface-name {
    interfaces-options;
  }
  policy-options {
    policy-options;
  }
  protocols protocol {
    protocol-options;
  }
  routing-instances routing-instance-name {
    routing-instances-options;
  }
  routing-options {
    routing-options;
  }
}
```

Minimum Logical System Configuration

To configure a logical system, you must include at least the following statements in the configuration:

```
[edit]
logical-systems logical-system-name {
  interfaces interface-name {
    unit unit-number {
      ...
    }
  }
}
```


Logical System Configuration Guidelines

The hierarchy level `[edit logical-systems logical-system-name]` in the JUNOS software contains the following hierarchy levels in their entirety:

- `[edit interfaces]`
- `[edit policy-options]`
- `[edit protocols]`
- `[edit routing-instances]`
- `[edit routing-options]`

Each of these hierarchy levels is used to configure an aspect of the logical system. The logical system fully supports each subsequent hierarchy level. You always have at least one logical system, the “master” logical system by default.

For documentation of these aspects of the logical system, see the documentation for each hierarchy level. The configurations are not documented separately for logical systems.

For a detailed example of a logical system configuration, see the *JUNOS Feature Guide*.

For information on configuring logical system interface properties, see the *JUNOS Network Interfaces Configuration Guide* and the *JUNOS Services Interfaces Configuration Guide*.

For information on configuring logical system routing policy properties, see the *JUNOS Policy Framework Configuration Guide*.

For information on configuring logical system multicast protocols, see the *JUNOS Multicast Protocols Configuration Guide*.

For information on configuring logical system routing protocols, see “Interior Gateway Protocols” on page 291 and “BGP” on page 633.

For information on configuring logical system routing instances, see “Routing Instances” on page 203.

For information on configuring logical system routing options, see “Protocol-Independent Routing Properties” on page 41.

Configuring a Logical System

To configure a logical system, include the `logical-systems` statement at the `[edit]` hierarchy level:

```
[edit]
logical-systems {
  logical-system-name;
}
```

Specify any logical system name to configure a logical system.

Logical System Configuration Statement

The syntax for the `logical-system` statement follows:

logical-systems

Syntax	<code>logical-systems logical-system-name;</code>
Hierarchy Level	[edit]
Release Information	Statement introduced before JUNOS Release 7.4. Statement name changed from <code>logical-router</code> beginning with JUNOS Release 9.3.
Description	(M-series, MX-series, and T-series only) Configure a logical system.
Options	<code>logical-system-name</code> —Name of the logical system.
Usage Guidelines	See “Logical System Configuration Guidelines” on page 129.
Required Privilege Level	<code>routing</code> —To view this statement in the configuration. <code>routing-control</code> —To add this statement to the configuration.

Chapter 7

Summary of Protocol-Independent Routing Properties Configuration Statements

This chapter provides a reference for each of the protocol-independent routing configuration statements. The statements are organized alphabetically.

active

Syntax (active | passive);

Hierarchy Level [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* routing-options (aggregate | generate | static) (defaults | route)],
 [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* routing-options rib *routing-table-name* (aggregate | generate | static) (defaults | route)],
 [edit logical-systems *logical-system-name* routing-options (aggregate | generate | static) (defaults | route)],
 [edit logical-systems *logical-system-name* routing-options rib *routing-table-name* (aggregate | generate | static) (defaults | route)],
 [edit routing-instances *routing-instance-name* routing-options (aggregate | generate | static) (defaults | route)],
 [edit routing-instances *routing-instance-name* routing-options rib *routing-table-name* (aggregate | generate | static) (defaults | route)],
 [edit routing-options (aggregate | generate | static) (defaults | route)],
 [edit routing-options rib *routing-table-name* (aggregate | generate | static) (defaults | route)]

Release Information Statement introduced before JUNOS Release 7.4.

Description Configure whether static, aggregate, or generated routes are removed from the routing and forwarding tables when they become inactive. Routes that have been configured to remain continually installed in the routing and forwarding tables are marked with **reject** next hops when they are inactive.

- **active**—Remove a route from the routing and forwarding tables when it becomes inactive.
- **passive**—Have a route remain continually installed in the routing and forwarding tables even when it becomes inactive.

Default active

Usage Guidelines See “Configuring Static Routes” on page 51, “Configuring Aggregate Routes” on page 78, and “Configuring Generated Routes” on page 86.

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

aggregate

Syntax

```
aggregate {
  defaults {
    ... aggregate-options ...
  }
  route destination-prefix {
    policy policy-name;
    ... aggregate-options ...
  }
}
```

Hierarchy Level

```
[edit logical-systems logical-system-name routing-instances routing-instance-name
 routing-options],
[edit logical-systems logical-system-name routing-instances routing-instance-name
 routing-options rib routing-table-name],
[edit logical-systems logical-system-name routing-options],
[edit logical-systems logical-system-name routing-options rib routing-table-name],
[edit routing-instances routing-instance-name routing-options],
[edit routing-instances routing-instance-name routing-options rib routing-table-name],
[edit routing-options],
[edit routing-options rib routing-table-name]
```

Release Information Statement introduced before JUNOS Release 7.4.

Description Configure aggregate routes.

Options *aggregate-options*—Additional information about aggregate routes that is included with the route when it is installed in the routing table. Specify zero or more of the following options in *aggregate-options*. Each option is explained separately.

- (active | passive);
- as-path <as-path> <origin (egp | igp | incomplete)> <atomic-aggregate> <aggregator as-number in-address>;
- community [community-ids];
- discard;
- (brief | full);
- (metric | metric2 | metric3 | metric4) value <type type>;
- (preference | preference2 | color | color2) preference <type type>;
- tag string;

defaults—Specify global aggregate route options. These options only set default attributes inherited by all newly created aggregate routes. These are treated as global defaults and apply to all the aggregate routes you configure in the **aggregate** statement. This part of the **aggregate** statement is optional.

route destination-prefix—Configure a nondefault aggregate route:

- **default**—For the default route to the destination. This is equivalent to specifying an IP address of 0.0.0.0/0.
- ***destination-prefix/prefix-length***—*destination-prefix* is the network portion of the IP address, and *prefix-length* is the destination prefix length.

The **policy** statement is explained separately.

Usage Guidelines See “Configuring Aggregate Routes” on page 78.

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

as-path

Syntax	<code>as-path <as-path> <origin (egp igp incomplete)> <atomic-aggregate> <aggregator as-number ip-address>;</code>
Hierarchy Level	<p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options (aggregate generate static) (defaults route)],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options rib <i>routing-table-name</i> (aggregate generate static) (defaults route)],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-options (aggregate generate static) (defaults route)],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-options rib <i>routing-table-name</i> (aggregate generate static) (defaults route)],</p> <p>[edit routing-instances <i>routing-instance-name</i> routing-options (aggregate generate static) (defaults route)],</p> <p>[edit routing-instances <i>routing-instance-name</i> routing-options rib <i>routing-table-name</i> (aggregate generate static) (defaults route)],</p> <p>[edit routing-options (aggregate generate static) (defaults route)],</p> <p>[edit routing-options rib <i>routing-table-name</i> (aggregate generate static) (defaults route)]</p>
Release Information	Statement introduced before JUNOS Release 7.4.
Description	<p>Associate Border Gateway Protocol (BGP) autonomous system (AS) path information with a static, aggregate, or generated route.</p> <p>Beginning with JUNOS Release 9.1, the numeric range for the AS number has been extended to provide BGP support for 4-byte AS numbers. For more information, see “Configuring the AS Number” on page 102. JUNOS continues to support 2-byte AS numbers.</p>
Options	<p>aggregator—(Optional) Attach the BGP aggregator path attribute to the aggregate route. You must specify the last AS number that formed the aggregate route (encoded as two octets) for <i>as-number</i>, followed by the IP address of the BGP system that formed the aggregate route for <i>in-address</i>.</p> <p>as-path—(Optional) AS path to include with the route. It can include a combination of individual AS path numbers and AS sets. Enclose sets in brackets ([]). The first AS number in the path represents the AS immediately adjacent to the local AS. Each subsequent number represents an AS that is progressively farther from the local AS, heading toward the origin of the path. You cannot specify a regular expression for <i>as-path</i>; you must use a full, valid AS path.</p> <p>atomic-aggregate—(Optional) Attach the BGP atomic-aggregate path attribute to the aggregate route. This path attribute indicates that the local system selected a less specific route instead of a more specific route.</p> <p>origin egp—(Optional) BGP origin attribute that indicates that the path information originated in another AS.</p>

origin igp—(Optional) BGP origin attribute that indicates that the path information originated within the local AS.

origin incomplete—(Optional) BGP origin attribute that indicates that the path information was learned by some other means.

Usage Guidelines See “Configuring Static Routes” on page 51, “Configuring Aggregate Routes” on page 78, and “Configuring Generated Routes” on page 86.

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

auto-export

Syntax

```

auto-export {
  (disable | enable);
  family {
    inet {
      multicast {
        (disable | enable);
        rib-group rib-group;
      }
      unicast {
        (disable | enable);
        rib-group rib-group;
      }
    }
  }
  traceoptions {
    file name <size size> <files number> <world-readable | no-world-readable>;
    flag flag <flag-modifier> <disable>;
  }
}

```

Hierarchy Level [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* routing-options],
 [edit logical-systems *logical-system-name* routing-options],
 [edit routing-instances *routing-instance-name* routing-options],
 [edit routing-options]

Release Information Statement introduced before JUNOS Release 7.4.

Description Export routes between routing instances.

Options (disable | enable)—Disable or enable auto-export.
Default: Enable

family—Address family.

inet—Internet Protocol version 4 (IPv4) address family.

multicast—Multicast routing information.

unicast—Unicast routing information.

The remaining statements are explained separately in this chapter.

Usage Guidelines See “Configuring Policy-Based Export for Routing Instances” on page 241.

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

autonomous-system

Syntax	<code>autonomous-system <i>autonomous-system</i> <loops <i>number</i>> { independent-domain; }</code>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options], [edit logical-systems <i>logical-system-name</i> routing-options], [edit routing-instances <i>routing-instance-name</i> routing-options], [edit routing-options]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Specify the router's AS number. Beginning with JUNOS Release 9.1, the numeric range is extended to provide BGP support for 4-byte AS numbers as defined in RFC 4893, <i>BGP Support for Four-octet AS Number Space</i> . Beginning with JUNOS Release 9.2, you can also configure a 4-byte AS number using the AS-dot notation format of two integer values joined by a period: <i>< 16-bit high-order value in decimal > . < 16-bit low-order value in decimal ></i> . For example, the 4-byte AS number of 65,546 in plain-number format is represented as 1.10 in the AS-dot notation format.
Options	<i>autonomous-system</i> —AS number. Use a number assigned to you by the Network Information Center (NIC). Range: 1 through 4,294,967,295 in plain-number format Range: 0.0 through 65535.65535 in AS-dot notation format. <i>number</i> —(Optional) Maximum number of times this AS number can appear in an AS path. Range: 1 through 10 Default: 1 (AS number can appear once)



NOTE: When you specify the same AS number in more than one routing instance on the local router, you must configure the same number of loops for the AS number in each instance. For example, if you configure a value of 3 for the **loops** statement in a VRF routing instance that uses the same AS number as that of the master instance, you must also configure a value of 3 loops for the AS number in the master instance.

Use the **independent-domain** option if the **loops** statement must be enabled only on a subset of routing instances.

The remaining statement is described separately in this chapter.

Usage Guidelines	See “Configuring the AS Number” on page 102.
Required Privilege Level	routing—To view this statement in the configuration.

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

Related Topics independent-domain

bfd-liveness-detection

Syntax bfd-liveness-detection {
 detection-time {
 threshold *milliseconds*;
 }
 holddown-interval *milliseconds*;
 local-address *ip-address*;
 minimum-interval *milliseconds*;
 minimum-receive-interval *milliseconds*;
 minimum-receive-ttl *number*;
 multiplier *number*;
 neighbor *address*;
 no-adaptation;
 transmit-interval {
 threshold *milliseconds*;
 minimum-interval *milliseconds*;
 }
 version (1 | automatic);
 }

Hierarchy Level [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* routing-options rib *routing-table-name* static route *destination-prefix*],
 [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* routing-options rib *routing-table-name* static route *destination-prefix* qualified-next-hop (*interface-name* | *address*)],
 [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* routing-options static route *destination-prefix*],
 [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* routing-options static route *destination-prefix* qualified-next-hop (*interface-name* | *address*)],
 [edit logical-systems *logical-system-name* routing-options rib *routing-table-name* static route *destination-prefix*],
 [edit logical-systems *logical-system-name* routing-options rib *routing-table-name* static route *destination-prefix* qualified-next-hop (*interface-name* | *address*)],
 [edit logical-systems *logical-system-name* routing-options static route *destination-prefix*],
 [edit logical-systems *logical-system-name* routing-options static route *destination-prefix* qualified-next-hop (*interface-name* | *address*)],
 [edit routing-instances *routing-instance-name* routing-options rib *routing-table-name* static route *destination-prefix*],
 [edit routing-instances *routing-instance-name* routing-options rib *routing-table-name* static route *destination-prefix* qualified-next-hop (*interface-name* | *address*)],
 [edit routing-instances *routing-instance-name* routing-options static route *destination-prefix* qualified-next-hop (*interface-name* | *address*)],
 [edit routing-instances *routing-instance-name* routing-options static route *destination-prefix*],
 [edit routing-options rib *routing-table-name* static route *destination-prefix*],
 [edit routing-options rib *routing-table-name* static route *destination-prefix* qualified-next-hop (*interface-name* | *address*)],
 [edit routing-options static route *destination-prefix*],
 [edit routing-options static route *destination-prefix* qualified-next-hop (*interface-name* | *address*)]

Release Information	<p>Statement introduced before JUNOS Release 7.4.</p> <p><code>detection-time threshold</code> and <code>transmit-interval threshold</code> options introduced in JUNOS Release 8.2.</p> <p><code>local-address</code> statement introduced in JUNOS Release 8.2.</p> <p><code>minimum-receive-ttl</code> statement introduced in JUNOS Release 8.2.</p> <p>Support for logical routers introduced in JUNOS Release 8.3.</p> <p><code>holddown-interval</code> statement introduced in JUNOS Release 8.5.</p> <p><code>no-adaptation</code> statement introduced in JUNOS Release 9.0.</p> <p>Support for IPv6 static routes introduced in JUNOS Release 9.1.</p>
Description	<p>Configure bidirectional failure detection timers for static routes.</p>

Options **detection-time threshold** *milliseconds*—Configure a threshold. When the Bidirectional Forwarding Detection (BFD) protocol session detection time adapts to a value equal to or greater than the threshold, a single trap and a single system log message are sent.

holddown-interval *milliseconds*—Configure an interval specifying how long a BFD session must remain up before a state change notification is sent.

Range: 0 through 255,000

Default: 0

minimum-interval *milliseconds*—Configure the minimum intervals at which the local router transmits a hello packet and then expects to receive a reply from the neighbor with which it has established a BFD session.

Range: 1 through 255,000

minimum-receive-interval *milliseconds*—Configure the minimum interval at which the local router expects to receive a reply from a neighbor with which it has established a BFD session.

Range: 1 through 255,000

multiplier *number*—Configure number of hello packets not received by the neighbor that causes the originating interface to be declared down.

Range: 1 through 255

Default: 3

version—Configure the BFD protocol version to detect.

Range: 1 or automatic

Default: automatic (autodetect the BFD protocol version)

local-address *ip-address*—Enable a multihop BFD session and configure the source address for the BFD session.

minimum-receive-ttl *number*—Configure the time-to-live (TTL) for the multihop BFD session.

Range: 1 through 255

Default: 255

neighbor *address*—Configure a next-hop address for the BFD session for a next hop specified as an interface name.

no-adaptation—Specify for BFD sessions not to adapt to changing network conditions. We recommend that you not disable BFD adaptation unless it is preferable not to have BFD adaptation enabled in your network.

transmit-interval threshold *milliseconds*—Configure a threshold. When the BFD session transmit interval adapts to a value greater than the threshold, a single trap and a single system log message are sent. The interval threshold must be greater than the minimum transmit interval.

Range: 0 through 4,294,967,295

transmit-interval minimum-interval *milliseconds*—Configure the minimum interval at which the local router transmits hello packets to a neighbor with which it has established a BFD session.

Range: 1 through 255,000

Usage Guidelines See “Configuring Bidirectional Forwarding Detection” on page 71.

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

brief

Syntax (brief | full);

Hierarchy Level [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* routing-options (aggregate | generate) (defaults | route)],
[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* routing-options rib *routing-table-name* (aggregate | generate) (defaults | route)],
[edit logical-systems *logical-system-name* routing-options (aggregate | generate) (defaults | route)],
[edit logical-systems *logical-system-name* routing-options rib *routing-table-name* (aggregate | generate) (defaults | route)],
[edit routing-instances *routing-instance-name* routing-options (aggregate | generate) (defaults | route)],
[edit routing-instances *routing-instance-name* routing-options rib *routing-table-name* (aggregate | generate) (defaults | route)],
[edit routing-options (aggregate | generate) (defaults | route)],
[edit routing-options rib *routing-table-name* (aggregate | generate) (defaults | route)]

Release Information Statement introduced before JUNOS Release 7.4.

Description Configure all AS numbers from all contributing paths to be included in the aggregate or generated route’s path.

- **brief**—Include only the longest common leading sequences from the contributing AS paths. If this results in AS numbers being omitted from the aggregate route, the BGP **ATOMIC_ATTRIBUTE** path attribute is included with the aggregate route.
- **full**—Include all AS numbers from all contributing paths in the aggregate or generated route’s path.

Default full

Usage Guidelines See “Configuring Aggregate Routes” on page 78 and “Configuring Generated Routes” on page 86.

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

Related Topics aggregate, generate

color

See preference

community

Syntax	<code>community ([<i>community-ids</i>] no-advertise no-export no-export-subconfed none);</code>
Hierarchy Level	<p>[edit routing-instances <i>routing-instance-name</i> routing-options (aggregate generate static) (defaults route)],</p> <p>[edit routing-instances <i>routing-instance-name</i> routing-options rib <i>routing-table-name</i> (aggregate generate static) (defaults route)],</p> <p>[edit routing-options (aggregate generate static) (defaults route)],</p> <p>[edit routing-options rib <i>routing-table-name</i> (aggregate generate static) (defaults route)],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options (aggregate generate static) (defaults route)],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options rib <i>routing-table-name</i> (aggregate generate static) (defaults route)],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-options (aggregate generate static) (defaults route)],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-options rib <i>routing-table-name</i> (aggregate generate static) (defaults route)]</p>
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Associate BGP community information with a static, aggregate, or generated route.
Options	<p><i>community-ids</i>—One or more community identifiers. The <i>community-ids</i> format varies according to the type of attribute that you use.</p> <p>The BGP community attribute format is <i>as-number:community-value</i>:</p> <ul style="list-style-type: none"> ■ <i>as-number</i>—AS number of the community member. It can be a value from 1 through 65,535. ■ <i>community-value</i>—Identifier of the community member. It can be a number from 0 through 65,535. <p>For more information about BGP community attributes, see the “Configuring the Extended Communities Attribute” section in the <i>JUNOS Policy Framework Configuration Guide</i>.</p> <p>For specifying the BGP community attribute only, you also can specify <i>community-ids</i> as one of the following well-known community names defined in RFC 1997:</p> <ul style="list-style-type: none"> ■ <i>no-advertise</i>—Routes containing this community name are not advertised to other BGP peers. ■ <i>no-export</i>—Routes containing this community name are not advertised outside a BGP confederation boundary. ■ <i>no-export-subconfed</i>—Routes containing this community name are not advertised to external BGP peers, including peers in other members’ ASs inside a BGP confederation.

- **none**—Explicitly exclude BGP community information with a static route. Include this option when configuring an individual route in the **route** portion to override a community option specified in the **defaults** portion.



NOTE: Extended community attributes are not supported at the [edit routing-options] hierarchy level. You must configure extended communities at the [edit policy-options] hierarchy level. For information about configuring extended communities, see the *JUNOS Policy Framework Configuration Guide*.

Usage Guidelines	See “Configuring Static Routes” on page 51, “Configuring Aggregate Routes” on page 78, and “Configuring Generated Routes” on page 86.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	aggregate, generate, static

confederation

Syntax	confederation <i>confederation-autonomous-system</i> members [<i>autonomous-systems</i>];
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-options], [edit routing-options]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Specify the router’s confederation AS number.
Options	<p><i>autonomous-system</i>—AS numbers of the confederation members. Range: 1 through 65,535</p> <p><i>confederation-autonomous-system</i>—Confederation AS number. Use one of the numbers assigned to you by the NIC. Range: 1 through 65,535</p>
Usage Guidelines	See “Configuring AS Confederation Members” on page 103.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

destination-networks

Syntax	<code>destination-networks prefix;</code>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options dynamic-tunnels <i>tunnel-name</i>], [edit logical-systems <i>logical-system-name</i> routing-options dynamic-tunnels <i>tunnel-name</i>], [edit routing-instances <i>routing-instance-name</i> routing-options dynamic-tunnels <i>tunnel-name</i>], [edit routing-options dynamic-tunnels <i>tunnel-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Specify the IPv4 prefix range for the destination network by including the destination-networks statement. Only tunnels within the specified IPv4 prefix range can be created.
Options	<i>prefix</i> —Destination prefix of network.
Usage Guidelines	See “Configuring a Dynamic Tunnel” on page 114.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

disable

Syntax	<code>disable;</code>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options graceful-restart], [edit logical-systems <i>logical-system-name</i> routing-options graceful-restart], [edit routing-instances <i>routing-instance-name</i> routing-options graceful-restart], [edit routing-options graceful-restart]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Disable graceful restart.
Usage Guidelines	See “Configuring Graceful Restart” on page 113.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

discard

Syntax	discard;
Hierarchy Level	<pre>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options (aggregate generate) (defaults route)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options rib <i>routing-table-name</i> (aggregate generate) (defaults route)], [edit logical-systems <i>logical-system-name</i> routing-options (aggregate generate) (defaults route)], [edit logical-systems <i>logical-system-name</i> routing-options rib <i>routing-table-name</i> (aggregate generate) (defaults route)], [edit routing-instances <i>routing-instance-name</i> routing-options (aggregate generate) (defaults route)], [edit routing-instances <i>routing-instance-name</i> routing-options rib <i>routing-table-name</i> (aggregate generate) (defaults route)], [edit routing-options (aggregate generate) (defaults route)], [edit routing-options rib <i>routing-table-name</i> (aggregate generate) (defaults route)]</pre>
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Do not forward packets addressed to this destination. Instead, drop the packets, do not send ICMP unreachable messages to the packets' originators, and install a reject route for this destination into the routing table.
Default	When an aggregate route becomes active, it is installed in the routing table with a reject next hop, which means that ICMP unreachable messages are sent.
Usage Guidelines	See "Configuring Aggregate Routes" on page 78 and "Configuring Generated Routes" on page 86.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	aggregate, generate

dynamic-tunnels

Syntax	dynamic-tunnels <i>tunnel-name</i> { destination-networks <i>prefix</i> ; source-address <i>address</i> ; tunnel-type <i>type-of-tunnel</i> ; }
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options], [edit logical-systems <i>logical-system-name</i> routing-options], [edit routing-instances <i>routing-instance-name</i> routing-options], [edit routing-options]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure a dynamic tunnel between two PE routers.
Options	<i>tunnel-name</i> —Name of the dynamic tunnel. The remaining statements are explained separately in this chapter.
Usage Guidelines	See “Configuring a Dynamic Tunnel” on page 114.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

export

Syntax	export [<i>policy-names</i>];
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options forwarding-table], [edit logical-systems <i>logical-system-name</i> routing-options forwarding-table], [edit routing-instances <i>routing-instance-name</i> routing-options forwarding-table], [edit routing-options forwarding-table]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Apply one or more policies to routes being exported from the routing table into the forwarding table.
Options	<i>policy-name</i> —Name of one or more policies.
Usage Guidelines	See “Configuring Per-Packet Load Balancing” on page 109 and the <i>JUNOS Policy Framework Configuration Guide</i> .
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

export-rib

Syntax	<code>export-rib <i>routing-table-name</i>;</code>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options rib-group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> routing-options passive <i>group-name</i>], [edit routing-instances <i>routing-instance-name</i> routing-options rib-group <i>group-name</i>], [edit routing-options passive <i>group-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Name of the routing table from which the JUNOS software should export routing information.
Options	<i>routing-table-name</i> —Routing table group name.
Usage Guidelines	See “Creating Routing Table Groups” on page 104.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	import-rib, passive

fate-sharing

Syntax	<pre>fate-sharing { group <i>group-name</i>; cost <i>value</i>; from <i>address</i> <to <i>address</i>>; }</pre>
Hierarchy Level	<p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-options],</p> <p>[edit routing-instances <i>routing-instance-name</i> routing-options],</p> <p>[edit routing-options]</p>
Release Information	Statement introduced before JUNOS Release 7.4.
Description	<p>Specify a backup path in case the primary path becomes unusable.</p> <p>You specify one or more objects within a group. The objects can be a LAN interface, a router ID, or a point-to-point link. Sequence is insignificant.</p> <p>Changing the fate-sharing database does not affect existing established LSP until the next CSPF reoptimization. The fate-sharing database does affect fast-reroute detour path computations.</p>
Options	<p>group <i>group-name</i>—Each fate-sharing group must have a name, which can be up to 32 characters long and can contain letters, digits, periods (.) and hyphens (-). You can define up to 512 groups.</p> <p>cost <i>value</i>—Cost assigned to the group. Range: 1 through 65,535 Default: 1</p> <p>from <i>address</i>—Address of ingress router.</p> <p>to <i>address</i>—Address of egress router. For point-to-point link objects, you must specify both a from and a to address.</p>
Usage Guidelines	See the <i>JUNOS MPLS Applications Configuration Guide</i> .
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

filter

Syntax	filter { input <i>filter-name</i> ; }
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options rib <i>routing-table-name</i>], [edit logical-systems <i>logical-system-name</i> routing-options rib <i>routing-table-name</i>], [edit routing-instances <i>routing-instance-name</i> routing-options rib <i>routing-table-name</i>], [edit routing-options rib <i>routing-table-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Name of the routing table from which the JUNOS software should export routing information.
Options	input <i>filter-name</i> —Forwarding table filter name.
Usage Guidelines	See “Applying a Filter to a Forwarding Table” on page 99.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

flow

Syntax

```

flow {
  route name {
    match {
      match-conditions;
    }
    then {
      actions;
    }
  }
  validation {
    traceoptions {
      file name <size size> <files number> <world-readable | no-world-readable>;
      flag flag <flag-modifier> <disable>;
    }
  }
}

```

Hierarchy Level [edit routing-options]

Release Information Statement introduced before JUNOS Release 7.4.

Description Configure a flow route.

Options route *name*—Name of the flow route.

actions—An action to take if conditions match. The actions are described in Table 9 on page 98.

match-conditions—Match packets to these conditions. The match conditions are described in Table 8 on page 96.

then—Actions to take on matching packets.

Usage Guidelines See “Configuring a Flow Route” on page 95.

Required Privilege Level

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

forwarding-cache

Syntax	forwarding-cache { threshold suppress <i>value</i> <reuse <i>value</i> >; }
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options multicast], [edit logical-systems <i>logical-system-name</i> routing-options multicast], [edit routing-instances <i>routing-instance-name</i> routing-options multicast], [edit routing-options multicast]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure multicast forwarding cache limits.
Options	The threshold statement is explained separately.
Usage Guidelines	See “Configuring Multicast Forwarding Cache Limits” on page 109.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

forwarding-table

Syntax	forwarding-table { export [<i>policy-names</i>]; (indirect-next-hop no-indirect-next-hop); unicast-reverse-path (active-paths feasible-paths); }
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-options], [edit routing-options]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure information about the router’s forwarding table.
Options	The statement is explained separately.
Usage Guidelines	See “Configuring Per-Packet Load Balancing” on page 109.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

full

See brief

generate

Syntax

```
generate {
  defaults {
    generate-options;
  }
  route destination-prefix {
    policy policy-name;
    generate-options;
  }
}
```

Hierarchy Level [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* routing-options],
[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* routing-options rib *routing-table-name*],
[edit routing-options],
[edit routing-options rib *routing-table-name*]

Release Information Statement introduced before JUNOS Release 7.4.

Description Configure generated routes, which are used as routes of last resort.

Options *generate-options*—Additional information about generated routes, which is included with the route when it is installed in the routing table. Specify zero or more of the following options in *generate-options*. Each option is explained separately.

- (active | passive);
- as-path <as-path> <origin (egp | igp | incomplete)> <atomic-aggregate> <aggregator as-number in-address>;
- community [*community-ids*];
- discard;
- (brief | full);
- (metric | metric2 | metric3 | metric4) *value* <type type>;
- (preference | preference2 | color | color2) *preference* <type type>;
- tag *string*;

defaults—Specify global generated route options. These options only set default attributes inherited by all newly created generated routes. These are treated as global defaults and apply to all the generated routes you configure in the **generate** statement. This part of the **generate** statement is optional.

route destination-prefix—Configure a non-default generated route:

- **default**—For the default route to the destination. This is equivalent to specifying an IP address of 0.0.0.0/0.

- *destination-prefix/prefix-length*—*destination-prefix* is the network portion of the IP address, and *prefix-length* is the destination prefix length.

The policy statement is explained separately.

Usage Guidelines See “Configuring Generated Routes” on page 86.

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

graceful-restart

Syntax graceful-restart {
 disable;
 restart-duration *seconds*;
}

Hierarchy Level [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* routing-options],
[edit logical-systems *logical-system-name* routing-options],
[edit routing-instances *routing-instance-name* routing-options],
[edit routing-options]

Release Information Statement introduced before JUNOS Release 7.4.

Description Configure graceful restart.

Options The statements are explained separately.

Usage Guidelines See “Configuring Graceful Restart” on page 113 and the *JUNOS High Availability Configuration Guide*.

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

import

Syntax	import [<i>policy-names</i>];
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options resolution rib], [edit logical-systems <i>logical-system-name</i> routing-options resolution rib], [edit routing-instances <i>routing-instance-name</i> routing-options resolution rib], [edit routing-options resolution rib]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Specify one or more import policies to use for route resolution.
Options	The statements are explained separately.
Usage Guidelines	See “Configuring Route Resolution” on page 116.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

import-policy

Syntax	import-policy [<i>policy-names</i>];
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options rib-group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> routing-options passive <i>group-name</i>], [edit routing-instances <i>routing-instance-name</i> routing-options rib-group <i>group-name</i>], [edit routing-options passive <i>group-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Apply one or more policies to routes imported into the routing table group. The import-policy statement complements the import-rib statement and cannot be used unless you first specify the routing tables to which routes are being imported.
Options	<i>policy-name</i> —Name of one or more policies.
Usage Guidelines	See “Creating Routing Table Groups” on page 104.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	export-rib, passive

import-rib

Syntax	import-rib [<i>routing-table-names</i>];
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options rib-group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> routing-options rib-group <i>group-name</i>], [edit routing-instances <i>routing-instance-name</i> routing-options rib-group <i>group-name</i>], [edit routing-options rib-group <i>group-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Name of the routing table into which the JUNOS software should import routing information. The first routing table name you enter is the primary routing table. Any additional names you enter identify secondary routing tables. When a protocol imports routes, it imports them into the primary and any secondary routing tables. If the primary route is deleted, the secondary route also is deleted. For IPv4 import routing tables, the primary routing table must be <i>inet.0</i> or <i>routing-instance-name.inet.0</i> . For IPv6 import routing tables, the primary routing table must be <i>inet6.0</i> .
Options	<i>routing-table-names</i> —Name of one or more routing tables.
Usage Guidelines	See “Creating Routing Table Groups” on page 104.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	export-rib, passive

independent-domain

Syntax	independent-domain;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options autonomous-system <i>autonomous-system</i>], [edit routing-instances <i>routing-instance-name</i> routing-options autonomous-system <i>autonomous-system</i>],
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure an independent AS domain.
Usage Guidelines	See “Configuring an Independent AS Domain” on page 251.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	autonomous-system

indirect-next-hop

Syntax	(indirect-next-hop no-indirect-next-hop);
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-options forwarding-table], [edit routing-options forwarding-table]
Release Information	Statement introduced in JUNOS Release 8.2.
Description	Enable indirectly connected next hops for route convergence.



NOTE: When virtual private LAN service (VPLS) is configured on the router, the indirect-next-hop statement is not supported.

Usage Guidelines	See “Enabling an Indirect Next Hop” on page 117.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

input

Syntax	input <i>filter-name</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-options rib <i>routing-table-name</i> filter], [edit routing-options rib <i>routing-table-name</i> filter]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Name of the input filter.
Options	<i>filter-name</i> —Name of the input filter.
Usage Guidelines	See “Applying a Filter to a Forwarding Table” on page 99.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

install

Syntax	(install no-install);
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options static (defaults route)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options rib <i>routing-table-name</i> static (defaults route)], [edit logical-systems <i>logical-system-name</i> routing-options rib <i>routing-table-name</i> static (defaults route)], [edit logical-systems <i>logical-system-name</i> routing-options static (defaults route)], [edit routing-instances <i>routing-instance-name</i> routing-options rib <i>routing-table-name</i> static (defaults route)], [edit routing-instances <i>routing-instance-name</i> routing-options static (defaults route)], [edit routing-options rib <i>routing-table-name</i> static (defaults route)] [edit routing-options static (defaults route)]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure whether the JUNOS software installs all static routes into the forwarding table. Even if you configure a route so it is not installed in the forwarding table, the route is still eligible to be exported from the routing table to other protocols.
Default	install
Options	install—Explicitly install all static routes into the forwarding table. no-install—Do not install the route into the forwarding table, even if it is the route with the lowest preference.
Usage Guidelines	See “Configuring Static Routes” on page 51.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	static

instance-export

Syntax	instance-export [<i>policy-names</i>];
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options], [edit logical-systems <i>logical-system-name</i> routing-options], [edit routing-instances <i>routing-instance-name</i> routing-options], [edit routing-options]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Apply one or more policies to routes being exported from a routing instance.
Options	<i>policy-names</i> —Name of one or more export policies.
Usage Guidelines	See “Configuring Policy-Based Export for Routing Instances” on page 241 and the <i>JUNOS Policy Framework Configuration Guide</i> .
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

instance-import

Syntax	instance-import [<i>policy-names</i>];
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options], [edit logical-systems <i>logical-system-name</i> routing-options], [edit routing-instances <i>routing-instance-name</i> routing-options], [edit routing-options]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Apply one or more policies to routes being imported into a routing instance.
Options	<i>policy-names</i> —Name of one or more import policies.
Usage Guidelines	See “Configuring Policy-Based Export for Routing Instances” on page 241 and the <i>JUNOS Policy Framework Configuration Guide</i> .
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

interface

See the following sections:

- interface (Multicast via Static Routes) on page 161
- interface (Multicast Scoping) on page 162

interface (Multicast via Static Routes)

Syntax interface *interface-name* {
 disable;
 }

Hierarchy Level [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* routing-options multicast],
 [edit logical-systems *logical-system-name* routing-options multicast],
 [edit routing-instances *routing-instance-name* routing-options multicast],
 [edit routing-options multicast]

Release Information Statement introduced in JUNOS Release 8.1.

Description Enable multicast traffic on an interface.



NOTE: You cannot enable multicast traffic on an interface using the **enable** statement and configure PIM on the same interface simultaneously.

Options *interface-name*—Name of the interface on which to enable multicast traffic. Specify the *interface-name* to enable multicast traffic on the interface.

disable—Disable multicast traffic previously enabled.

Usage Guidelines See “Enabling Multicast on an Interface” on page 108.

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

interface (Multicast Scoping)

Syntax interface [*interface-names*];

Hierarchy Level [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* routing-options multicast scope *scope-name*],
 [edit logical-systems *logical-system-name* routing-options multicast scope *scope-name*],
 [edit routing-instances *routing-instance-name* routing-options multicast scope *scope-name*],
 [edit routing-options multicast scope *scope-name*]

Release Information Statement introduced before JUNOS Release 7.4.

Description Configure the set of interfaces for multicast scoping.

Options *interface-names*—Names of the interfaces on which to configure scoping. Specify the full interface name, including the physical and logical address components. To configure all interfaces, you can specify all. For details about specifying interfaces, see the *JUNOS Network Interfaces Configuration Guide*.



NOTE: You cannot apply a scoping policy to a specific routing instance. All scoping policies are applied to all routing instances. However, you can apply the **scope** statement to a specific routing instance.

Usage Guidelines See “Configuring Multicast Scoping” on page 107.

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

Related Topics multicast

interface-routes

Syntax	<pre> interface-routes { family (inet inet6) { export { lan; point-to-point; } } rib-group <i>group-name</i>; } </pre>
Hierarchy Level	<p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-options],</p> <p>[edit routing-instances <i>routing-instance-name</i> routing-options],</p> <p>[edit routing-options]</p>
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Associate a routing table group with the router's interfaces and specify routing table groups into which interface routes are imported.
Options	<p>inet—Specify the IPv4 address family.</p> <p>inet6—Specify the IPv6 address family.</p> <p>lan—Export LAN routes.</p> <p>point-to-point—Export point-to-point routes.</p> <p>The remaining statement is explained separately.</p>
Usage Guidelines	See “Configuring How Interface Routes Are Imported into Routing Tables” on page 106.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>
Related Topics	passive

lsp-next-hop

Syntax	lsp-next-hop <i>lsp-name</i> { metric <i>metric</i> ; preference <i>preference</i> ; }
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options static route <i>destination-prefix</i>], [edit logical-systems <i>logical-system-name</i> routing-options static route <i>destination-prefix</i>], [edit routing-instances <i>routing-instance-name</i> routing-options static route <i>destination-prefix</i>] [edit routing-options static route <i>destination-prefix</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Specify an LSP as the next hop for a static route, and configure an independent metric or preference on that next-hop LSP.
Options	<p><i>lsp-name</i>—Name of the next-hop LSP.</p> <p><i>metric</i>—Metric value. Range: 0 through 4,294,967,295 ($2^{32} - 1$).</p> <p><i>preference</i>—Preference value. A lower number indicates a more preferred route. Range: 0 through 4,294,967,295 ($2^{32} - 1$) Default: 5</p>
Usage Guidelines	See “Specifying an LSP as the Next Hop for a Static Route” on page 59.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

martians

Syntax	<pre>martians { destination-prefix match-type <allow>; }</pre>
Hierarchy Level	<p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options rib <i>routing-table-name</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-options],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-options rib <i>routing-table-name</i>],</p> <p>[edit routing-instances <i>routing-instance-name</i> routing-options],</p> <p>[edit routing-instances <i>routing-instance-name</i> routing-options rib <i>routing-table-name</i>],</p> <p>[edit routing-options],</p> <p>[edit routing-options rib <i>routing-table-name</i>]</p>
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure martian addresses.
Options	<p>allow—(Optional) Explicitly allow a subset of a range of addresses that has been disallowed.</p> <p>destination-prefix—Destination route you are configuring:</p> <ul style="list-style-type: none"> ■ destination-prefix/prefix-length—<i>destination-prefix</i> is the network portion of the IP address, and <i>prefix-length</i> is the destination prefix length. ■ default—Default route to use when routing packets that do not match a network or host in the routing table. This is equivalent to specifying the IP address 0.0.0.0/0. <p>match-type—Criteria that the destination must match:</p> <ul style="list-style-type: none"> ■ exact—Exactly match the route's mask length. ■ longer—The route's mask length is greater than the specified mask length. ■ orlonger—The route's mask length is equal to or greater than the specified mask length. ■ through destination-prefix—The route matches the first prefix, the route matches the second prefix for the number of bits in the route, and the number of bits in the route is less than or equal to the number of bits in the second prefix. ■ upto prefix-length—The route's mask length falls between the two destination prefix lengths, inclusive.
Usage Guidelines	See “Configuring Martian Addresses” on page 93.

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

maximum-paths

Syntax maximum-paths *path-limit* <log-only | threshold *value* log-interval *seconds*>;

Hierarchy Level [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* routing-options],
 [edit logical-systems *logical-system-name* routing-options],
 [edit routing-instances *routing-instance-name* routing-options],
 [edit routing-options]

Release Information Statement introduced in JUNOS Release 8.0.

Description Configure a limit for the number of routes installed in a routing table based upon the route path.

Options *path-limit*—Maximum number of routes. If this limit is reached, a warning is triggered and additional routes are rejected.

Range: 1 through 4,294,967,295

Default: None

log-only—(Optional) Sets the route limit as an advisory limit. An advisory limit triggers only a warning, and additional routes are not rejected.

log-interval seconds—(Optional) Minimum time interval (in seconds) between log messages.

Range: 5 through 86,400

threshold value—(Optional) Percentage of the maximum number of routes that starts triggering warning. You can configure a percentage of the *path-limit* value that starts triggering the warnings.

Range: 1 through 100




NOTE: When the number of routes reaches the **threshold** value, routes are still installed into the routing table while warning messages are sent. When the number of routes reaches the *path-limit* value, then additional routes are rejected.

Usage Guidelines See “Configuring Route Limits for Routing Tables” on page 251.

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

maximum-prefixes

Syntax	maximum-prefixes <i>prefix-limit</i> <log-only threshold value log-interval seconds>;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options], [edit logical-systems <i>logical-system-name</i> routing-options], [edit routing-instances <i>routing-instance-name</i> routing-options], [edit routing-options]
Release Information	Statement introduced in JUNOS Release 8.0.
Description	Configure a limit for the number of routes installed in a routing table based upon the route prefix.
Options	<p><i>prefix-limit</i>—Maximum number of route prefixes. If this limit is reached, a warning is triggered and any additional routes are rejected. Range: 1 through 4,294,967,295 Default: None</p> <p><i>log-only</i>—(Optional) Sets the prefix limit as an advisory limit. An advisory limit triggers only a warning, and additional routes are not rejected.</p> <p><i>log-interval seconds</i>—(Optional) Minimum time interval (in seconds) between log messages. Range: 5 through 86,400</p> <p><i>threshold value</i>—(Optional) Percentage of the maximum number of prefixes that starts triggering warning. You can configure a percentage of the <i>prefix-limit</i> value that starts triggering the warnings. Range: 1 through 100</p>
	<p>NOTE: When the number of routes reaches the <i>threshold</i> value, routes are still installed into the routing table while warning messages are sent. When the number of routes reaches the <i>prefix-limit</i> value, then additional routes are rejected.</p>
Usage Guidelines	See “Configuring Route Limits for Routing Tables” on page 251.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

med-igp-update-interval

Syntax	med-igp-update-interval <i>minutes</i> ;
Hierarchy Level	[edit routing-options]
Release Information	Statement introduced in JUNOS Release 9.0
Description	Configure a timer for how long to delay updates for the multiple-exit discriminator (MED) path attribute for BGP groups and peers configured with the metric-out igp offset delay-med-update statement. The timer delays MED updates for the interval configured unless the MED is lower than the previously advertised attribute or another attribute associated with the route has changed or if the BGP peer is responding to a refresh route request.
Default	10 minutes
Options	<i>minutes</i> —Interval to delay MED updates. Range: 10 through 600
Usage Guidelines	See “Configuring a Timer to Delay Multiple Exit Discriminator IGP Updates” on page 122.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	metric-out

metric

See the following sections:

- [metric \(Aggregate, Generated, or Static Route\)](#) on page 169
- [metric \(Qualified Next Hop on Static Route\)](#) on page 170

metric (Aggregate, Generated, or Static Route)

Syntax	(metric metric2 metric3 metric4) <i>metric</i> <type type>;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-options (aggregate generate static) (defaults route)], [edit routing-options (aggregate generate static) (defaults route)]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Metric value for an aggregate, generated, or static route. You can specify up to four metric values, starting with metric (for the first metric value) and continuing with metric2 , metric3 , and metric4 .
Options	<i>metric</i> —Metric value. Range: 0 through 4,294,967,295 ($2^{32}-1$). <i>type type</i> —(Optional) Type of route. Range: 1 through 16
Usage Guidelines	See “Specifying the Route Metric” on page 64, “Specifying the Route Metric” on page 81, and “Specifying the Route Metric” on page 89.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	aggregate, generate, static

metric (Qualified Next Hop on Static Route)

Syntax	<code>metric <i>metric</i>;</code>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-options static route <i>destination-prefix</i> qualified-next-hop], [edit routing-options static route <i>destination-prefix</i> qualified-next-hop]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Metric value for a static route.
Options	<i>metric</i> —Metric value. Range: 0 through 4,294,967,295 ($2^{32}-1$).
Usage Guidelines	See “Specifying an Independent Preference for a Static Route” on page 55.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	qualified-next-hop, static

multicast

Syntax

```
multicast {
  forwarding-cache {
    threshold suppress value <reuse value>;
  }
  interface interface-name {
    enable;
  }
  scope scope-name {
    interface [ interface-names ];
    prefix destination-prefix;
  }
  ssm-groups {
    address;
  }
}
```

Hierarchy Level [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* routing-options],
[edit logical-systems *logical-system-name* routing-options],
[edit routing-instances *routing-instance-name* routing-options],
[edit routing-options]

Release Information Statement introduced before JUNOS Release 7.4.

Description Configure generic multicast properties.



NOTE: You cannot apply a scoping policy to a specific routing instance. All scoping policies are applied to all routing instances. However, you can apply the **scope** statement to a specific routing instance.

Options The statements are explained separately in this chapter.

Usage Guidelines See “Configuring Multicast Scoping” on page 107 and “Configuring Additional Source-Specific Multicast Groups” on page 108.

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

no-install

See install

no-readvertise

See readvertise

no-retain

See retain

nonstop-routing

Syntax nonstop-routing;

Hierarchy Level [edit logical-systems *logical-system-name* routing-options],
[edit logical-systems *logical-system-name* routing-instances *routing-instance-name*
routing-options],
[edit routing-instances *routing-instance-name* routing-options],
[edit routing-options]

Release Information Statement introduced in JUNOS Release 8.4.

Description For routing platforms with two Routing Engines, configure a master Routing Engine to switch over gracefully to a backup Routing Engine and to preserve routing protocol information.

Default disabled

Usage Guidelines See “Enabling Nonstop Routing” on page 118.

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

Related Topics *JUNOS High Availability Configuration Guide*

options

Syntax	options { syslog (level <i>level</i> upto level); }
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options], [edit logical-systems <i>logical-system-name</i> routing-options], [edit routing-instances <i>routing-instance-name</i> routing-options], [edit routing-options]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure the types of system logging messages sent about the routing protocols process to the system message logging file. These messages are also displayed on the system console. You can log messages at a particular level, or up to and including a particular level.
Options	<p>level <i>level</i>—Severity of the message. It can be one or more of the following levels, in order of decreasing urgency:</p> <ul style="list-style-type: none"> ■ emergency—Panic or other conditions that cause the system to become unusable. ■ alert—Conditions that should be corrected immediately, such as a corrupted system database. ■ critical—Critical conditions, such as hard drive errors. ■ error—Standard error conditions. ■ warning—System warning messages. ■ notice—Conditions that are not error conditions, but might warrant special handling. ■ info—Informational messages. ■ debug—Software debugging messages. <p>upto level—Log all messages up to a particular level.</p>
Usage Guidelines	See “Configuring Logging for the Routing Protocol Process” on page 116.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	syslog in the <i>JUNOS System Basics Configuration Guide</i>

p2mp-lsp-next-hop

Syntax	p2mp-lsp-next-hop { metric <i>metric</i> ; preference <i>preference</i> ; }
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options static route <i>destination-prefix</i>], [edit logical-systems <i>logical-system-name</i> routing-options static route <i>destination-prefix</i>], [edit routing-instances <i>routing-instance-name</i> routing-options static route <i>destination-prefix</i>], [edit routing-options static route <i>destination-prefix</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Specify a point-to-multipoint LSP as the next hop for a static route, and configure an independent metric or preference on that next-hop LSP.
Options	<p><i>metric</i>—Metric value. Range: 0 through 4,294,967,295 ($2^{32}-1$).</p> <p><i>preference</i>—Preference value. A lower number indicates a more preferred route. Range: 0 through 4,294,967,295 ($2^{32} - 1$) Default: 5</p>
Usage Guidelines	See “Specifying an LSP as the Next Hop for a Static Route” on page 59.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

passive

See active

policy

Syntax	<code>policy <i>policy-name</i>;</code>
Hierarchy Level	<pre>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options (aggregate generate) (defaults route)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options rib <i>routing-table-name</i> (aggregate generate) (defaults route)], [edit logical-systems <i>logical-system-name</i> routing-options (aggregate generate) (defaults route)], [edit logical-systems <i>logical-system-name</i> routing-options rib <i>routing-table-name</i> (aggregate generate) (defaults route)], [edit routing-instances <i>routing-instance-name</i> routing-options (aggregate generate) (defaults route)], [edit routing-instances <i>routing-instance-name</i> routing-options rib <i>routing-table-name</i> (aggregate generate) (defaults route)], [edit routing-options (aggregate generate) (defaults route)], [edit routing-options rib <i>routing-table-name</i> (aggregate generate) (defaults route)]</pre>
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Associate a routing policy when configuring an aggregate or generated route's destination prefix in the routes part of the aggregate or generate statement. This provides the equivalent of an import routing policy filter for the destination prefix. That is, each potential contributor to an aggregate route, along with any aggregate options, is passed through the policy filter. The policy then can accept or reject the route as a contributor to the aggregate route and, if the contributor is accepted, the policy can modify the default preferences. The contributor with the numerically smallest prefix becomes the most preferred, or <i>primary</i> , contributor. A rejected contributor still can contribute to a less specific aggregate route. If you do not specify a policy filter, all candidate routes contribute to an aggregate route.
Options	<i>policy-name</i> —Name of a routing policy.
Usage Guidelines	See “Configuring Aggregate Routes” on page 78 and “Configuring Generated Routes” on page 86.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	aggregate, generate

ppm

Syntax	ppm { delegate-processing; }
Hierarchy Level	[edit routing-options], [edit logical-systems <i>logical-system-name</i> routing-options],
Release Information	Statement introduced in JUNOS Release 8.2
Description	(M120, M320, MX-series, T-series, and TX Matrix routing platforms only) Distribute packet processing management (PPM) to the Packet Forwarding Engine.
Default	disabled
Options	delegate-processing—Distribute PPM to the Packet Forwarding Engine.
Usage Guidelines	See “Enabling Distributed Periodic Packet Management” on page 121
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

preference

Syntax	(preference preference2 color color2) <i>preference</i> <type type>;
Hierarchy Level	<pre>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options (aggregate generate static) (defaults route)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options rib <i>routing-table-name</i> (aggregate generate static) (defaults route)], [edit logical-systems <i>logical-system-name</i> routing-options (aggregate generate static) (defaults route)], [edit logical-systems <i>logical-system-name</i> routing-options rib <i>routing-table-name</i> (aggregate generate static) (defaults route)], [edit routing-instances <i>routing-instance-name</i> routing-options (aggregate generate static) (defaults route)], [edit routing-instances <i>routing-instance-name</i> routing-options rib <i>routing-table-name</i> (aggregate generate static) (defaults route)], [edit routing-options (aggregate generate static) (defaults route)], [edit routing-options rib <i>routing-table-name</i> (aggregate generate static) (defaults route)]</pre>
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Preference value for a static, aggregated, or generated route. You also can specify a secondary preference value (preference2), as well as colors, which are even finer-grained preference values (color and color2).
Options	<p>preference—Preference value. A lower number indicates a more preferred route.</p> <p>Range: 0 through 4,294,967,295 ($2^{32} - 1$)</p> <p>Default: 5 (for static routes), 130 (for aggregate and generated routes)</p> <p>type—(Optional) Type of route.</p> <p>Range: 1 through 16</p>
Usage Guidelines	See “Configuring Static Routes” on page 51, “Configuring Aggregate Routes” on page 78, and “Configuring Generated Routes” on page 86.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>
Related Topics	aggregate, generate, static

prefix

Syntax	<code>prefix destination-prefix;</code>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options multicast scope <i>scope-name</i>], [edit logical-systems <i>logical-system-name</i> routing-options multicast scope <i>scope-name</i>], [edit routing-instances <i>routing-instance-name</i> routing-options multicast scope <i>scope-name</i>], [edit routing-options multicast scope <i>scope-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure the prefix for multicast scopes.
Options	<i>destination-prefix</i> —Address range for the multicast scope.
Usage Guidelines	See “Configuring Multicast Scoping” on page 107.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	multicast

qualified-next-hop

Syntax	qualified-next-hop (<i>address</i> <i>interface-name</i>) { interface <i>interface-name</i> ; metric <i>metric</i> ; preference <i>preference</i> ; }
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options static route <i>destination-prefix</i>], [edit logical-systems <i>logical-system-name</i> routing-options rib inet6.0 static route <i>destination-prefix</i>], [edit logical-systems <i>logical-system-name</i> routing-options static route <i>destination-prefix</i>], [edit routing-instances <i>routing-instance-name</i> routing-options static route <i>destination-prefix</i>], [edit routing-options rib inet6.0 static route <i>destination-prefix</i>], [edit routing-options static route <i>destination-prefix</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure an independent metric or preference on a static route.
Options	<p><i>address</i>—IPv4, IPv6, or ISO network address of the next hop. For an unnumbered Ethernet interface, only an IPv4 address is valid.</p> <p><i>interface-name</i>—Name of the interface on which to configure an independent metric or preference for a static route. To configure an unnumbered Ethernet interface as the next-hop interface for a static route, specify qualified-next-hop <i>interface-name</i>, where <i>interface-name</i> is the name of the unnumbered Ethernet interface.</p> <p><i>metric</i>—Metric value. Range: 0 through 4,294,967,295 ($2^{32}-1$).</p> <p><i>preference</i>—Preference value. A lower number indicates a more preferred route. Range: 0 through 4,294,967,295 ($2^{32} - 1$) Default: 5</p>
Usage Guidelines	See “Specifying an Independent Preference for a Static Route” on page 55.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

readvertise

Syntax	(readvertise no-readvertise);
Hierarchy Level	<pre>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options rib <i>routing-table-name</i> static (defaults route)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options static (defaults route)], [edit logical-systems <i>logical-system-name</i> routing-options rib <i>routing-table-name</i> static (defaults route)], [edit logical-systems <i>logical-system-name</i> routing-options static (defaults route)], [edit routing-instances <i>routing-instance-name</i> routing-options rib <i>routing-table-name</i> static (defaults route)], [edit routing-instances <i>routing-instance-name</i> routing-options static (defaults route)], [edit routing-options rib <i>routing-table-name</i> static (defaults route)], [edit routing-options static (defaults route)]</pre>
Release Information	Statement introduced before JUNOS Release 7.4.
Description	<p>Configure whether static routes are eligible to be readvertised by routing protocols:</p> <ul style="list-style-type: none"> ■ readvertise—Readvertise static routes. ■ no-readvertise—Mark a static route as being ineligible for readvertisement; include the no-readvertise option when configuring the route.
Default	readvertise
Usage Guidelines	See “Configuring Static Routes” on page 51.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>
Related Topics	static

resolution

Syntax	<pre>resolution { rib <i>routing-table-name</i> { import [<i>policy-names</i>]; resolution-ribs [<i>routing-table-names</i>]; } }</pre>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options], [edit logical-systems <i>logical-system-name</i> routing-options], [edit routing-instances <i>routing-instance-name</i> routing-options], [edit routing-options]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure route resolution.
Options	The statements are explained separately.
Usage Guidelines	See “Configuring Route Resolution” on page 116.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

resolution-ribs

Syntax	<pre>resolution-ribs [<i>routing-table-names</i>];</pre>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options resolution rib], [edit logical-systems <i>logical-system-name</i> routing-options resolution rib], [edit routing-instances <i>routing-instance-name</i> routing-options resolution rib], [edit routing-options resolution rib]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Specify one or more routing tables to use for route resolution.
Options	The statements are explained separately.
Usage Guidelines	See “Configuring Route Resolution” on page 116.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

resolve

Syntax	resolve;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options rib <i>routing-table-name</i> static (defaults route)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options static (defaults route)], [edit logical-systems <i>logical-system-name</i> routing-options rib <i>routing-table-name</i> static (defaults route)], [edit logical-systems <i>logical-system-name</i> routing-options static (defaults route)], [edit routing-instances <i>routing-instance-name</i> routing-options rib <i>routing-table-name</i> static (defaults route)], [edit routing-instances <i>routing-instance-name</i> routing-options static (defaults route)], [edit routing-options rib <i>routing-table-name</i> static (defaults route)], [edit routing-options static (defaults route)]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure statically configured routes to be resolved to a next hop that is not directly connected. The route is resolved through the <i>inet.0</i> and <i>inet.3</i> routing tables.
Usage Guidelines	See “Specifying When the Route Can Be Resolved to a Prefix That Is Not Directly Connected” on page 70.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	static

restart-duration

Syntax	<code>restart-duration seconds;</code>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options graceful-restart], [edit logical-systems <i>logical-system-name</i> routing-options graceful-restart], [edit routing-instances <i>routing-instance-name</i> routing-options graceful-restart], [edit routing-options graceful-restart]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure the restart timer.
Options	<code>restart-duration seconds</code> —Configure the time period for the restart to last. Range: 120 through 900 seconds Default: 90 seconds
Usage Guidelines	See “Configuring Graceful Restart” on page 113.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

retain

Syntax	(retain no-retain);
Hierarchy Level	<pre>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options rib <i>routing-table-name</i> static (defaults route)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options static (defaults route)], [edit logical-systems <i>logical-system-name</i> routing-options rib <i>routing-table-name</i> static (defaults route)], [edit logical-systems <i>logical-system-name</i> routing-options static (defaults route)], [edit routing-instances <i>routing-instance-name</i> routing-options rib <i>routing-table-name</i> static (defaults route)], [edit routing-instances <i>routing-instance-name</i> routing-options static (defaults route)], [edit routing-options rib <i>routing-table-name</i> static (defaults route)], [edit routing-options static (defaults route)]</pre>
Release Information	Statement introduced before JUNOS Release 7.4.
Description	<p>Configure statically configured routes to be deleted from or retained in the forwarding table when the routing protocol process shuts down normally:</p> <ul style="list-style-type: none"> ■ retain—Have a static route remain in the forwarding table when the routing protocol process shuts down normally. Doing this greatly reduces the time required to restart a system that has a large number of routes in its routing table. ■ no-retain—Delete statically configured routes from the forwarding table when the routing protocol process shuts down normally.
Default	no-retain
Usage Guidelines	See “Configuring Static Routes” on page 51.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>
Related Topics	static

rib

See the following sections:

- **rib (General)** on page 186
- **rib (Route Resolution)** on page 187

rib (General)

Syntax `rib routing-table-name {`
 `static {`
 `defaults {`
 `static-options;`
 `}`
 `rib-group group-name;`
 `route destination-prefix {`
 `next-hop;`
 `static-options;`
 `}`
 `}`
 `aggregate {`
 `defaults {`
 `... aggregate-options ...`
 `}`
 `route destination-prefix {`
 `policy policy-name;`
 `... aggregate-options ...`
 `}`
 `generate {`
 `defaults {`
 `generate-options;`
 `}`
 `route destination-prefix {`
 `policy policy-name;`
 `generate-options;`
 `}`
 `}`
 `}`
 `martians {`
 `destination-prefix match-type <allow>;`
 `}`
 `}`

Hierarchy Level [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* routing-options],
 [edit logical-systems *logical-system-name* routing-options],
 [edit routing-instances *routing-instance-name* routing-options],
 [edit routing-options]

Release Information Statement introduced before JUNOS Release 7.4.

Description Create a routing table.

Explicitly creating a routing table with the *routing-table-name* statement is optional if you are not adding any static, martian, aggregate, or generated routes to the routing table and if you also are creating a routing table group. Simply including the **passive** statement to declare that a routing table is part of a routing table group is sufficient to create it.



NOTE: The IPv4 multicast routing table (*inet.1*) and the IPv6 multicast routing table (*inet6.1*) are not supported for this statement.

Default If you do not specify a routing table name with the *routing-table-name* statement, the software uses the default routing tables, which are *inet.0* for unicast routes and *inet.1* for the multicast cache.

Options *routing-table-name*—Name of the routing table, in the following format:
protocol [.identifier]

- *protocol* is the protocol family. It can be *inet6* for the IPv6 family, *inet* for the IPv4 family, *iso* for the ISO protocol family, or *instance-name.iso.0* for a ISO routing instance.
- *identifier* is a positive integer that specifies the instance of the routing table.

Default: *inet.0*

Usage Guidelines See “Creating Routing Tables” on page 49.

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

rib (Route Resolution)

Syntax *rib routing-table-name* {
 import [*policy-names*];
 resolution-ribs [*routing-table-names*];
 }

Hierarchy Level [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* routing-options resolution],
 [edit logical-systems *logical-system-name* routing-options resolution],
 [edit routing-instances *routing-instance-name* routing-options resolution],
 [edit routing-options resolution]

Release Information Statement introduced before JUNOS Release 7.4.

Description Specify routing table name for route resolution.

Options The statements are explained separately.

Usage Guidelines See “Configuring Route Resolution” on page 116.

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

rib-group

Syntax	<code>rib-group group-name;</code>
Hierarchy Level	<p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options interface-routes],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-options interface-routes],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-options rib <i>routing-table-name</i> static],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-options static],</p> <p>[edit routing-instances <i>routing-instance-name</i> routing-options interface-routes],</p> <p>[edit routing-options interface-routes],</p> <p>[edit routing-options rib <i>routing-table-name</i> static],</p> <p>[edit routing-options static]</p>
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure which routing table groups interface routes are imported into.
Options	<i>group-name</i> —Name of the routing table group. The name must start with a letter and can include letters, numbers, and hyphens. It generally does not make sense to specify more than a single routing table group.
Usage Guidelines	See “Configuring How Interface Routes Are Imported into Routing Tables” on page 106 and “Creating Routing Table Groups” on page 104.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>
Related Topics	interface-routes, rib-groups

rib-groups

Syntax	<pre> rib-groups { group-name { import-policy [policy-names]; import-rib [group-names]; export-rib group-name; } } </pre>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-options], [edit routing-options]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	<p>Group one or more routing tables to form a routing table group. A routing protocol can import routes into all the routing tables in the group and can export routes from a single routing table.</p> <p>Each routing table group must contain one or more routing tables that the JUNOS software uses when importing routes (specified in the import-rib statement) and optionally can contain one routing table group that the JUNOS software uses when exporting routes to the routing protocols (specified in the export-rib statement).</p>
Options	<p><i>group-name</i>—Name of the routing table group. The name must start with a letter and can include letters, numbers, and hyphens.</p> <p>The remaining statements are explained separately.</p>
Usage Guidelines	See “Creating Routing Table Groups” on page 104.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>
Related Topics	rib-group


route-distinguisher-id

Syntax	route-distinguisher-id <i>address</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options], [edit logical-systems <i>logical-system-name</i> routing-options], [edit routing-instances <i>routing-instance-name</i> routing-options], [edit routing-options]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure a route distinguisher identifier for a routing instance, specifying an IP address. If a route distinguisher is configured for a particular routing instance, that value supersedes the route distinguisher configured by this statement.
Options	<i>address</i> —IP address.
Usage Guidelines	See “Configuring a Route Distinguisher” on page 114.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

route-record

Syntax	route-record;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-options], [edit routing-options]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Export the AS path and routing information to the traffic sampling process.
Usage Guidelines	See “Configuring Route Recording for Flow Aggregation” on page 104.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	<i>JUNOS Network Interfaces Configuration Guide</i>

router-id

Syntax	router-id <i>address</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options], [edit logical-systems <i>logical-system-name</i> routing-options], [edit routing-instances <i>routing-instance-name</i> routing-options], [edit routing-options]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Specify the router's IP address.
<hr/>  NOTE: We strongly recommend that you configure the router identifier under the [routing-options] hierarchy level to avoid unpredictable behavior if the interface address on a loopback interface changes.	
Options	<i>address</i> —IP address of the router. Default: Address of the first interface encountered by the JUNOS software.
Usage Guidelines	See “Configuring the Router Identifier” on page 103.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

routing-options

Syntax	routing-options { ... }
Hierarchy Level	[edit], [edit logical-systems <i>logical-system-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i>], [edit routing-instances <i>routing-instance-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure protocol-independent routing properties.
Usage Guidelines	See “Protocol-Independent Routing Properties Overview” on page 43.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

scope

Syntax	scope <i>scope-name</i> { interface [<i>interface-names</i>]; prefix <i>destination-prefix</i> ; }
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options multicast], [edit logical-systems <i>logical-system-name</i> routing-options multicast], [edit routing-instances <i>routing-instance-name</i> routing-options multicast], [edit routing-options multicast]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure multicast scoping.
Options	<i>scope-name</i> —Name of the multicast scope. The remaining statements are explained separately.
Usage Guidelines	See “Configuring Multicast Scoping” on page 107.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	multicast

source-address

Syntax	source-address <i>address</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options dynamic-tunnels <i>tunnel-name</i> , [edit logical-systems <i>logical-system-name</i> routing-options dynamic-tunnels <i>tunnel-name</i> , [edit routing-instances <i>routing-instance-name</i> routing-options dynamic-tunnels <i>tunnel-name</i>], [edit routing-options dynamic-tunnels <i>tunnel-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Specifies the source address for the GRE tunnels. The source address specifies the address used as the source for the local tunnel endpoint. This address can be any local address on the router (typically the router ID or the loopback address).
Options	<i>address</i> —Name of the source address.
Usage Guidelines	See “Configuring a Dynamic Tunnel” on page 114.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

source-routing

Syntax	source-routing { (ip ipv6) }
Hierarchy Level	[edit routing-options]
Release Information	Statement for IPv6 introduced in JUNOS Release 8.2. Statement for IPv4 introduced in JUNOS Release 8.5.
Description	Enable source routing.
Usage Guidelines	See “Enabling Source Routing” on page 122.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

ssm-groups

Syntax	ssm-groups { <i>address</i> ; }
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options multicast] [edit logical-systems <i>logical-system-name</i> routing-options multicast], [edit routing-instances <i>routing-instance-name</i> routing-options multicast], [edit routing-options multicast]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure additional SSM groups.
Options	<i>address</i> —Address range of the additional SSM group.
Usage Guidelines	See “Configuring Additional Source-Specific Multicast Groups” on page 108.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	multicast

static

Syntax	<pre> static { defaults { static-options; } rib-group <i>group-name</i>; route <i>destination-prefix</i> { bfd-liveness-detection { detection-time { threshold <i>milliseconds</i>; } <local-address <i>ip-address</i>>; minimum-interval <i>milliseconds</i>; minimum-receive-interval <i>milliseconds</i>; minimum-receive-ttl <i>number</i>; multiplier <i>number</i>; neighbor <i>address</i>; no-adaptation; transmit-interval { threshold <i>milliseconds</i>; minimum-interval <i>milliseconds</i>; } version (1 automatic); } next-hop <i>address</i>; next-hop <i>options</i>; qualified-next-hop <i>address</i> { metric <i>metric</i>; preference <i>preference</i>; } static-options; } }</pre>
Hierarchy Level	<pre> [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options], [edit logical-systems <i>logical-system-name</i> routing-options], [edit logical-systems <i>logical-system-name</i> routing-options rib <i>routing-table-name</i>], [edit routing-instances <i>routing-instance-name</i> routing-options], [edit routing-options], [edit routing-options rib <i>routing-table-name</i>]</pre>
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure static routes to be installed in the routing table. You can specify any number of routes within a single static statement, and you can specify any number of static options in the configuration.
Options	defaults —Specify global static route options. These options only set default attributes inherited by all newly created static routes. These are treated as global defaults

and apply to all the static routes you configure in the **static** statement. This part of the **static** statement is optional.

route *destination-prefix*—Destination of the static route.

- **defaults**—For the default route to the destination. This is equivalent to specifying an IP address of 0.0.0.0/0.
- ***destination-prefix/prefix-length***—*destination-prefix* is the network portion of the IP address, and *prefix-length* is the destination prefix length.
- **next-hop *address***—Reach the next-hop router by specifying an IP address, an interface name, or an ISO network entity title (NET).
- ***nsap-prefix***—*nsap-prefix* is the network service access points (NSAP) address for ISO.

next-hop options—Additional information for how to manage forwarding of packets to the next hop.

- **discard**—Do not forward packets addressed to this destination. Instead, drop the packets, do not send ICMP unreachable messages to the packets' originators, and install a reject route for this destination into the routing table.
- ***iso-net***—Reach the next-hop router by specifying an ISO NSAP.
- **next-table *routing-table-name***—Name of the next routing table to the destination.
- **receive**—Install a receive route for this destination into the routing table.
- **reject**—Do not forward packets addressed to this destination. Instead, drop the packets, send ICMP unreachable messages to the packets' originators, and install a reject route for this destination into the routing table.

static-options—(Optional under **route**) Additional information about static routes, which is included with the route when it is installed in the routing table.

You can specify one or more of the following in *static-options*. Each of the options is explained separately.

- (active | passive);
- as-path <as-path> <origin (egp | igp | incomplete)> <atomic-aggregate> <aggregator as-number in-address>;
- community [*community-ids*];
- (install | no-install);
- (metric | metric2 | metric3 | metric4) *value* <type type>;
- (preference | preference2 | color | color2) *preference* <type type>;
- (readvertise | no-readvertise);
- (resolve | no-resolve);
- (no-retain | retain);
- tag *string*;

The remaining statements are explained separately.

Usage Guidelines See “Configuring Static Routes” on page 51.

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

tag

Syntax	<code>tag <i>string</i>;</code>
Hierarchy Level	<p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options (aggregate generate static) (defaults route)],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options rib <i>routing-table-name</i> (aggregate generate static) (defaults route)],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-options (aggregate generate static) (defaults route)],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-options rib <i>routing-table-name</i> (aggregate generate static) (defaults route)],</p> <p>[edit routing-instances <i>routing-instance-name</i> routing-options aggregate generate static) (defaults route)],</p> <p>[edit routing-instances <i>routing-instance-name</i> routing-options rib <i>routing-table-name</i> (aggregate generate static) (defaults route)],</p> <p>[edit routing-options (aggregate generate static) (defaults route)],</p> <p>[edit routing-options rib <i>routing-table-name</i> (aggregate generate static) (defaults route)]</p>
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Associate an OSPF tag with a static, aggregate, or generated route.
Options	<i>string</i> —OSPF tag string.
Usage Guidelines	See “Configuring Static Routes” on page 51, “Configuring Aggregate Routes” on page 78, and “Configuring Generated Routes” on page 86.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>
Related Topics	aggregate, generate, static

threshold

Syntax	threshold suppress <i>value</i> <reuse <i>value</i> >;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options multicast forwarding-cache], [edit logical-systems <i>logical-system-name</i> routing-options multicast forwarding-cache], [edit routing-instances <i>routing-instance-name</i> routing-options multicast forwarding-cache], [edit routing-options multicast forwarding-cache]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure the suppression and reuse thresholds for multicast forwarding cache limits.
Options	<p>suppress <i>value</i>—Value at which to begin suppressing new multicast forwarding cache entries. This value is mandatory. This number should be greater than the reuse <i>value</i>.</p> <p>Range: 1 through 200,000</p> <p>reuse <i>value</i>—Value at which to begin creating new multicast forwarding cache entries. This value is optional. If configured, this number should be less than the suppress <i>value</i>.</p> <p>Range: 1 through 200,000</p>
Usage Guidelines	See “Configuring Multicast Forwarding Cache Limits” on page 109.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

traceoptions

Syntax traceoptions {
 file *filename* <size *size*> <files *number*> <(world-readable | no-world-readable)>;
 flag *flag* <flag-modifier> <disable>;
 }

Hierarchy Level [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* routing-options],
 [edit logical-systems *logical-system-name* routing-options],
 [edit routing-instances *routing-instance-name* routing-options],
 [edit routing-options],
 [edit routing-options flow]

Release Information Statement introduced before JUNOS Release 7.4.

Description Define tracing operations that track all routing protocol functionality in the router.

To specify more than one tracing operation, include multiple **flag** statements.

Default If you do not include this statement, no global tracing operations are performed.

Options **disable**—(Optional) Disable the tracing operation. You can use this option to disable a single operation when you have defined a broad group of tracing operations, such as **all**.

file *filename*—Name of the file to receive the output of the tracing operation. Enclose the name within quotation marks. All files are placed in the directory **/var/log**. We recommend that you place global routing protocol tracing output in the file **routing-log**.

files *number*—(Optional) Maximum number of trace files. When a trace file named **trace-file** reaches its maximum size, it is renamed **trace-file.0**, then **trace-file.1**, and so on, until the maximum number of trace files is reached. Then, the oldest trace file is overwritten.

If you specify a maximum number of files, you also must specify a maximum file size with the **size** option.

Range: 2 through 1000 files

Default: 2 files

flag *flag*—Tracing operation to perform. To specify more than one tracing operation, include multiple **flag** statements. These are the global routing protocol tracing options:

- **all**—All tracing operations
- **condition-manager**—Condition-manager events
- **config-internal**—Configuration internals
- **event**—Event processing

- **flash**—Flash processing
- **general**—All normal operations and routing table changes (a combination of the **normal** and **route** trace operations)
- **indirect**—Indirect next-hop add/change/delete
- **kernel**—Kernel communication
- **normal**—All normal operations
- **nsr-synchronization**—Nonstop-routing synchronization
- **parse**—Configuration parsing
- **policy**—Routing policy operations and actions
- **regex-parse**—Regular-expression parsing
- **route**—Routing table changes
- **state**—State transitions
- **task**—Interface transactions and processing
- **timer**—Timer usage

flag-modifier—(Optional) Modifier for the tracing flag. You can specify one or more of these modifiers:

- **detail**—Detailed trace information
- **receive**—Packets being received
- **send**—Packets being transmitted

no-world-readable—(Optional) Prevent any user from reading the log file.

size size—(Optional) Maximum size of each trace file, in kilobytes (KB), megabytes (MB), or gigabytes (GB). When a trace file named *trace-file* reaches this size, it is renamed *trace-file.0*. When the *trace-file* again reaches its maximum size, *trace-file.0* is renamed *trace-file.1* and *trace-file* is renamed *trace-file.0*. This renaming scheme continues until the maximum number of trace files is reached. Then, the oldest trace file is overwritten.

If you specify a maximum file size, you also must specify a maximum number of trace files with the **files** option.

Syntax: *xk* to specify KB, *xm* to specify MB, or *xg* to specify GB

Range: 10 KB through the maximum file size supported on your system

Default: 1 MB

world-readable—(Optional) Allow any user to read the log file.

Usage Guidelines See “Tracing Global Routing Protocol Operations” on page 119.

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

tunnel-type

Syntax tunnel-type *type*;

Hierarchy Level [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* routing-options dynamic-tunnels *tunnel-name*],
[edit logical-systems *logical-system-name* routing-options dynamic-tunnels *tunnel-name*,
[edit routing-instances *routing-instance-name* routing-options dynamic-tunnels *tunnel-name*],
[edit routing-options dynamic-tunnels *tunnel-name*

Release Information Statement introduced before JUNOS Release 7.4.

Description Specify the type of tunnel to be dynamically created. The only valid value is **gre** (for GRE tunnels).

Options *type*—Tunnel type.

Usage Guidelines See “Configuring a Dynamic Tunnel” on page 114.

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

unicast-reverse-path

Syntax unicast-reverse-path (active-paths | feasible-paths);

Hierarchy Level [edit logical-systems *logical-system-name* routing-options forwarding-table],
[edit routing-instances *routing-instance-name* instance-type *name* routing-options forwarding-table],
[edit routing-options forwarding-table]

Release Information Statement introduced before JUNOS Release 7.4.
Support for routing instances added in JUNOS Release 8.3.

Description Control the operation of unicast reverse-path-forwarding check.

Options *active-paths*—Consider only active paths during the unicast reverse-path check.

feasible-paths—Consider all feasible paths during the unicast reverse-path check.

Usage Guidelines See “Configuring Unicast Reverse-Path-Forwarding Check” on page 112 and the *JUNOS Network Interfaces Configuration Guide*.

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

Part 3

Routing Instances

- Routing Instances Overview on page 205
- Routing Instances Configuration Guidelines on page 207
- Summary of Routing Instances Configuration Statements on page 253

Chapter 8

Routing Instances Overview

You can create multiple instances of Border Gateway Protocol (BGP), Intermediate System-to-Intermediate System (IS-IS), Open Shortest Path First (OSPF), Protocol Independent Multicast (PIM), Routing Information Protocol (RIP), and static routes by including statements at the following hierarchy levels:

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

A routing instance is a collection of routing tables, interfaces, and routing protocol parameters. The set of interfaces belongs to the routing tables, and the routing protocol parameters control the information in the routing tables.

You can configure six types of routing instances: forwarding, Layer 2 virtual private network (VPN), nonforwarding, VPN routing and forwarding (VRF), virtual router, and virtual private LAN service (VPLS).

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



NOTE: The default routing instance, **master**, refers to the main **inet.0** routing table. The master routing instance is reserved and cannot be specified as a routing instance.

Configure global routing options and protocols for the master instance by including statements at the [edit protocols] and [edit routing-options] hierarchy levels. Routes are installed into the master routing instance **inet.0** by default, unless a routing instance is specified.

Multiple instances of BGP, OSPF, and RIP are used for Layer 3 VPN implementation. The multiple instances of BGP, OSPF, and RIP keep routing information for different VPNs separate. The VRF instance advertises routes from the customer edge (CE) router to the provider edge (PE) router and advertises routes from the PE router to the CE router. Each VPN receives only routing information belonging to that VPN.

Forwarding instances are used to implement filter-based forwarding for Common Access Layer applications.

PIM instances are used to implement multicast over VPN applications.

Nonforwarding instances of IS-IS and OSPF can be used to separate a very large network into smaller administrative entities. Instead of configuring a large number of filters, nonforwarding instances can be used to filter routes, thereby instantiating policy. Nonforwarding instances can be used to reduce the amount of routing information advertised throughout all components of a network. Routing information associated with a particular instance can be announced where required, instead of being advertised to the whole network.

Layer 2 VPN instances are used for Layer 2 VPN implementation.

Virtual router instances are similar to a VPN routing and forwarding instance type, but used for non-VPN-related applications. There are no VRF import, VRF export, VRF target, or route distinguisher requirements for this instance type.

Use the VPLS routing instance type for point-to-multipoint LAN implementations between a set of sites in a VPN.

Chapter 9

Routing Instances Configuration Guidelines

You can create multiple instances of Border Gateway Protocol (BGP), Intermediate System-to-Intermediate System (IS-IS), Label Distribution Protocol (LDP), Multicast Source Discovery Protocol (MSDP), Open Shortest Path First version 2 (OSPF), Open Shortest Path First version 3 (OSPFv3), Protocol Independent Multicast (PIM), Routing Information Protocol (RIP), and static routes by including statements at the following hierarchy levels:

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



NOTE: The default routing instance, *master*, refers to the main *inet.0* routing table. The master routing instance is reserved and cannot be specified as a routing instance.

Each routing instance consists of sets of the following:

- Routing tables
- Interfaces that belong to these routing tables
- Routing option configurations

You can configure eight types of routing instances:

- Forwarding—Use this routing instance type for filter-based forwarding applications. For this instance type, there is no one-to-one mapping between an interface and a routing instance. All interfaces belong to the default instance *inet.0*.
- Layer2-control—(MX-series routers only) Use this routing instance type for RSTP or MSTP in customer edge interfaces of a VPLS routing instance. This instance type cannot be used if the customer edge interface is multihomed to two provider edge interfaces. If the customer edge interface is multihomed to two provider edge interfaces, use the default BPDU tunneling.
- Layer 2 VPN—Use this routing instance type for Layer 2 virtual private network (VPN) implementations.

- Nonforwarding—Use this routing instance type when a separation of routing table information is required. There is no corresponding forwarding table. All routes are installed into the default forwarding table. IS-IS instances are strictly nonforwarding instance types.
- Virtual router—Similar to a VPN routing and forwarding instance type, but used for non-VPN-related applications. There are no virtual routing and forwarding (VRF) import, VRF export, VRF target, or route distinguisher requirements for this instance type.
- Virtual switch—(MX-series routers only) Use the virtual switch instance type to group one or more Layer 2 bridge domains. A bridge domain consists of a set of ports that share the same flooding or broadcast characteristics. Each virtual switch represents a Layer 2 network. You can optionally configure a virtual switch to support Integrating Routing and Bridging (IRB), which facilitates simultaneous Layer 2 bridging and Layer 3 IP routing on the same interface. You can also configure Layer 2 control protocols to provide loop resolution. Protocols supported include the Spanning Tree Protocol, the Rapid Spanning Tree Protocol, and the Multiple Spanning Tree Protocol.
- VPLS—Use the virtual private local-area network service (VPLS) routing instance type for point-to-multipoint LAN implementations between a set of sites in a VPN.
- VRF—Use the VPN routing and forwarding routing (VRF) instance type for Layer 3 VPN implementations. This routing instance type has a VPN routing table as well as a corresponding VPN forwarding table. For this instance type, there is a one-to-one mapping between an interface and a routing instance. Each VRF instance corresponds with a forwarding table. Routes on an interface go into the corresponding forwarding table.

For more detailed information about configuring VPNs and Layer 2 VPNs, see the *JUNOS VPNs Configuration Guide*.

For more detailed information about configuring virtual switches and Layer 2 services on MX-series routers, see the *JUNOS MX-series Layer 2 Configuration Guide*.

This chapter describes the following tasks for configuring routing instances:

- Configuring Routing Instances on page 209
- Routing Instances Minimum Configuration on page 213
- Configuring Multiple Instances of BGP on page 219
- Configuring Multiple Instances of IS-IS on page 220
- Configuring Multiple Instances of LDP on page 225
- Configuring Multiple Instances of MSDP on page 226
- Configuring Multiple Instances of OSPF on page 226
- Configuring Multiple Instances of PIM on page 229
- Configuring Multiple Instances of RIP on page 230
- Configuring an Instance on page 231
- Configuring VPNs on page 232

- Configuring a Virtual Switch on page 232
- Configuring an Instance Type on page 233
- Configuring a Route Distinguisher on page 236
- Configuring Filter-Based Forwarding on page 237
- Configuring Class-of-Service-Based Forwarding on page 239
- Configuring Secondary VRF Import and Export Policy on page 240
- Configuring Policy-Based Export for Routing Instances on page 241
- Configuring a VRF Table Label on page 245
- Configuring a VRF Target on page 245
- Configuring an OSPF Domain ID on page 246
- Configuring Route Limits for Routing Tables on page 251
- Configuring an Independent AS Domain on page 251

Configuring Routing Instances

To configure routing instances, include the following statements:

```

routing-instances {
  routing-instance-name {
    description text;
    forwarding-options;
    interface interface-name;
    instance-type (forwarding | layer2-control | l2vpn | no-forwarding | virtual-router |
      virtual-switch | vpls | vrf);
    bridge-domains {
      bridge-domains-name {
        domain-type bridge;
        vlan-id (none | all | number);
        vlan-tags outer number inner number;
        interface interface-name;
        routing-interface routing-interface-name;
        bridge-options {
          mac-limit limit;
          mac-statistics;
          mac-table-size limit;
          no-mac-learning;
          static-mac mac-address;
        }
      }
    }
  }
  no-vrf-advertise;
  route-distinguisher (as-number:number | ip-address:number);
  vrf-import [ policy-names ];
  vrf-export [ policy-names ];
  vrf-table-label;
  vrf-target {
    export community-name;
    import community-name;
  }
}

```

```

protocols {
  bgp {
    ... bgp-configuration ...
  }
  isis {
    ... isis-configuration ...
  }
  l2vpn {
    ... l2vpn-configuration ...
  }
  ldp {
    ... ldp-configuration ...
  }
  msdp {
    ... msdp-configuration ...
  }
  mstp {
    ... mstp-configuration ...
  }
  ospf {
    domain-id domain-id;
    domain-vpn-tag number;
    route-type-community (iana | vendor);
    ... ospf-configuration ...
  }
  ospf3 {
    domain-id domain-id;
    domain-vpn-tag number;
    route-type-community (iana | vendor);
    ... ospf3-configuration ...
  }
  pim {
    ... pim-configuration ...
  }
  rip {
    ... rip-configuration ...
  }
  ripng {
    ... ripng-configuration ...
  }
  rstp {
    ... rstp-configuration ...
  }
  vpls {
    ... vpls-configuration ...
  }
}
routing-options {
  aggregate {
    defaults {
      ... aggregate-options ...
    }
    route destination-prefix {
      policy policy-name;
      ... aggregate-options ...
    }
  }
}

```

```

}
auto-export {
  (disable | enable);
  family {
    inet {
      multicast {
        (disable | enable);
        rib-group rib-group;
      }
      unicast {
        (disable | enable);
        rib-group rib-group;
      }
    }
  }
}
traceoptions {
  file filename <size size> <files number> <world-readable |
    no-world-readable>;
  flag flag <flag-modifier> <disable>;
}
}
autonomous-system autonomous-system <loops number> {
  independent-domain;
}
confederation confederation-autonomous-system members autonomous-system;
fate-sharing {
  group group-name;
  cost value;
  from address [to address];
}
forwarding-table {
  export [ policy-names ];
  (indirect-next-hop | no-indirect-next-hop);
}
generate {
  defaults {
    generate-options;
  }
  route destination-prefix {
    policy policy-name;
    generate-options;
  }
}
instance-export [ policy-names ];
instance-import [ policy-names ];
interface-routes {
  rib-group group-name;
}
martians {
  destination-prefix match-type <allow>;
}
maximum-paths path-limit <log-only | threshold value log-interval seconds>;
maximum-prefixes prefix-limit <log-only | threshold value log-interval seconds>;
multicast {
  scope scope-name {
    interface interface-name;

```

```

        prefix destination-prefix;
    }
    ssm-groups {
        addresses;
    }
}
options {
    syslog (level level | upto level);
}
rib routing-table-name {
    aggregate {
        defaults {
            ... aggregate-options ...
        }
        route destination-prefix {
            policy policy-name;
            ... aggregate-options ...
        }
    }
    generate {
        defaults {
            generate-options;
        }
        route destination-prefix {
            policy policy-name;
            generate-options;
        }
    }
}
martians {
    destination-prefix match-type <allow>;
}
static {
    defaults {
        static-options;
    }
    rib-group group-name;
    route destination-prefix {
        lsp-next-hop {
            metric metric;
            preference preference;
        }
        next-hop;
        p2mp-lsp-next-hop {
            metric metric;
            preference preference;
        }
        qualified-next-hop {
            interface interface-name;
            metric metric;
            preference preference;
        }
        static-options;
    }
}
}
route-record;

```

```

router-id address;
static {
    defaults {
        static-options;
    }
    rib-group group-name;
    route destination-prefix {
        lsp-next-hop {
            metric metric;
            preference preference;
        }
        next-hop;
        p2mp-lsp-next-hop {
            metric metric;
            preference preference;
        }
        qualified-next-hop {
            interface interface-name;
            metric metric;
            preference preference;
        }
        static-options;
    }
}
traceoptions {
    file filename <size size> <files number> <world-readable | no-world-readable>;
    flag flag <flag-modifier> <disable>;
}
}
}

```

You can include the statements at the following hierarchy levels:

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

Routing Instances Minimum Configuration

You can configure BGP, IS-IS, Layer 2 VPN, LDP, MSDP, OSPF, OSPFv3, PIM, RIP, RIPng, and VPLS routing instances.

This section discusses the following routing instance minimum configurations:

- BGP on page 214
- IS-IS on page 214
- Layer 2 VPN on page 215
- LDP on page 215
- MSDP on page 216
- Multiprotocol BGP-Based Multicast VPNs on page 216
- OSPF on page 217

- OSPFv3 on page 217
- PIM on page 218
- RIP on page 218
- VPLS on page 219

BGP

To configure a routing instance for BGP, you must include at least the following statements in the configuration.

```
[edit]
routing-instances {
  routing-instance-name {
    interface interface-name;
    instance-type (forwarding | l2vpn | no-forwarding | virtual-router | vpls | vrf);
    route-distinguisher (as-number:number | ip-address:number);
    vrf-import [ policy-names ];
    vrf-export [ policy-names ];
    protocols {
      bgp {
        bgp configuration;
      }
    }
  }
}
```

For more information about the BGP configuration statements, see “BGP Configuration Guidelines” on page 641. For more information about configuring VPNs, see the *JUNOS System Configuration Guide*.

IS-IS

To configure a routing instance for IS-IS, you must include at least the following statements in the configuration:

```
[edit]
routing-instances {
  routing-instance-name {
    interface interface-name;
    instance-type (forwarding | l2vpn | no-forwarding | virtual-router | vpls | vrf);
    route-distinguisher (as-number:number | ip-address:number);
    vrf-import [ policy-names ];
    vrf-export [ policy-names ];
    protocols {
      isis {
        ... isis configuration ...
      }
    }
  }
}
```

For more information about the IS-IS configuration statements, see “IS-IS Configuration Guidelines” on page 299.

Layer 2 VPN

To create a routing instance for Layer 2 VPN, you must include at least the following statements in the configuration:

```
[edit]
routing-instances {
  routing-instance-name {
    instance-type l2vpn;
    interface interface-name;
    route-distinguisher (as-number:number | ip-address:number);
    vrf-import [ policy-names ];
    vrf-export [ policy-names ];
    protocols {
      l2vpn {
        ... l2vpn-configuration ...
      }
    }
  }
}
```

For more information about configuring Layer 2 VPNs, see the *JUNOS VPNs Configuration Guide*.

LDP

To create a routing instance for LDP, you must include at least the following statements in the configuration:

```
[edit]
routing-instances {
  routing-instance-name {
    instance-type (forwarding | l2vpn | no-forwarding | virtual-router | vpls | vrf);
    interface interface-name;
    route-distinguisher (as-number:number | ip-address:number);
    vrf-import [ policy-names ];
    vrf-export [ policy-names ];
    protocols {
      ldp {
        ... ldp-configuration ...
      }
    }
  }
}
```

For more information about configuring LDP, see the *JUNOS MPLS Applications Configuration Guide*.

LDP routing instances are used to support LDP over VPNs. For more information about configuring multicast over VPNs, see the *JUNOS VPNs Configuration Guide*.

MSDP

To create a routing instance for MSDP, you must include at least the following statements in the configuration:

```
[edit]
routing-instances {
  routing-instance-name {
    instance-type (forwarding | l2vpn | no-forwarding | virtual-router | vpls | vrf);
    interface interface-name;
    route-distinguisher (as-number:number | ip-address:number);
    vrf-import [ policy-names ];
    vrf-export [ policy-names ];
    protocols {
      msdp {
        ... msdp-configuration ...
      }
    }
  }
}
```

For more information about configuring MSDP, see the *JUNOS Multicast Protocols Configuration Guide*.

Multiprotocol BGP-Based Multicast VPNs

To configure a routing instance for a multiprotocol BGP-based multicast VPN, you must include at least the following minimum configuration:

```
[edit]
routing-instances {
  routing-instance-name;
  instance-type vrf;
  interface interface-name;
  provider-tunnel {
    pim-asm {
      group-address -address;
    }
  }
  protocols {
    mvpn;
    route-target {
      export-target {
        target;
        unicast;
      }
      import-target {
        target {
          receiver;
          sender;
        }
      }
      unicast {
        receiver;
        sender;
      }
    }
  }
}
```



```

    }
  }
}
route-distinguisher (as:number | ip-address:number);
vrf-target community | export community-name | import community-name);
}
}

```

For more information about Multiprotocol BGP-based Multicast VPNs, see the *JUNOS VPNs Configuration Guide* and the *JUNOS Multicast Protocols Configuration Guide*.

OSPF

To configure a routing instance for OSPF, you must include at least the following statements in the configuration:

```

[edit]
routing-instances {
  routing-instance-name {
    interface interface-name;
    instance-type (forwarding | l2vpn | no-forwarding | virtual-router | vpls | vrf);
    route-distinguisher (as:number | ip-address:number);
    vrf-import [ policy-names ];
    vrf-export [ policy-names ];
    protocols {
      ospf {
        ... ospf-configuration ...
      }
    }
  }
}

```



NOTE: You can configure a logical interface under only one routing instance.

For more information about the OSPF configuration statements, see “OSPF Configuration Guidelines” on page 413.

OSPFv3

To configure a routing instance for OSPFv3, you must include at least the following statements in the configuration:

```

[edit]
routing-instances {
  routing-instance-name {
    interface interface-name;
    instance-type (no-forwarding | vrf);
    vrf-export [ policy-names ];
    vrf-import [ policy-names ];
    protocols {
      ospf3 {
        ... ospf3-configuration ...
      }
    }
  }
}

```

```

    }
  }
}

```



NOTE: You can configure a logical interface under only one routing instance.



NOTE: OSPFv3 supports the `no-forwarding` and `vrf` routing instance types only.

For more information about the OSPF configuration statements, see “OSPF Configuration Guidelines” on page 413.

PIM

To create a routing instance for PIM, you must include at least the following statements in the configuration:

```

[edit]
routing-instances {
  routing-instance-name {
    instance-type (forwarding | l2vpn | no-forwarding | virtual-router | vpls | vrf);
    interface interface-name;
    route-distinguisher (as-number:number | ip-address:number);
    vrf-import [ policy-names ];
    vrf-export [ policy-names ];
    protocols {
      pim {
        ... pim-configuration ...
      }
    }
  }
}

```

For more information about configuring PIM, see the *JUNOS Multicast Protocols Configuration Guide*.

PIM routing instances are used to support multicast over VPNs. For more detailed information about configuring multicast over VPNs, see the *JUNOS VPNs Configuration Guide*.

RIP

RIP instances are supported only for VPN routing and forwarding (VRF) instance types. This instance type provides support for Layer 3 VPNs. To configure a routing instance for RIP, you must include at least the following statements in the configuration:

```

[edit]
routing-instances {
  routing-instance-name {

```

```

interface interface-name;
instance-type vrf;
route-distinguisher (as-number:number | ip-address:number);
vrf-import [ policy-names ];
vrf-export [ policy-names ];
protocols {
    rip {
        ... rip-configuration ...
    }
}
}

```

For more information about the RIP configuration statements, see “RIP Configuration Guidelines” on page 521. For more information about configuring VPNs, see the *JUNOS VPNs Configuration Guide*.

VPLS

To create a routing instance for virtual private LAN services (VPLS), you must include at least the following statements in the configuration:

```

[edit]
routing-instances {
    routing-instance-name {
        instance-type vpls;
        interface interface-name;
        route-distinguisher (as-number:number | ip-address:number);
        vrf-import [ policy-names ];
        vrf-export [ policy-names ];
        protocols {
            vpls {
                ... vpls configuration ...
            }
        }
    }
}

```

For more information about configuring VPLS, see the *JUNOS VPNs Configuration Guide*. For a detailed VPLS example configuration, see the *JUNOS Feature Guide*.

Configuring Multiple Instances of BGP

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

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

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

Currently, EBGp (nonmultihop) peers are supported under the `routing-instances` hierarchy. EBGp peering is established over one of the interfaces configured under

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

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

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

Example: Configuring Multiple Instances of BGP

Configure multiple instances of BGP:

```
[edit]
routing-instances {
  routing-instance-name {
    interface so-1/1/1.0;
    interface so-1/1/1.1;
    instance-type vrf;
    route distinguisher (as-number:number | ip-address:number);
    protocols {
      bgp {
        group group-name {
          peer-as 01;
          type external;
          import route-name;
          export route-name;
          neighbor 10.0.0.1;
        }
      }
    }
  }
}
```

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



NOTE: BGP route reflection is not supported for VRF routing instances.

Configuring Multiple Instances of IS-IS

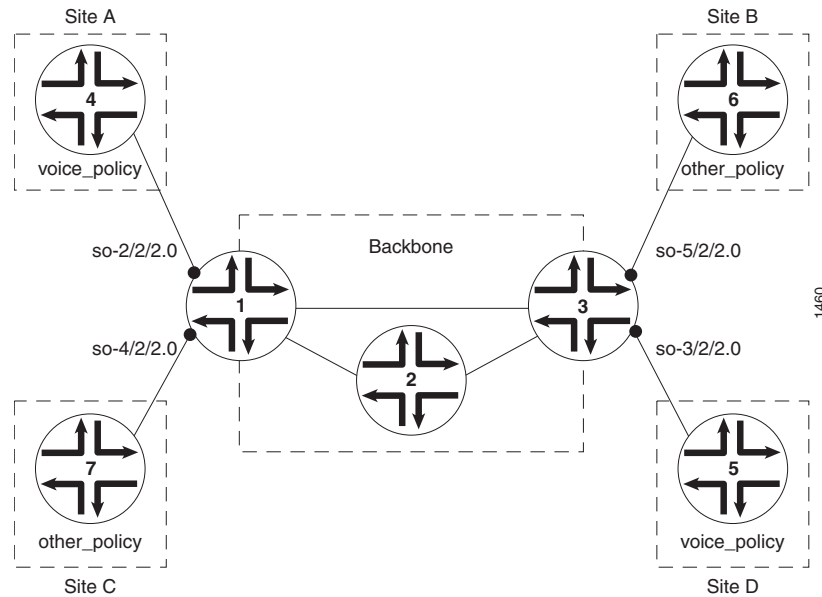
You can configure multiple instances of IS-IS for administrative separation.

To configure multiple routing instances, perform the following tasks:

1. Configure the IS-IS default instance at the [edit protocols isis] or [edit logical-systems *logical-system-name* protocols isis] hierarchy levels with the statements needed for your network so that routes are installed in `inet.0` and in the forwarding table. Make sure to include the routing table group.
2. Configure an IS-IS routing instance for each additional IS-IS routing entity, configuring the following items:
 - Interfaces
 - Routing options
 - IS-IS protocol statements belonging to that entity
 - Routing table group
3. Configure a routing table group to install routes from the routing instance into the `inet.0` routing table. You can do this in two ways:
 - Create a common routing table group so that either one of two conditions is configured:
 - Routes from the routing instances are installed in `inet.0` and therefore installed in the forwarding table.
 - Routes from one router in a routing instance are forwarded to another router in the same routing instance.
 - Create a routing table group with just the routing table from one instance and `inet.0` to keep the routes from going to other instances.
4. Create an export policy to export routes with a specific tag and to use that tag to export routes back into the instances. For more information, see the *JUNOS Policy Framework Configuration Guide*.

Example: Configuring Multiple Routing Instances of IS-IS

Figure 4 on page 222 shows how you can use multiple instances of IS-IS to segregate traffic within a large network. The network consists of three administrative entities: `voice_policy`, `other_policy`, and the backbone or core. Each entity is composed of several geographically separate sites that are connected by the backbone and managed by the backbone entity.

Figure 4: Configuration for Multiple Routing Instances

Sites A and D belong to the **voice_policy** routing instance. Sites B and C belong to the **other_policy** instance. Router 1 and Router 3 at the edge of the backbone connect the routing instances. Each runs a separate IS-IS instance (one per entity).

Router 1 runs three IS-IS instances: one each for Site A (**voice_policy**), Site C (**other_policy**), and the backbone, otherwise known as the default instance. Router 3 also runs three IS-IS instances: one each for Site B (**other_policy**), Site D (**voice_policy**), and the backbone (default instance).

When Router 1 runs the IS-IS instances, the following occur:

- Routes from the default instance routing table are placed in the **voice_policy** and **other_policy** instance routing tables.
- Routes from the **voice_policy** routing instance are placed in the default instance routing table.
- Routes from the **other_policy** routing instance are placed in the default instance routing table.
- Routes from the **voice_policy** routing instance do not enter the **other_policy** instance routing table.
- Routes from the **other_policy** routing instance do not enter the **voice_policy** instance routing table.

Configuring Router 1 The following sections describe how to configure Router 1 in the backbone entity with multiple routing instances.

Configure the routing instances for **voice-policy** and **other-policy**. Use all routes learned from the routing tables in the routing table group **common**. Export routes tagged as belonging to the routing instance.

```
[edit]
routing-instances {
  voice-policy {
    interface so-2/2/2.0;
    protocols {
      isis {
        rib-group voice_to_inet;
        export filter-on-voice-policy;
        interface so-2/2/2.0 {
          level 2 metric 20;
        }
      }
    }
  }
  other-policy {
    interface so-4/2/2.0;
    protocols {
      isis {
        rib-group other_to_inet;
        export filter-on-other-policy;
        interface so-4/2/2.0 {
          level 2 metric 20;
        }
      }
    }
  }
}
```

Configure the routing table group `inet_to_voice_and_other` to share routes with the `inet.0` (in the backbone entity), `voice-policy.inet.0`, and `other-policy.inet.0` routing tables:

```
[edit]
routing-options {
  rib-groups {
    inet_to_voice_and_other {
      import-rib [ inet.0 voice-policy.inet.0 other-policy.inet.0 ];
    }
  }
}
```

Configure the routing table group `voice_to_inet` to share routes with the `inet.0` (in the backbone entity) and `voice-policy.inet.0` routing tables:

```
[edit]
routing-options {
  rib-groups {
    voice_to_inet {
      import-rib [ voice-policy.inet.0 inet.0 ];
    }
  }
}
```

Configure the routing table group `other_to_inet` to share routes with the `inet.0` (in the backbone entity) and `other-policy.inet.0` routing tables:

```
[edit]
```

```

routing-options {
  rib-groups {
    other_to_inet {
      import-rib [ other-policy.inet.0 inet.0];
    }
  }
}

```

Configure the default IS-IS instance so that the routes learned from the routing instances are installed in `inet.0` and the tagged routes are exported from `voice-policy` and `other-policy`:

```

[edit]
protocols {
  isis {
    export apply-tag;
    rib-group inet_to_voice_and_other;
    interface so-1/0/0.0 {
      level 2 metric 20;
    }
    interface fxp0.0 {
      disable;
    }
    interface lo0.0 {
      passive;
    }
  }
}

```

Configure routing policy for the routes learned from the routing instances:

```

[edit]
policy-options {
  policy-statement apply-tag {
    term voice-policy {
      from instance voice-policy;
      then {
        tag 10;
        accept;
      }
    }
    term other-policy {
      from instance other-policy;
      then {
        tag 12;
        accept;
      }
    }
  }
  policy-statement filter-on-voice-policy {
    from {
      tag 10;
      protocol isis;
    }
    then {
      accept;
    }
  }
}

```



```

    }
  }
  policy-statement filter-on-other-policy {
    from {
      tag 12;
      protocol isis;
    }
    then {
      accept;
    }
  }
}

```

Configuring Router 3 The configuration for Router 3 is the same as for Router 1 except that the interface names might differ. In this topology, the interface `so-5/2/2.0` belongs to `other-policy`, and `so-3/2/2.0` belongs to `voice-policy`.

Configuring Multiple Instances of LDP

LDP is a protocol used to distribute labels in an MPLS-enabled network.

LDP instances are used to distribute labels from a provider edge (PE) router to a customer edge (CE) router. LDP instances in a VPN are useful in carrier-of-carrier networks, where data is transmitted between two or more telecommunications carrier sites across a core provider network. Each carrier may want to restrict Internet routes strictly to the PE routers.

An advantage of using LDP instances within a VPN is that a full-mesh internal BGP (IBGP) is not required between the PE and CE routers. A router ID is required to configure an instance of LDP.

To configure multiple instances of LDP, include the following statements:

```

routing-instances {
  routing-instance-name {
    interface interface-name;
    instance-type vrf;
    protocols {
      ldp {
        ... ldp-configuration ...
      }
    }
  }
}

```

You can include the statements at the following hierarchy levels:

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

For more information about configuring LDP, see the *JUNOS MPLS Applications Configuration Guide*. For more information about configuring LDP over VPNs, see the *JUNOS VPNs Configuration Guide*.

Configuring Multiple Instances of MSDP

MSDP instances are supported only for VRF instance types. You can configure multiple instances of MSDP to support multicast over VPNs.

To configure multiple instances of MSDP, include the following statements:

```
routing-instances {
  routing-instance-name {
    interface interface-name;
    instance-type vrf;
    route-distinguisher (as-number:number | ip-address:number);
    vrf-import [ policy-names ];
    vrf-export [ policy-names ];
    protocols {
      msdp {
        ... msdp-configuration ...
      }
    }
  }
}
```

You can include the statements at the following hierarchy levels:

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

For more information about configuring MSDP, see the *JUNOS Multicast Protocols Configuration Guide*. For more information about configuring multicast over VPNs, see the *JUNOS VPNs Configuration Guide*.

Configuring Multiple Instances of OSPF

To configure multiple routing instances of OSPF or OSPFv3, perform the following tasks:

1. Configure the OSPF or OSPFv3 default instance at the [edit protocols (ospf | ospf3)] and [edit logical-systems *logical-system-name* protocols (ospf | ospf3)] hierarchy levels with the statements needed for your network so that routes are installed in *inet.0* and in the forwarding table. Make sure to include the routing table group.
2. Configure an OSPF or OSPFv3 routing instance for each additional OSPF or OSPFv3 routing entity, configuring the following:
 - Interfaces
 - Routing options

- OSPF protocol statements belonging to that entity
 - Routing table group
3. Configure a routing table group to install routes from the default route table, `inet.0`, into a routing instance's route table.
 4. Configure a routing table group to install routes from a routing instance into the default route table, `inet.0`.



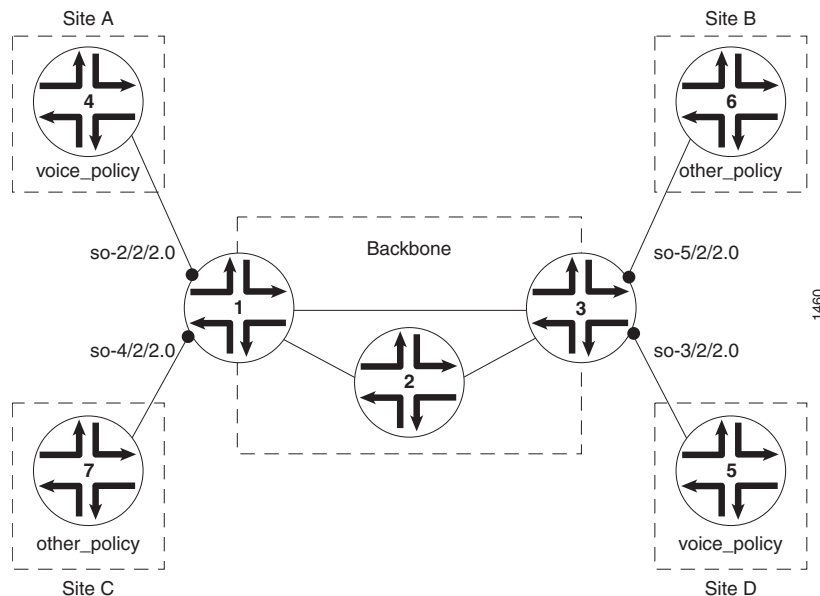
NOTE: Nonforwarding routing instances do not have forwarding tables that correspond to their routing tables.

5. Create an export policy to export routes with a specific tag and to use that tag to export routes back into the instances. For more information, see the *JUNOS Policy Framework Configuration Guide*.

Example: Configuring Multiple Routing Instances of OSPF

Figure 5 on page 227 shows how you can use multiple routing instances of OSPF or OSPFv3 to segregate prefixes within a large network. The network consists of three administrative entities: `voice_policy`, `other_policy`, and the default routing instance. Each entity is composed of several geographically separate sites that are connected by the backbone and managed by the backbone entity.

Figure 5: Configuration for Multiple Routing Instances



Sites A and D belong to the `voice_policy` routing instance. Sites B and C belong to the `other_policy` instance. Router 1 and Router 3 at the edge of the backbone connect the routing instances. Each runs a separate OSPF or OSPFv3 instance (one per entity).

Router 1 runs three OSPF or OSPFv3 instances: one each for Site A (**voice_policy**), Site C (**other_policy**), and the backbone, otherwise known as the default instance. Router 3 also runs three OSPF or OSPFv3 instances: one each for Site B (**other_policy**), Site D (**voice_policy**), and the backbone (default instance).

When Router 1 runs the OSPF or OSPFv3 instances, the following occur:

- Routes from the default instance routing table are placed in the **voice_policy** and **other_policy** instance routing tables.
- Routes from the **voice_policy** routing instance are placed in the default instance routing table.
- Routes from the **other_policy** routing instance are placed in the default instance routing table.
- Routes from the **voice_policy** routing instance do not enter the **other_policy** instance routing table.
- Routes from the **other_policy** routing instance do not enter the **voice_policy** instance routing table.

Configuring Router 1 The following sections describe how to configure Router 1 in the backbone entity with multiple routing instances.

Configure the routing instances for **voice-policy** and **other-policy**:

```
[edit]
routing-instances {
  voice-policy {
    interface so-2/2/2.0;
    protocols {
      (ospf | ospf3) {
        rib-group voice_to_inet; # Places routes into inet.0 #
        area 0.0.0.0 {
          interface so-2/2/2.0;
        }
      }
    }
  }
  other-policy {
    interface so-4/2/2.0;
    protocols {
      (ospf | ospf3) {
        rib-group other_to_inet; # Places routes into inet.0 #
        area 0.0.0.0 {
          interface so-4/2/2.0;
        }
      }
    }
  }
}
```

Configure the routing table group **inet_to_voice_and_others** to take routes from **inet.0** (default routing table) and place them in the **voice-policy.inet.0** and **other-policy.inet.0** routing tables:

```
[edit]
routing-options {
  rib-groups {
    inet_to_voice_and_other {
      import-rib [ inet.0 voice-policy.inet.0 other-policy.inet.0 ];
    }
  }
}
```

Configure the routing table group `voice_to_inet` to take routes from `voice-policy.inet.0` and place them in the `inet.0` default routing table:

```
[edit]
routing-options {
  rib-groups {
    voice_to_inet {
      import-rib [ inet.0 voice-policy.inet.0 ];
    }
  }
}
```

Configure the routing table group `other_to_inet` to take routes from `other-policy.inet.0` and place them in the `inet.0` default routing table:

```
[edit]
routing-options {
  rib-groups {
    other_to_inet {
      import-rib [ inet.0 other-policy.inet.0 ];
    }
  }
}
```

Configure the default OSPF or OSPFv3 instance:

```
[edit]
protocols {
  (ospf | ospf3) {
    rib-group inet_to_voice_and_other;# Place prefixes from inet.0 into
    area 0.0.0.0 {# voice-policy.inet.0 and
    interface so-2/2/2.0;# other-policy.inet.0
    interface so-4/2/2.0;
  }
}
```

Configuring Router 3 The configuration for Router 3 is the same as for Router 1 except that the interface names might differ. In this topology, the interface `so-5/2/2.0` belongs to `other-policy`, and `so-3/2/2.0` belongs to `voice-policy`.

Configuring Multiple Instances of PIM

PIM instances are supported only for VRF instance types. You can configure multiple instances of PIM to support multicast over VPNs.

To configure multiple instances of PIM, include the following statements:

```
routing-instances {
  routing-instance-name {
    interface interface-name;
    instance-type vrf;
    protocols {
      pim {
        ... pim-configuration ...
      }
    }
  }
}
```

You can include the statements at the following hierarchy levels:

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

For more information about configuring PIM, see the *JUNOS Multicast Protocols Configuration Guide*. For more information about configuring multicast over VPNs, see the *JUNOS VPNs Configuration Guide*.

Configuring Multiple Instances of RIP

RIP instances are supported only for VRF instance types. You can configure multiple instances of RIP for VPN support only. You can use RIP in the customer edge-provider edge (CE-PE) environment to learn routes from the CE router and to propagate the PE router's instance routes in the CE router.

RIP routes learned from neighbors configured under any instance hierarchy are added to the instance's routing table, *instance-name.inet.0*.

RIP does not support routing table groups; therefore, it cannot import routes into multiple tables as the OSPF or OSPFv3 protocol does.

To configure multiple instances of RIP, include the following statements:

```
routing-instances {
  routing-instance-name {
    interface interface-name;
    instance-type vrf;
    protocols {
      rip {
        interface interface-name;
        neighbor ip-address;
      }
    }
  }
}
```

You can include the statements at the following hierarchy levels:

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

Configuring an Instance

You can create multiple instances of BGP, IS-IS, OSPF, OSPFv3, RIP, and static routes. For information about how to configure a virtual switch, see “Configuring a Virtual Switch” on page 232.

You can include the statements at the following hierarchy levels:

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

Each routing instance consist of the following:

- A set of routing tables
- A set of interfaces that belong to these routing tables
- A set of routing option configurations

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

Configure global routing options and protocols for the default instance by including statements.

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Routes are installed into the default routing instance **inet.0** by default, unless a routing instance is specified.

For details about specifying interfaces, see the *JUNOS Network Interfaces Configuration Guide*.

To configure a routing instance, include the following statements:

```
routing-instances {
  routing-instance-name {
    interface interface-name;
    instance-type (forwarding | layer2-control | l2vpn | no-forwarding | virtual-router |
      virtual-switch | vpls | vrf);
    no-vrf-advertise;
    route-distinguisher (as-number:number | ip-address:number);
    vrf-import [ policy-names ];
    vrf-export [ policy-names ];
```

```

vrf-table-label;
protocols {
  bgp {
    ... bgp-configuration ...
  }
  isis {
    isis-configuration;
  }
  l2vpn {
    l2vpn-configuration;
  }
  ldp {
    ... ldp-configuration ...
  }
  msdp {
    msdp-configuration;
  }
  ospf {
    domain-id domain-id;
    domain-vpn-tag number;
    route-type-community (iana | vendor);
    ospf-configuration;
  }
  ospf3 {
    domain-id domain-id;
    domain-vpn-tag number;
    route-type-community (iana | vendor);
    ospf3-configuration;
  }
  pim {
    pim-configuration;
  }
  rip {
    rip-configuration;
  }
  ripng {
    ripng-configuration;
  }
  vpls {
    vpls-configuration;
  }
}
}

```

Configuring VPNs

To configure virtual private networks (VPNs), see the *JUNOS VPNs Configuration Guide*.

Configuring a Virtual Switch

To configure a virtual switch on MX-series routers, see the *JUNOS MX-series Layer 2 Configuration Guide*.

Configuring an Instance Type

You can configure eight routing instance types at the [edit routing-instances *routing-instance-name* instance-type] and [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* instance-type] hierarchy levels:

- Forwarding—Use this routing instance type for filter-based forwarding applications. For this instance type, there is no one-to-one mapping between an interface and a routing instance. All interfaces belong to the default instance inet.0.
- Layer 2 VPN—Use this routing instance type for Layer 2 VPN implementations.
- Layer2-control—Use this routing instance type for RSTP or MSTP in customer edge interfaces of a VPLS routing instance. This instance type cannot be used if the customer edge interface is multihomed to two provider edge interfaces. If the customer edge interface is multihomed to two provider edge interfaces, use the default BPDU tunneling. For more information about configure a layer2-control instance type, see the *JUNOS MX-series Layer 2 Configuration Guide*.
- Nonforwarding—Use this routing instance type when a separation of routing table information is required. There is no corresponding forwarding table. All routes are installed into the default forwarding table. IS-IS instances are strictly nonforwarding instance types.
- Virtual router—This routing instance is similar to a VPN routing and forwarding instance type, but used for non-VPN-related applications. There are no VRF import, VRF export, VRF target, or route distinguisher requirements for this instance type.
- Virtual switch—(MX-series routers only) Use the virtual switch instance type to group one or more Layer 2 bridge domains. A bridge domain consists of a set of ports that share the same flooding or broadcast characteristics. Each virtual switch represents a Layer 2 network. You can optionally configure a virtual switch to support Integrating Routing and Bridging (IRB), which facilitates simultaneous Layer 2 bridging and Layer 3 IP routing on the same interface. You can also configure Layer 2 control protocols to provide loop resolution. Protocols supported include the Spanning Tree Protocol, the Rapid Spanning Tree Protocol, and the Multiple Spanning Tree Protocol. For more information about configuring a virtual switch instance type, see the *JUNOS MX-series Layer 2 Configuration Guide*.
- VPLS—Use this routing instance type for point-to-multipoint LAN implementations between a set of sites in a VPN.
- VRF—Use this routing instance type for Layer 3 VPN implementations. For this instance type, there is a one-to-one mapping between an interface and a routing instance. Each VRF instance corresponds with a forwarding table. Routes on an interface go into the corresponding forwarding table.

To configure a routing instance type, include the `instance-type` statement:

```
routing-instances {
  routing-instance-name {
    interface interface-name;
    instance-type (forwarding | l2vpn | no-forwarding | virtual-router | virtual-switch |
      vpls | vrf);
```

```
}
}
```

You can include the statement at the following hierarchy levels:

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

For more information about configuring Layer 2 VPNs, Layer 3 VPNs, and VPLS, see the *JUNOS VPNs Configuration Guide*.

For more information about configuring the types of routing instances, see the following sections:

- Configuring a VRF Routing Instance on page 234
- Configuring a Non-VPN VRF Routing Instance on page 235
- Configuring a VPLS Routing Instance on page 236

Configuring a VRF Routing Instance

To configure a VPN VRF routing instance, include the following statements:

```
routing-instances {
  routing-instance-name {
    interface interface-name;
    instance-type vrf;
    no-vrf-advertise;
    route-distinguisher (as-number:number | ip-address:number);
    vrf-import [ policy-names ];
    vrf-export [ policy-names ];
    vrf-table-label;
    protocols {
      bgp {
        ... bgp-configuration ...
      }
      isis {
        ... isis-configuration ...
      }
      l2vpn {
        ... l2vpn-configuration ...
      }
      ldp {
        ... ldp-configuration ...
      }
      msdp {
        ... msdp-configuration ...
      }
      ospf {
        domain-id domain-id;
        domain-vpn-tag number;
        route-type-community (iana | vendor);
        ... ospf-configuration ...
      }
    }
  }
}
```

```

ospf3 {
    domain-id domain-id;
    domain-vpn-tag number;
    route-type-community (iana | vendor);
    ... ospf3-configuration ...
}
pim {
    ... pim-configuration ...
}
rip {
    ... rip-configuration ...
}
vpls {
    ... vpls-configuration ...
}
}
}

```

You can include the statements at the following hierarchy levels:

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

Configuring a Non-VPN VRF Routing Instance

To configure a non-VPN VRF routing instance (for example, to allow IPsec tunnels within VRFs), include the following statements:

```

routing-instances {
    routing-instance-name {
        interface interface-name;
        instance-type virtual-router;
        protocols {
            bgp {
                ... bgp-configuration ...
            }
            isis {
                ..., isis-configuration ...
            }
            ldp {
                ... ldp-configuration ...
            }
            msdp {
                ... msdp-configuration ...
            }
            ospf {
                domain-id domain-id;
                domain-vpn-tag number;
                route-type-community (iana | vendor);
                ... ospf-configuration ...
            }
            ospf3 {
                domain-id domain-id;

```

```

        domain-vpn-tag number;
        route-type-community (iana | vendor);
        ... ospf3-configuration ...
    }
    pim {
        ... pim-configuration ...
    }
    rip {
        ... rip-configuration ...
    }
}

```

You can configure the statements at the following hierarchy levels:

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

Configuring a VPLS Routing Instance

To configure a VPLS routing instance, include the following statements:

```

routing-instances {
    routing-instance-name {
        interface interface-name;
        instance-type vpls;
        protocols {
            vpls {
                ... vpls-configuration ...
            }
        }
    }
}

```

You can configure the statements at the following hierarchy levels:

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

For more detailed information about configuring VPLS and Layer 2 VPN, see the *JUNOS VPNs Configuration Guide* and the *JUNOS Feature Guide*.

Configuring a Route Distinguisher

Each routing instance must have a unique route distinguisher associated with it. The route distinguisher is used to place bounds around a VPN so the same IP address prefixes can be used in different VPNs without having them overlap.

We recommend that you use a unique route distinguisher for each routing instance that you configure. Although you could use the same route distinguisher on all PE

routers for the same VPN, if you use a unique route distinguisher, you can determine the CE router from which a route originated.

To configure a route distinguisher, include the `route-distinguisher` statement:

```
routing-instances routing-instance-name {
  route-distinguisher (as-number:number | ip-address:number);
}
```

You can configure the statements at the following hierarchy levels:

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

The route distinguisher is a 6-byte value that you can specify in one of the following formats:

- *as-number:number*, where *as-number* is your assigned AS number and *number* is any 2-byte or 4-byte value. The AS number can be in the range from 1 through 4,294,967,295. If the AS number is a 2-byte value, the administrative number is a 4-byte value. If the AS number is 4-byte value, the administrative number is a 2-byte value.



NOTE: Beginning with JUNOS Release 9.1, the numeric range for AS numbers has been extended to provide BGP support for 4-byte AS numbers, as defined in RFC 4893, *BGP support for Four-octet AS Number Space*. The JUNOS software continues to support 2-byte AS numbers.

Beginning with JUNOS Release 9.2, you can also configure a 4-byte AS number using the AS-dot notation format of two integer values joined by a period: *< 16-bit high-order value in decimal > . < 16-bit low-order value in decimal >* . For example, the 4-byte AS number of 65,546 in plain-number format is represented as 1.10 in the AS-dot notation format.

-
- *ip-address:number*, where *ip-address* is an IP address in your assigned prefix range (a 4-byte value) and *number* is any 2-byte value. The IP address can be in the range from 0 through 4,294,967,295 ($2^{32} - 1$).

Configuring Filter-Based Forwarding

You can create a filter to classify packets to determine their forwarding path within a router. Use filter-based forwarding to redirect traffic for analysis.

Filter-based forwarding is supported for Internet Protocol version 4 (IPv4) and Internet Protocol version 6 (IPv6).

Use filter-based forwarding for service provider selection when customers have Internet connectivity provided by different ISPs yet share a common access layer. When a shared media (such as a cable modem) is used, a mechanism on the common access layer looks at Layer 2 or Layer 3 addresses and distinguishes between

customers. You can use filter-based forwarding when the common access layer is implemented using a combination of Layer 2 switches and a single router.

With filter-based forwarding, all packets received on an interface are considered. Each packet passes through a filter that has match conditions. If the match conditions are met for a filter and you have created a routing instance, filter-based forwarding is applied to a packet. The packet is forwarded based on the next hop specified in the routing instance. For static routes, the next hop can be a specific LSP. For more information about configuring LSPs, see the *JUNOS MPLS Applications Configuration Guide*.



NOTE: Source-class usage filter matching and unicast reverse-path forwarding checks are not supported on an interface configured with filter-based forwarding (FBF).

To configure filter-based forwarding, perform the following tasks:

- Create a match filter on an ingress router. To specify a match filter, include the filter *filter-name* statement at the [edit firewall] hierarchy level. For more information about creating a match filter for packet forwarding, see the *JUNOS Policy Framework Configuration Guide*. A packet that passes through the filter is compared against a set of rules to classify it and to determine its membership in a set. Once classified, the packet is forwarded to a routing table specified in the accept action in the filter description language. The routing table then forwards the packet to the next hop that corresponds to the destination address entry in the table.
- Create routing instances that specify the routing table(s) to which a packet is forwarded, and the destination to which the packet is forwarded at the [edit routing-instances] or [edit logical-systems *logical-system-name* routing-instances] hierarchy levels. For example:

```
[edit]
routing-instances {
  routing-table-name1 {
    instance-type forwarding;
    routing-options {
      static {
        route 0.0.0.0/0 nexthop 10.0.0.1;
      }
    }
  }
  routing-table-name2 {
    instance-type forwarding;
    routing-options {
      static {
        route 0.0.0.0/0 nexthop 10.0.0.2;
      }
    }
  }
}
```

- Create a routing table group that adds interface routes to the forwarding routing instances used in filter-based forwarding (FBF), as well as to the default routing

instance `inet.0`. This part of the configuration resolves the routes installed in the routing instances to directly connected next hops on that interface. Create the routing table group at the `[edit routing-options]` or `[edit logical-systems logical-system-name routing-options]` hierarchy levels.

For IPv4, the following configuration installs interface routes into the default routing instance `inet.0`, as well as two forwarding routing instances—`routing-table-name1.inet.0` and `routing-table-name2.inet.0`:

```
[edit]
routing-options {
  interface-routes {
    rib-group inet group-name;
  }
  rib-groups {
    group-name {
      import-rib [ inet.0 routing-table-name1.inet.0
                  routing-table-name2.inet.0 ];
    }
  }
}
```



NOTE: Specify `inet.0` as one of the routing instances that the interface routes will be imported into. If the default instance `inet.0` is not specified, interface routes will not be imported into the default routing instance.

Configuring Class-of-Service-Based Forwarding

Class-of-service (CoS)-based forwarding allows you to control the next-hop selection based on a packet's class of service or IP precedence. It allows path selection based on a multifield classifier.

To configure CoS-based forwarding, perform the following tasks:

1. Create a routing policy at the `[edit policy-options]` or `[edit logical-systems logical-system-name policy-options]` hierarchy levels to limit the configuration so that routes matching the route filter will be subject to the CoS next-hop mapping specified in `my-cos-map`:

```
[edit]
policy-options {
  policy-statement my-cos-forwarding {
    from {
      route-filter ...;
    }
    then {
      cos-next-hop-map my-cos-map;
    }
  }
}
```

2. Create a CoS next-hop map. To specify a CoS next-hop map, include the `cos-next-hop-map` statement at the `[edit class-of-service]` hierarchy level. For more information about creating a CoS next-hop map, see the *JUNOS Class of Service Configuration Guide*.
3. Specify the exporting of the routes to the forwarding table at the `[edit routing-options]` or `[edit logical-systems logical-system-name routing-options]` hierarchy levels:

```
[edit]
routing-options {
  forwarding-table {
    export my-cos-forwarding;
  }
}
```

4. Specify a static route that has multiple next hops for load balancing at the `[edit routing-options]` or `[edit logical-systems logical-system-name routing-options]` hierarchy levels:

```
[edit]
routing-options {
  static {
    route 12.1.1.1/32 {
      next-hop [ 3.1.1.2 3.1.1.4 3.1.1.6 3.1.1.8 ];
    }
  }
}
```

Configuring Secondary VRF Import and Export Policy

You configure a VPN routing and forwarding instance (VRF) so that routes received from the provider edge-provider edge (PE-PE) session (in the default instance) can be imported into any of an instance's VRF secondary routing tables. Importing depends on defined policies. Routes to be exported should pass through the policies listed in the export list.

To configure secondary VRF import and export policies, include the following statements:

```
[edit]
routing-instances {
  routing-instance-name {
    instance-type vrf;
    vrf-import [ policy-names ];
    vrf-export [ policy-names ];
  }
}
policy-options {
  policy-statement policy-name {
    from community community-name;
    then accept;
  }
}
```


For more information about configuring VPNs, see the *JUNOS VPNs Configuration Guide*.

Configuring Policy-Based Export for Routing Instances

Configuring policy-based export simplifies the process of exchanging route information between routing instances.

Exporting routing information between routing instances typically is accomplished by configuring separate routing table groups for each instance. The use of policy-based export reduces the configuration needed for exporting routes between multiple routing instances by eliminating the configuration of separate routing table groups for each instance.

Policy-based export is particularly useful in the following two cases:

- Overlapping VPNs—VPN configurations in which more than one VRF has the same route target
- Nonforwarding instances—Multilevel IGPs using multiple routing instances



NOTE: The `instance-export` and `instance-import` statements are not valid for VRF instances. The `auto-export` statement is valid for VRF and non-VRF instances. The `instance-import` statement automatically enables `auto-export` for non-VRF instances.

For detailed information about configuring overlapping VPNs and nonforwarding instances, see the *JUNOS VPNs Configuration Guide*.

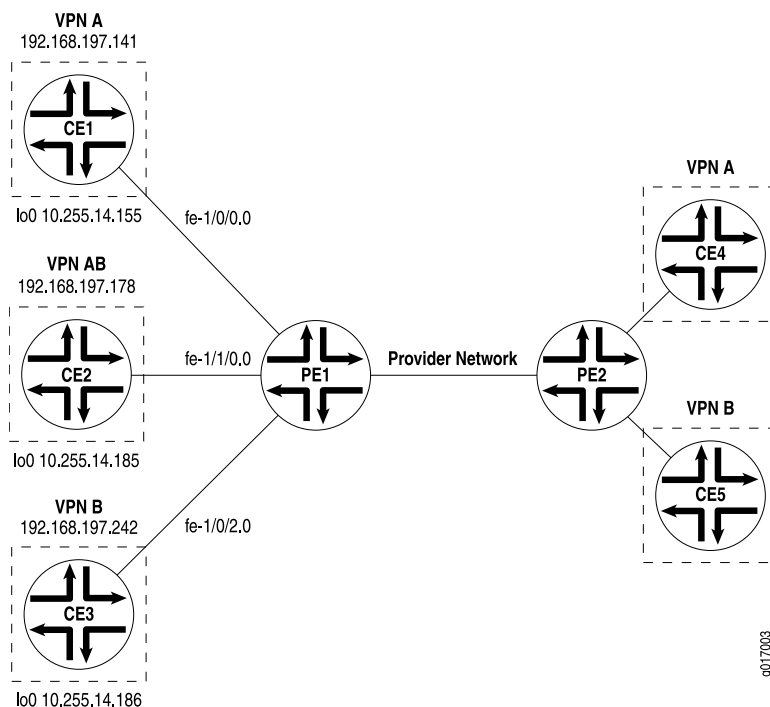
For sample configurations, see the following sections:

- Example: Configuring Policy-Based Export for an Overlapping VPN on page 241
- Example: Configuring Policy-Based Export for a Nonforwarding Instance on page 243

Example: Configuring Policy-Based Export for an Overlapping VPN

In Layer 3 VPNs, a CE router is often a member of more than one VPN. Figure 6 on page 242 illustrates the topology for the configuration example in this section. The configurations in this section illustrate local connectivity between CE routers connected to the same PE router using BGP.

The configuration statements enable the VPN AB Router CE2 to communicate with the VPN A Router CE1 and the VPN B Router CE3, both directly connected to the Router PE1. VPN routes that originate from the remote PE routers (the PE2 Router, in this case) are placed in a global Layer 3 VPN routing table (`bgp.l3vpn.inet.0`) and routes with appropriate route targets are imported into the routing tables, as dictated by the VRF import policy configuration.

Figure 6: Configuration of Policy-Based Export for an Overlapping VPN

Configuring Router PE1 This section describes how to configure Router PE1 in the backbone entity for this overlapping VPN by means of policy-based export.

Configure the routing instances for VPN-A, VPN-AB, and VPN-B:

```
[edit]
routing-instances {
  VPN-A {
    instance-type vrf;
    interface fe-1/0/0.0;
    route-distinguisher 10.255.14.175:3;
    vrf-export A-out;
    vrf-import A-in;
    routing-options {
      auto-export;
      static {
        route 1.1.1.1/32 next-hop fe-1/0/0.0;
        route 1.1.1.2/32 next-hop fe-1/0/0.0;
      }
    }
  }
  VPN-AB {
    instance-type vrf;
    interface fe-1/1/0.0;
    route-distinguisher 10.255.14.175:9;
    vrf-export AB-out;
    vrf-import AB-in;
    routing-options {
      auto-export;
    }
  }
}
```

```

static {
    route 1.1.3.1/32 next-hop fe-1/1/0.0;
    route 1.1.3.2/32 next-hop fe-1/1/0.0;
}
}
VPN-B {
    instance-type vrf;
    interface fe-1/0/2.0;
    route-distinguisher 10.255.14.175:9;
    vrf-export B-out;
    vrf-import B-in;
    routing-options {
        auto-export;
        static {
            route 1.1.2.1/32 next-hop fe-1/0/2.0;
            route 1.1.2.2/32 next-hop fe-1/0/2.0;
        }
    }
}
}
}
}

```

Configuring Router PE2 The configuration for Router PE2 is the same as that for Router PE1; however, the interface names might differ.

Example: Configuring Policy-Based Export for a Nonforwarding Instance

This example shows how to use the `instance-import` and `instance-export` statements to control route export between multiple instances. This is equivalent to using the `vrf-import` and `vrf-export` statements for VPNs, except these are with nonforwarding instances, not VRF instances.

There are two nonforwarding instances: `data` and `voice`. The following is the configuration for a PE router.

Configure the routing instances for `data` and `voice`:

```

[edit]
routing-instances {
    data {
        instance-type no-forwarding;
        interface t3-0/1/3.0;
        routing-options {
            instance-import data-import;
            auto-export;
            protocols {
                ospf {
                    export accept;
                    area 0.0.0.0 {
                        interface all;
                    }
                }
            }
        }
    }
}

```

```

voice {
  instance-type no-forwarding;
  interface t3-0/1/0.0;
  routing-options {
    instance-import voice-import;
    auto-export;
  }
  protocols {
    ospf {
      export accept;
      area 0.0.0.0 {
        interface all;
      }
    }
  }
}

```

Configure a master policy:

```

[edit]
policy-options {
  policy-statement {
    master-import {
      term a {
        from instance master;
        then {
          tag 11;
          accept;
        }
      }
      term b {
        from instance data;
        then {
          tag 10;
          accept;
        }
      }
    }
  }
}

```

Configure policies for each instance:

```

[edit]
policy-options {
  policy-statement {
    data-import {
      term a {
        from {
          instance master;
          tag 10;
        }
        then accept;
      }
    }
  }
}

```

```

        term b {
            then reject;
        }
    }
    voice-import {
        term a {
            from {
                instance master;
                protocol ospf;
                tag 11;
            }
        }
        term b {
            then reject;
        }
    }
}

```

Configuring a VRF Table Label

You configure a separate label for each VRF to provide double lookup and egress filtering. To configure a label for a VRF, include the following statements:

```

[edit]
routing-instances {
    routing-instance-name {
        instance-type vrf;
        vrf-import [ policy-names ];
        vrf-export [ policy-names ];
        vrf-table-label;
    }
}

```

For more information about configuring VPNs, see the *JUNOS VPNs Configuration Guide*.

Configuring a VRF Target

Configuring a VPN routing and forwarding (VRF) target provides a configurable community within a VRF routing instance and allows a single policy for import and a single policy for export to replace the per-VRF policies for every community.

To configure a VRF target, include the `vrf-target` statement. Use the `import` and `export` options to specify the allowed communities to accept from neighbors and to send to neighbors:

```

routing-instances {
    routing-instance-name {
        vrf-target {
            community;
            export community-name;
            import community-name;
        }
    }
}

```

```

    }
  }
}

```

You can configure the statements at the following hierarchy levels:

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

Within a hub-and-spoke configuration, you can configure a PE router not to advertise VPN routes from the primary (hub) instance. Instead, these routes are advertised from the secondary (downstream) instance. You can do this without configuring routing table groups, by using the `no-vrf-advertise` statement.



NOTE: This statement does not prevent the exportation of VPN routes to other VRFs on the same router by configuring the [edit routing-options `auto-export`] statement.

To prevent advertising VPN routes from the primary instance, include the `no-vrf-advertise` statement:

```

routing-instances {
  routing-instance-name {
    no-vrf-advertise;
  }
}

```

You can configure the statement at the following hierarchy levels:

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

For more information about configuring VPNs, see the *JUNOS VPNs Configuration Guide*.

Configuring an OSPF Domain ID

For most OSPF or OSPFv3 configurations involving Layer 3 VPNs, you do not need to configure an OSPF domain ID. However, for a Layer 3 VPN connecting multiple OSPF or OSPFv3 domains, configuring domain IDs can help you control LSA translation (for Type 3 and Type 5 LSAs) between the OSPF domains and back-door paths. The default domain ID is 0.0.0.0. Each VPN routing table in a PE router associated with an OSPF or OSPFv3 instance is configured with the same OSPF domain ID.

JUNOS software is fully compliant with Internet draft draft-ietf-l3vpn-ospf-2547-04.txt, *OSPF as the Provider/Customer Edge Protocol for BGP/MPLS IP VPNs*.

For more detailed information about configuring VPNs, see the *JUNOS VPNs Configuration Guide*.

Without the domain IDs, there is no way to identify which domain the routes originated from after the OSPF or OSPFv3 routes are distributed into BGP routes and advertised across the BGP VPN backbone. Distinguishing which OSPF or OSPFv3 domain a route originated from allows classification of routes as Type 3 LSAs or Type 5 LSAs.

To configure a domain ID, perform the following tasks:

1. Specify a domain ID in the BGP extended community ID.
2. Set a route type.
3. Configure a VRF export policy to explicitly attach the outbound extended community ID to outbound routes.
4. Define a community with members that possess the community ID.

For more information about configuring export policies, see the *JUNOS Policy Framework Configuration Guide*.

This extended community ID can then be carried across the BGP VPN backbone. When the route is redistributed back as an OSPF or OSPFv3 route on the PE router and advertised to the CE near the destination, the domain ID identifies which domain the route originated from. The routing instance checks incoming routes for the domain ID. The route is then propagated as either a Type 3 LSA or Type 5 LSA.

When a PE router receives a route, it redistributes and advertises the route as either a Type 3 LSA or a Type 5 LSA, depending on the following:

- If the receiving PE router sees a Type 3 route with a matching domain ID, the route is redistributed and advertised as a Type 3 LSA.
- If the receiving PE router sees a Type 3 route without a domain ID (the extended attribute field of the route's BGP update does not include a domain ID), the route is redistributed and advertised as a Type 3 LSA.
- If the receiving PE router sees a Type 3 route with a non-matching domain ID, the route is redistributed and advertised as a Type 5 LSA.
- If the receiving PE router sees a Type 3 route with a domain ID, but the router does not have a domain ID configured, the route is redistributed and advertised as a Type 5 LSA.
- If the receiving PE router sees a Type 5 route, the route is redistributed and advertised as a Type 5 LSA, regardless of the domain ID.

On the local PE router, the prefix of the directly connected PE/CE interface is an active direct route. This route is also an OSPF or OSPFv3 route.

In the VRF export policy, the direct prefix is exported to advertise the route to the remote PE. This route is injected as an AS-External-LSA, much as when a direct route is exported into OSPF or OSPFv3.

Domain ID ensures that an originated summary LSA arrives at the remote PE as a summary LSA. Domain ID does not translate AS-external-LSAs into summary LSAs.

To configure an OSPF or OSPFv3 domain ID match condition for incoming Layer 3 VPN routes going into a routing instance, include the **domain-id** statement:

```
(ospf | ospf3) {
  domain-id domain-id;
}
```

You can configure the statement at the following hierarchy levels:

- [edit routing-instances *routing-instance-name* protocols (ospf | ospf3)]
- [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols (ospf | ospf3)]

If the router ID is not configured in the routing instance, the router ID is derived from an interface address belonging to the routing instance.

You can set a VPN tag for the OSPF or OSPFv3 external routes generated by the PE router. This prevents looping when a domain ID is used as an alternate route preference. By default, this tag is automatically calculated and needs no configuration. To configure the domain VPN tag for Type 5 LSAs, include the **domain-vpn-tag number** statement:

```
(ospf | ospf3) {
  domain-vpn-tag number;
}
```

You can configure the statement at the following hierarchy levels:

- [edit routing-instances *routing-instance-name* protocols (ospf | ospf3)]
- [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols (ospf | ospf3)]

The range is from 1 through 4,294,967,295. If you set VPN tags manually, you must set the same value for all PE routers in the VPN.

To set the route type, include the **route-type-community** statement:

```
routing-instances routing-instance-name {
  protocols {
    (ospf | ospf3) {
      route-type-community (iana | vendor);
    }
  }
}
```

You can include the statement at the following hierarchy levels:

- [edit routing-instances *routing-instance-name* protocols (ospf | ospf3)]
- [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols (ospf | ospf3)]

The **domain-id** setting in the routing instance is for a match on inbound Layer 3 VPN routes. A VRF export policy must be explicitly set for the outbound extended

community *domain-id* attribute. You must configure an export policy to attach the domain ID to outgoing routes. To configure an export policy to attach the domain ID and route distinguisher to the extended community ID on outbound routes, include the *community* statement:

```

policy-statement policy-name {
  term term-name {
    from protocol (ospf | ospf3);
    then {
      community add community-name;
      accept;
    }
  }
  term b {
    then reject;
  }
}
community community-name members [ target:target-id domain-id:domain-id];

```

You can include the statement at the following hierarchy levels:

- [edit policy-options policy-statement *policy-name* term *term-name* then]
- [edit logical-systems *logical-system-name* policy-options policy-statement *policy-name* term *term-name* then]

To define the members of a community, include the *community* statement:

```

community name {
  members [ community-ids ];
}

```

You can include the statement at the following hierarchy levels:

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

Examples: Configuring an OSPF Domain ID

Configure a domain ID as a match condition for inbound Layer 3 VPN routes. Then configure an export policy to tag the extended community ID and the route distinguisher onto outgoing routes:

```

[edit]
routing-instances {
  CE_A {
    instance-type vrf;
    interface ge-0/1/0.0;
    route-distinguisher 1:100;
    vrf-import vrf_import_routes;
    vrf-export vrf_export_routes;
    protocols {
      ospf {
        domain-id 1.1.1.1; #match for inbound routes
      }
    }
  }
}

```

```

        route-type-community vendor;
        export vrf_import_routes;
        area 0.0.0.0 {
            interface ge-0/1/0.0;
        }
    }
}
}
}
policy-options {
    policy-statement vrf_export_routes {
        term a {
            from protocol ospf;
            then {
                community add export_target;
                accept;
            }
        }
        term b {
            then reject;
        }
    }
    community export_target members [ target:1:100 domain-id:1.1.1.1:0 ];
}

```

Leak a noninstance route into the instance routing table:

```

[edit]
routing-options {
    interface-routes {
        rib-group inet inet_to_site_A;
    }
}
[edit]
rib-groups {
    inet_to_site_A {
        import-rib [ inet.0 site_A.inet.0 ];
    }
}
[edit]
protocols {
    ospf {
        rib-group inet_to_site_A;
    }
}
[edit]
policy-options {
    policy-statement announce_to_ce {
        term a {
            from {
                protocol direct;
                interface lo0.0;
            }
            then accept;
        }
    }
}

```

```

}
[edit]
routing-instances {
  site_A {
    protocols {
      ospf {
        export announce_to_ce;
      }
    }
  }
}

```

Configuring Route Limits for Routing Tables

A route limit sets an upper limit for the number of paths and prefixes installed in routing tables. You can, for example, use a route limit to limit the number of routes received from the CE router in a VPN. A route limit applies only to dynamic routing protocols, not to static or interface routes.

To configure a route limit on route paths, include the `maximum-paths` statement:

```
maximum-paths path-limit <log-only | threshold value log-interval seconds>;
```

To configure a route limit on route prefixes, include the `maximum-prefixes` statement:

```
maximum-prefixes prefix-limit <log-only | threshold value log-interval seconds>;
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Specify the `log-only` option to generate warning messages only (an advisory limit). Specify the `threshold` option to generate warnings before the limit is reached. Specify the `log-interval` option to configure the minimum time interval between log messages.

There are two modes for route limits: advisory and mandatory. An advisory limit triggers warnings. A mandatory limit rejects additional routes after the limit is reached.



NOTE: Application of a route limit may result in unpredictable dynamic routing protocol behavior. For example, when the limit is reached and routes are rejected, BGP may not reinstall the rejected routes after the number of routes drops back below the limit. BGP sessions may need to be cleared.

For more information about configuring VPNs, see the *JUNOS VPNs Configuration Guide*.

Configuring an Independent AS Domain

You can configure an independent autonomous system (AS) domain that is separate from the primary routing instance domain. An AS is a set of routers that are under a single technical administration and that generally use a single IGP and metrics to propagate routing information within the set of routers. An AS appears to other ASs

to have a single, coherent interior routing plan and presents a consistent picture of what destinations are reachable through it.

Configuring an independent domain allows you to keep the AS paths of the independent domain from being shared with the AS path and AS path attributes of other domains, including the master routing instance domain.

If you are using BGP on the router, you must configure an AS number.

To configure an independent domain, include the **independent-domain** statement:

```
independent-domain;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

There is a limit of 16 ASs for each domain.

Chapter 10

Summary of Routing Instances Configuration Statements

This chapter provides a reference for each of the routing instance configuration statements. The statements are organized alphabetically.

description

Syntax	<code>description text;</code>
Hierarchy Level	<code>[edit routing-instances <i>routing-instance-name</i>]</code>
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Provide a text description for the routing instance. If the text includes one or more spaces, enclose it in quotation marks (" "). Any descriptive text you include is displayed in the output of the <code>show route instance detail</code> command and has no effect on the operation of the routing instance.
Usage Guidelines	See “Configuring Routing Instances” on page 209.
Required Privilege Level	interface—To view this statement in the configuration. interface-control—To add this statement to the configuration.

forwarding-options

See *JUNOS Policy Framework Configuration Guide*

instance-type

Syntax	instance-type (forwarding l2vpn layer2-control no-forwarding virtual-router virtual-switch vpls vrf);
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i>], [edit routing-instances <i>routing-instance-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4. virtual-switch and layer2-control options introduced in JUNOS Release 8.4.
Description	Define the type of routing instance.
Default	no-forwarding
Options	<p>forwarding—Provide support for filter-based forwarding, where interfaces are not associated with instances. All interfaces belong to the default instance. Other instances are used for populating RPD learned routes. See “Configuring Filter-Based Forwarding” on page 237.</p> <p>l2vpn—Provide support for Layer 2 VPNs. For more detailed information about configuring VPNs, see the <i>JUNOS VPNs Configuration Guide</i>.</p> <p>layer2-control—(MX-series routers only) Provide support for RSTP or MSTP in customer edge interfaces of a VPLS routing instance. For more detailed information about configuring RSTP and MSTP, see the <i>JUNOS MX-series Layer 2 Configuration Guide</i>.</p> <p>no-forwarding—This is the default routing instance. Do not create a corresponding forwarding instance.</p> <p>virtual-router—Similar to a VPN routing and forwarding instance type, but used for non-VPN-related applications. There are no VRF import, VRF export, VRF target, or route distinguisher requirements for this instance type.</p> <p>virtual-switch—(MX-series routers only) Provide support for Layer 2 bridging. Use to group one or more bridge domains to represent a Layer 2 network. For more detailed information about configuring a virtual switch, see the <i>JUNOS MX-series Layer 2 Configuration Guide</i>.</p> <p>vpls—Virtual private local-area network (LAN) service. Use this routing instance type for point-to-multipoint LAN implementations between a set of sites in a VPN. For more information about configuring VPLS, see the <i>JUNOS VPNs Configuration Guide</i>.</p> <p>vrf—VPN routing and forwarding instance. Provides support for Layer 3 VPNs, where interface routes for each instance go into the corresponding forwarding table only. For more information about configuring VPNs, see the <i>JUNOS VPNs Configuration Guide</i>.</p>
Usage Guidelines	See “Configuring an Instance” on page 231 and the <i>JUNOS VPNs Configuration Guide</i> .

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

interface

Syntax interface *interface-name*;

Hierarchy Level [edit logical-systems *logical-system-name* routing-instances *routing-instance-name*],
 [edit routing-instances *routing-instance-name*]

Release Information Statement introduced before JUNOS Release 7.4.

Description Identify the logical, private interface between the provider edge (PE) router and the customer edge (CE) router on the PE side.

Options *interface-name*—Name of the interface.

Usage Guidelines See “Configuring an Instance” on page 231.

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

no-vrf-advertise

Syntax no-vrf-advertise;

Hierarchy Level [edit logical-systems *logical-system-name* routing-instances *routing-instance-name*],
 [edit routing-instances *routing-instance-name*]

Release Information Statement introduced before JUNOS Release 7.4.

Description Prevent advertising VPN routes from a VRF instance to remote PEs.

Usage Guidelines See “Configuring a VRF Target” on page 245.

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

protocols

Syntax

```

protocols {
  bgp {
    ... bgp-configuration ...
  }
  isis {
    ... isis-configuration ...
  }
  ldp {
    ... ldp-configuration ...
  }
  msdp {
    ... msdp-configuration ...
  }
  mstp {
    ... mstp-configuration ...
  }
  ospf {
    domain-id domain-id;
    domain-vpn-tag number;
    route-type-community (iana | vendor);
    ... ospf-configuration ...
  }
  ospf3 {
    domain-id domain-id;
    domain-vpn-tag number;
    route-type-community (iana | vendor);
    ... ospf3-configuration ...
  }
  pim {
    ... pim-configuration ...
  }
  rip {
    ... rip-configuration ...
  }
  ripng {
    ... ripng-configuration ...
  }
  rstp {
    rstp-configuration;
  }
  vstp {
    vstp configuration;
  }
}

```

Hierarchy Level [edit logical-systems *logical-system-name* routing-instances *routing-instance-name*],
[edit routing-instances *routing-instance-name*]

Release Information Statement introduced before JUNOS Release 7.4.
Support for RIPng introduced in JUNOS Release 9.0.

Description Specify the protocol for a routing instance. You can configure multiple instances of the following supported protocols: BGP, IS-IS, LDP, MSDP, OSPF, OSPFv3, PIM, RIP, and RIPng.

- Options**
- bgp**—Specify the Border Gateway Protocol (BGP) for a routing instance. For a description of the BGP configuration statements, see “BGP Configuration Guidelines” on page 641.
 - isis**—Specify the Intermediate System-to-Intermediate System (IS-IS) protocol for a routing instance. For a description of the IS-IS configuration statements, see “IS-IS Configuration Guidelines” on page 299.
 - ldp**—Specify the Label Distribution Protocol (LDP) for a routing instance. For more information about configuring LDP, see the *JUNOS MPLS Applications Configuration Guide*.
 - msdp**—Specify the Multicast Source Discovery Protocol (MSDP) for a routing instance. For more information about configuring MSDP, see the *JUNOS Multicast Protocols Configuration Guide*.
 - mstp**—Specify the Multiple Spanning Tree Protocol (MSTP) for a virtual switch routing instance. For more information about configuring MSTP, see the *JUNOS MX-series Layer 2 Configuration Guide*.
 - ospf**—Specify the Open Shortest Path First (OSPF) protocol for a routing instance. For a description of the OSPF configuration statements, see “OSPF Configuration Guidelines” on page 413.
 - ospf3**—Specify the Open Shortest Path First version 3 (OSPFv3) protocol for a routing instance. For a description of the OSPFv3 configuration statements, see “OSPF Configuration Guidelines” on page 413.



NOTE: OSPFv3 supports the **no-forwarding** and **vrf** routing instance types only.

- pim**—Specify the Protocol Independent Multicast (PIM) protocol for a routing instance. For more information about configuring PIM, see the *JUNOS Multicast Protocols Configuration Guide*.
- rip**—Specify the Routing Information Protocol (RIP) for a routing instance. For a description of the RIP configuration statements, see “RIP Configuration Guidelines” on page 521.
- ripng**—Specify the Routing Information Protocol next generation (RIPng) for a routing instance. For a description of the RIPng configuration statements, see “RIPng Configuration Guidelines” on page 559.
- rstp**—Specify the Rapid Spanning Tree Protocol (RSTP) for a virtual switch routing instance. For information about configuring RSTP, see the *JUNOS MX-series Layer 2 Configuration Guide*.
- vstp**—Specify the VLAN Spanning Tree Protocol (VSTP) for a virtual switch routing instance. For information about configuring VSTP, see the *JUNOS MX-series Layer 2 Configuration Guide*.

Usage Guidelines See “Configuring Multiple Instances of BGP” on page 219, “Configuring Multiple Instances of IS-IS” on page 220, “Configuring Multiple Instances of LDP” on page 225, “Configuring Multiple Instances of MSDP” on page 226, “Configuring Multiple Instances of OSPF” on page 226, “Configuring Multiple Instances of PIM” on page 229, and “Configuring Multiple Instances of RIP” on page 230.

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

route-distinguisher

Syntax route-distinguisher (*as-number:number* | *ip-address:number*);

Hierarchy Level [edit logical-systems *logical-system-name* routing-instances *routing-instance-name*],
[edit routing-instances *routing-instance-name*]

Release Information Statement introduced before JUNOS Release 7.4.

Description An identifier attached to a route, enabling you to distinguish to which VPN the route belongs. Each routing instance must have a unique route distinguisher associated with it. The route distinguisher is used to place bounds around a VPN so that the same IP address prefixes can be used in different VPNs without having them overlap. If the instance type is *vrf*, the **route-distinguisher** statement is required.

Options *as-number:number*—*as-number* is an assigned AS number and *number* is any 2-byte for 4-byte value. The AS number can be from 1 through 4,294,967,295. If the AS number is a 2-byte value, the administrative number is a 4-byte value. If the AS number is 4-byte value, the administrative number is a 2-byte value.



NOTE: Beginning with JUNOS Release 9.1, the numeric range for AS numbers has been extended to provide BGP support for 4-byte AS numbers, as defined in RFC 4893, *BGP Support for Four-octet AS Number Space*.

Beginning with JUNOS Release 9.2, you can also configure a 4-byte AS number using the AS-dot notation format of two integer values joined by a period: *< 16-bit high-order value in decimal > . < 16-bit low-order value in decimal >* . For example, the 4-byte AS number of 65,546 in plain-number format is represented as 1.10 in the AS-dot notation format.

ip-address:number—*ip-address* is an IP address in your assigned prefix range (a 4-byte value) and *number* is any 2-byte value.

Usage Guidelines See “Configuring a Route Distinguisher” on page 236.

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

routing-instances

Syntax	<code>routing-instances <i>routing-instance-name</i> { ... }</code>
Hierarchy Level	[edit], [edit logical-systems <i>logical-system-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure an additional routing entity for a router. You can create multiple instances of BGP, IS-IS, OSPF, OSPFv3, and RIP for a router.
Default	Routing instances are disabled for the router.
Options	<i>routing-instance-name</i> —Name of the routing instance, a maximum of 128 characters. A routing instance name can contain letters, numbers, and hyphens.
	The remaining statements are explained separately.



NOTE: Beginning with JUNOS Release 9.0, you can no longer specify a routing-instance name of **default** or include special characters within the name of a routing instance.

Usage Guidelines	See “Routing Instances Configuration Guidelines” on page 207 and the <i>JUNOS Policy Framework Configuration Guide</i> .
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

routing-options

See routing-options


vrf-export

Syntax	<code>vrf-export [<i>policy-names</i>];</code>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i>], [edit routing-instances <i>routing-instance-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Define which routes will be exported from a local instance table— <i>instance-name</i> .inet.0—to a remote PE router. Specify one or more policy names.
Default	If the instance-type is <code>vrf</code> , <code>vrf-export</code> is a required statement. The default action is to reject.
Options	<i>policy-names</i> —Specify one or more policy names.
Usage Guidelines	See “Configuring Secondary VRF Import and Export Policy” on page 240.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

vrf-import

Syntax	<code>vrf-import [<i>policy-names</i>];</code>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i>], [edit routing-instances <i>routing-instance-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	How routes are imported into the local PE router's VPN routing table— <i>instance-name</i> .inet.0—from the remote PE router.
Default	If the instance-type is <code>vrf</code> , <code>vrf-import</code> is a required statement. The default action is to accept.
Options	<i>policy-names</i> —Specify one or more policy names.
Usage Guidelines	See “Configuring Secondary VRF Import and Export Policy” on page 240.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

vrf-table-label

Syntax	vrf-table-label;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i>], [edit routing-instances <i>routing-instance-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Enable mapping of the inner label of a packet to a specific VRF, thereby allowing the examination of the encapsulated IP header. All routes in the VRF configured with this option are advertised with the label allocated per VRF.
<hr/>	
	NOTE: This statement does not support IPv6 VPNs.
<hr/>	
Usage Guidelines	See “Configuring a VRF Table Label” on page 245.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

vrf-target

Syntax	vrf-target { <i>community</i> ; import <i>community</i> ; export <i>community</i> ; }
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i>], [edit routing-instances <i>routing-instance-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure a single policy for import and a single policy for export to replace the per-VRF policies for every community.
Options	<i>community</i> —Community name. import—Specifies the allowed communities to accept from neighbors. export—Specifies the allowed communities to send to neighbors.
Usage Guidelines	See “Configuring a VRF Target” on page 245.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

Part 4

Multitopology Routing

- Multitopology Routing Overview on page 265
- Configuring Multitopology Routing on page 269
- Summary of Multitopology Routing Configuration Statements on page 281

Chapter 11

Multitopology Routing Overview

Multitopology Routing enables you to configure class-based forwarding for different types of traffic, such as voice, video, and data. Each type of traffic is defined by a topology that is used to create a new routing table for that topology. Multitopology Routing provides the ability to generate forwarding tables based on the resolved entries in the routing tables for the custom topologies you create. In this way, packets of different classes can be routed independently from one another.

This chapter discusses the following topics that provide background information about Multitopology Routing:

- Routing Table Naming Conventions for Multitopology Routing on page 265
- Routing Protocol Support for Multitopology Routing on page 266
- Filter-Based Forwarding Support on page 266
- Multitopology Routing Standards on page 267

Routing Table Naming Conventions for Multitopology Routing

Each routing protocol creates a routing table based on the topology name, the instance name, and the purpose of the table. A routing table for each topology uses the following format:

logical-system-name/routing-instance-name:topology-name.protocol.identifier

The routing instance string is included only if the instance is not the master. The logical system string is included only if the logical system identifier has a value other than 0 (zero). Each routing table for a topology includes a colon (:) before the topology name that also separates the routing-instance name from the topology name. *protocol* is the protocol family, which can be *inet* or *inet6*. *identifier* is a positive integer that specifies the instance of the routing table. Table 10 on page 265 shows specific examples of routing tables for various topologies.

Table 10: Examples of Routing Tables for Custom Topologies

Name of Routing Table	Description
:voice.inet.0	Master instance, voice topology, unicast IPv4 routes
:voice.inet6.0	Master instance, voice topology, unicast IPv6 routes

Table 10: Examples of Routing Tables for Custom Topologies *(continued)*

Name of Routing Table	Description
:voice.inet.3	Master instance, voice topology, ingress label-switched paths (LSPs)
private_1/:voice.inet.0	Logical system private, voice topology, unicast IPv4 routes
customer-A:voice.inet.0	Virtual-router customer-A, voice topology, unicast IPv4 routes
customer-B:voice.inet.3	Virtual-router customer-B, voice topology, ingress LSPs
customer-A:voice.mpls.0	Virtual-router customer-A, voice topology, unicast carrier-of-carriers IPv4 routes

Routing Protocol Support for Multitopology Routing

To run Multitopology Routing (MTR), you must configure IP routing. Multitopology Routing supports OSPF version 2 (OSPFv2), static routes, and BGP. You must configure an interior gateway protocol (IGP), such as OSPFv2 or static routing. Configure BGP to add routes learned through BGP to the appropriate custom topologies.

OSPF in MTR uses a single instance of OSPF to carry connectivity and IP reachability information for different topologies. That information is used to calculate shortest-path-first (SPF) trees and routing tables. OSPF for MTR supports protocol extensions that include metrics that correspond to different topologies for link and prefix reachability information. The type-of-service (TOS) metric field is used to advertise the topology-specific metric for links and prefixes belonging to that topology. The TOS field is redefined as MT-ID in the payload of router, summary, and Type 5 and Type 7 autonomous-system-external link-state advertisements (LSAs).

BGP in MTR provides the ability to resolve BGP routes against configured topologies. An inbound policy is used to select routes for inclusion in the appropriate routing tables for the topologies.



NOTE: Multitopology Routing is also supported on logical systems and the virtual router routing instance. No other routing instance type is supported on Multitopology Routing. For more information about configuring logical systems, see “Logical System Overview” on page 125. For more information about configuring routing instances see, “Routing Instances Configuration Guidelines” on page 207. For more information about configure a virtual router instance, see the *JUNOS VPNs Configuration Guide*.

Filter-Based Forwarding Support

By default, the ingress interface forwards traffic to the default topology for each configured routing instance. Multitopology Routing supports filter-based forwarding, which enables you to match traffic on the ingress interface with a specific type of forwarding class and then forward that traffic to the specified topology. You can further define how traffic is handled for each forwarding class by configuring

additional firewall filters that match traffic for such values as the IP precedence field or the Differentiated Services code point (DSCP).

Multitopology Routing Standards

Multitopology Routing is defined in the following document:

- RFC 4915, *Multi-Topology (MT) Routing in OSPF*

Chapter 12

Configuring Multitopology Routing

To enable Multitopology Routing, you must configure a topology for each type of traffic and interface; an interior gateway protocol, such as OSPFv2 or static routes; filter-based forwarding; and BGP. Depending on your network configuration, you can also configure MPLS label-switched paths (LSPs). This chapter discusses the following tasks for configuring Multitopology Routing (MTR).

- Configuring Topologies on page 269
- Configuring Multitopology Routing in OSPF on page 270
- Configuring Multitopology Routing in Static Routes on page 276
- Configuring Multitopology Routing in BGP on page 277
- BGP Route Resolution in Multitopology Routing on page 277
- Configuring Filter-Based Forwarding for Multitopology Routing on page 278

Configuring Topologies

For Multitopology Routing (MTR) to run on the router, you need to configure one or more topologies. For each topology, you specify a string value, such as *voice*, that defines the type of traffic, as well as an interface family, such as IPv4. In addition, a default topology is automatically created. You can also enable a topology for IPv4 multicast traffic. Each topology that you configure creates a new routing table and populates it with direct routes from the topology. For more information about the naming conventions for routing tables for topologies, see “Routing Table Naming Conventions for Multitopology Routing” on page 265. To configure a custom topology, include the following statements at the `[edit routing options]` hierarchy level:

```
[edit routing-options]
topologies {
  family (inet | inet6) {
    topology topology-name;
  }
}
```

Include the `family inet` statement to specify IPv4 traffic. Include the `family inet6` statement to specify IPv6 traffic.

Include the `topology topology-name` statement to create a topology. For *topology-name*, specify a name for the topology in the form of a string. Typically, you would specify a name that describes the type of traffic, such as *video*. You can also specify

`ipv4-multicast` to create a topology for IPv4 multicast traffic. A default topology is also automatically created.

Configuring Multitopology Routing in OSPF

OSPF Multitopology Routing (MT-OSPF) enables you to define multiple topologies and to configure topology-specific metrics for individual links as well as to exclude individual links from specific topologies. As a result, you can use a single instance of OSPF to carry connectivity and IP reachability information for different topologies. Information for different topologies is used to calculate independent shortest-path-first (SPF) trees and routing tables. For information about configuration tasks for MT-OSPF, see the following sections:

- Configuring Topologies and SPF Options for MT-OSPF on page 270
- Configuring a Prefix Export Limit for MT-OSPF on page 272
- Configuring a Topology to Appear Overloaded on page 272
- Configuring Interface Properties for MT-OSPF on page 272
- Disabling MT-OSPF on an OSPF Interface on page 273
- Disabling MT-OSPF on a Virtual Link on page 273
- Advertising MPLS Label-Switched Paths into MT-OSPF on page 274
- Configuring Other MT-OSPF Properties on page 275

Configuring Topologies and SPF Options for MT-OSPF

Include the following statements to enable topologies for OSPF and to configure topology identifiers. Any topologies you enable for OSPF must first be created under the `[edit routing-options]` hierarchy level. The routes for each topology are added to the routing table for the topology. For more information about the naming conventions for routing tables for topologies, see “Routing Table Naming Conventions for Multitopology Routing” on page 265.

The default topology is automatically created and has a topology identifier of 0 (zero), which cannot be modified. The routes that correspond to the default topology are added to the `inet.0` routing table. You can, however, modify other parameters, such as shortest-path first (SPF) options. In addition, you can specify a topology for IPv4 multicast traffic. The topology for IPv4 multicast has a topology identifier of 1, which you cannot modify. The routes corresponding to this topology are added to the `inet.2` routing table. You can also configure for each topology options for the SPF algorithm that override the default or globally configured SPF values. Include the following statements to configure a topology for OSPF and SPF options for the topology at the `[edit protocols ospf]` hierarchy level:

```
[edit protocols ospf]
topology (default | ipv4-multicast | name) {
  topology-id number;
  spf-options {
    delay milliseconds;
    holddown milliseconds;
    rapid-runs number;
  }
}
```

```
}
```

For *name*, include the name of a topology that you configured under the [edit routing-options] hierarchy level to create the topology.

Use `ipv4-multicast` for IPv4 multicast traffic. You must first enable this topology under the [edit routing-options] hierarchy level.

topology-id number is the topology identifier. The range for *topology-id number* is from 32 through 127 for any topology you create, except for the default and IPv4 multicast topologies. The identifier for those topologies is predefined and cannot be modified.



NOTE: Multitopology Routing is not currently supported for OSPF version 3 (OSPFv3).

You can configure SPF options for each topology. The values you configure for each of the following options override the default or globally configured values.

- The delay in the time between the detection of a topology change and when the SPF algorithm actually runs
- The maximum number of times that the SPF algorithm can run in succession before the hold-down timer begins
- The time to hold down, or wait, before running another SPF calculation after the SPF algorithm has run in succession the configured maximum number of times

To configure the SPF delay, include the **delay** statement when specifying the **spf-options** statement:

```
delay milliseconds;
```

By default, the SPF algorithm runs 200 milliseconds after the detection of a topology change. The range that you can configure is from 50 through 8000 milliseconds.

To configure the maximum number of times that the SPF algorithm can run in succession, include the **rapid-runs** statement when specifying the **spf-options** statement:

```
rapid-runs number;
```

The default number of SPF calculations that can occur in succession is 3. The range that you can configure is from 1 through 5. Each SPF algorithm is run after the configured SPF delay. When the maximum number of SPF calculations occurs, the hold-down timer begins. Any subsequent SPF calculation is not run until the hold-down timer expires.

To configure the SPF hold-down timer, include the **holddown** statement when specifying the **spf-options** statement:

```
holddown milliseconds;
```

The default is 5000 milliseconds, and the range that you can configure is from 2000 through 20,000 milliseconds. Use the hold-down timer to hold down, or wait, before running any subsequent SPF calculations after the SPF algorithm runs for the

configured maximum number of times. If the network stabilizes during the hold-down period and the SPF algorithm does not need to run again, the system reverts to the configured values for the `delay` and `rapid-runs` statements.

Configuring a Prefix Export Limit for MT-OSPF

By default, each topology uses the globally configured value to determine the maximum number of prefixes that can be exported into OSPF. You can override the globally configured value for any configured topology. Include the `prefix-export-limit number` statement at the `[edit protocols ospf topology name]` hierarchy level:

```
[edit protocols ospf]
topology (default | ipv4-multicast | name) {
    prefix-export-limit number;
}
```

The number that you can configure for each topology is from 0 through 4,294,967,295.

Configuring a Topology to Appear Overloaded

You can configure a specific topology so that it appears to be overloaded. You might do this when you want the topology to participate in OSPF routing but do not want it to be used for transit traffic.

To mark a topology as overloaded, include the `overload` statement:

```
[edit protocols ospf]
topology (default | ipv4-multicast | name) {
    overload;
}
```

Configuring Interface Properties for MT-OSPF

The default value of the topology metric is the same as the default metric value calculated by OSPF or the value configured for the OSPF metric. You can configure a topology-specific metric for an OSPF interface. To configure interfaces of MT-OSPF, Include the following statements at the `[edit protocols ospf area area-id]` hierarchy level:

```
interface interface-name {
    metric metric;
    topology (ipv4-multicast | name);
    metric metric;
}
```

All OSPF interfaces have a cost, which is a routing metric that is used in the link-state calculation. Routes with lower total path metrics are preferred over those with higher path metrics. The default value for the OSPF metric for an interface is 1. You can modify the default value for an OSPF interface and configure a topology-specific metric for that interface. The topology-specific metric applies to routes advertised

from the interface that belong only to that topology. The range that you can configure is from 1 through 65,535.

You can also configure any interface that belongs to one or more topologies to advertise the direct interface addresses without actually running OSPF on that interface. By default, OSPF must be configured on an interface for direct interface addresses to be advertised as interior routes. Include the **passive** statement at the `[edit protocols ospf area area-id interface interface-name]` hierarchy level:

```
[edit protocols ospf]
area area-id {
  interface interface-name {
    passive;
    topology name;
  }
}
```



NOTE: If you configure an interface with the **passive** statement, it applies to all the topologies to which the interface belongs. You cannot configure an interface as passive for only one specific topology and have it remain active for any other topologies to which it belongs.

Disabling MT-OSPF on an OSPF Interface

By default, all topologies configured for OSPF are enabled on all OSPF interfaces. You can disable one or more configured topologies on an OSPF interface. To disable a configured topology on an OSPF interface, include the **disable** statement at the `[edit protocols ospf area area-id interface interface-name topology name]` hierarchy level:

```
[edit protocols ospf]
area area-id {
  interface interface-name {
    topology (ipv4-multicast | name) {
      disable;
    }
  }
}
```

You cannot disable an interface in the default topology and have it remain active in any other configured topologies.



NOTE: If you disable OSPF on an interface by including the **disable** statement at the `[edit protocols ospf area area-id interface interface-name]` hierarchy level, the interface is disabled for all topologies, including the default topology.

Disabling MT-OSPF on a Virtual Link

By default, control packets sent to the remote end of a virtual link must be forwarded using the default topology. In addition, the transit area path consists only of links

that are in the default topology. You can disable a virtual link for a configured topology, but not for a default topology. Include the **disable** statement at the `[edit protocols ospf area area-id virtual-link neighbor-id router-id transit-area area-id topology name]` hierarchy level:

```
[edit protocols ospf]
area area-id {
  virtual-link neighbor-id router-id transit-area area-id {
    topology (ipv4-multicast | name) {
      disable;
    }
  }
}
```



NOTE: If you disable the virtual link by including the **disable** statement at the `[edit protocols ospf area area-id virtual-link neighbor-id router-id transit-area area-id]` hierarchy level, you disable the virtual link for all topologies, including the default topology. You cannot disable the virtual link only in the default topology.

Advertising MPLS Label-Switched Paths into MT-OSPF

You can advertise label-switched paths (LSPs) into OSPFv2 as point-to-point links so that all participating routers can take the LSP into account when performing SPF calculations. By default, all topologies configured for OSPF are enabled on all MPLS LSPs advertised into OSPF. You can override this behavior by disabling one or more configured topologies on an MPLS LSP.

The LSP advertisement contains a local address (the **from** address of the LSP), a remote address (the **to** address of the LSP), and a metric with the following precedence:

1. Use the label-switched path metric defined under OSPFv2.
2. Use the label-switched path metric configured for the label-switched path under MPLS.
3. If you do not configure any of the above, use the default OSPFv2 metric of 1.

In addition, the default value of the topology-specific metric is the same as the default metric calculated by OSPF or configured for the MPLS LSPs. You can also override this value by configuring a specific metric for the topology. For more information about configuring a topology-specific metric, see “Configuring Interface Properties for MT-OSPF” on page 272.

To disable a topology on LSPs and configure a label-switched path metric for OSPFv2, include the following statements at the `[edit protocols ospf]` hierarchy level:

```
[edit protocols ospf]
area area-id {
  label-switched-path name;
  metric metric;
  topology (ipv4-multicast | name) {
    disable;
  }
}
```

```

    }
  }
}

```



NOTE: You cannot disable an MPLS LSP only on the default topology and have it remain enabled on other topologies.

For more information about advertising label-switched paths, see the *JUNOS MPLS Applications Configuration Guide*.

Configuring Other MT-OSPF Properties

You can also configure the following properties for all topologies in an instance. You cannot configure the following properties for an individual topology:

- Disable not-so-stubby-area (NSSA) support on an autonomous-system border router (ASBR)
- Modify the preference value for OSPF internal routes
- Modify the default preference value for OSPF external routes
- Modify the reference-bandwidth value
- Enable graceful restart

To disable exporting Type 7 LSAs into LSAs, include the `no-nssa-abr` statement.

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

```

[edit protocols ospf]
no-nssa-abr;

```

By default, internal OSPF routes have a preference value of 10, and external OSPF routes have a preference value of 150. To modify the preference values for all topologies, include the `preference` statement (for internal routes) or the `external-preference` statement (for external routes):

```

[edit protocols ospf]
external-preference preference;
preference preference;

```

For a complete list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

You can configure a preference value of from 0 through 255 for each statement.

The reference bandwidth is used to calculate the default cost of a route using the following formula:

$$\text{cost} = \text{reference-bandwidth} / \text{bandwidth}$$

The default value for the reference bandwidth is 100 Mbps (which you specify as 100,000,000), which gives a metric of 1 for any bandwidth that is 100 Mbps or greater. To modify the default value, include the `reference-bandwidth` statement:

```
[edit protocols ospf]
reference-bandwidth;
```

The range that you can specify is from 9,600 through 1,000,000,000.

For a complete list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.



NOTE: You can specify topology-specific metrics for routes advertised from an interface. For more information, see “Configuring Interface Properties for MT-OSPF” on page 272.

Graceful restart enables a restarting router and its neighbors to continue forwarding packets without disrupting network performance. Because neighboring routers assist in the restart (these neighbors are called *helper routers*), the restarting router can quickly resume full operation without recalculating algorithms.

Graceful restart is disabled by default. You can globally configure graceful restart for all routing protocols at the `[edit routing-options]` hierarchy level. To configure graceful restart parameters specifically for OSPF, include the `graceful-restart` statement at the `[edit protocols ospf]` hierarchy level. For more information about how to configure graceful restart, see the *JUNOS High Availability Configuration Guide*.

Configuring Multitopology Routing in Static Routes

You can configure static routes to become installed in the routing table for any configured topology. Include the `rib routing-table-name` statement at the `[edit routing-options]` hierarchy level:

```
[edit routing-options]
  rib routing-table-name {
    static {
      route destination-prefix {
        next-hop;
      }
      static-options;
    }
  }
```

For *routing-table-name*, use the following format:

logical-system-name/routing-instance-name:topology-name.protocol.identifier. The routing instance string is included only if the instance is not the master. The logical system string is included only if the logical system identifier has a value other than 0 (zero). Each routing table for a topology includes a colon (:) before the topology name that also separates the routing instance name from the topology name. *protocol* is the protocol family, which can be *inet* or *inet6*. *identifier* is a positive integer that specifies

the instance of the routing table. When you create a topology for an instance (master or virtual-router), a new routing table is created within the instance for that topology. For more detailed information about routing table naming conventions for Multitopology Routing, see “Routing Table Naming Conventions for Multitopology Routing” on page 265.

For route *destination-prefix*, specify the destination of the route in the following way: *network/mask-length*, where *network* is the network portion of the IP address and *mask-length* is the destination prefix length. You can specify an IPv4 or IPv6 address.

You can optionally specify how to reach the destination by including the *next-hop* statement.

In addition, you can specify *static-options*, which defines additional information about static routes that is included with the route when it is installed in the routing table. For more information about specific static options you can optionally configure, see “Specifying Static Route Options” on page 62.

Configuring Multitopology Routing in BGP

Multitopology Routing in BGP enables you to configure a community target identifier for each type of traffic, or topology. The target community identifies the destination to which the route is going. BGP uses these community target identifiers to have routes imported into the routing tables for the specific topologies. The forwarding class then determines which table to use to forward traffic.

To configure Multitopology Routing in BGP, include the *community target identifier* statement at the [edit protocols family (inet | inet6) unicast topology *name*] hierarchy level:

```
[edit protocols bgp]
family (inet | inet6) {
  unicast {
    topology name {
      community target identifier;
    }
  }
}
```

Multitopology Routing in BGP is also supported for BGP groups and BGP peers. To configure for a BGP group, include the *family (inet | inet6) unicast topology name community target identifier* statement at the [edit protocols bgp group *group-name*] hierarchy level. To configure for a BGP peer, include the *family (inet | inet6) unicast topology name community target identifier* statement at the [edit protocols bgp group *group-name* neighbor *address*] hierarchy level.

BGP Route Resolution in Multitopology Routing

The default behavior is for the JUNOS software to resolve BGP routes against the *inet.0* and *inet.3* routing tables. By default, the secondary route points to the next hop of the primary BGP route. This means that under the default behavior, BGP

cannot perform secondary route resolution. Multitopology Routing in BGP provides support for secondary routes to resolve to an independent set of next hops.

When Multitopology Routing in BGP resolves a route against the `inet.0` routing table, a forwarding state is generated to match the topologies for which you configured a BGP import policy.

Configuring Filter-Based Forwarding for Multitopology Routing

Each routing instance (master or virtual-router) supports one default topology to which all forwarding classes are forwarded. For Multitopology Routing, you can configure a firewall filter on the ingress interface to match a specific forwarding class, such as expedited forwarding, with a specific topology. The traffic that matches the specified forwarding class is then added to the routing table for that topology.

To configure filter-based forwarding for Multitopology Routing, include the following statements at the `[edit firewall]` hierarchy level:

```
[edit firewall]
family (inet | inet6) {
  filter filter-name {
    term term-name {
      from {
        forwarding-class (assured-forwarding | best-effort | expedited-forwarding |
          network-control)
      }
      then {
        (topology topology-name | routing-instance routing-instance-name topology
          topology-name | logical-system logical-system-name topology topology-name
          | logical-system logical-system-name routing-instance routing-instance-name
          topology topology-name);
      }
    }
  }
}
```

To configure the family address type, specify `family inet` to filter IPv4 packets or `family inet6` to filter IPv6 packets.

To configure the filter name, include the `filter filter-name` statement. The filter name can contain letters, numbers, and hyphens (-) and can be up to 64 characters long. To include spaces in the name, enclose the entire name in quotation marks (" ").

Each filter consists of one or more terms. To configure a term, include the `term term-name` statement. The term name can contain letters, numbers, and hyphens (-) and can be up to 255 characters long. To include spaces in the name, enclose the entire name in quotation marks (" "). Each term name must be unique within a filter.

Include the `forwarding-class class` statement to define the forwarding class against which to match the incoming packets. You can configure the following types of forwarding classes: `assured-forwarding`, `expedited-forwarding`, `best-effort`, and `network-control`.

You can specify multiple terms in a filter, effectively chaining together a series of match-action operations to apply to the packets on an interface. Firewall filter terms are evaluated in the order in which you specify them in the configuration. To reorder terms, use the configuration mode **insert** command. For example, the command **insert term up before term start** places the term **up** before the term **start**.

Use the **topology** statement to specify that packets that match the specified forwarding class be directed to the specified topology.

For a topology in the master instance, include the **topology name** statement, where **name** is the name of the topology.

For a topology in a nonmaster instance, include the **routing-instance routing-instance-name topology topology-name** statement, where **routing-instance-name** is the name of the routing instance and **topology-name** is the name of the topology.

For a topology in a nonmaster logical-system, include the **logical-system logical-system-name topology topology-name** statement, where **logical-system-name** is the name of the logical system and **topology-name** is the name of the topology.

For a topology in a nonmaster instance within a nonmaster logical system, include the **logical-system logical-system-name routing-instance routing-instance-name topology topology-name** statement, where **logical-system-name** is the name of the logical system, **routing-instance-name** is the name of the routing instance configured within the logical system, and **topology-name** is the name of the topology.

You must apply the filter to an ingress interface. Include the following statements to apply the filter to an interface:

```
[edit interfaces interface-name]
unit number {
  family (inet | inet6) {
    filter {
      input filter-name {
      }
    }
  }
}
```

For more detailed information about how to configure firewall filters, see the *JUNOS Policy Framework Configuration Guide*.

Chapter 13

Summary of Multitopology Routing Configuration Statements

The following sections explain each of the Multitopology Routing configuration statements. They are organized alphabetically.

community

Syntax	community { target <i>identifier</i> ; }
Hierarchy Level	<p>[edit logical-systems <i>logical-system-name</i> protocols bgp family (inet inet6) unicast topology <i>name</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> family (inet inet6) unicast topology <i>name</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> neighbor address family (inet inet6) unicast topology <i>name</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp family (inet inet6) unicast topology <i>name</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> family (inet inet6) unicast topology <i>name</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor address family (inet inet6) unicast topology <i>name</i>],</p> <p>[edit protocols bgp family (inet inet6) unicast topology <i>name</i>],</p> <p>[edit protocols bgp group <i>group-name</i> family (inet inet6) unicast topology <i>name</i>],</p> <p>[edit protocols bgp group <i>group-name</i> neighbor address family (inet inet6) unicast topology <i>name</i>],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols bgp family (inet inet6) unicast topology <i>name</i>],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> family (inet inet6) unicast topology <i>name</i>],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor address family (inet inet6) topology <i>name</i>]</p>
Release Information	Statement introduced in JUNOS Release 9.0.
Description	Configure the community to identify the multitopology routes. BGP uses the target community identifier to install the routes it learns in the appropriate Multitopology Routing tables.
Options	target <i>identifier</i> —Configure the destination to which the route is going.
Usage Guidelines	See “Configuring Multitopology Routing in BGP” on page 277.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

rib

Syntax `rib routing-table-name {
 static {
 route destination-prefix {
 next-hop;
 }
 static-options;
 }
 }`

Hierarchy Level [edit logical-systems *logical-system-name* routing-options],
 [edit logical-systems *logical-system-name* routing-instances *routing-instance-name*
 routing-options],
 [edit routing-instances *routing-instance-name* routing-options],
 [edit routing-options]

Release Information Statement support for Multitopology Routing introduced in JUNOS Release 9.0.

Description Configure a static route to install routes in the routing table for a specific topology.

Options *routing-table-name*—Name of the routing table for a topology. Use the following format: *logical-system-name/routing-instance-name:topology-name.protocol.identifier*. Include the routing instance string only if the instance is not the master. The logical system string is included only if the logical system identifier has a value other than 0 (zero). Each routing table for a topology includes a colon (:) before the topology name. *protocol* is the protocol family, which can be *inet* or *inet6*. *identifier* is the positive integer that specifies the instance of the routing table. For example, to install IPv6 routes to the routing table for a topology named voice in the master instance, include `:voice.inet6.0`.

The remaining statements are explained separately in the “Summary of Protocol-Independent Routing Properties Configuration Statements” chapter.

Usage Guidelines See “Configuring Multitopology Routing in Static Routes” on page 276.

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

Related Topics static

topologies

Syntax	<pre> topologies { family (inet inet6) { topology <i>topology-name</i>; } } </pre>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-options], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options], [edit routing-instances <i>routing-instance-name</i> routing-options], [edit routing-options]
Release Information	Statement introduced in JUNOS Release 9.0.
Description	Configure a topology for Multitopology Routing. Each topology creates a new routing table that is populated with direct routes from the topology.
Options	<p>family—Configure the type of family address type.</p> <p>inet—IPv4</p> <p>inet6—IPv6</p> <p>The remaining statement is explained separately.</p>
Usage Guidelines	See “Configuring Topologies” on page 269.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	topology (Multitopology Routing)

topology

- topology (Filter-Based Forwarding) on page 286
- topology (Multitopology Routing) on page 287
- topology (OSPF) on page 288
- topology (OSPF Interface) on page 289

topology (Filter-Based Forwarding)

Syntax `topology topology-name;`

Hierarchy Level [edit firewall family (inet | inet6) filter *filter-name* term *term-name* then],
 [edit firewall family (inet | inet6) filter *filter-name* term *term-name* then logical-system
logical-system-name],
 [edit firewall family (inet | inet6) filter *filter-name* term *term-name* then logical-system
logical-system-name routing-instance *routing-instance-name*],
 [edit firewall family (inet | inet6) filter *filter-name* term *term-name* then routing-instance
routing-instance-name]

Release Information Statement introduced in JUNOS Release 9.0.

Description Configure a topology for filter-based forwarding for Multitopology Routing. The firewall filter you apply to the ingress interface is used to look up traffic against the configured topology, and, if a route matches the conditions you configure for the term, the route is accepted and added to the routing table for the specific topology.

There are multiple ways to configure a topology for filter-based forwarding, depending on the type of instance or logical system you want to specify for the forwarding class. See Options for more information.



NOTE: The options for logical system and routing instance precede the **topology** statement with the **then** statement.

Options *topology-name*—Name of a topology against which you want to match traffic.

logical-system logical-system-name topology topology-name—For a nonmaster logical system, specify the name of the logical system and a topology name configured for a nonmaster logical system.

routing-instance routing-instance-name topology topology-name—For a nonmaster routing instance, specify the name of the routing instance and a topology name configured for a nonmaster routing instance.

logical-system logical-system-name routing-instance routing-instance-name topology topology-name—For a nonmaster routing instance configured within a nonmaster logical system, specify the name of the logical system, the name of the routing instance, and a topology name configured for a nonmaster routing instance within a nonmaster logical system.

Usage Guidelines See “Configuring Filter-Based Forwarding for Multitopology Routing” on page 278.

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

Related Topics *JUNOS Policy Framework Configuration Guide*

topology (Multitopology Routing)

Syntax	<code>topology topology-name;</code>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> topologies family (inet inet6)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> topologies family (inet inet6)], [edit routing-instances <i>routing-instance-name</i> topologies family (inet inet6)], [edit routing-options topologies family (inet inet6)]
Release Information	Statement introduced in JUNOS Release 9.0.
Description	Configure the name of a topology configured to run Multitopology Routing.
Options	<i>topology-name</i> —Name of the topology. Include a string value that describes the type of traffic, such as voice or video. For IPv4 multicast traffic, include <i>ipv4-multicast</i> as the name.
Usage Guidelines	See “Configuring Topologies” on page 269.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	topologies

topology (OSPF)

Syntax	<pre> topology (default ipv4-multicast <i>name</i>) { topology-id <i>number</i>; spf-options { delay <i>milliseconds</i>; holddown <i>milliseconds</i>; rapid-runs <i>number</i>; } } </pre>
Hierarchy Level	<p>[edit logical-systems <i>logical-system-name</i> protocols ospf], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf], [edit protocols ospf], [edit routing-instances <i>routing-instance-name</i> protocols ospf]</p>
Release Information	Statement introduced in JUNOS Release 9.0.
Description	Enable a topology for OSPF Multitopology Routing. You must first configure one or more topologies under the [edit routing-options] hierarchy level.
Options	<p>default—Name of the default topology. This topology is automatically created and all routes that correspond to it are automatically added to the <i>inet.0</i> routing table. You can modify certain default parameters, such as for the shortest-path-first (SPF) algorithm.</p> <p>ipv4-multicast—Name of the topology for IPv4 multicast traffic.</p> <p><i>name</i>—Name of a topology you configured under the [edit routing-options] hierarchy level to create a topology for a specific type of traffic, such a voice or video.</p>
Usage Guidelines	See “Configuring Topologies and SPF Options for MT-OSPF” on page 270.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

topology (OSPF Interface)

Syntax	<pre> topology (ipv4-multicast <i>name</i>) { metric <i>metric</i>; } </pre>
Hierarchy Level	<p>[edit logical-systems <i>logical-system-name</i> protocols ospf area <i>area-id</i> interface <i>interface-name</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf area <i>area-id</i> interface <i>interface-name</i>],</p> <p>[edit protocols ospf area <i>area-id</i> interface <i>interface-name</i>],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols ospf area <i>area-id</i> interface <i>interface-name</i>]</p>
Release Information	Statement introduced in JUNOS Release 9.0.
Description	Configure interface-specific properties for MT-OSPF, including topology-specific metric values for an interface.
Default	The default value of the topology metric is the same as the default metric value calculated by OSPF or the value configured for the OSPF metric.
Options	<p>ipv4-multicast—Name of the topology for IPv4 multicast traffic.</p> <p><i>name</i>—Name of a topology created under the [edit routing-options] hierarchy level.</p> <p><i>metric metric</i>—Cost of a route from an OSPF interface. You can specify a metric value for a topology that is different from the value specified for the interface.</p> <p>Range: 1 through 65,535</p> <p>Default: 1</p>
Usage Guidelines	See “Configuring Interface Properties for MT-OSPF” on page 272.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

topology-id

Syntax	topology-id <i>number</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols ospf topology <i>name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf topology <i>name</i>], [edit protocols ospf topology <i>name</i>], [edit routing-instances <i>routing-instance-name</i> protocols ospf topology <i>name</i>]
Release Information	Statement introduced in JUNOS Release 9.0.
Description	Configure a topology identifier for a topology enabled for OSPF.
Default	The default identifier for the default topology is 0, and the default identifier for the topology for IPv4 multicast traffic is 1. These identifiers are predefined and cannot be modified.
Options	<i>number</i> —the integer value used to identify the topology. Range: 32 through 127
Usage Guidelines	See “Configuring Topologies and SPF Options for MT-OSPF” on page 270.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	topology (OSPF)

Part 5

Interior Gateway Protocols

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- IS-IS Configuration Guidelines on page 299
- Summary of IS-IS Configuration Statements on page 337
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- Summary of Neighbor Discovery Router Advertisement Configuration Statements on page 609
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Chapter 14

IS-IS Overview

The Intermediate System-to-Intermediate System (IS-IS) protocol is an interior gateway protocol (IGP) that uses link-state information to make routing decisions.

IS-IS is a link-state IGP that uses the shortest path first (SPF) algorithm to determine routes. IS-IS evaluates the topology changes and determines whether to perform a full SPF recalculation or a partial route calculation (PRC). This protocol originally was developed for routing International Organization for Standardization (ISO) Connectionless Network Protocol (CLNP) packets.



NOTE: Because IS-IS uses ISO addresses, the configuration of the Internet Protocol version 6 (IPv6) and Internet Protocol version 4 (IPv4) implementations of IS-IS is identical.

This chapter discusses the following topics that provide background information about IS-IS:

- IS-IS Standards on page 293
- IS-IS Terminology on page 294
- ISO Network Addresses on page 295
- IS-IS Packets on page 296
- Persistent Route Reachability on page 296
- IS-IS Extensions to Support Traffic Engineering on page 296
- IS-IS Extensions to Support Route Tagging on page 297

IS-IS Standards

IS-IS is defined in the following documents:

- ISO 8473, *Protocol for providing the connectionless-mode network services*
- ISO 9542, *End System to Intermediate System Routing Exchange Protocol for Use in Conjunction with the Protocol for the Provision of the Connectionless-mode Network Service*
- ISO 10589, *Intermediate System to Intermediate System Routing Exchange Protocol for Use in Conjunction with the Protocol for the Provision of the Connectionless-mode Network Service*

- RFC 1195, *Use of OSI IS-IS for Routing in TCP/IP and Dual Environments*
- RFC 2763, *Dynamic Hostname Exchange Mechanism for IS-IS*
- RFC 2966, *Domain-wide Prefix Distribution with Two-Level IS-IS*
- RFC 2973, *IS-IS Mesh Groups*
- RFC 3373, *Three-Way Handshake for IS-IS Point-to-Point Adjacencies*
- RFC 3567, *IS-IS Cryptographic Authentication*
- RFC 3784, *Intermediate System to Intermediate System (IS-IS) Extensions for Traffic Engineering*
- RFC 3787, *Recommendations for Interoperable IP Networks Using Intermediate System to Intermediate System (IS-IS)*
- RFC 3847, *Restart Signaling for Intermediate System to Intermediate System (IS-IS)*
- RFC 4205, *Intermediate System to Intermediate System (IS-IS) Extensions in Support of Generalized Multi-Protocol Label Switching (GMPLS)*
- RFC 5120, *M-ISIS: Multi Topology (MT) Routing in Intermediate System to Intermediate Systems (IS-ISs)*
- RFC 5130, *A Policy Control Mechanism in IS-IS Using Administrative Tags*
- Internet draft draft-ietf-bfd-base-05.txt, *Bidirectional Forwarding Detection* (except for the transmission of echo packets)
- Internet draft draft-ietf-isis-igp-p2p-over-lan-06.txt, *Point-to-point operation over LAN in link-state routing protocols* (expires October 2006)
- Internet draft draft-ietf-isis-ipv6-06.txt, *Routing IPv6 with IS-IS*
- Internet draft draft-ietf-isis-wg-255adj-02.txt, *Maintaining more than 255 circuits in IS-IS*

To access Internet Requests for Comments (RFCs) and drafts, go to the Internet Engineering Task Force (IETF) Web site at <http://www.ietf.org>.

IS-IS Terminology

An IS-IS network is a single autonomous system (AS), also called a *routing domain*, that consists of *end systems* and *intermediate systems*. End systems are network entities that send and receive packets. Intermediate systems send and receive packets and relay (forward) packets. (Intermediate system is the Open System Interconnection [OSI] term for a router.) ISO packets are called network *protocol data units (PDUs)*.

In IS-IS, a single AS can be divided into smaller groups called *areas*. Routing between areas is organized hierarchically, allowing a domain to be administratively divided into smaller areas. This organization is accomplished by configuring *Level 1* and *Level 2* intermediate systems. Level 1 systems route within an area; when the destination is outside an area, they route toward a Level 2 system. Level 2 intermediate systems route between areas and toward other ASs.

ISO Network Addresses

IS-IS uses ISO network addresses. Each address identifies a point of connection to the network, such as a router interface, and is called a *network service access point (NSAP)*.

IS-IS supports multiple NSAP addresses on the loopback (lo0) interface.

An end system can have multiple NSAP addresses, in which case the addresses differ only by the last byte (called the *n-selector*). Each NSAP represents a service that is available at that node. In addition to having multiple services, a single node can belong to multiple areas.

Each network entity also has a special network address called a *network entity title (NET)*. Structurally, an NET is identical to an NSAP address but has an n-selector of 00. Most end systems and intermediate systems have one NET. Intermediate systems that participate in multiple areas can have multiple NETs.

The following ISO addresses illustrate the IS-IS address format:

```
49.0001.00a0.c96b.c490.00
49.0001.2081.9716.9018.00
```

The first portion of the address is the area number, which is a variable number from 1 through 13 bytes. The first byte of the area number (49) is the authority and format indicator (AFI). The next bytes are the assigned domain (area) identifier, which can be from 0 through 12 bytes. In the examples above, the area identifier is 0001.

The next six bytes form the system identifier. The system identifier can be any six bytes that are unique throughout the entire domain. The system identifier commonly is the media access control (MAC) address (as in the first example, 00a0.c96b.c490) or the IP address expressed in binary-coded decimal (BCD) (as in the second example, 2081.9716.9018, which corresponds to IP address 208.197.169.18). The last byte (00) is the n-selector.



NOTE: The system identifier cannot be 0000.0000.0000. All 0s is an illegal setting and the adjacency will not form with this setting.

To provide help with IS-IS debugging, the JUNOS software supports dynamic mapping of ISO system identifiers to the hostname. Each system can be configured with a hostname, which allows the system identifier-to-hostname mapping to be carried in a dynamic hostname type length value (TLV) in IS-IS link-state protocol data units (LSPs). This permits ISs in the routing domain to learn about the ISO system identifier of a particular IS.

IS-IS Packets

IS-IS uses the following protocol data units (PDUs) to exchange protocol information:

- IS-IS hello (IIH) PDUs—Broadcast to discover the identity of neighboring IS-IS systems and to determine whether the neighbors are Level 1 or Level 2 intermediate systems.
- Link-state PDUs (LSPs)—Contain information about the state of adjacencies to neighboring IS-IS systems. LSPs are flooded periodically throughout an area.
- Complete sequence number PDUs (CSNPs)—Contain a complete list of all LSPs in the IS-IS database. CSNPs are sent periodically on all links, and the receiving systems use the information in the CSNP to update and synchronize their LSP databases. The designated router multicasts CSNPs on broadcast links in place of sending explicit acknowledgments for each LSP.
- Partial sequence number PDUs (PSNPs)—Multicast by a receiver when it detects that it is missing an LSP; that is, when its LSP database is out of date. The receiver sends a PSNP to the system that transmitted the CSNP, effectively requesting that the missing LSP be transmitted. That router, in turn, forwards the missing LSP to the requesting router.

Persistent Route Reachability

IPv4 and IPv6 route reachability information in IS-IS link-state PDUs is preserved when you commit a configuration. IP prefixes are preserved to their original packet fragment upon LSP regeneration.

IS-IS Extensions to Support Traffic Engineering

To help provide traffic engineering and MPLS with information about network topology and loading, extensions have been added to the JUNOS implementation of IS-IS. Specifically, IS-IS supports new TLVs that specify link attributes. These TLVs are included in the IS-IS link-state PDUs. The link-attribute information is used to populate the Traffic Engineering Database (TED), which is used by the Constrained Shortest Path First (CSPF) algorithm to compute the paths that MPLS LSPs will take. This path information is used by RSVP to set up LSPs and reserve bandwidth for them.



NOTE: Whenever possible, use IS-IS IGP shortcuts instead of traffic engineering shortcuts.

The traffic engineering extensions are defined in Internet draft draft-isis-traffic-traffic-02, *IS-IS Extensions for Traffic Engineering*.

Configuring IS-IS IGP Shortcuts

In IS-IS, you can configure shortcuts, which allow IS-IS to use an LSP as the next hop as if it were a subinterface from the ingress router to the egress router. The address specified on the `to` statement at the `[edit protocols mpls label-switched-path`

lsp-path-name] hierarchy level must match the router ID of the egress router for the LSP to function as a direct link to the egress router and to be used as input to IS-IS SPF calculations. When used in this way, LSPs are no different than Asynchronous Transfer Mode (ATM) and Frame Relay virtual circuits (VCs), except that LSPs carry only IPv4 traffic.

IS-IS Extensions to Support Route Tagging

To control the transmission of routes into IS-IS, or to control transmission of IS-IS routes between different IS-IS levels, you can tag routes with certain attributes. IS-IS routes can carry these attributes, which the routing policies can use to export and import routes between different IS-IS levels. A sub-TLV to the IP prefix TLV is used to carry the tag or attribute on the routes.



NOTE: Route tagging does not work when IS-IS traffic engineering is disabled.

Chapter 15

IS-IS Configuration Guidelines

To configure Intermediate System-to-Intermediate System (IS-IS), you include the following statements in the configuration:

```
protocols {
  isis {
    clns-routing;
    disable;
    ignore-attached-bit;
    graceful-restart {
      disable;
      helper-disable;
      restart-duration seconds;
    }
    label-switched-path name level level metric metric;
    level level-number {
      authentication-key key;
      authentication-type authentication;
      external-preference preference;
      no-csnp-authentication;
      no-hello-authentication;
      no-psnp-authentication;
      preference preference;
      prefix-export-limit number;
      wide-metrics-only;
    }
    loose-authentication-check;
    lsp-lifetime seconds;
    max-areas seconds;
    no-adjacency-holddown;
    no-authentication-check;
    no-ipv4-routing;
    no-ipv6-routing;
    overload {
      advertise-high-metrics;
      timeout seconds;
    }
    reference-bandwidth reference-bandwidth;
    rib-group {
      inet group-name;
      inet6 group-name;
    }
    spf-options {
      delay milliseconds;
    }
  }
}
```

```

        holddown milliseconds;
        rapid-runs number;
    }
    topologies {
        ipv4-multicast;
        ipv6-multicast;
        ipv6-unicast;
    }
    traffic-engineering {
        disable;
        ignore-lsp-metrics;
        family inet;
            shortcuts {
                multicast-rpf-routes;
            }
        }
        family inet6;
            shortcuts;
        }
    }
    traceoptions {
        file filename <size size> <files number> <world-readable | no-world-readable>;
        flag flag <flag-modifier> <disable>;
    }
    interface (all | interface-name) {
        disable;
        bfd-liveness-detection {
            detection-time {
                threshold milliseconds;
            }
            minimum-interval milliseconds;
            minimum-receive-interval milliseconds;
            multiplier number;
            no-adaptation;
            transmit-interval {
                threshold milliseconds;
                minimum-interval milliseconds;
            }
            version (1 | automatic);
        }
        checksum;
        csnp-interval (seconds | disable);
        hello-padding (adaptive | loose | strict);
        ldp-synchronization {
            disable;
            hold-time seconds;
        }
        lsp-interval milliseconds;
        mesh-group (value | blocked);
        no-adjacency-down-notification;
        no-ipv4-multicast;
        no-ipv6-multicast;
        no-ipv6-unicast;
        no-unicast-topology;
        passive;
        point-to-point;
    }

```

```

    level level-number {
        disable;
        hello-authentication-key key;
        hello-authentication-type authentication;
        hello-interval seconds;
        hold-time seconds;
        ipv4-multicast-metric number;
        ipv6-multicast-metric number;
        ipv6-unicast-metric number;
        metric metric;
        passive;
        priority number;
        te-metric metric;
    }
}

```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

By default, IS-IS is enabled for Level 1 and Level 2 routers on all interfaces on which an International Standards Organization (ISO) address is configured.

This chapter discusses the following topics that provide information about configuring IS-IS:

- Minimum IS-IS Configuration on page 302
- Configuring IS-IS Authentication on page 303
- Configuring Interface-Specific Properties on page 304
- Enabling Checksum on page 305
- Configuring the CSNP Interval on page 306
- Configuring Mesh Groups on page 306
- Modifying the Interface Metric on page 306
- Modifying the Maximum Number of Areas Advertised on page 307
- Enabling Wide Metrics for Traffic Engineering on page 307
- Configuring Route Preferences on page 308
- Configuring a Prefix Export Limit on page 308
- Configuring IS-IS Levels on an Interface on page 308
- Modifying the LSP Interval on page 313
- Configuring Label Distribution Protocol Synchronization on page 313
- Modifying the LSP Lifetime on page 314
- Advertising Label-Switched Paths into IS-IS on page 314
- Configuring the Router to Appear Overloaded on page 315
- Configuring SPF Options for IS-IS on page 316
- Configuring Graceful Restart on page 317

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- Configuring Point-to-Point Interfaces on page 317
- Configuring IS-IS Traffic Engineering Attributes on page 318
- Configuring the BFD Protocol on page 320
- Configuring Loose Authentication Check on page 323
- Disabling Adjacency Hold-Down Timers on page 323
- Configuring Hello Packet Padding on page 323
- Configuring Support for Connectionless Network Services on page 324
- Disabling IS-IS on page 326
- Disabling IPv4 Routing on page 327
- Disabling IPv6 Routing on page 327
- Configuring IS-IS Routing Policy on page 328
- Configuring IS-IS Multicast Topologies on page 330
- Configuring IS-IS IPv6 Unicast Topologies on page 332
- Installing a Default Route to the Nearest Level 1/Level 2 Router on page 333
- Tracing IS-IS Protocol Traffic on page 333

Minimum IS-IS Configuration

For IS-IS to run on the router, you must enable IS-IS on the router, configure a network entity title (NET) on one of the router's interfaces (preferably the loopback interface, `lo0`), and configure the ISO family on all interfaces on which you want IS-IS to run. When you enable IS-IS, Level 1 and Level 2 are enabled by default. The following is the minimum IS-IS configuration. In the `address` statement, *address* is the NET:

```

interfaces {
  lo0 {
    unit logical-unit-number {
      family iso {
        address address;
      }
    }
  }
  interface-type-fpc/pic/port {
    unit logical-unit-number {
      family iso;
    }
  }
}
protocols {
  isis {
    interface all;
  }
}

```



NOTE: To create the IS-IS interface, you must also configure IS-IS at the [edit protocols isis interface *interface-name*] hierarchy level. If you want the JUNOS software to create IS-IS interfaces automatically, include the **interface all** option at the [edit protocols isis] hierarchy level.

Configuring IS-IS Authentication

All IS-IS protocol exchanges can be authenticated to guarantee that only trusted routers participate in the autonomous system (AS) routing. By default, IS-IS authentication is disabled on the router.

To configure IS-IS authentication, you must define an authentication password and specify the authentication type.

You can configure one of the following authentication methods:

- Simple authentication—Uses a text password that is included in the transmitted packet. The receiving router uses an authentication key (password) to verify the packet. Simple authentication is included for compatibility with existing IS-IS implementations. However, we recommend that you do *not* use this authentication method because it is insecure (the text can be "sniffed").



CAUTION: A simple password that exceeds 254 characters is truncated.

- HMAC-MD5 authentication—Uses an iterated cryptographic hash function. The receiving router uses an authentication key (password) to verify the packet.

You can also configure more fine-grained authentication for hello packets. To do this, see “Configuring Authentication for Hello Packets” on page 310.

To enable authentication and specify an authentication method, include the **authentication-type** statement, specifying the **simple** or **md5** authentication type:

```
authentication-type authentication;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

To configure a password, include the **authentication-key** statement. The authentication password for all routers in a domain must be the same.

```
authentication-key key;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

The password can contain up to 255 characters. If you include spaces, enclose all characters in quotation marks (" ").

If you are using the JUNOS IS-IS software with another implementation of IS-IS, the other implementation must be configured to use the same password for the domain, the area, and all interfaces that are shared with a JUNOS implementation.

Authentication of hello packets, partial sequence number PDU (PSNP), and complete sequence number PDU (CSNP) may be suppressed to enable interoperability with the routing software of different vendors. Different vendors handle authentication in various ways, and suppressing authentication for different PDU types may be the simplest way to allow compatibility within the same network.

To configure IS-IS to generate authenticated packets, but not to check the authentication on received packets, include the **no-authentication-check** statement:

```
no-authentication-check;
```

To suppress authentication of IS-IS hello packets, include the **no-hello-authentication** statement:

```
no-hello-authentication;
```

To suppress authentication of PSNP packets, include the **no-psnp-authentication** statement:

```
no-psnp-authentication;
```

To suppress authentication of CSNP packets, include the **no-csnp-authentication** statement:

```
no-csnp-authentication;
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.



NOTE: The authentication and the **no-authentication** statements must be configured at the same hierarchy level. Configuring **authentication** at the **interface** hierarchy level and configuring **no-authentication** at the **isis** hierarchy level has no effect.

Configuring Interface-Specific Properties

You can configure interface-specific IS-IS properties by including the **interface** statement. These properties are explained later in this chapter.

```
interface (all | interface-name) {
  disable;
  bfd-liveness-detection {
    detection-time {
      threshold milliseconds;
    }
    minimum-interval milliseconds;
    minimum-receive-interval milliseconds;
    transmit-interval {
      threshold milliseconds;
    }
  }
}
```



```

        minimum-interval milliseconds;
    }
    multiplier number;
    version (1 | automatic);
}
checksum;
csnp-interval (seconds | disable);
ldp-synchronization {
    disable;
    hold-time seconds;
}
lsp-interval milliseconds;
mesh-group (value | blocked);
no-ipv4-multicast;
no-ipv6-multicast;
no-ipv6-unicast;
no-unicast-topology;
passive;
point-to-point;
level level-number {
    disable;
    hello-authentication-type authentication;
    hello-authentication-key key;
    hello-interval seconds;
    hold-time seconds;
    ipv4-multicast-metric number;
    ipv6-multicast-metric number;
    ipv6-unicast-metric number;
    metric metric;
    passive;
    priority number;
    te-metric metric;
}
}

```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

For *interface-name*, specify the full interface name, including the physical and logical address components. To configure all interfaces, specify the interface name as *all*. For information about configuring interfaces, see the *JUNOS Network Interfaces Configuration Guide*.

Enabling Checksum

You can enable checksum for packets on a per-interface basis. To enable checksum, include the `checksum` statement:

```
checksum;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Configuring the CSNP Interval

By default, IS-IS sends complete sequence number (CSN) packets periodically. If the router is the designated router on a LAN, IS-IS sends CSN packets every 10 seconds. If the router is on a point-to-point interface, it sends CSN packets every 5 seconds. You might want to modify the default interval to protect against link-state PDU (LSP) flooding.

To modify the CSNP interval, include the `csnp-interval` statement:

```
csnp-interval seconds;
```

The time can range from 1 through 65,535 seconds.

To configure the interface not to send any CSN packets, specify the `disable` option:

```
csnp-interval disable;
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Configuring Mesh Groups

A *mesh group* is a set of routers that are fully connected; that is, they have a fully meshed topology. When link-state PDU packets are being flooded throughout an area, each router within a mesh group receives only a single copy of a link-state PDU packet instead of receiving one copy from each neighbor, thus minimizing the overhead associated with the flooding of link-state PDU packets.

To create a mesh group and designate that an interface is part of the group, assign a mesh-group number to all the router interfaces in the group:

```
mesh-group value;
```

To prevent an interface in the mesh group from flooding link-state PDUs, configure blocking on that interface:

```
mesh-group blocked;
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Modifying the Interface Metric

All IS-IS interfaces have a cost, which is a routing metric that is used in the IS-IS link-state calculation. Routes with lower total path metrics are preferred over those with higher path metrics. When there are several equal-cost routes to a destination, traffic is distributed equally among them.

The cost of a route is described by a single dimensionless metric that is determined using the following formula:

$$\text{cost} = \text{reference-bandwidth} / \text{bandwidth}$$

reference-bandwidth is the reference bandwidth. If the reference bandwidth is not configured, all interfaces have a default metric of 10 (with the exception of the *lo0* interface, which has a default metric of 0).

To modify the reference bandwidth, include the **reference-bandwidth** statement:

```
reference-bandwidth reference-bandwidth;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

For example, if you set the reference bandwidth to 1 Gbps (that is, *reference-bandwidth* is set to 1,000,000,000), a 100-Mbps interface has a default metric of 10.

For more information about IS-IS route metrics, see “Modifying the IS-IS Metric” on page 312.

Modifying the Maximum Number of Areas Advertised

By default, IS-IS advertises a maximum of three areas in the IS-IS hello (IIH) PDUs and link-state PDUs. To advertise more than three ISO network addresses for a router, include the **max-areas** statement:

```
max-areas number;
```

The range that you can configure is from 3 through 36, and the default is 3. This value is included in the Maximum Address Area field of the IS-IS common PDU header included in all outgoing PDUs.



NOTE: The maximum number areas you can advertise is restricted to 36 to ensure that the IIH PDUs have enough space to include other type, length, and value (TLV) fields, such as the Authentication and IPv4 and IPv6 Interface Address TLVs.

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Enabling Wide Metrics for Traffic Engineering

Normally, IS-IS metrics can have values up to 63, and IS-IS generates two type length values (TLVs), one for an IS-IS adjacency and the second for an IP prefix. To allow IS-IS to support traffic engineering, a second pair of TLVs has been added to IS-IS, one for IP prefixes and the second for IS-IS adjacency and traffic engineering information. With these TLVs, IS-IS metrics can have values up to $2^{24}-1$ (16,777,215).

By default, the JUNOS software supports the sending and receiving of wide metrics. The JUNOS software allows a maximum metric value of 63 and generates both pairs of TLVs. To configure IS-IS to generate only the new pair of TLVs and thus to allow the wider range of metric values, include the **wide-metrics-only** statement:

```
wide-metrics-only;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Configuring Route Preferences

Route preferences are used to select which route is installed in the forwarding table when several protocols calculate routes to the same destination. The route with the lowest preference value is selected. For more information about route preferences, see “Route Preferences” on page 6.

By default, Level 1 IS-IS internal routes have a preference value of 15, Level 2 IS-IS internal routes have a preference of 18, Level 1 IS-IS external routes have a preference of 160, and Level 2 external routes have a preference of 165. To change the preference values, include the **preference** statement (for internal routes) or the **external-preference** statement:

```
external-preference preference;
preference preference;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

The preference value can range from 0 through 4,294,967,295 ($2^{32} - 1$).

Configuring a Prefix Export Limit

By default, there is no limit to the number of prefixes that can be exported into IS-IS. To configure a limit to the number of prefixes that can be exported into IS-IS, include the **prefix-export-limit** statement:

```
prefix-export-limit number;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

You can specify a number range from 0 through 4,294,967,295.

Configuring IS-IS Levels on an Interface

You can administratively divide a single AS into smaller groups called areas. You configure each router interface to be in an area. Any interface can be in any area. The area address applies to the entire router; you cannot specify one interface to be in one area and another interface in a different area. In order to route between areas you must have two adjacent Level 2 routers that communicate with each other. Level 1 routers can only route within their IS-IS area. To send traffic outside their area, Level 1 routers must send packets to the nearest intra-area Level 2 router. A router can be a Level 1 router, a Level 2 router, or both. You specify the router level on a per-interface basis, and a router becomes adjacent with other routers on the same level on that link only.

You can configure one Level 1 routing process and one Level 2 routing process on each interface, and you can configure the two levels differently.

To configure an area, include the **level** statement:

```
level level-number {
  disable;
  hello-authentication-key key;
  hello-authentication-type authentication;
  hello-interval seconds;
  hold-time seconds;
  ipv4-multicast-metric number;
  ipv6-multicast-metric number;
  ipv6-unicast-metric number;
  metric metric;
  passive;
  priority number;
  te-metric metric;
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

The statements within the **level** statement allow you to perform the following tasks when configuring the following optional level-specific properties:

- Disabling IS-IS on a Level on page 309
- Advertising Interface Addresses Without Running IS-IS on page 310
- Configuring Authentication for Hello Packets on page 310
- Modifying the Hello Interval on page 311
- Modifying the Hold-Time Value on page 311
- Modifying the IS-IS Metric on page 312
- Modifying the Traffic Engineering Metric on page 312
- Configuring the Priority for Becoming the Designated Router on page 312
- Configuring the Router to Advertise Without Running IS-IS on page 313

Disabling IS-IS on a Level

By default, IS-IS is enabled for IS-IS areas on all enabled interfaces on which the ISO protocol family is enabled (at the [edit interfaces *interface* unit *logical-unit-number*] hierarchy level). To disable IS-IS at any particular level on an interface, include the **disable** statement:

```
disable;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Enabling IS-IS on an interface (by including the **interface** statement at the [edit protocols isis] hierarchy level), disabling it (by including the **disable** statement), and

not actually having IS-IS run on an interface (by including the **passive** statement) are mutually exclusive states.

Example: Disabling IS-IS on a Level

On SONET/SDH interface **so-0/0/0**, enable IS-IS for Level 1 only. With this configuration, tracing messages periodically will indicate that IS-IS is creating Level 2 link-state PDUs. However, because IS-IS for Level 2 is disabled, these link-state PDUs are never distributed to neighboring routers.

```
protocols {
  isis {
    traceoptions {
      file isis size 1m files 10;
      flag spf;
      flag lsp;
      flag error;
    }
    interface so-0/0/0 {
      level 2 {
        disable;
      }
    }
  }
}
```

Advertising Interface Addresses Without Running IS-IS

By default, IS-IS must be configured on an interface or a level for direct interface addresses to be advertised into that level. To advertise the direct interface addresses without actually running IS-IS on that interface or level, include the **passive** statement:

```
passive;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Enabling IS-IS on an interface (by including the **interface** statement at the [edit **protocols isis**] hierarchy level), disabling it (by including the **disable** statement), and not actually having IS-IS run on an interface (by including the **passive** statement) are mutually exclusive states.



NOTE: If neither passive mode nor family ISO are configured on the IS-IS interface, then the router treats the interface as not being operational and no direct IPv4/IPv6 routes are exported into IS-IS.

Configuring Authentication for Hello Packets

You can configure authentication for a given IS-IS level on an interface. On a point-to-point link, if you enable hello authentication for both IS-IS levels, the password configured for Level 1 is used for both levels.



CAUTION: If no authentication is configured for Level 1 on a point-to-point link with both levels enabled, the hello packets are sent without any password, regardless of the Level 2 authentication configurations.

By default, hello authentication is not configured on an interface. However, if IS-IS authentication is configured, the hello packets are authenticated using the IS-IS authentication type and password.

To enable hello authentication for an IS-IS level on an interface and define the password, include the **hello-authentication-type** and **hello-authentication-key** statements:

```
hello-authentication-type (md5 | simple);
hello-authentication-key password;
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Modifying the Hello Interval

Routers send hello packets at a fixed interval on all interfaces to establish and maintain neighbor relationships. This interval is advertised in the hello interval field in the hello packet. By default, a designated intersystem (DIS) router sends hello packets every 3 seconds, and a non-DIS router sends hello packets every 9 seconds.

To modify how often the router sends hello packets out of an interface, include the **hello-interval** statement:

```
hello-interval seconds;
```

The hello interval range is from 1 through 20,000 seconds.

You can send out hello packets in sub-second intervals. To send out hello packets every 333 milliseconds, set the hello-interval value to 1.

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Modifying the Hold-Time Value

The hold time specifies how long a neighbor should consider this router to be operative without receiving another hello packet. If the neighbor does not receive a hello packet from this router within the hold time, it marks the router as being unavailable. The default hold-time value is three times the default hello interval: 9 seconds for a DIS router and 27 seconds for a non-DIS router.

To modify the hold-time value on the local router, include the **hold-time** statement:

```
hold-time seconds;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Modifying the IS-IS Metric

All IS-IS routes have a cost, which is a routing metric that is used in the IS-IS link-state calculation. The cost is an arbitrary, dimensionless integer that can be from 1 through 63, or from 1 through $2^{24}-1$ (16,777,215) if you are using wide metrics. The default metric value is 10 (with the exception of the lo0 interface, which has a default metric of 0). To modify the default value, include the `metric` statement:

```
metric metric;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

For more information about IS-IS interface metrics, see “Modifying the Interface Metric” on page 306.

Modifying the Traffic Engineering Metric

When traffic engineering is enabled on the router, you can configure an IS-IS metric that is used exclusively for traffic engineering. The traffic engineering metric is used for information injected into the Traffic Engineering Database (TED). Its value does not affect normal IS-IS forwarding.

To modify the default value, include the `te-metric` statement:

```
te-metric metric;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Configuring the Priority for Becoming the Designated Router

A router advertises its priority to become a designated router in its hello packets. On all multiaccess networks, IS-IS uses the advertised priorities to elect a designated router for the network. This router is responsible for sending network link-state advertisements, which describe all the routers attached to the network. These advertisements are flooded throughout a single area.

The priority value is meaningful only on a multiaccess network. It has no meaning on a point-to-point interface.

A router’s priority for becoming the designated router is indicated by an arbitrary number from 0 through 127; routers with a higher value are more likely to become the designated router. By default, routers have a priority value of 64.

To modify the interface’s priority value, include the `priority` statement:

```
priority number;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Configuring the Router to Advertise Without Running IS-IS

The router can advertise the direct interface addresses on an interface or on a sub-level of the interface without actually running IS-IS on that interface or at that level. This occurs in passive mode.

To enable an interface as passive, include the **passive** statement:

```
passive;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Modifying the LSP Interval

By default, the router sends one link-state PDU packet out an interface every 100 milliseconds. To modify this interval, include the **lsp-interval** statement:

```
lsp-interval milliseconds;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

To disable the transmission of all link-state PDU packets, set the interval to 0.

Configuring Label Distribution Protocol Synchronization

The Label Distribution Protocol (LDP) distributes labels in non-traffic-engineered applications. Labels are distributed along the best path determined by IS-IS. If the synchronization between LDP and IS-IS is lost, the label-switched path (LSP) goes down. Therefore, LDP and IS-IS synchronization is beneficial. When LDP is not fully operational on a given link (a session is not established and labels are not exchanged), IS-IS advertises the link with the maximum cost metric. The link is not preferred but remains in the network topology.

LDP synchronization is supported only on point-to-point interfaces and LAN interfaces configured as point-to-point interfaces under IS-IS. LDP synchronization is not supported during graceful restart.

To advertise the maximum cost metric until LDP is operational for LDP synchronization, include the **ldp-synchronization** statement:

```
ldp-synchronization {
    disable;
    hold-time seconds;
}
```

To disable synchronization, include the **disable** statement. To configure the time period to advertise the maximum cost metric for a link that is not fully operational, include the **hold-time** statement.



NOTE: When an interface has been in the **holddown** state for more than three minutes, a system log message with a **warning** level is sent. This message appears in both the messages file and the trace file.

For a list of hierarchy levels at which you can configure these statements, see the statement summary section for these statements.

Modifying the LSP Lifetime

By default, link-state PDUs (LSPs) are maintained in network databases for 1200 seconds (20 minutes) before being considered invalid. This length of time, called the *LSP lifetime*, normally is sufficient to guarantee that link-state PDUs never expire.

To modify the link-state PDU lifetime, include the **lsp-lifetime** statement:

```
lsp-lifetime seconds;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

The time can range from 350 through 65,535 seconds.

The link-state PDU refresh interval is derived from the link-state PDU lifetime and is equal to the lifetime minus 317 seconds.

Advertising Label-Switched Paths into IS-IS

You can advertise label-switched paths into IS-IS as point-to-point links, and the label-switched paths can be used in SPF calculations. The advertisement contains a local address (the **from** address of the label-switched path), a remote address (the **to** address of the label-switched path), and a metric with the following precedence:

- Use the label-switched path metric defined under IS-IS.
- Use the label-switched path metric configured for the label-switched path under MPLS.
- If you do not configure any of the above, use the default IS-IS metric of 10.

To advertise label-switched paths, include the **label-switched-path** statement, with a specified **level** and **metric**:

```
label-switched-path name level level metric metric;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.



NOTE: Before a single-hop label-switched path between a multiaccess link can be announced as up and used in SPF calculations, you must configure a label-switched path in both directions between two label-switched routers.

For more information about advertising label-switched paths, see the *JUNOS MPLS Applications Configuration Guide*.

Configuring the Router to Appear Overloaded

If the time elapsed after the IS-IS instance is enabled is less than the specified timeout, overload mode is set.

You configure or disable overload mode in IS-IS with or without a timeout. Without a timeout, overload mode is set until it is explicitly deleted from the configuration. With a timeout, overload mode is set if the time elapsed since the IS-IS instance started is less than the specified timeout.

A timer is started for the difference between the timeout and the time elapsed since the instance started. When the timer expires, overload mode is cleared. In overload mode, the router IS-IS advertisements are originated with the overload bit set. This causes the transit traffic to avoid the overloaded router and take paths around the router. However, the overloaded router's own links are still accessible.

In overload mode, the router advertisement is originated with all the transit router links (except stub) set to a metric of 0xFFFF. The stub router links are advertised with the actual cost of the interfaces corresponding to the stub. This causes the transit traffic to avoid the overloaded router and take paths around the router. However, the overloaded router's own links are still accessible.

You can configure the local router so that it appears to be overloaded. You might want to do this when you want the router to participate in IS-IS routing, but do not want it to be used for transit traffic. (Note that traffic to immediately attached interfaces continues to transit the router.) To mark the router as overloaded, include the **overload** statement:

```
overload {
  advertise-high-metrics;
  timeout seconds;
}
```

To advertise maximum link metrics in NLRIs instead of setting the overload bit, include the **advertise-high-metrics** option when specifying the **overload** statement:

```
advertise-high-metrics;
```

To specify the number of seconds at which overload is reset, include the **timeout** option when specifying the **overload** statement:

```
overload timeout seconds;
```

The time can range from 60 through 1800 seconds.

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Configuring SPF Options for IS-IS

You can configure the following shortest-path-first (SPF) options:

- The delay in the time between the detection of a topology change and when the SPF algorithm actually runs.
- The maximum number of times that the SPF algorithm can run in succession before the hold-down timer begins.
- The time to hold down, or wait, before running another SPF calculation after the SPF algorithm has run in succession the configured maximum number of times.

To configure SPF options, include the **spf-options** statement:

```
spf-options {
  delay milliseconds;
  holddown milliseconds;
  rapid-runs number;
}
```

To configure the SPF delay, include the **delay** statement when specifying the **spf-options** statement:

```
delay milliseconds;
```

By default, the SPF algorithm runs 200 milliseconds after the detection of a topology change. The range that you can configure is from 50 through 1000 milliseconds.

To configure the maximum number of times that the SPF algorithm can run in succession, include the **rapid-runs** statement when specifying the **spf-options** statement:

```
rapid-runs number;
```

The default number of SPF calculations that can occur in succession is 3. The range that you can configure is from 1 through 5. Each SPF algorithm is run after the configured SPF delay. When the maximum number of SPF calculations occurs, the hold-down timer begins. Any subsequent SPF calculation is not run until the hold-down timer expires.

To configure the SPF hold-down timer, include the **holddown** statement when specifying the **spf-options** statement:

```
holddown milliseconds;
```

The default is 5000 milliseconds, and the range that you can configure is from 2000 through 10,000 milliseconds. Use the hold-down timer to hold down, or wait, before running any subsequent SPF calculations after the SPF algorithm runs for the configured maximum number of times. If the network stabilizes during the hold-down period and the SPF algorithm does not need to run again, the system reverts to the configured values for the **delay** and **rapid-runs** statements.

Configuring Graceful Restart

Graceful restart allows a router to restart with minimal effects to the network, and is enabled globally for all routing protocols at the [edit routing-options] hierarchy level. When graceful restart for IS-IS is enabled, the restarting router is not removed from the network topology during the restart period. The adjacencies are reestablished after restart is complete.

You can configure graceful restart parameters specifically for IS-IS. To do this, include the `graceful-restart` statement:

```
graceful-restart {  
  helper-disable;  
  restart-duration seconds;  
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

To disable graceful restart for IS-IS, specify the `disable` statement. Helper mode is enabled by default. To disable the graceful restart helper capability, specify the `helper-disable` statement. To configure a time period for complete restart, specify the `restart-duration` statement. You can specify a number between 1 and 3600. The default value is 90 seconds.

IS-IS and Multipoint Configurations

IS-IS does not support multipoint configurations. Therefore, when configuring Frame Relay or Asynchronous Transfer Mode (ATM) networks, you must configure them as collections of point-to-point links, not as multipoint clouds.

Configuring Point-to-Point Interfaces

You can use the `point-to-point` statement to configure a LAN interface to act like a point-to-point interface for IS-IS. You do not need an unnumbered LAN interface, and it has no effect if configured on an interface that is already point-to-point.

The `point-to-point` statement affects only IS-IS protocol procedures on that interface; all other protocols will continue to treat the interface as a LAN interface. Only two IS-IS routers can be connected to the LAN interface and both must be configured as point-to-point.

To configure a point-to-point IS-IS interface, include the `point-to-point` statement:

```
point-to-point;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Configuring IS-IS Traffic Engineering Attributes

You can configure the following IS-IS traffic engineering attributes:

- Configuring IS-IS to Use IGP Shortcuts on page 318
- Configuring IS-IS to Ignore the Metric of RSVP Label-Switched Paths on page 319
- Disabling IS-IS Support for Traffic Engineering on page 320
- Installing IPv4 Routes into the Multicast Routing Table on page 320

When configuring traffic engineering support, you can also configure IS-IS to use metric values greater than 63, as described in “Enabling Wide Metrics for Traffic Engineering” on page 307.

Configuring IS-IS to Use IGP Shortcuts

IS-IS always performs SPF calculations to determine next hops. For prefixes reachable through a particular next hop, IS-IS places that next hop for that prefix in the `inet.0` routing table. In addition, for routers running MPLS, IS-IS installs the prefix for IPv4 routes in the `inet.3` routing table as well. The `inet.3` table, which is present on the ingress router, contains the host address of each MPLS label-switched path (LSP) egress router. BGP uses this routing table to resolve next-hop addresses.



NOTE: Whenever possible, use IS-IS IGP shortcuts instead of traffic engineering shortcuts.

If you enable IS-IS traffic engineering shortcuts and if there is a label-switched path to a point along the path to that prefix, IS-IS installs the prefix in the `inet.3` routing table and uses the label-switched path as a next hop. The net result is that for BGP egress routers for which there is no label-switched path (LSP), BGP automatically uses an LSP along the path to reach the egress router.

Beginning with JUNOS Release 9.3, IS-IS traffic engineering shortcuts support IPv6 routes. LSPs to be used for shortcuts continue to be signaled using IPv4. However, by default, shortcut routes calculated through IPv6 routes are added to the `inet6.3` routing table. The default behavior is for only BGP to use LSPs in its calculations. If you configure MPLS so that both BGP and interior gateway protocols use LSPs for forwarding traffic, shortcut routes calculated through IPv6 are added to the `inet6.0` routing table.

RSVP LSPs with a higher preference than IS-IS routes are not considered during the computation of traffic engineering shortcuts.

To configure IS-IS so that it uses label-switched paths as shortcuts when installing information in the `inet.3` or `inet6.3` routing table, include the following statements:

```
traffic-engineering {
  family inet {
    shortcuts;
    multicast-rpf-routes;
  }
}
```

```

    }
    family inet6 {
        shortcuts;
    }
}

```

For IPv4 traffic, include the `inet` statement. For IPv6 traffic, include the `inet6` statement.

To ignore the metric of RSVP LSPs in shortcut decisions, include the `ignore-lsp-metrics` statement:

```

traffic-engineering {
    ignore-lsp-metrics;
}

```

This option avoids mutual dependency between IS-IS and RSVP, eliminating the time period when the RSVP metric used for shortcuts is not up to date.

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Because the `inet.3` routing table is present only on ingress routers, you can configure label-switched path shortcuts only on these routers.

For more information about configuring label-switched paths and MPLS, see the *JUNOS MPLS Applications Configuration Guide*.

Configuring IS-IS to Ignore the Metric of RSVP Label-Switched Paths

You can configure IS-IS to ignore the metric of RSVP label-switched paths (LSPs) when LDP tunneling is enabled. If you are using the RSVP for traffic engineering, you can run LDP simultaneously to eliminate the distribution of external routes in the core. The LSPs established by LDP are tunneled through the LSPs established by RSVP. LDP effectively treats the traffic-engineered LSPs as single hops. Ignoring the metric of RSVP LSPs avoids mutual dependency between IS-IS and RSVP, eliminating the time period when the RSVP metric used for tunneling traffic is not up to date.

To configure IS-IS to ignore the metric of RSVP LSPs, include the `ignore-lsp-metrics` statement:

```

traffic-engineering {
    ignore-lsp-metrics;
}

```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

For more information about configuring label-switched paths and MPLS, see the *JUNOS MPLS Applications Configuration Guide*.

Disabling IS-IS Support for Traffic Engineering

By default, IS-IS supports traffic engineering by exchanging basic information with the traffic engineering database. To disable this support, and to disable IS-IS shortcuts if they are configured, include the **disable** statement:

```
traffic-engineering {
  disable;
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Installing IPv4 Routes into the Multicast Routing Table

You can install unicast IPv4 routes into the multicast routing table (**inet.2**) for multicast reverse-path forwarding (RPF) checks.

To install routes into the multicast routing table for RPF checks, include the **multicast-rpf-routes** statement:

```
traffic-engineering {
  family inet {
    shortcuts {
      multicast-rpf-routes;
    }
  }
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.



NOTE: Traffic engineering shortcuts must be enabled.



NOTE: IPv4 multicast topology must not be enabled.



NOTE: LSPs must not be advertised into IS-IS.

Configuring the BFD Protocol

The bidirectional forwarding detection (BFD) protocol is a simple hello mechanism that detects failures in a network. Hello packets are sent at a specified, regular interval. A neighbor failure is detected when the router stops receiving a reply after a specified interval. BFD works with a wide variety of network environments and topologies. The failure detection timers for BFD have shorter time limits than the failure detection mechanisms of IS-IS, providing faster detection. These timers are also adaptive and can be adjusted to be more or less aggressive. For example, the timers can adapt to

a higher value if the adjacency fails, or a neighbor can negotiate a higher value for a timer than the configured.



NOTE: BFD for IS-IS with IPv6 is not supported. For IPv6, BFD supports only IPv6 static routes and OSPFv3.

To enable failure detection, include the **bfd-liveness-detection** statement:

```
bfd-liveness-detection {
  detection-time {
    threshold milliseconds;
  }
  minimum-interval milliseconds;
  minimum-receive-interval milliseconds;
  no-adaptation;
  transmit-interval {
    threshold milliseconds;
    minimum-interval milliseconds;
  }
  multiplier number;
  version (1 | automatic);
}
```

To specify the threshold for the adaptation of the detection time, include the **threshold** statement:

```
detection-time {
  threshold milliseconds;
}
```

When the BFD session detection time adapts to a value equal to or higher than the threshold, a single trap and a system log message are sent.

To specify the minimum transmit and receive intervals for failure detection, include the **minimum-interval** statement:

```
minimum-interval milliseconds;
```

This value represents the minimum interval at which the local router transmits hellos packets as well as the minimum interval at which the router expects to receive a reply from a neighbor with which it has established a BFD session. You can configure a number in the range from 1 through 255,000 milliseconds. You can also specify the minimum transmit and receive intervals separately



NOTE: Specifying an interval less than 300 milliseconds can cause undesired BFD flapping.

To specify only the minimum receive interval for failure detection, include the **minimum-receive-interval** statement:

```
minimum-receive-interval milliseconds;
```

This value represents the minimum interval at which the local router expects to receive a reply from a neighbor with which it has established a BFD session. You can configure a number in the range of 1 through 255,000 milliseconds.

To specify the number of hello packets not received by the neighbor that causes the originating interface to be declared down, include the **multiplier** statement:

```
multiplier number;
```

The default is 3, and you can configure a value in the range from 1 through 225.

To specify the minimum transmit interval for failure detection, include the **transmit-interval minimum-interval** statement:

```
transmit-interval {
  minimum-interval milliseconds;
}
```

This value represents the minimum interval at which the local router transmits hello packets to the neighbor with which it has established a BFD session. You can configure a value in the range from 1 through 255,000 milliseconds.

To specify the threshold for detecting the adaptation of the transmit interval, include the **threshold** statement:

```
transmit-interval {
  threshold milliseconds;
}
```

The threshold value must be greater than the minimum transmit interval.

Beginning with JUNOS Release 9.0, you can specify that the BFD sessions not adapt to changing network conditions. To disable BFD adaptation, include the **no-adaptation** statement:

```
no-adaptation;
```



NOTE: We recommend that you not disable BFD adaptation unless it is preferable not to have BFD adaptation enabled in your network.

To specify the BFD version used for detection, include the **version** statement:

```
version (1 | automatic);
```

The default is to have the version detected automatically.

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Configuring Loose Authentication Check

To allow the use of authentication without requiring network-wide deployment, include the `loose-authentication-check` statement:

```
loose-authentication-check;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Disabling Adjacency Hold-Down Timers

A hold-down timer delays the advertising of adjacencies by waiting until a time period has elapsed before labeling adjacencies in the up state. You can disable this hold-down timer, which labels adjacencies up faster. However, disabling the hold-down timer creates more frequent link-state PDU updates and SPF computation.

To disable the adjacency hold-down timer, include the `no-adjacency-holddown` statement:

```
no-adjacency-holddown;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Configuring Hello Packet Padding

You can configure padding on hello packets to accommodate asymmetrical maximum transfer units (MTUs) from different routers. This helps prevent a premature adjacency UP state when one router's MTU does not meet the requirements to establish the adjacency.

As an OSI Layer 2 protocol, IS-IS does not support data fragmentation. Therefore, maximum packet sizes must be established and supported between two routers. During adjacency establishment, the IS-IS protocol makes sure that the link supports a packet size of 1,492 bytes by padding outgoing hello packets up to the maximum packet size of 1,492 bytes.

To configure padding for hello packets, include the `hello-padding` statement:

```
hello-padding (adaptive | loose | strict);
```

There are three types of hello padding:

- Adaptive padding. On point-to-point connections, the hello packets are padded from the initial detection of a new neighbor until the neighbor verifies the adjacency as Up in the adjacency state TLV. If the neighbor does not support the adjacency state TLV, then padding continues. On LAN connections, padding starts from the initial detection of a new neighbor until there is at least one active adjacency on the interface. Adaptive padding has more overhead than loose padding and is able to detect MTU asymmetry from one side of the connection. This one-sided detection may result in generation of extra LSPs that are flooded

throughout the network. Specify the **adaptive** option to configure enough padding to establish an adjacency to neighbors.

- Loose padding (the default). The hello packet is padded from the initial detection of a new neighbor until the adjacency transitions to the Up state. Loose padding may not be able to detect certain situations such as asymmetrical MTUs between the routers. Specify the **loose** option to configure enough padding to initialize an adjacency to neighbors.
- Strict padding. Padding is done on all interface types and for all adjacency states, and is continuous. Strict padding has the most overhead. The advantage is that strict padding detects MTU issues on both sides of a link. Specify the **strict** option to configure padding to allow all adjacency states with neighbors.

For a list of hierarchy levels at which you can configure this statement, see the statement summary sections for this statement.

Configuring Support for Connectionless Network Services

Connectionless Network Services (CLNS) is a Layer 3 protocol, similar to Internet Protocol Version 4 (IPv4). CLNS uses network service access points (NSAPs) to address end systems and intermediate systems.

You can use IS-IS as the IGP to carry ISO CLNS routes through a network.



NOTE: CLNS is supported for the J-series Services Router only.

To enable IS-IS to exchange CLNS routes, include the **clns-routing** statement:

```
clns-routing;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

You can configure a pure CLNS network by disabling IPv4 and IPv6 for IS-IS.

To disable IPv4, include the **no-ipv4-routing** statement:

```
no-ipv4-routing;
```

To disable IPv6, include the **no-ipv6-routing** statement:

```
no-ipv6-routing;
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary section for these statements.

You can export BGP routes into Layer 2 IS-IS by configuring an export policy and applying the policy to IS-IS. You can export BGP routes from a specific VRF instance into IS-IS by configuring and applying an export policy at the **[edit routing-instance instance-name protocols isis]** hierarchy level. ES-IS routes from one routing instance cannot be exported into a Layer 1 IS-IS area of another routing instance.

To configure an export policy to export BGP routes into IS-IS, include the `policy-statement` statement:

```
policy-statement policy-name {
  from {
    protocol bgp;
    family iso;
  }
  then {
    accept;
  }
}
```

To apply an export policy, include the `export` statement at the `[edit protocols isis]` hierarchy level:

```
export policy-name;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for these statements.

For more information on policy configuration, see the *JUNOS Policy Framework Configuration Guide*.

You can also export routes from protocols other than BGP into IS-IS. ES-IS routes are exported to IS-IS by default. You can export ES-IS routes into IS-IS by configuring a routing policy.

For information on CLNS, see the *J-series Services Router Advanced WAN Access Configuration Guide*.

Example: Configuring CLNS for IS-IS

Configure a routing policy to accept CLNS routes:

```
policy-options {
  policy-statement dist-bgp {
    from {
      protocol bgp;
      family iso;
    }
    then accept;
  }
  policy-statement dist-static {
    from {
      protocol static;
      family iso;
    }
    then accept;
  }
}
```

Configure CLNS for IS-IS:

```
protocols {
```

```

isis {
  traceoptions {
    file isis size 5m world-readable;
    flag error;
  }
  export dist-static;
  no-ipv6-routing;
  no-ipv4-routing;
  clns-routing;
  interface fe-0/0/1.0;
  interface t1-0/2/1.0;
  interface fxp0.0 {
    disable;
  }
  interface lo0.0;
}

```

Configure a routing instance that supports CLNS routes:

```

routing-instances {
  aaaa {
    instance-type vrf;
    interface lo0.1;
    interface t1-3/0/0.0;
    interface fe-5/0/1.0;
    route-distinguisher 10.245.245.1:1;
    vrf-target target:11111:1;
    protocols {
      isis {
        export dist-bgp;
        no-ipv4-routing;
        no-ipv6-routing;
        clns-routing;
        interface all;
      }
    }
  }
}

```

Disabling IS-IS

To disable IS-IS on the router without removing the IS-IS configuration statements from the configuration, include the **disable** statement:

```

isis {
  disable;
}

```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

To reenab IS-IS, remove the **disable** statement from the configuration:

```
[edit protocols]
```

```

user@host# delete isis disable
[edit protocols]
user@host# show
isis;

```

Disabling IPv4 Routing

You can disable Internet Protocol version 4 (IPv4) routing for IS-IS. Disabling IPv4 routing results in the following:

- Router does not advertise the NLPID for IPv4 in JUNOS software 0th link-state PDU fragment.
- Router does not advertise any IPv4 prefixes in JUNOS software link-state PDUs.
- Router does not advertise the NLPID for IPv4 in JUNOS software hello packets.
- Router does not advertise any IPv4 addresses in JUNOS software hello packets.
- Router does not calculate any IPv4 routes.

To disable IPv4 routing on the router, include the **no-ipv4-routing** statement:

```

isis {
  no-ipv4-routing;
}

```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

To re-enable IS-IS, remove the **no-ipv4-routing** statement from the configuration:

```

[edit protocols]
user@host# delete isis no-ipv4-routing

```

Disabling IPv6 Routing

You can disable IP version 6 (IPv6) routing for IS-IS. Disabling IPv6 routing results in the following:

- Router does not advertise the NLPID for IPv6 in JUNOS software 0th link-state PDU fragment.
- Router does not advertise any IPv6 prefixes in JUNOS software link-state PDUs.
- Router does not advertise the NLPID for IPv6 in JUNOS software hello packets.
- Router does not advertise any IPv6 addresses in JUNOS software hello packets.
- Router does not calculate any IPv6 routes.

To disable IPv6 routing on the router, include the **no-ipv6-routing** statement:

```

isis {
  no-ipv6-routing;
}

```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

To re-enable IS-IS, remove the **disable** statement from the configuration:

```
[edit protocols]
user@host# delete isis no-ipv6-routing
```

Configuring IS-IS Routing Policy

All routing protocols store the routes that they learn in the routing table. The routing table uses this collected route information to determine the active routes to destinations. The routing table then installs the active routes into its forwarding table and exports them into the routing protocols. It is these exported routes that the protocols advertise.

For each protocol, you control which routes the protocol stores in the routing table and which routes the routing table exports into the protocol from the routing table by defining a *routing policy* for that protocol. For information about defining routing policy, see the *JUNOS Policy Framework Configuration Guide*.

To apply routing policies that affect how the routing protocol process (rpd) exports routes into IS-IS, include the **export** statement:

```
export [ policy-names ];
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.



NOTE: For IS-IS, you cannot apply routing policies that affect how routes are imported into the routing table; doing so with a link-state protocol can easily lead to an inconsistent topology database.

Examples: Configuring IS-IS Routing Policy

Define a policy that allows only host routes from USC (128.125.0.0/16), and apply the policy to routes exported from the routing table into IS-IS:

```
policy-options {
  policy-statement usc-hosts-only {
    term first {
      from {
        route-filter 128.125.0.0/16 upto /31;
      }
      then reject;
    }
    then accept;
  }
}
protocols {
  isis {
```



```

        export usc-hosts-only;
    }
}

```

Define a policy that takes Border Gateway Protocol (BGP) routes from the **Edu** community and places them into IS-IS with a metric of 14. Apply the policy to routes exported from the routing table into IS-IS:

```

protocols {
    isis {
        export edu-to-isis;
    }
}
policy-options {
    community Edu members 666:5;
    policy-statement edu-to-isis {
        from {
            protocol bgp;
            community Edu;
        }
        to protocol isis;
        then metric 14;
    }
}

```

Define a policy that rejects all IS-IS Level 1 routes so that none are exported into IS-IS:

```

policy-options {
    policy-statement level1 {
        term first {
            from level 1;
            then reject;
        }
        then accept;
    }
}
protocols {
    isis {
        export level1;
        interface fxp0;
    }
}

```

Define a routing policy to export IS-IS Level 1 internal-only routes into Level 2:

```

[edit]
protocols {
    isis {
        export L1-L2;
    }
}
policy-statement L1-L2 {
    term one {
        from {
            level 1;

```

```

        external;
    }
    then reject;
}
term two {
    from level 1;
    to level 2;
    then accept;
}
}

```

Define a routing policy to export IS-IS Level 2 routes into Level 1:

```

[edit]
protocols {
    isis {
        export L2-L1;
    }
}
policy-statement L2-L1 {
    term one {
        from level 2;
        to level 1;
        then accept;
    }
}

```

Configuring IS-IS Multicast Topologies

Most multicast routing protocols perform a reverse-path forwarding (RPF) check on the source of multicast data packets. If a packet comes in on the interface that is used to send data to the source, the packet is accepted and forwarded to one or more downstream interfaces. Otherwise, the packet is discarded and a notification is sent to the multicast routing protocol running on the interface.

In certain instances, the unicast routing table used for the RPF check is also the table used for forwarding unicast data packets. Thus, unicast and multicast routing are congruent. In other cases, where it is preferred that multicast routing be independent of unicast routing, the multicast routing protocols are configured to perform the RPF check using an alternate unicast routing table `inet.2`.

You can configure IS-IS to calculate an alternate IPv4 multicast topology, in addition to the normal IPv4 unicast topology, and add the corresponding routes to `inet.2`. The IS-IS interface metrics for the multicast topology can be configured independently of the unicast metrics. You can also selectively disable interfaces from participating in the multicast topology while continuing to participate in the regular unicast topology. This lets you exercise control over the paths that multicast data takes through a network so that it is independent of unicast data paths.

You can also configure IS-IS to calculate an alternate IPv6 multicast topology, in addition to the normal IPv6 unicast topology.

To enable an alternate IPv4 multicast topology for IS-IS, include the `ipv4-multicast` statement:

```
ipv4-multicast;
```

To configure the multicast metric for an alternate multicast topology, include the `ipv4-multicast-metric` statement:

```
ipv4-multicast-metric number;
```

To exclude an interface from the multicast topology for IS-IS, include the `no-ipv4-multicast` statement:

```
no-ipv4-multicast;
```

To enable an alternate IPv6 multicast topology for IS-IS, include the `ipv6-multicast` statement:

```
ipv6-multicast;
```

To configure the multicast metric for an alternate IPv6 multicast topology, include the `ipv6-multicast-metric` statement:

```
ipv6-multicast-metric number;
```

To exclude an interface from the IPv6 multicast topology for IS-IS, include the `no-ipv6-multicast` statement:

```
no-ipv6-multicast;
```

To exclude an interface from the IPv4 unicast topologies for IS-IS, include the `no-unicast-topology` statement:

```
no-unicast-topology;
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Example: Configuring IS-IS Multicast Topologies

```
[edit]
protocols {
  isis {
    traceoptions {
      file isis size 5m world-readable;
    }
    isis so-0/0/0.0 {
      level 1 {
        metric 15;
        multicast-metric 18;
      }
      level 2 {
        metric 20;
        multicast-metric 14;
      }
    }
    isis so-1/0/0.0 {
      level 1 {
```

```

        metric 15;
        multicast-metric 12;
    }
    level 2 {
        metric 20;
        multicast-metric 23;
    }
}
isis so-2/0/0.0 {
    no-multicast;
    level 1 metric 14;
    level 2 metric 23;
}
isis fxp0.0 {
    disable;
}
}
}

```

Configuring IS-IS IPv6 Unicast Topologies

You can configure IS-IS to calculate an alternate IPv6 unicast topology, in addition to the normal IPv4 unicast topology, and add the corresponding routes to **inet6.0**. The IS-IS interface metrics for the IPv4 topology can be configured independently of the IPv6 metrics. You can also selectively disable interfaces from participating in the IPv6 topology while continuing to participate in the IPv4 topology. This lets you exercise control over the paths that unicast data takes through a network.

To enable an alternate IPv6 unicast topology for IS-IS, include the **ipv6-unicast** statement:

```

isis {
    topologies {
        ipv6-unicast;
    }
}

```

To configure a metric for an alternate IPv6 unicast topology, include the **ipv6-unicast-metric** statement:

```

isis {
    interface interface-name {
        level level-number {
            ipv6-unicast-metric number;
        }
    }
}

```

To exclude an interface from the IPv6 unicast topologies for IS-IS, include the **no-ipv6-unicast** statement:

```

isis {
    interface interface-name {
        no-ipv6-unicast;
    }
}

```

```

    }
}

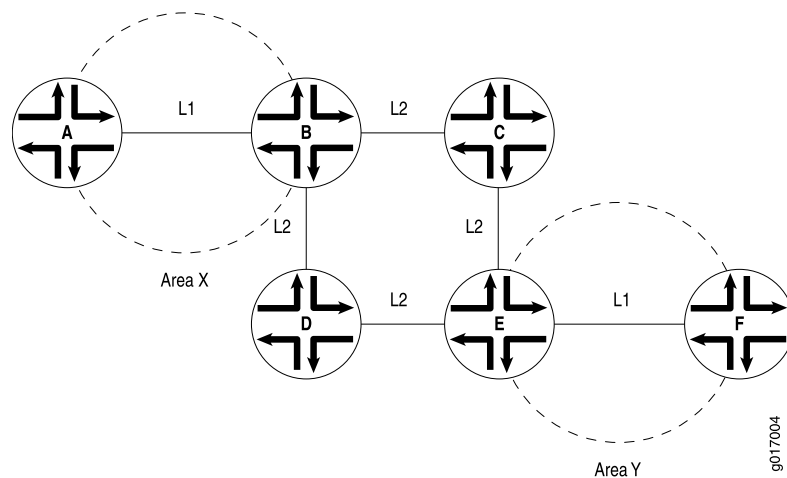
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Installing a Default Route to the Nearest Level 1/Level 2 Router

When a Level 1/Level 2 router (Router B) finds out that it can reach at least one area other than its own (for example, in Area Y), it sets the ATTACHED bit in its Level 1 LSP. Thereafter, the Level 1 router (Router A) introduces a default route pointing to the nearest attached Level 1/Level 2 router (Router B). See Figure 7 on page 333.

Figure 7: Install Default Route to Nearest Level 1/Level 2 Router



Tracing IS-IS Protocol Traffic

To trace IS-IS protocol traffic, you can specify options in the global `traceoptions` statement included at the `[edit routing-options]` hierarchy level, and you can specify IS-IS-specific options by including the `traceoptions` statement:

```

traceoptions {
  file filename <size size> <files number> <(world-readable | no-world-readable)>;
  flag flag <flag-modifier> <disable>;
}

```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

You can specify the following IS-IS-specific trace options in the IS-IS `flag` statement:

- `all`—Everything
- `csn`—Complete sequence number PDU (CSNP) packets
- `error`—Errored packets

- **general**—General events
- **hello**—Hello packets
- **lsp**—Link-state PDU (LSP) packets
- **lsp-generation**—Link-state PDU generation packets
- **normal**—Normal events
- **packets**—All IS-IS protocol packets
- **policy**—Policy processing
- **psn**—Partial sequence number PDU (PSNP) packets
- **route**—Routing information
- **spf**—Shortest-path-first (SPF) calculations
- **state**—State transitions
- **task**—Routing protocol task processing
- **timer**—Routing protocol timer processing

You can optionally specify one or more of the following flag modifiers:

- **detail**—Detailed trace information
- **receive**—Packets being received
- **send**—Packets being transmitted



NOTE: Use the trace flags **detail** and **all** with caution. These flags may cause the CPU to become very busy.

For information about tracing and global tracing options, see “Tracing Global Routing Protocol Operations” on page 119.

Examples: Tracing IS-IS Protocol Traffic

A common configuration traces SPF calculations, LSP calculations, normal protocol operations, and errors in protocol operation:

```
[edit]
protocols {
  isis {
    traceoptions {
      file isis-log size 1m files 10;
      flag spf;
      flag lsp;
      flag error;
      flag normal;
    }
  }
}
```

Trace only unusual or abnormal operations to the file `routing-log`, and trace detailed information about all IS-IS packets to the file `isis-log`:

```
[edit]
routing-options {
  traceoptions {
    file routing-log;
  }
}
protocols {
  isis {
    traceoptions {
      file isis-log size 10k files 5;
      flag csnp detail;
      flag hello detail;
      flag lsp detail;
      flag psnp detail;
    }
  }
}
```

Perform detailed tracing of mesh-group flooding:

```
[edit]
protocols {
  isis {
    traceoptions {
      file isis-log;
      flag lsp detail;
    }
  }
}
```

IS-IS LSP packets that contain errors are discarded by default. To log these errors, specify the `error` tracing operation:


```
[edit]
protocols {
  isis {
    traceoptions {
      file isis-log;
      flag error;
    }
  }
}
```


Chapter 16

Summary of IS-IS Configuration Statements

The following sections explain each of the Intermediate System-to-Intermediate System (IS-IS) configuration statements. The statements are organized alphabetically.

authentication-key

Syntax	authentication-key <i>key</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis level <i>level-number</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis level <i>level-number</i>], [edit protocols isis level <i>level-number</i>], [edit routing-instances <i>routing-instance-name</i> protocols isis level <i>level-number</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	<p>Authentication key (password). Neighboring routers use the password to verify the authenticity of packets sent from this interface. For the key to work, you also must include the authentication-type statement.</p> <p>All routers must use the same password. If you are using the JUNOS IS-IS software with another implementation of IS-IS, the other implementation must be configured to use the same password for the domain, the area, and all interfaces adjacent to the Juniper router.</p>
Default	If you do not include this statement and the authentication-type statement, IS-IS authentication is disabled.
Options	<p><i>key</i>—Authentication password. The password can be up to 1024 characters long.</p> <p>Characters can include any ASCII strings. If you include spaces, enclose all characters in quotation marks (" ").</p>
<hr/> <div style="display: flex; align-items: flex-start;"> <div style="margin-right: 10px;">  </div> <div> <p>CAUTION: A simple password for authentication is truncated if it exceeds 254 characters.</p> </div> </div> <hr/>	
Usage Guidelines	See “Configuring IS-IS Authentication” on page 303.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

authentication-type

Syntax	<code>authentication-type authentication;</code>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis level <i>level-number</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis level <i>level-number</i>], [edit protocols isis level <i>level-number</i>], [edit routing-instances <i>routing-instance-name</i> protocols isis level <i>level-number</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Enable authentication and specify the authentication scheme for IS-IS. If you enable authentication, you must specify a password by including the <code>authentication-key</code> statement.
Default	If you do not include this statement and the <code>authentication-key</code> statement, IS-IS authentication is disabled.
Options	<p><i>authentication</i>—Authentication scheme:</p> <ul style="list-style-type: none"> ■ md5—Use HMAC authentication in combination with MD5. HMAC-MD5 authentication is defined in RFC 2104, <i>HMAC: Keyed-Hashing for Message Authentication</i>. ■ simple—Use a simple password for authentication. The password is included in the transmitted packet, making this method of authentication relatively insecure. We recommend that you <i>not</i> use this authentication method.
Usage Guidelines	See “Configuring IS-IS Authentication” on page 303.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>
Related Topics	<code>authentication-key</code> , <code>no-authentication-check</code>

bfd-liveness-detection

Syntax	<pre> bfd-liveness-detection { detection-time { threshold <i>milliseconds</i>; } minimum-interval <i>milliseconds</i>; minimum-receive-interval <i>milliseconds</i>; no-adaptation; transmit-interval { threshold <i>milliseconds</i>; minimum-interval <i>milliseconds</i>; } multiplier <i>number</i>; version (1 automatic); } </pre>
Hierarchy Level	<pre> [edit logical-systems <i>logical-system-name</i> protocols isis interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i>], [edit protocols isis interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i>] </pre>
Release Information	<p>Statement introduced before JUNOS Release 7.4.</p> <p><code>detection-time threshold</code> and <code>transmit-interval threshold</code> options added in JUNOS Release 8.2.</p> <p>Support for logical systems introduced in JUNOS Release 8.3.</p> <p><code>no-adaptation</code> statement introduced in JUNOS Release 9.0.</p>
Description	Configure bidirectional failure detection timers.
Options	<p><code>detection-time threshold <i>milliseconds</i></code>—Configure a threshold. When the BFD session detection time adapts to a value equal to or greater than the threshold, a single trap and a single system log message are sent.</p> <p><code>minimum-interval <i>milliseconds</i></code>—Configure the minimum intervals at which the local router transmits a hello packet and then expects to receive a reply from the neighbor with which it has established a BFD session. Range: 1 through 255,000</p> <p><code>minimum-receive-interval <i>milliseconds</i></code>—Configure only the minimum interval at which the local router expects to receive a reply from a neighbor with which it has established a BFD session. Range: 1 through 255,000</p> <p><code>multiplier <i>number</i></code>—Configure the number hello packets not received by a neighbor that causes the originating interface to be declared down. Range: 1 through 255 Default: 3</p>

no-adaptation—Specify that BFD sessions not adapt to changing network conditions. We recommend that you not disable BFD adaptation unless it is preferable not to have BFD adaptation enabled in your network.

transmit-interval threshold *milliseconds*—Configure a threshold. When the BFD session transmit interval adapts to a value greater than the threshold, a single trap and a single system log message are sent. The interval threshold must be greater than the minimum transmit interval.

Range: 0 through 4,294,967,295

transmit-interval minimum-interval *milliseconds*—Configure only the minimum interval at which the router sends hello packets to a neighbor with which it has established a BFD session.

Range: 1 through 255,000

version—Specify the BFD version to detect.

Range: 1 (BFD version 1), or **automatic** (autodetection)

Default: automatic

Usage Guidelines See “Configuring the BFD Protocol” on page 320.

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

checksum

Syntax checksum;

Hierarchy Level [edit logical-systems *logical-system-name* protocols isis interface *interface-name*],
[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols
isis interface *interface-name*],
[edit protocols isis interface *interface-name*],
[edit routing-instances *routing-instance-name* protocols isis interface *interface-name*]


Release Information Statement introduced before JUNOS Release 7.4.

Description Enable checksum for packets on this interface. Checksum cannot be enabled with MD5 hello authentication on the same interface.

Usage Guidelines See “Enabling Checksum” on page 305.

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

clns-routing

Syntax	clns-routing;
Hierarchy Level	[edit protocols isis], [edit routing-instances <i>routing-instance-name</i> protocols isis]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Enable IS-IS to exchange CLNS routes.
<hr/>	
	NOTE: CLNS is supported for the J-Series Services Router only.
<hr/>	
Usage Guidelines	See “Configuring Support for Connectionless Network Services” on page 324.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	<i>J-series Services Router Advanced WAN Access Configuration Guide</i>

csnp-interval

Syntax	csnp-interval (<i>seconds</i> disable);
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i>], [edit protocols isis interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure the interval between complete sequence number (CSN) packets on a LAN interface.
Options	disable—Do not send CSN packets on this interface. <i>seconds</i> —Number of seconds between the sending of CSN packets. Range: 1 through 65,535 seconds Default: 10 seconds
Usage Guidelines	See “Configuring the CSNP Interval” on page 306.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

disable

See the following sections:

- `disable` (IS-IS) on page 344
- `disable` (LDP Synchronization) on page 345

disable (IS-IS)

Syntax	disable;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis], [edit logical-systems <i>logical-system-name</i> protocols isis interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> protocols isis interface <i>interface-name</i> level <i>level-number</i>], [edit logical-systems <i>logical-system-name</i> protocols isis traffic-engineering], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i> level <i>level-number</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis traffic-engineering], [edit protocols isis], [edit protocols isis interface <i>interface-name</i>], [edit protocols isis interface <i>interface-name</i> level <i>level-number</i>], [edit protocols isis traffic-engineering], [edit routing-instances <i>routing-instance-name</i> protocols isis], [edit routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i> level <i>level-number</i>], [edit routing-instances <i>routing-instance-name</i> protocols isis traffic-engineering]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	<p>Disable IS-IS on the router, on an interface, or on a level. At the [edit protocols isis traffic-engineering] hierarchy level, disable IS-IS support for traffic engineering.</p> <p>Enabling IS-IS on an interface (by including the interface statement at the [edit protocols isis] or the [edit routing-instances <i>routing-instance-name</i> protocols isis] hierarchy level), disabling it (by including the disable statement), and not actually having IS-IS run on an interface (by including the passive statement) are mutually exclusive states.</p>
Default	<p>IS-IS is enabled for Level 1 and Level 2 routers on all interfaces on which an International Organization of Standardization (ISO) protocol family is enabled.</p> <p>IS-IS support for traffic engineering is enabled.</p>
Usage Guidelines	See “IS-IS Overview” on page 293, “Disabling IS-IS Support for Traffic Engineering” on page 320, and “Disabling IS-IS” on page 326.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

disable (LDP Synchronization)

Syntax	disable;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i>], [edit protocols isis interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i>]
Release Information	Statement introduced in Release 7.5.
Description	Disable the Label Distribution Protocol (LDP) for IS-IS.
Usage Guidelines	See “Configuring Label Distribution Protocol Synchronization” on page 313.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

export

Syntax	export [<i>policy-names</i>];
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis], [edit protocols isis], [edit routing-instances <i>routing-instance-name</i> protocols isis]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Apply one or more policies to routes being exported from the routing table into IS-IS.
Options	<i>policy-names</i> —Name of one or more policies.
Usage Guidelines	See “Configuring IS-IS Routing Policy” on page 328 and the <i>JUNOS Policy Framework Configuration Guide</i> .
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	<i>J-series Services Router Advanced WAN Access Configuration Guide</i>

external-preference

Syntax	external-preference <i>preference</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis level <i>level-number</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis level <i>level-number</i>], [edit protocols isis level <i>level-number</i>], [edit routing-instances <i>routing-instance-name</i> protocols isis level <i>level-number</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure the preference of external routes.
Options	<i>preference</i> —Preference value. Range: 0 through 4,294,967,295 ($2^{32} - 1$) Default: 15 (for Level 1 internal routes), 18 (for Level 2 internal routes), 160 (for Level 1 external routes), 165 (for Level 2 external routes)
Usage Guidelines	See “Configuring Route Preferences” on page 308.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	preference

family

Syntax	<pre>family inet { shortcuts { multicast-rpf-routes; } } family inet6 { shortcuts; }</pre>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis traffic-engineering], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis traffic-engineering] [edit protocols isis traffic-engineering], [edit routing-instances <i>routing-instance-name</i> protocols isis traffic-engineering],
Release Information	Statement introduced in JUNOS Release 9.3.
Description	Configure the address family for traffic engineering IS-IS interior gateway protocol (IGP) shortcuts. Support for IPv6 for IGP shortcuts introduced in JUNOS Release 9.3.
Options	inet—IPv4 address family inet6—IPv6 address family The remaining statements are explained separately.
Usage Guidelines	See “Configuring IS-IS to Use IGP Shortcuts” on page 318.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

graceful-restart

Syntax	<pre>graceful-restart { disable; helper-disable; restart-duration <i>seconds</i>; }</pre>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis], [edit protocols isis]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure graceful restart for IS-IS.
Options	<p>disable—Disable graceful restart.</p> <p>helper-disable—Disable graceful restart helper capability. Helper mode is enabled by default.</p> <p>restart-duration <i>seconds</i>—Configure the time period for the restart to last, in seconds. Range: 30 through 300 seconds Default: 30 seconds</p>
Usage Guidelines	See “Configuring Graceful Restart” on page 113 and “Configuring Graceful Restart” on page 317.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

hello-authentication-key

Syntax	hello-authentication-key <i>password</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis interface <i>interface-name</i> level <i>number</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i> level <i>number</i>], [edit protocols isis interface <i>interface-name</i> level <i>number</i>], [edit routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i> level <i>number</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Authentication key (password) for hello packets. Neighboring routers use the password to verify the authenticity of packets sent from an interface. For the key to work, you also must include the hello-authentication-type statement.
Default	By default, hello authentication is not configured on an interface. However, if IS-IS authentication is configured, the hello packets are authenticated using the IS-IS authentication type and password.
Options	<i>password</i> —Authentication password. The password can be up to 255 characters. Characters can include any ASCII strings. If you include spaces, enclose all characters in quotation marks (" ").
Usage Guidelines	See “Configuring Authentication for Hello Packets” on page 310.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	authentication-key, authentication-type, hello-authentication-type

hello-authentication-type

Syntax	hello-authentication-type (md5 simple);
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis interface <i>interface-name</i> level <i>number</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i> level <i>number</i>], [edit protocols isis interface <i>interface-name</i> level <i>number</i>], [edit routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i> level <i>number</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Enable authentication on an interface for hello packets. If you enable authentication on hello packets, you must specify a password by including the hello-authentication-key statement.
Default	By default, hello authentication is not configured on an interface. However, if IS-IS authentication is configured, the hello packets are authenticated using the IS-IS authentication type and password.
Options	md5—Specifies Message Digest 5 as the packet verification type. simple—Specifies simple authentication as the packet verification type.
Usage Guidelines	See “Configuring Authentication for Hello Packets” on page 310.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	authentication-key, authentication-type, hello-authentication-key

hello-interval

Syntax	hello-interval <i>seconds</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis interface <i>interface-name</i> level <i>level-number</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i> level <i>level-number</i>], [edit protocols isis interface <i>interface-name</i> level <i>level-number</i>], [edit routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i> level <i>level-number</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Frequency at which the router sends hello packets out of an interface, in seconds.
Options	<i>seconds</i> —Frequency of transmission for hello packets. Range: 1 through 20,000 seconds Default: 3 seconds (for designated intersystem [DIS] routers), 9 seconds (for non-DIS routers)
Usage Guidelines	See “Modifying the Hello Interval” on page 311.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	hold-time

hello-padding

Syntax	hello-padding (adaptive loose strict);
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i>], [edit protocols isis interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i>]
Release Information	Statement introduced in JUNOS Release 8.0.
Description	Configure padding on hello packets to accommodate asymmetrical maximum transfer units (MTUs) from different hosts.
Options	adaptive—Configure padding until state of neighbor adjacency is up. loose—Configure padding until state of adjacency is initialized. strict—Configure padding for all adjacency states.
Usage Guidelines	See “Configuring Hello Packet Padding” on page 323.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

hold-time

See the following sections:

- hold-time (IS-IS) on page 353
- hold-time (LDP Synchronization) on page 354

hold-time (IS-IS)

Syntax	hold-time <i>seconds</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis interface <i>interface-name</i> level <i>level-number</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i> level <i>level-number</i>], [edit protocols isis interface <i>interface-name</i> level <i>level-number</i>], [edit routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i> level <i>level-number</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Set the length of time a neighbor considers this router to be operative (up) after receiving a hello packet. If the neighbor does not receive another hello packet within the specified time, it marks this router as inoperative (down). The hold time itself is advertised in the hello packets.
Options	<i>seconds</i> —Hold-time value, in seconds. Range: 3 through 65,535 seconds. Specify 1 to send out hello packets every 333 milliseconds. Default: 9 seconds (for DIS routers), 27 seconds (for non-DIS routers; three times the default hello interval)
Usage Guidelines	See “Modifying the Hold-Time Value” on page 311.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	hello-interval

hold-time (LDP Synchronization)

Syntax	hold-time <i>seconds</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis interface <i>interface-name</i> ldp-synchronization], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i> ldp-synchronization], [edit protocols isis interface <i>interface-name</i> ldp-synchronization], [edit routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i> ldp-synchronization]
Release Information	Statement introduced in Release 7.5.
Description	Configure the time period to advertise the maximum cost metric for a link that is not fully operational.
Options	<i>seconds</i> —Hold-time value, in seconds. Range: 1 through 65,535 seconds Default: Infinity
Usage Guidelines	See “Configuring Label Distribution Protocol Synchronization” on page 313.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

ignore-attached-bit

Syntax	ignore-attached-bit;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis], [edit protocols isis], [edit routing-instances <i>routing-instance-name</i> protocols isis]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Ignore the attached bit on IS-IS Level 1 routers. Configuring this statement allows the router to ignore the attached bit on incoming Level 1 LSPs. If the attached bit is ignored, no default route, which points to the router which has set the attached bit, will be installed.
Default	The ignore-attached-bit statement is disabled by default.
Usage Guidelines	See “Installing a Default Route to the Nearest Level 1/Level 2 Router” on page 333.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

ignore-lsp-metrics

Syntax	ignore-lsp-metrics;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis traffic-engineering], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis traffic-engineering], [edit protocols isis traffic-engineering], [edit routing-instances <i>routing-instance-name</i> protocols isis traffic-engineering]
Release Information	Statement introduced in JUNOS Release 8.0.
Description	Ignore the metrics for RSVP label-switched paths in IS-IS traffic engineering shortcut calculations or when you configure LDP over RSVP label-switched paths.
Usage Guidelines	See “Configuring IS-IS to Use IGP Shortcuts” on page 318 and “Configuring IS-IS to Ignore the Metric of RSVP Label-Switched Paths” on page 319.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	shortcuts and <i>JUNOS MPLS Applications Configuration Guide</i>

interface

Syntax interface (all | *interface-name*) {
 disable;
 bfd-liveness-detection {
 detection-time {
 threshold *milliseconds*;
 }
 minimum-interval *milliseconds*;
 minimum-receive-interval *milliseconds*;
 transmit-interval {
 threshold *milliseconds*;
 minimum-interval *milliseconds*;
 }
 multiplier *number*;
 }
 checksum;
 csnp-interval (*seconds* | disable);
 hello-padding (adaptive | loose | strict);
 ldp-synchronization {
 disable;
 hold-time *seconds*;
 }
 lsp-interval *milliseconds*;
 mesh-group (*value* | blocked);
 no-adjacency-down-notification;
 no-ipv4-multicast;
 no-ipv6-multicast;
 no-ipv6-unicast;
 no-unicast-topology;
 passive;
 point-to-point;
 level *level-number* {
 disable;
 hello-authentication-type *authentication*;
 hello-authentication-key *key*;
 hello-interval *seconds*;
 hold-time *seconds*;
 ipv4-multicast-metric *number*;
 ipv6-multicast-metric *number*;
 ipv6-unicast-metric *number*;
 metric *metric*;
 passive;
 priority *number*;
 te-metric *metric*;
 }
}

Hierarchy Level [edit logical-systems *logical-system-name* protocols isis],
 [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols
 isis],
 [edit protocols isis],

[edit routing-instances *routing-instance-name* protocols isis]

Release Information Statement introduced before JUNOS Release 7.4.

Description Configure interface-specific IS-IS properties. To configure more than one interface, include the **interface** statement multiple times.

Enabling IS-IS on an interface (by including the **interface** statement at the [edit protocols isis] or the [edit routing-instances *routing-instance-name* protocols isis] hierarchy level), disabling it (by including the **disable** statement), and not actually having IS-IS run on an interface (by including the **passive** statement) are mutually exclusive states.

Options all—Have the JUNOS software create IS-IS interfaces automatically.

interface-name—Name of an interface. Specify the full interface name, including the physical and logical address components. For details about specifying interfaces, see the *JUNOS Network Interfaces Configuration Guide* and the *JUNOS Services Interfaces Configuration Guide*.

The remaining statements are explained separately.

Usage Guidelines See “Configuring Interface-Specific Properties” on page 304.

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

ipv4-multicast

Syntax ipv4-multicast;

Hierarchy Level [edit logical-systems *logical-system-name* protocols isis topologies],
[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols isis topologies],
[edit protocols isis topologies],
[edit routing-instances *routing-instance-name* protocols isis topologies]

Release Information Statement introduced before JUNOS Release 7.4.

Description Configure alternate IPv4 multicast topologies.

Default Multicast topologies are disabled.

Usage Guidelines See “Configuring IS-IS Multicast Topologies” on page 330.

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

ipv4-multicast-metric

Syntax	ipv4-multicast-metric <i>metric</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis interface <i>interface-name</i> level <i>level-number</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i> level <i>level-number</i>], [edit protocols isis interface <i>interface-name</i> level <i>level-number</i>], [edit routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i> level <i>level-number</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Specify the multicast topology metric value for the level.
Options	<i>metric</i> —Metric value. Range: 0 through 16,777,215
Usage Guidelines	See “Configuring IS-IS Multicast Topologies” on page 330.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

ipv6-multicast

Syntax	ipv6-multicast;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis topologies], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis topologies], [edit protocols isis topologies], [edit routing-instances <i>routing-instance-name</i> protocols isis topologies]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure alternate IPv6 multicast topologies.
Default	Multicast topologies are disabled.
Usage Guidelines	See “Configuring IS-IS Multicast Topologies” on page 330.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

ipv6-multicast-metric

Syntax	ipv6-multicast-metric <i>metric</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis interface <i>interface-name</i> level <i>level-number</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i> level <i>level-number</i>], [edit protocols isis interface <i>interface-name</i> level <i>level-number</i>], [edit routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i> level <i>level-number</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Specify the IPv6 alternate multicast topology metric value for the level.
Options	<i>metric</i> —Metric value. Range: 0 through 16,777,215
Usage Guidelines	See “Configuring IS-IS Multicast Topologies” on page 330.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

ipv6-unicast

Syntax	ipv6-unicast;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis topologies], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis topologies], [edit protocols isis topologies], [edit routing-instances <i>routing-instance-name</i> protocols isis topologies]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure alternate IPv6 unicast topologies.
Default	IPv6 unicast topologies are disabled.
Usage Guidelines	See “Configuring IS-IS IPv6 Unicast Topologies” on page 332.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

ipv6-unicast-metric

Syntax	ipv6-unicast-metric <i>metric</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis interface <i>interface-name</i> level <i>level-number</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i> level <i>level-number</i>], [edit protocols isis interface <i>interface-name</i> level <i>level-number</i>], [edit routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i> level <i>level-number</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Specify the IPv6 unicast topology metric value for the level.
Options	<i>metric</i> —Metric value. Range: 0 through 16,777,215
Usage Guidelines	See “Configuring IS-IS IPv6 Unicast Topologies” on page 332.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

isis

Syntax	isis { ... }
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols], [edit protocols], [edit routing-instances <i>routing-instance-name</i> protocols]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Enable IS-IS routing on the router or for a routing instance. The <i>isis</i> statement is the one statement you must include in the configuration to run IS-IS on the router or in a routing instance.
Default	IS-IS is disabled on the router.
Usage Guidelines	See “Minimum IS-IS Configuration” on page 302.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

label-switched-path

Syntax	label-switched-path <i>name</i> level <i>level-number</i> metric <i>metric</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis], [edit protocols isis], [edit routing-instances <i>routing-instance-name</i> protocols isis]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Advertise label-switched paths into IS-IS as point-to-point links. The label-switched path is advertised in the appropriate IS-IS levels as a point-to-point link and contains a local address and a remote address.
Options	<p><i>name</i>—Identifies the label-switched path.</p> <p><i>level-number</i>—IS-IS level number. Values: 1 or 2</p> <p><i>metric</i>—Metric value. Range: 1 through 63, or 1 through 16,777,215 (if you have configured wide metrics) Default: 0 (for lo0), 10 (for all other interfaces)</p>
Usage Guidelines	See “Advertising Label-Switched Paths into IS-IS” on page 314.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

ldp-synchronization

Syntax	ldp-synchronization { disable; hold-time <i>seconds</i> ; }
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i>], [edit protocols isis interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i>]
Release Information	Statement introduced in Release 7.5.
Description	Enable synchronization by advertising the maximum cost metric until LDP is operational on the link.
Options	The statements are explained separately.
Usage Guidelines	See “Configuring Label Distribution Protocol Synchronization with the IGP” on page 438.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

level

See the following sections:

- `level` (Global IS-IS) on page 363
- `level` (IS-IS Interfaces) on page 364

level (Global IS-IS)

Syntax `level level-number {`
 `authentication-key key;`
 `authentication-type type;`
 `external-preference preference;`
 `no-csnp-authentication;`
 `no-hello-authentication;`
 `no-psnp-authentication;`
 `preference preference;`
 `wide-metrics-only;`
`}`

Hierarchy Level [edit logical-systems *logical-system-name* protocols isis],
 [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols
 isis],
 [edit protocols isis],
 [edit routing-instances *routing-instance-name* protocols isis]

Release Information Statement introduced before JUNOS Release 7.4.

Description Configure the global-level properties.

Options *level-number*—IS-IS level number.
Values: 1 or 2

The remaining statements are explained separately.

Usage Guidelines See “Configuring Route Preferences” on page 308.

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

level (IS-IS Interfaces)

Syntax	<pre> level level-number { disable; hello-authentication-key key; hello-authentication-type authentication; hello-interval seconds hold-time seconds; ipv4-multicast-metric number; ipv6-unicast-metric number; metric metric; passive; priority number; te-metric metric; } </pre>
Hierarchy Level	<pre> [edit logical-systems logical-system-name protocols isis interface interface-name], [edit logical-systems logical-system-name routing-instances routing-instance-name protocols isis interface interface-name], [edit protocols isis interface interface-name], [edit routing-instances routing-instance-name protocols isis interface interface-name] </pre>
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure the IS-IS level. You can configure one instance of Level 1 routing and one instance of Level 2 routing on each interface, and you can configure the two levels differently.
Options	<p><i>level-number</i>—IS-IS level number.</p> <p>Values: 1 or 2</p> <p>Default: The router operates as both a Level 1 and Level 2 router.</p> <p>The remaining statements are explained separately.</p>
Usage Guidelines	See “Configuring IS-IS Levels on an Interface” on page 308.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

loose-authentication-check

Syntax	loose-authentication-check;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis], [edit protocols isis], [edit routing-instances <i>routing-instance-name</i> protocols isis]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Allow the use of MD5 authentication without requiring network-wide deployment.
Usage Guidelines	See “Configuring Loose Authentication Check” on page 323.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

lsp-interval

Syntax	lsp-interval <i>milliseconds</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i>], [edit protocols isis interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure the link-state PDU (LSP) interval time.
Options	<i>milliseconds</i> —Number of milliseconds between the sending of LSPs. Specifying a value of 0 blocks all LSP transmission. Range: 0 through 1000 milliseconds Default: 100 milliseconds
Usage Guidelines	See “Modifying the LSP Interval” on page 313.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

lsp-lifetime

Syntax	<code>lsp-lifetime seconds;</code>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis], [edit protocols isis], [edit routing-instances <i>routing-instance-name</i> protocols isis]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	How long an LSP originating from the router should persist in the network. The router sends LSPs often enough so that the LSP lifetime never expires.
Options	<i>seconds</i> —LSP lifetime, in seconds. Range: 350 through 65,535 seconds Default: 1200 seconds
Usage Guidelines	See “Modifying the LSP Lifetime” on page 314.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

max-areas

Syntax	<code>max-areas number;</code>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis] [edit protocols isis], [edit routing-instances <i>routing-instance-name</i> protocols isis],
Release Information	Statement introduced in JUNOS Release 8.1.
Description	Modify the maximum number of IS-IS areas advertised.
Options	<i>number</i> —Maximum number of areas to include in the IS-IS hello (IIH) PDUs and link-state PDUs (LSPs). Range: 3 through 36 Default: 3
Usage Guidelines	See “Modifying the Maximum Number of Areas Advertised” on page 307.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

mesh-group

Syntax	mesh-group (<i>value</i> blocked);
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i>], [edit protocols isis interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure an interface to be part of a mesh group, which is a set of fully connected nodes.
Options	<i>value</i> —Number that identifies the mesh group. Range: 1 through 4,294,967,295 (32 bits are allocated to identify a mesh group) blocked—Configure the interface so that it does not flood LSP packets.
Usage Guidelines	See “Configuring Mesh Groups” on page 306.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

metric

Syntax	<code>metric <i>metric</i>;</code>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis interface <i>interface-name</i> level <i>level-number</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i> level <i>level-number</i>], [edit protocols isis interface <i>interface-name</i> level <i>level-number</i>], [edit routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i> level <i>level-number</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Metric value for the level.
Options	<i>metric</i> —Metric value. Range: 1 through 63, or 1 through 16,777,215 (if you have configured wide metrics) Default: 10 (for all interfaces except lo0), 0 (for the lo0 interface)
Usage Guidelines	See “Modifying the IS-IS Metric” on page 312.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	te-metric, wide-metrics-only

multicast-rpf-routes

Syntax	<code>multicast-rpf-routes;</code>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis traffic-engineering family inet shortcuts], [edit logical-systems <i>logical-system-name</i> routing-instances traffic-engineering family inet shortcuts], [edit protocols isis traffic-engineering family inet shortcuts], [edit routing-instances <i>routing-instance-name</i> protocols isis traffic-engineering family inet shortcuts]
Release Information	Statement introduced in JUNOS Release 9.3.
Description	Install IPv4 routes into the multicast routing table for RPF checks.
Usage Guidelines	See “Installing IPv4 Routes into the Multicast Routing Table” on page 320.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

no-adjacency-holddown

Syntax	no-adjacency-holddown;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis], [edit protocols isis], [edit routing-instances <i>routing-instance-name</i> protocols isis]
Release Information	Statement introduced in JUNOS Release 8.0.
Description	Disable hold-down timer for IS-IS adjacencies.
Usage Guidelines	See “Disabling Adjacency Hold-Down Timers” on page 323.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

no-authentication-check

Syntax	no-authentication-check;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis], [edit protocols isis], [edit routing-instances <i>routing-instance-name</i> protocols isis]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Generate authenticated packets, check the authentication on received packets, but do not reject packets that cannot be authenticated.
Usage Guidelines	See “Configuring IS-IS Authentication” on page 303.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	csnp-interval, hello-authentication-type

no-csnp-authentication

Syntax	no-csnp-authentication;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis level <i>level-number</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis level <i>level-number</i>], [edit protocols isis level <i>level-number</i>], [edit routing-instances <i>routing-instance-name</i> protocols isis level <i>level-number</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Suppress authentication check on complete sequence number PDU (CSNP) packets.
Usage Guidelines	See “Configuring IS-IS Authentication” on page 303.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	csnp-interval

no-hello-authentication

Syntax	no-hello-authentication;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis level <i>level-number</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis level <i>level-number</i>], [edit protocols isis level <i>level-number</i>], [edit routing-instances <i>routing-instance-name</i> protocols isis level <i>level-number</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Suppress authentication check on complete sequence number hello packets.
Usage Guidelines	See “Configuring IS-IS Authentication” on page 303.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	hello-authentication-type

no-ipv4-multicast

Syntax	no-ipv4-multicast;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i>], [edit protocols isis interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Exclude an interface from the IPv4 multicast topologies.
Default	Multicast topologies are disabled.
Usage Guidelines	See “Configuring IS-IS Multicast Topologies” on page 330.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

no-ipv4-routing

Syntax	no-ipv4-routing;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis], [edit protocols isis], [edit routing-instances <i>routing-instance-name</i> protocols isis]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Disable Internet Protocol version 4 (IPv4) routing.
Usage Guidelines	See “Disabling IPv4 Routing” on page 327.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

no-ipv6-multicast

Syntax	no-ipv6-multicast;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i>], [edit protocols isis interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Exclude an interface from the IPv6 multicast topologies.
Default	Multicast topologies are disabled.
Usage Guidelines	See “Configuring IS-IS Multicast Topologies” on page 330.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

no-ipv6-routing

Syntax	no-ipv6-routing;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis], [edit protocols isis], [edit routing-instances <i>routing-instance-name</i> protocols isis]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Disable Internet Protocol version 6 (IPv6) routing.
Usage Guidelines	See “Disabling IPv6 Routing” on page 327.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

no-ipv6-unicast

Syntax	no-ipv6-unicast;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i>], [edit protocols isis interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Exclude an interface from the IPv6 unicast topologies.
Default	IPv6 unicast topologies are disabled.
Usage Guidelines	See “Configuring IS-IS IPv6 Unicast Topologies” on page 332.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

no-psnp-authentication

Syntax	no-psnp-authentication;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis level <i>level-number</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis level <i>level-number</i>], [edit protocols isis level <i>level-number</i>], [edit routing-instances <i>routing-instance-name</i> protocols isis level <i>level-number</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Suppress authentication check on partial sequence number PDU (PSNP) packets.
Usage Guidelines	See “Configuring IS-IS Authentication” on page 303.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

no-unicast-topology

Syntax	no-unicast-topology;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i>], [edit protocols isis interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Exclude an interface from the IPv4 unicast topologies.
Default	IPv4 unicast topologies are disabled.
Usage Guidelines	See “Configuring IS-IS Multicast Topologies” on page 330.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

overload

Syntax `overload {
 advertise-high-metrics;
 timeout seconds;
 }`

Hierarchy Level [edit logical-systems *logical-system-name* protocols isis],
 [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols
 isis],
 [edit protocols isis],
 [edit routing-instances *routing-instance-name* protocols isis]

Release Information Statement introduced before JUNOS Release 7.4.

Description Configure the local router so that it appears to be overloaded. You might want to do this when you want the router to participate in IS-IS routing, but do not want it to be used for transit traffic. Note that traffic to immediately attached interfaces continues to transit the router. You can also advertise maximum link metrics in NLRIs instead of setting the overload bit.



NOTE: If the time elapsed after the IS-IS instance is enabled is less than the specified timeout, overload mode is set.

Options `advertise-high-metrics`—Advertise maximum link metrics in NLRIs instead of setting the overload bit.

`timeout seconds`—Number of seconds at which the overloading is reset.

Default: 0 seconds

Range: 60 through 1800 seconds

Usage Guidelines See “Configuring the Router to Appear Overloaded” on page 315.

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

passive

Syntax	passive;
Hierarchy Level	<pre>[edit logical-systems <i>logical-system-name</i> protocols isis interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> protocols isis interface <i>interface-name</i> level <i>level-number</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i> level <i>level-number</i>], [edit protocols isis interface <i>interface-name</i>], [edit protocols isis interface <i>interface-name</i> level <i>level-number</i>], [edit routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i> level <i>level-number</i>]</pre>
Release Information	Statement introduced before JUNOS Release 7.4.
Description	<p>Advertise the direct interface addresses on an interface or into a level on the interface without actually running IS-IS on that interface or level.</p> <p>This statement effectively prevents IS-IS from running on the interface. To enable IS-IS on an interface, include the <code>interface</code> statement at the <code>[edit protocols isis]</code> or the <code>[edit routing-instances <i>routing-instance-name</i> protocols isis]</code> hierarchy level. To disable it, include the <code>disable</code> statement at those hierarchy levels. The three states are mutually exclusive.</p>
Usage Guidelines	See “Advertising Interface Addresses Without Running IS-IS” on page 310.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

point-to-point

Syntax	point-to-point;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i>], [edit protocols isis interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure an IS-IS interface to behave like a point-to-point connection.
Usage Guidelines	See “Configuring Point-to-Point Interfaces” on page 317.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

preference

Syntax	preference <i>preference</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis level <i>level-number</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis level <i>level-number</i>], [edit protocols isis level <i>level-number</i>], [edit routing-instances <i>routing-instance-name</i> protocols isis level <i>level-number</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure the preference of internal routes.
Options	<i>preference</i> —Preference value. Range: 0 through 4,294,967,295 ($2^{32} - 1$) Default: 15 (for Level 1 internal routes), 18 (for Level 2 internal routes), 160 (for Level 1 external routes), 165 (for Level 2 external routes)
Usage Guidelines	See “Configuring Route Preferences” on page 308.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	external-preference

prefix-export-limit

Syntax	prefix-export-limit <i>number</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis level <i>level-number</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis level <i>level-number</i>], [edit protocols isis level <i>level-number</i>], [edit routing-instances <i>routing-instance-name</i> protocols isis level <i>level-number</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure a limit to the number of prefixes exported into IS-IS.
Options	<i>number</i> —Prefix limit. Range: 0 through 4,294,967,295
Usage Guidelines	See “Configuring a Prefix Export Limit” on page 308.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

priority

Syntax	priority <i>number</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis interface <i>interface-name</i> level <i>level-number</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i> level <i>level-number</i>], [edit protocols isis interface <i>interface-name</i> level <i>level-number</i>], [edit routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i> level <i>level-number</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	The interface’s priority for becoming the designated router. The interface with the highest priority value becomes that level’s designated router. The priority value is meaningful only on a multiaccess network. It has no meaning on a point-to-point interface.
Options	<i>number</i> —Priority value. Range: 0 through 127 Default: 64
Usage Guidelines	See “Configuring the Priority for Becoming the Designated Router” on page 312.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

reference-bandwidth

Syntax	<code>reference-bandwidth <i>reference-bandwidth</i>;</code>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis], [edit protocols isis], [edit routing-instances <i>routing-instance-name</i> protocols isis]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Set the reference bandwidth used in calculating the default interface cost. The cost is calculated using the following formula: $\text{cost} = \text{reference-bandwidth} / \text{bandwidth}$
Options	<i>reference-bandwidth</i> —Reference bandwidth, in megabits per second. Default: 10 Mbps Range: 9600 through 1,000,000,000,000 Mbps
Usage Guidelines	See “Modifying the Interface Metric” on page 306.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

rib-group

Syntax	<pre> rib-group { inet <i>group-name</i>; inet6 <i>group-name</i>; } </pre>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis], [edit protocols isis], [edit routing-instances <i>routing-instance-name</i> protocols isis]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	<p>Install routes learned from IS-IS routing instances into routing tables in the IS-IS routing table group. You can install IPv4 routes or IPv6 routes.</p> <p>Support for IPv6 routing table groups in IS-IS enables IPv6 routes that are learned from IS-IS routing instances to be installed into other routing tables defined in an IS-IS routing table group.</p>
Options	<p><i>group-name</i>—Name of the routing table group.</p> <p>inet—Install IPv4 IS-IS routes.</p> <p>inet6—Install IPv6 IS-IS routes.</p>
Usage Guidelines	See “Creating Routing Table Groups” on page 104, “Configuring How Interface Routes Are Imported into Routing Tables” on page 106, “IS-IS Configuration Guidelines” on page 299, and “Configuring BGP Routing Table Groups” on page 686.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

shortcuts

Syntax	shortcuts { multicast-rpf-routes; }
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis traffic-engineering family (inet inet6)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis traffic-engineering family (inet inet6)], [edit protocols isis traffic-engineeringfamily (inet inet6)], [edit routing-instances <i>routing-instance-name</i> protocols isis traffic-engineeringfamily (inet inet6)]
Release Information	Statement introduced before JUNOS Release 7.4. The family statement and support for IPv6 routes for IS-IS traffic engineering shortcuts introduced in JUNOS Release 9.3.
Description	Configure IS-IS to use MPLS label-switched paths (LSPs) as next hops if possible when installing routing information into the inet.3 or inet6.3 routing table.
Options	The remaining statement is explained separately.
Usage Guidelines	See “Configuring IS-IS to Use IGP Shortcuts” on page 318.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

spf-options

Syntax	<pre>spf-options { delay <i>milliseconds</i>; holddown <i>milliseconds</i>; rapid-runs <i>number</i>; }</pre>
Hierarchy Level	<p>[edit logical-systems <i>logical-system-name</i> protocols isis], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis], [edit protocols isis], [edit routing-instances <i>routing-instance-name</i> protocols isis]</p>
Release Information	Statement introduced in JUNOS Release 8.5.
Description	Configure options for running the shortest-path-first (SPF) algorithm. You can configure a delay for when to run the SPF algorithm after a network topology change is detected, the maximum number of times the SPF algorithm can run in succession, and a holddown interval after SPF algorithm runs the maximum number of times.
Options	<p>delay <i>milliseconds</i>—Time interval between the detection of a topology change and when the SPF algorithm runs. Range: 50 through 1000 milliseconds Default: 200 milliseconds</p> <p>holddown <i>milliseconds</i>—Time interval to hold down, or wait before a subsequent SPF algorithm runs after the SPF algorithm has run the configured maximum number of times in succession. Range: 2000 through 10,000 milliseconds Default: 5000 milliseconds</p> <p>rapid-runs <i>number</i>—Maximum number of times the SPF algorithm can run in succession. After the maximum is reached, the holddown interval begins. Range: 1 through 5 Default: 3</p>
Usage Guidelines	See “Configuring SPF Options for IS-IS” on page 316.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

te-metric

Syntax	te-metric <i>metric</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis interface <i>interface-name</i> level <i>level-number</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i> level <i>level-number</i>], [edit protocols isis interface <i>interface-name</i> level <i>level-number</i>], [edit routing-instances <i>routing-instance-name</i> protocols isis interface <i>interface-name</i> level <i>level-number</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Metric value used by traffic engineering for information injected into the traffic engineering database. The value of the traffic engineering metric does not affect normal IS-IS forwarding.
Options	<i>metric</i> —Metric value. Range: 1 through 16,777,215 Default: Value of the IGP metric
Usage Guidelines	See “Modifying the IS-IS Metric” on page 312.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	metric, wide-metrics-only

topologies

Syntax	<pre>topologies { ipv4-multicast; ipv6-multicast; ipv6-unicast; }</pre>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis], [edit protocols isis], [edit routing-instances <i>routing-instance-name</i> protocols isis]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure alternate IS-IS topologies.
Options	The statements are explained separately in this chapter.
Usage Guidelines	See “Configuring IS-IS Multicast Topologies” on page 330.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

traceoptions

Syntax traceoptions {
 file *name* <size *size*> <files *number*> <world-readable | no-world-readable>;
 flag *flag* <flag-modifier> <disable>;
 }

Hierarchy Level [edit logical-systems *logical-system-name* protocols isis],
 [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols isis],
 [edit protocols isis],
 [edit routing-instances *routing-instance-name* protocols isis]

Release Information Statement introduced before JUNOS Release 7.4.

Description Configure IS-IS protocol-level tracing options.

To specify more than one tracing operation, include multiple **flag** statements.

Default The default IS-IS protocol-level tracing options are those inherited from the routing protocols **traceoptions** statement included at the [edit **routing-options**] hierarchy level.

Options **disable**—(Optional) Disable the tracing operation. You can use this option to disable a single operation when you have defined a broad group of tracing operations, such as **all**.

file *filename*—Name of the file to receive the output of the tracing operation. Enclose the name within quotation marks. All files are placed in the directory **/var/log**. We recommend that you place IS-IS tracing output in the file **isis-log**.

files *number*—(Optional) Maximum number of trace files. When a trace file named *trace-file* reaches its maximum size, it is renamed *trace-file.0*, then *trace-file.1*, and so on, until the maximum number of trace files is reached. Then, the oldest trace file is overwritten.

If you specify a maximum number of files, you also must specify a maximum file size with the **size** option.

Range: 2 through 1000 files

Default: 10 files

flag—Tracing operation to perform. To specify more than one flag, include multiple **flag** statements.

IS-IS Tracing Flags

- **csn**—Complete sequence number PDU (CSNP) packets
- **error**—Errored IS-IS packets
- **graceful-restart**—Graceful restart operation
- **hello**—Hello packets

- **lsp**—Link-state PDU packets
- **lsp-generation**—Link-state PDU generation packets
- **packets**—All IS-IS protocol packets
- **psn**—Partial sequence number PDU (PSNP) packets
- **spf**—Shortest-path-first calculations

Global Tracing Flags

- **all**—All tracing operations
- **general**—A combination of the **normal** and **route** trace operations
- **normal**—All normal operations, including adjacency changes
Default: If you do not specify this option, only unusual or abnormal operations are traced.
- **policy**—Policy operations and actions
- **route**—Routing table changes
- **state**—State transitions
- **task**—Interface transactions and processing
- **timer**—Timer usage

flag-modifier—(Optional) Modifier for the tracing flag. You can specify one or more of these modifiers:

- **detail**—Detailed trace information
- **receive**—Packets being received
- **send**—Packets being transmitted

no-world-readable—(Optional) Prevent any user from reading the log file.

size size—(Optional) Maximum size of each trace file, in kilobytes (KB), megabytes (MB), or gigabytes (GB). When a trace file named **trace-file** reaches this size, it is renamed **trace-file.0**. When the **trace-file** again reaches its maximum size, **trace-file.0** is renamed **trace-file.1** and **trace-file** is renamed **trace-file.0**. This renaming scheme continues until the maximum number of trace files is reached. Then, the oldest trace file is overwritten.

If you specify a maximum file size, you also must specify a maximum number of trace files with the **files** option.

Syntax: **xk** to specify KB, **xm** to specify MB, or **xg** to specify GB

Range: 10 KB through the maximum file size supported on your system

Default: 128 KB

world-readable—(Optional) Allow any user to read the log file.

Usage Guidelines See “Tracing IS-IS Protocol Traffic” on page 333.

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

traffic-engineering

Syntax

```
traffic-engineering {
  disable;
  family inet6 {
    shortcuts;
  }
  family inet;
  shortcuts {
    multicast-rpf-routes;
  }
}
```

Hierarchy Level [edit logical-systems *logical-system-name* protocols isis],
[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols isis],
[edit protocols isis],
[edit routing-instances *routing-instance-name* protocols isis]

Release Information Statement introduced before JUNOS Release 7.4.
Support for the **family** statement introduced in JUNOS Release 9.3.

Description Configure traffic engineering properties for IS-IS.

The remaining statements are explained separately.

Default IS-IS traffic engineering support is enabled.

Usage Guidelines See “Configuring IS-IS Traffic Engineering Attributes” on page 318.

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

wide-metrics-only

Syntax	wide-metrics-only;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols isis level <i>level-number</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols isis level <i>level-number</i>], [edit protocols isis level <i>level-number</i>], [edit routing-instances <i>routing-instance-name</i> protocols isis level <i>level-number</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure IS-IS to generate metric values greater than 63 on a per IS-IS level basis.
Usage Guidelines	See “Enabling Wide Metrics for Traffic Engineering” on page 307.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	te-metric

Chapter 17

ES-IS Overview

End System-to-Intermediate System (ES-IS) is a protocol that resolves Layer 3 ISO network service access points (NSAP) to Layer 2 addresses. ES-IS has an equivalent role as Address Resolution Protocol (ARP) in Internet Protocol version 4 (IPv4).



NOTE: ES-IS configuration is supported for the J-series Services Router only.

Overview

Connectionless Network Services (CLNS) is a Layer 3 protocol similar to IPv4. CLNS uses network service access points (NSAPs) to address end systems and intermediate systems.

ES-IS provides the basic interaction between CLNS hosts (end systems) and routers (intermediate systems). ES-IS allows hosts to advertise NSAP addresses to other routers and hosts attached to the network. Those routers can then advertise the address to the rest of the network using Intermediate System-to-Intermediate System (IS-IS). Routers use ES-IS to advertise their network entity title (NET) to hosts and routers attached to that network.

ES-IS routes are exported to Layer 1 Intermediate System-to-Intermediate System (IS-IS) by default. You can also export ES-IS routes into Layer 2 IS-IS by configuring a routing policy.

ES-IS generates and receives end system hello (ESH) hello messages when the protocol is configured on an interface.

ES-IS is a resolution protocol that allows a network to be fully ISO integrated at both the network and data layer.

For more information on CLNS, see “Configuring Support for Connectionless Network Services” on page 324 and the *J-series Services Router Advanced WAN Access Configuration Guide*.

Chapter 18

ES-IS Configuration Guidelines

End System-to-Intermediate System (ES-IS) provides the basic interaction between Connectionless Network Services (CLNS) hosts (end systems) and routers (intermediate systems). ES-IS allows hosts to advertise network services access point (NSAP) addresses to other routers and hosts attached to the network. Those routers can then advertise the address to the rest of the network using Intermediate System-to-Intermediate System (IS-IS). Routers use ES-IS to advertise their network entity title (NET) to hosts and routers attached to that network.

ES-IS routes are exported to Layer 1 Intermediate System-to-Intermediate System (IS-IS) by default. You can also export ES-IS routes into Layer 2 IS-IS by configuring a routing policy.

ES-IS is enabled only if either ES-IS or IS-IS is configured on the router. ES-IS must not be disabled. If ES-IS is not explicitly configured, the interface sends and receives only Intermediate System Hello (ISH) messages. If ES-IS is explicitly configured and disabled, the interface does not send or receive ES-IS packets. If ES-IS is explicitly configured and not disabled, the interface sends and receives ISH messages as well as ES-IS packets.

One of the interfaces configured for ES-IS must be configured with an ISO address used for hello messages. The ISO address family must be configured on an interface to support ES-IS on that interface.

For more information on configuring an address family on an interface, see the *JUNOS Network Interfaces Configuration Guide*.

To configure ES-IS properties on an interface, you include the following statements:

```
esis {
  disable;
  graceful-restart {
    disable;
    restart-duration seconds;
  }
  preference preference;
  interface (interface-name | all) {
    disable;
    hello-interval seconds;
    esct seconds;
  }
  traceoptions {
    file filename <size size> <files number> <world-readable | no-world-readable>;
```

```

        flag flag <flag-modifier> <disable>;
    }
}

```

For a list of hierarchy levels at which you can configure these statements, see the statement summary section for these statements.

This chapter discusses the following topics that provide information about configuring ES-IS:

- Minimum ES-IS Configuration on page 392
- Configuring ES-IS on an Interface on page 392
- Configuring the Hello Interval on page 393
- Configuring the End System Configuration Timer on page 393
- Configuring Graceful Restart for ES-IS on page 393
- Configuring the Preference on page 394
- Tracing ES-IS Protocol Traffic on page 394

Minimum ES-IS Configuration

To enable ES-IS on an interface, you must include the following statement as a minimum:

```

esis {
    interface (interface-name | all);
}

```

For a list of hierarchy levels at which you can configure these statements, see the statement summary section for the **esis** statement.

Configuring ES-IS on an Interface

To configure ES-IS on an interface, include the following statements in the configuration:

```

esis {
    interface (interface-name | all);
    disable;
    hello-interval seconds;
    esct seconds;
}

```

For a list of hierarchy levels at which you can configure these statements, see the statement summary section for the **esis** statement.

ES-IS protocol is enabled automatically if the IS-IS protocol is configured and enabled. ES-IS does not need to be explicitly configured if IS-IS is enabled. If an interface is not configured as an ISO family interface, ES-IS will not run on it.

Specify the **interface** statement to configure an interface to send and receive hello messages. Specify the **disable** statement to stop sending or receiving ES-IS packets on the interface.

Configuring the Hello Interval

ES-IS sends out hello messages at a set interval. You can configure this interval.

To configure the hello interval for ES-IS, include the **hello-interval** statement:

```
hello-interval seconds;
```

The default value is 60 seconds.

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Configuring the End System Configuration Timer

The end system configuration timer determines how often a system reports its availability to other systems. To configure the configuration timer on an interface, include the **esct** statement:

```
esct seconds;
```

The default value is 180 seconds.

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Configuring Graceful Restart for ES-IS

Graceful restart allows a router to restart with minimal impact to the network, and is enabled globally for all routing protocols at the [edit routing-options] hierarchy level. When graceful restart for ES-IS is enabled, the routes to end systems or intermediate systems are not removed from the forwarding table. The adjacencies are reestablished after restart is complete.

You can configure graceful restart parameters specifically for ES-IS. To do this, include the **graceful-restart** statement:

```
graceful-restart {
  disable;
  restart-duration seconds;
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

To disable graceful restart for ES-IS, specify the **disable** statement. To configure a time limit for restart completion, specify the **restart-duration** statement. You can specify a number between 1 and 3600. The default value is 180 seconds.



NOTE: Graceful restart is enabled automatically for ES-IS if graceful restart is configured globally at the [edit routing-options] hierarchy level.

Configuring the Preference

The preference value is used to determine the best path by the Routing Engine. To configure the preference value for ES-IS, include the **preference** statement at the [edit protocols es-is] hierarchy level:

```
preference value;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Tracing ES-IS Protocol Traffic

To debug ES-IS protocol or trace ES-IS protocol traffic, you can specify options in the global **traceoptions** statement included at the [edit routing-options] hierarchy level, and you can specify ES-IS-specific options by including the **traceoptions** statement:

```
traceoptions {
  file filename <size size> <files number> <world-readable | no-world-readable>;
  flag flag <flag-modifier> <disable>;
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

You can specify the following ES-IS-specific trace options in the ES-IS **flag** statement:

- **all**—Everything
- **error**—Errored packets
- **esh**—End-system hello packets
- **general**—General events
- **graceful-restart**—Graceful restart events
- **ish**—Intermediate-System hello packets
- **normal**—Normal events
- **policy**—Policy processing
- **route**—Routing information
- **state**—State transitions
- **task**—Routing protocol task processing
- **timer**—Routing protocol timer processing

You can optionally specify one or more of the following flag modifiers:

- **detail**—Detailed trace information
- **receive**—Packets being received
- **send**—Packets being transmitted



NOTE: Use the trace flags **detail** and **all** with caution. These flags may cause the CPU to become very busy.

Chapter 19

Summary of ES-IS Configuration Statements

The following sections explain each of the End System-to-Intermediate System (ES-IS) configuration statements. The statements are organized alphabetically.

disable

Syntax	disable;
Hierarchy Level	[edit protocols esis], [edit protocols esis interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols esis], [edit routing-instances <i>routing-instance-name</i> protocols esis interface <i>interface-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Disable ES-IS globally or on an interface.
Usage Guidelines	See “Minimum ES-IS Configuration” on page 392.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

esct

Syntax	<code>esct seconds;</code>
Hierarchy Level	[edit protocols esis interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols esis interface <i>interface-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure the ES-IS end system configuration timer.
Options	<i>seconds</i> —How often a system reports its availability to other systems. Default: 180 seconds
Usage Guidelines	See “Configuring the End System Configuration Timer” on page 393.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

esis

Syntax	<code>esis { ... }</code>
Hierarchy Level	[edit protocols], [edit routing-instances <i>routing-instance-name</i> protocols]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Enable ES-IS.
Options	The remaining statements are explained separately.
Usage Guidelines	See “Minimum ES-IS Configuration” on page 392.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

graceful-restart

Syntax	graceful-restart { disable; restart-duration <i>seconds</i> ; }
Hierarchy Level	[edit protocols esis]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure graceful restart for ES-IS.
Options	disable—Disable graceful restart. restart-duration <i>seconds</i> —Configure the time period for the restart to last. Range: 30 through 300 seconds Default: 180 seconds
Usage Guidelines	See “Configuring Graceful Restart for ES-IS” on page 393.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

hello-interval

Syntax	hello-interval <i>seconds</i> ;
Hierarchy Level	[edit protocols esis interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols esis interface <i>interface-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure the ES-IS hello interval.
Options	<i>seconds</i> —Time interval between hello messages. Default: 60 seconds
Usage Guidelines	See “Configuring the Hello Interval” on page 393.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

interface

Syntax	interface (<i>interface-name</i> all);
Hierarchy Level	[edit protocols esis], [edit routing-instances <i>routing-instance-name</i> protocols esis]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure ES-IS on an interface.
Options	<i>interface-name</i> —Name of the interface. all—Configure on all interfaces.
Usage Guidelines	See “Configuring ES-IS on an Interface” on page 392.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

preference

Syntax	preference <i>preference</i> ;
Hierarchy Level	[edit protocols esis], [edit routing-instances <i>routing-instance-name</i> protocols esis]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure the ES-IS preference value.
Options	<i>preference</i> —Preference value.
Usage Guidelines	See “Configuring the Preference” on page 394.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

traceoptions

Syntax	<pre> traceoptions { file <i>filename</i> <size <i>size</i>> <files <i>number</i>> <(world-readable no-world-readable)>; flag <i>flag</i> <flag-modifier> <disable>; } </pre>
Hierarchy Level	[edit protocols <i>esis</i>], [edit routing-instances <i>routing-instance-name</i> protocols <i>esis</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	<p>Configure ES-IS protocol-level tracing options.</p> <p>To specify more than one tracing operation, include multiple <i>flag</i> statements.</p>
Default	The default ES-IS protocol-level tracing options are those inherited from the routing protocols <i>traceoptions</i> statement included at the [edit routing-options] hierarchy level.
Options	<p>disable—(Optional) Disable the tracing operation. You can use this option to disable a single operation when you have defined a broad group of tracing operations, such as <i>all</i>.</p> <p>file <i>filename</i>—Name of the file to receive the output of the tracing operation. Enclose the name within quotation marks. All files are placed in the directory <i>/var/log</i>. We recommend that you place ES-IS tracing output in the file <i>esis-log</i>.</p> <p>files <i>number</i>—(Optional) Maximum number of trace files. When a trace file named <i>trace-file</i> reaches its maximum size, it is renamed <i>trace-file.0</i>, then <i>trace-file.1</i>, and so on, until the maximum number of trace files is reached. Then the oldest trace file is overwritten.</p> <p>If you specify a maximum number of files, you also must specify a maximum file size with the <i>size</i> option.</p> <p>Range: 2 through 1000 files Default: 2 files</p> <p><i>flag</i>—Tracing operation to perform. To specify more than one flag, include multiple <i>flag</i> statements.</p> <p>ES-IS Tracing Flags</p> <ul style="list-style-type: none"> ■ error—Errored ES-IS packets ■ esh—End-System hello packets ■ graceful-restart—Graceful restart events ■ ish—Intermediate-System hello packets <p>Global Tracing Flags</p>

- **all**—All tracing operations
- **general**—A combination of the **normal** and **route** trace operations
- **normal**—All normal operations, including adjacency changes
Default: If you do not specify this option, only unusual or abnormal operations are traced.
- **policy**—Policy operations and actions
- **route**—Routing table changes
- **state**—State transitions
- **task**—Interface transactions and processing
- **timer**—Timer usage

flag-modifier—(Optional) Modifier for the tracing flag. You can specify one or more of these modifiers:

- **detail**—Detailed trace information
- **receive**—Packets being received
- **send**—Packets being transmitted

no-world-readable—(Optional) Prevent any user from reading the log file.

size size—(Optional) Maximum size of each trace file, in kilobytes (KB), megabytes (MB), or gigabytes (GB). When a trace file named *trace-file* reaches this size, it is renamed *trace-file.0*. When the *trace-file* again reaches its maximum size, *trace-file.0* is renamed *trace-file.1* and *trace-file* is renamed *trace-file.0*. This renaming scheme continues until the maximum number of trace files is reached. Then the oldest trace file is overwritten.

If you specify a maximum file size, you also must specify a maximum number of trace files with the **files** option.

Syntax: *xk* to specify KB, *xm* to specify MB, or *xg* to specify GB

Range: 10 KB through the maximum file size supported on your system

Default: Default: 1 MB

world-readable—(Optional) Allow any user to read the log file.

Usage Guidelines See “Tracing ES-IS Protocol Traffic” on page 394.

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

Chapter 20

OSPF Overview

The Open Shortest Path First version 2 (OSPF) protocol is an interior gateway protocol (IGP) that routes packets within a single autonomous system (AS). OSPF uses link-state information to make routing decisions.

In this document, the term *OSPF* refers to both OSPFv2 and OSPFv3.

This chapter discusses the following topics that provide background information about OSPF:

- OSPF Protocol Overview on page 403
- OSPF Standards on page 405
- OSPF Area Terminology on page 406
- OSPF Routing Algorithm on page 407
- OSPF Packets on page 408
- External Metrics on page 411
- Designated Router on page 411
- OSPF Extensions to Support Traffic Engineering on page 411

OSPF Protocol Overview

OSPF is an IGP that routes packets within a single AS. OSPF uses link-state information to make routing decisions, making route calculations using the shortest path first (SPF) algorithm (also referred to as the Dijkstra algorithm). Each router running OSPF floods link-state advertisements throughout the AS that contain information about that router's attached interfaces and routing metrics. Each router takes the information in these link-state advertisements and creates a complete routing table for the network.

The JUNOS software supports OSPF version 2, including virtual links, stub areas, and authentication. The JUNOS software does not support type-of-service (ToS) routing.

OSPF was designed for the Transmission Control Protocol/Internet Protocol (TCP/IP) environment and as a result explicitly supports IP subnetting and the tagging of externally derived routing information. OSPF also provides for the authentication of routing updates.

OSPF routes IP packets based solely on the destination IP address contained in the IP packet header. OSPF quickly detects topological changes, such as when router

interfaces become unavailable, and calculates new loop-free routes quickly and with a minimum of routing overhead traffic.

Each interface running OSPF is assigned a cost, which is a unitless number based on factors such as throughput, round-trip time, and reliability, which are used to determine how easy or difficult it is to reach a destination. If two or more routes to a destination have the same cost, OSPF distributes traffic equally among the routes, a process that is called *load balancing*.

Each router maintains a database that describes the topology of the AS. Each OSPF router has an identical topological database so that all routers in the area have a consistent view of the network. All routers maintain summarized topologies of other areas within an AS. Each router distributes information about its local state by flooding link-state advertisements throughout the AS. When the AS topology changes, OSPF ensures that the contents of all routers' topological databases converge quickly.

All OSPF protocol exchanges can be authenticated. This means that only trusted routers can participate in the AS's routing. A variety of authentication schemes can be used; a single authentication scheme is configured for each area, which enables some areas to use stricter authentication than others.

Externally derived routing data (for example, routes learned from BGP) is passed transparently throughout the AS. This externally derived data is kept separate from the OSPF link-state data. Each external route can be tagged by the advertising router, enabling the passing of additional information between routers on the boundaries of the AS.



NOTE: By default, the JUNOS software is compatible with RFC 1583, *OSPF Version 2*. Beginning with JUNOS 8.5, you can disable compatibility with RFC 1583 by including the `no-rfc-1583` statement.

OSPF Version 3

OSPFv3 is a modified version of OSPF that supports Internet Protocol version 6 (IPv6) addressing. OSPFv3 differs from OSPFv2 in the following ways:

- All neighbor ID information is based on a 32-bit router ID.
- The protocol runs per link rather than per subnet.
- Router and network link-state advertisements (LSAs) do not carry prefix information.
- Two new LSA types are included: link-LSA and intra-area-prefix-LSA.
- Flooding scopes are as follows:
 - Link-local
 - Area
 - AS
- Link-local addresses are used for all neighbor exchanges except virtual links.

- Authentication is removed; the IPv6 authentication header relies on the IP layer.
- The packet format has changed as follows:
 - Version number 2 is now version number 3.
 - The **db** option field has been expanded to 24 bits.
 - Authentication information has been removed.
 - Hello messages do not have address information.
 - Two new option bits are included: **R** and **V6**.
- Type 3 summary LSAs have been renamed *inter-area-prefix-LSAs*.
- Type 4 summary LSAs have been renamed *inter-area-router-LSAs*.

OSPF Standards

OSPF and OSPFv3 are defined in the following documents:

- RFC 1793, *Extending OSPF to Support Demand Circuits*
- RFC 2328, *OSPF Version 2*
- RFC 2370, *The OSPF Opaque LSA Option*
- RFC 2740, *OSPF for IPv6*
- RFC 3101, *The OSPF Not-So-Stubby Area (NSSA) Option*
- RFC 3509, *Alternative Implementations of OSPF Area Border Routers*
- RFC 3623, *OSPF Graceful Restart*
- RFC 3630, *Traffic Engineering (TE) Extensions to OSPF Version 2*
- RFC 4203, *OSPF Extensions in Support of Generalized Multi-Protocol Label Switching (GMPLS) (only interface switching)*
- RFC 4552, *Authentication/Confidentiality for OSPFv3*
- RFC 4576, *Using a Link State Advertisement (LSA) Options Bit to Prevent Looping in BGP/MPLS Virtual Private Networks (VPNs)*
- RFC 4577, *OSPF as the Provider/Customer Edge Protocol for BGP/MPLS IP Virtual Private Networks (VPNs)*
- RFC 5185, *OSPF Multi-Area Adjacency*
- Internet draft draft-ietf-katz-ward-bfd-00.txt, *Bidirectional Forwarding Detection* (except the transmission of echo packets) (expires January 2005)
- Internet draft draft-ietf-isis-igp-p2p-over-lan-03.txt, *Point-to-point operation over LAN in link-state routing protocols* (expires February 2004)
- Internet draft draft-ospf-alt-06.txt, *Support of address families in OSPFv3* (expires April 2008)

To access Internet RFCs and drafts, go to the IETF Web site at <http://www.ietf.org>.

OSPF Area Terminology

In OSPF, a single AS can be divided into smaller groups called *areas*. This reduces the number of link-state advertisements and other OSPF overhead traffic sent on the network, and it reduces the size of the topological database that each router must maintain.

This section discusses the following topics:

- Areas on page 406
- Area Border Routers on page 406
- Backbone Areas on page 406
- AS Boundary Routers on page 407
- Stub Areas on page 407
- Not-So-Stubby Areas on page 407
- Transit Areas on page 407

Areas

An *area* is a set of networks and hosts within an AS that have been administratively grouped together. We recommend that you configure an area as a collection of contiguous IP subnetted networks. Routers that are wholly within an area are called *internal routers*. All interfaces on internal routers are directly connected to networks within the area.

The topology of an area is hidden from the rest of the AS, thus significantly reducing routing traffic in the AS. Also, routing within the area is determined only by the area's topology, providing the area with some protection from bad routing data.

All routers within an area have identical topological databases.

Area Border Routers

Routers that belong to more than one area are called *area border routers*. They maintain a separate topological database for each area to which they are connected.

Backbone Areas

An OSPF *backbone area* consists of all networks in area ID 0.0.0.0, their attached routers, and all area border routers. The backbone itself does not have any area border routers. The backbone distributes routing information between areas. The backbone is simply another area, so the terminology and rules of areas apply: a router that is directly connected to the backbone is an internal router on the backbone, and the backbone's topology is hidden from the other areas in the AS.

The routers that make up the backbone must be physically contiguous. If they are not, you must configure *virtual links* to create the appearance of backbone connectivity. You can create virtual links between any two area border routers that have an interface to a common nonbackbone area. OSPF treats two routers joined by a virtual link as if they were connected to an unnumbered point-to-point network.

AS Boundary Routers

Routers that exchange routing information with routers in other ASs are called *AS boundary routers*. They advertise externally learned routes throughout the AS. Any router in the AS—an internal router, an area border router, or a backbone router—can be an AS boundary router.

Every router within the AS knows the path to the AS boundary routers.

Stub Areas

Stub areas are areas through which or into which AS external advertisements are not flooded. You might want to create stub areas when much of the topological database consists of AS external advertisements. Doing so reduces the size of the topological databases and therefore the amount of memory required on the internal routers in the stub area.

When an area border router is configured for a stub area, the router automatically advertises a default route in place of the external routes that are not being advertised within the stub area so that routers in the stub area can reach destinations outside the area.

The following restrictions apply to stub areas: you cannot create a virtual link through a stub area, and a stub area cannot contain an AS boundary router.

Not-So-Stubby Areas

An OSPF stub area has no external routes in it, so you cannot redistribute from another protocol into a stub area. A not-so-stubby area (NSSA) allows external routes to be flooded within the area. These routes are then leaked into other areas. However, external routes from other areas still do not enter the NSSA.

Transit Areas

Transit areas are used to pass traffic from one adjacent area to the backbone (or to another area if the backbone is more than two hops away from an area). The traffic does not originate in, nor is it destined for, the transit area.

OSPF Routing Algorithm

OSPF uses the shortest path first (SPF) algorithm, also referred to as the Dijkstra algorithm, to determine the route to reach each destination. All routers in an area run this algorithm in parallel, storing the results in their individual topological databases. Routers with interfaces to multiple areas run multiple copies of the algorithm. This section provides a brief summary of how the SPF algorithm works.

When a router starts, it initializes OSPF and waits for indications from lower-level protocols that the router interfaces are functional. The router then uses the OSPF hello protocol to acquire neighbors, doing this by sending hello packets to its neighbors and receiving their hello packets.

On broadcast or nonbroadcast multiaccess networks (physical networks that support the attachment of more than two routers), the OSPF hello protocol elects a designated router for the network. This router is responsible for sending *link-state advertisements* that describe the network, which reduces the amount of network traffic and the size of the routers' topological databases.

The router then attempts to form *adjacencies* with some of its newly acquired neighbors. (On multiaccess networks, only the designated router and backup designated router form adjacencies with other routers.) Adjacencies determine the distribution of routing protocol packets: routing protocol packets are sent and received only on adjacencies, and topological database updates are sent only along adjacencies. When adjacencies have been established, pairs of adjacent routers synchronize their topological databases.

A router sends LSA packets to advertise its state periodically and when the router's state changes. These packets include information about the router's adjacencies, which allows detection of nonoperational routers.

Using a reliable algorithm, the router floods LSAs throughout the area, which ensures that all routers in an area have exactly the same topological database. Each router uses the information in its topological database to calculate a shortest-path tree, with itself as the root. The router then uses this tree to route network traffic.

The description of the SPF algorithm up to this point has explained how the algorithm works within a single area (*intra-area routing*). For internal routers to be able to route to destinations outside the area (*interarea routing*), the area border routers must inject additional routing information into the area. Because the area border routers are connected to the backbone, they have access to complete topological data about the backbone. They use this information to calculate paths to all destinations outside its area and then advertise these paths to the area's internal routers.

AS boundary routers flood information about external ASs throughout the AS, except to stub areas. Area border routers are responsible for advertising the paths to all AS boundary routers.

OSPF Packets

This section contains the following topics:

- OSPF Packet Header on page 409
- Hello Packets on page 409
- Database Description Packets on page 410
- Link-State Request Packets on page 410
- Link-State Update Packets on page 410
- Link-State Acknowledgment Packets on page 410
- Link-State Advertisement Packet Types on page 410

There also are several types of link-state advertisement packets, which are discussed in "Link-State Advertisement Packet Types" on page 410.

OSPF Packet Header

All OSPF packets have a common 24-byte header that contains all information necessary to determine whether OSPF should accept the packet. The header consists of the following fields:

- Version number—The current OSPF version number. This can be either 2 or 3.
- Type—Type of OSPF packet.
- Packet length—Length of the packet, in bytes, including the header.
- Router ID—IP address of the router from which the packet originated.
- Area ID—Identifier of the area in which the packet is traveling. Each OSPF packet is associated with a single area. Packets traveling over a virtual link are labeled with the backbone area ID, 0.0.0.0. You configure the area ID with the **area** statements.
- Checksum—Fletcher checksum.
- Authentication—Authentication scheme and authentication information. You configure authentication with the **authentication** statement. This is valid for OSPFv2 only.

Hello Packets

Routers periodically send hello packets on all interfaces, including virtual links, to establish and maintain neighbor relationships. Hello packets are multicast on physical networks that have a multicast or broadcast capability, which enables dynamic discovery of neighboring routers. (On nonbroadcast networks, dynamic neighbor discovery is not possible, so you must configure all neighbors statically using the **neighbor** statement.)

Hello packets consist of the OSPF header plus the following fields:

- Network mask—Network mask associated with the interface.
- Hello interval—How often the router sends hello packets. All routers on a shared network must use the same hello interval. You configure this interval with the **hello-interval** statement.
- Options—Optional capabilities of the router.
- Router priority—The router's priority to become the designated router. You can configure this value with the **priority** statement.
- Router dead interval—How long the router waits without receiving any OSPF packets from a router before declaring that router to be down. All routers on a shared network must use the same router dead interval. You can configure this value with the **dead-interval** statement.
- Designated router—IP address of the designated router.
- Backup designated router—IP address of the backup designated router.
- Neighbor—IP addresses of the routers from which valid hello packets have been received within the time specified by the router dead interval.

Database Description Packets

When initializing an adjacency, OSPF exchanges database description packets, which describe the contents of the topological database. These packets consist of the OSPF header, packet sequence number, and the link-state advertisement's header.

Link-State Request Packets

When a router detects that portions of its topological database are out of date, it sends a link-state request packet to a neighbor requesting a precise instance of the database. These packets consist of the OSPF header plus fields that uniquely identify the database information that the router is seeking.

Link-State Update Packets

Link-state update packets carry one or more link-state advertisements one hop farther from their origin. The router multicasts (floods) these packets on physical networks that support multicast or broadcast mode. The router acknowledges all link-state update packets and, if retransmission is necessary, sends the retransmitted advertisements unicast.

Link-state update packets consist of the OSPF header plus the following fields:

- Number of advertisements—Number of link-state advertisements included in this packet.
- Link-state advertisements—The link-state advertisements themselves.

Link-State Acknowledgment Packets

The router sends link-state acknowledgment packets in response to link-state update packets to verify that the update packets have been received successfully. A single acknowledgment packet can include responses to multiple update packets.

Link-state acknowledgment packets consist of the OSPF header plus the link-state advertisement header.

Link-State Advertisement Packet Types

Link-state request, link-state update, and link-state acknowledgment packets are used to reliably flood link-state advertisement packets. OSPF sends the following types of link-state advertisements:

- Router link advertisements—Are sent by all routers to describe the state and cost of the router's links to the area. These link-state advertisements are flooded throughout a single area only.
- Network link advertisements—Are sent by designated routers to describe all the routers attached to the network. These link-state advertisements are flooded throughout a single area only.
- Summary link advertisements—Are sent by area border routers to describe the routes that they know about in other areas. There are two types of summary

link advertisements: those used when the destination is an IP network, and those used when the destination is an AS boundary router. Summary link advertisements describe interarea routes; that is, routes to destinations outside the area but within the AS. These link-state advertisements are flooded throughout the advertisement's associated areas.

- AS external link advertisement—Are sent by AS boundary routers to describe external routes that they know about. These link-state advertisements are flooded throughout the AS (except for stub areas).

Each link-state advertisement type describes a portion of the OSPF routing domain. All link-state advertisements are flooded throughout the AS.

Each link-state advertisement packet begins with a common 20-byte header.

External Metrics

When OSPF exports route information from external ASs, it includes a cost, or *external metric*, in the route. There are two types of external metrics: Type 1 and Type 2. Type 1 external metrics are equivalent to the link-state metric; that is, the cost of the route used in the internal AS. Type 2 external metrics are greater than the cost of any path internal to the AS.

Designated Router

Each multiaccess network has a designated router, which performs two main functions:

- Originate network link advertisements on behalf of the network.
- Establish adjacencies with all routers on the network, thus participating in the synchronizing of the link-state databases.

The OSPF hello protocol elects a designated router for the network based on the priorities advertised by all the routers. In general, when an interface first becomes functional, it checks whether the network currently has a designated router. If there is one, the router accepts that designated router regardless of its own router priority. Otherwise, if the router has the highest priority on the network, it becomes the designated router. If router priorities tie, the router with the highest router ID (which is typically the router's IP address) is chosen as the designated router.

OSPF Extensions to Support Traffic Engineering

To help provide traffic engineering and MPLS with information about network topology and loading, extensions have been added to the JUNOS implementation of OSPF. Specifically, OSPF generates opaque LSAs, which carry traffic engineering parameters. These parameters are used to populate the traffic engineering database, which is used by the Constrained Shortest Path First (CSPF) algorithm to compute the paths that MPLS LSPs will take. This path information is used by RSVP to set up LSPs and reserve bandwidth for them.

Configuring OSPF IGP Shortcuts

In OSPF, you can configure shortcuts, which allow OSPF to use an LSP as the next hop as if it were a logical interface from the ingress router to the egress router. The address specified on the `to` statement at the `[edit protocols mpls label-switched-path lsp-path-name]` hierarchy level must match the router ID of the egress router for the LSP to function as a direct link to the egress router and to be used as input to OSPF SPF calculations. When used in this way, LSPs are no different than Asynchronous Transfer Mode (ATM) and Frame Relay virtual circuits (VCs), except that LSPs carry only IPv4 traffic.



NOTE: Whenever possible, use IS-IS IGP shortcuts instead of traffic engineering shortcuts.

Chapter 21

OSPF Configuration Guidelines

To configure Open Shortest Path First version 2 (OSPF), you include the following statements:

```
protocols {
  ospf {
    disable;
    export [ policy-names ];
    external-preference preference;
    graceful-restart {
      disable;
      helper-disable;
      notify-duration seconds;
      restart-duration seconds;
    }
    import [ policy-names ];
    no-nssa-abr;
    no-rfc-1583;
    overload {
      timeout seconds;
    }
    preference preference;
    prefix-export-limit;
    rib-group group-name;
    reference-bandwidth reference-bandwidth;
    sham-link {
      local address;
    }
    spf-options {
      delay milliseconds;
      rapid-runs number;
      holddown milliseconds;
    }
    traffic-engineering {
      advertise-unnumbered-interfaces;
      multicast-rpf-routes;
      no-topology;
      shortcuts {
        ignore-lsp-metrics;
        lsp-metric-into-summary;
      }
    }
  }
  traceoptions {
    file filename <size size> <files number> <(world-readable | no-world-readable)>;
```

```

    flag flag <flag-modifier> <disable>;
}
area area-id {
    area-range network/mask-length <restrict> <exact> <override-metric metric>;
    interface interface-name {
        demand-circuit;
        disable;
        ipsec-sa <sa-name>;
        secondary;
        authentication {
            md5 key-id {
                key [ key-values ];
            }
            simple-password key-id;
        }
        bfd-liveness-detection {
            detection-time {
                threshold milliseconds;
            }
            minimum-interval milliseconds;
            minimum-receive-interval milliseconds;
            multiplier number;
            no-adaptation;
            transmit-interval {
                threshold milliseconds;
                minimum-interval milliseconds;
            }
            version (1 | automatic);
        }
        dead-interval seconds;
        hello-interval seconds;
        interface-type type;
        ldp-synchronization {
            disable;
            hold-time seconds;
        }
        metric metric;
        neighbor address <eligible>;
        network-summary-export [ policy-names ];
        network-summary-import [ policy-names ];
        passive {
            traffic-engineering {
                remote-node-id address;
            }
        }
        poll-interval seconds;
        priority number;
        retransmit-interval seconds;
        te-metric metric;
        transit-delay seconds;
    }
}
label-switched-path name metric metric;
nssa {
    area-range network/mask-length <restrict> <exact> <override-metric metric>;
    default-lsa {
        default-metric metric;
    }
}

```

```

        metric-type type;
        type-7;
    }
    (no-summaries | summaries);
}
peer-interface interface-name {
    disable;
    dead-interval seconds;
    hello-interval seconds;
    retransmit-interval seconds;
    transit-delay seconds;
}
sham-link-remote address {
    demand-circuit;
    ipsec-sa name;
    metric metric;
}
}
stub <default-metric metric> <summaries | no-summaries>;
virtual-link neighbor-id router-id transit-area area-id {
    disable;
    ipsec-sa <sa-name>;
    authentication {
        md5 key-id {
            key [ key-values ];
        }
        simple-password key-id;
    }
    dead-interval seconds;
    hello-interval seconds;
    retransmit-interval seconds;
    transit-delay seconds;
}
}
}

```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

To configure OSPF version 3 (OSPFv3), you include the following statements:

```

protocols {
    ospf3 {
        disable;
        export [ policy-names ];
        external-preference preference;
        graceful-restart {
            disable;
            helper-disable;
            notify-duration seconds;
            restart-duration seconds;
        }
        import [ policy-names ];
        overload {
            timeout seconds;
        }
    }
}

```

```

preference preference;
prefix-export-limit;
reference-bandwidth reference-bandwidth;
realm (ipv4-unicast | ipv4-multicast | ipv6-multicast);
rib-group group-name;
spf-options {
    delay milliseconds;
    holddown milliseconds;
    rapid-runs number;
}
traceoptions {
    file filename <size size> <files number> <world-readable | no-world-readable>;
    flag flag <flag-modifier> <disable>;
}
area area-id {
    area-range network/mask-length <restrict> <exact> <override-metric metric>;
    interface interface-name {
        bfd-liveness-detection {
            detection-time {
                threshold milliseconds;
            }
            minimum-interval milliseconds;
            minimum-receive-interval milliseconds;
            multiplier number;
            no-adaptation;
            transmit-interval {
                threshold milliseconds;
                minimum-interval milliseconds;
            }
            version (1 | automatic);
        }
        disable;
        dead-interval seconds;
        hello-interval seconds;
        ipsec-sa name;
        metric metric;
        passive {
            traffic-engineering {
                remote-node-id address;
            }
        }
        priority number;
        retransmit-interval seconds;
        transit-delay seconds;
    }
    inter-area-prefix-export policy-name;
    inter-area-prefix-import policy-name;
    nssa {
        area-range network/mask-length <restrict> <exact> <override-metric metric>;
        default-lsa {
            default-metric metric;
            metric-type type;
            type-7;
        }
        (no-summaries | summaries);
    }
}

```



```

stub <default-metric metric> <summaries | no-summaries>;
virtual-link neighbor-id router-id transit-area area-id {
    disable;
    dead-interval seconds;
    hello-interval seconds;
    ipsec-sa name;
    retransmit-interval seconds;
    transit-delay seconds;
}
}
}
}

```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

For a detailed OSPFv3 example configuration, see the *JUNOS Feature Guide*.

By default, OSPFv2 and OSPFv3 are disabled.



NOTE: In this manual, the term *OSPF* refers to both OSPFv2 and OSPFv3.

This chapter describes the following tasks for configuring OSPF:

- Minimum OSPF Configuration on page 418
- Configuring the Backbone Area and Other Areas on page 418
- Disabling NSSA Support on an ASBR ABR on page 422
- Disabling Compatibility with RFC 1583 on page 423
- Configuring OSPF on Router Interfaces on page 423
- Configuring Multiarea Adjacency in OSPFv2 on page 426
- Configuring Multiple Address Families for OSPFv3 on page 427
- Configuring Authentication for OSPFv2 on page 427
- Configuring Authentication for OSPFv3 on page 431
- Configuring a Prefix Export Limit on page 431
- Configuring the Priority for Becoming the Designated Router on page 432
- Configuring Route Summarization on page 432
- Modifying the Interface Metric on page 433
- Configuring Route Preferences on page 433
- Configuring OSPF Timers on page 434
- Configuring the BFD Protocol on page 436
- Configuring Label Distribution Protocol Synchronization with the IGP on page 438
- Configuring Graceful Restart on page 439
- Configuring SPF Options for OSPF on page 439
- Advertising Interface Addresses Without Running OSPF on page 440

- Configuring OSPF Passive Traffic Engineering Mode on page 441
- Advertising Label-Switched Paths into OSPF on page 442
- Configuring the Router to Appear Overloaded on page 442
- Enabling OSPF Traffic Engineering Support on page 443
- Modifying the Traffic Engineering Metric on page 445
- Configuring OSPF Routing Policy on page 445
- Configuring OSPF Routing Table Groups on page 449
- Configuring a Sham Link on page 449
- Configuring a Peer Interface on page 449
- Tracing OSPF Protocol Traffic on page 450

Minimum OSPF Configuration

You must create a backbone area if your network consists of multiple areas. An area border router (ABR) must have at least one interface in the backbone area, or it must have a virtual link to a router in the backbone area. To do this, include at least the following statements. All other OSPF configuration statements are optional.

```
protocols {
  (ospf | ospf3 ) {
    area 0 {
      interface interface-name;
    }
  }
}
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.



NOTE: When you configure OSPFv2 on an interface, you must also include the **family inet** statement at the [edit interfaces *interface-name* unit *logical-unit-number*] hierarchy level. When you configure OSPFv3 on an interface, you must also include the **family inet6** statement at the [edit interfaces *interface-name* unit *logical-unit-number*] hierarchy level. For more information about the **family inet** statement, see the *JUNOS Network Interfaces Configuration Guide*.



NOTE: OSPFv3 does not support routing instances.

Configuring the Backbone Area and Other Areas

You can group the routers in a single autonomous system (AS) into areas to reduce the amount of link-state advertisement (LSA) traffic on the network and to reduce

the size of the topological databases that OSPF routers must maintain. If you do this, the AS must contain a single backbone area and optionally can contain any number of nonbackbone areas. The routers that make up the backbone must be physically contiguous. If they are not, you must configure virtual links to create the appearance of connectivity. You also can configure stub areas, which are areas through which AS external advertisements are not flooded, and not-so-stubby areas (NSSAs), which allow external routes to be flooded within an area.

The JUNOS software supports active backbone detection. Active backbone detection is implemented to verify that area border routers are connected to the backbone. If the connection to the backbone area is lost, then the router's default metric is not advertised, effectively rerouting traffic through another area border router with a valid connection to the backbone.

Active backbone detection enables transit through an area border router with no active backbone connection. An area border router advertises to other routers that it is an area border router even if the connection to the backbone is down, so that the neighbors can consider it for interarea routes.

To configure areas, you can perform the following tasks:

- Configuring the Backbone Area on page 419
- Configuring a Nonbackbone Area on page 419
- Configuring a Stub Area on page 420
- Configuring a Not-So-Stubby Area on page 420
- Configuring an OSPF Virtual Link on page 421

Configuring the Backbone Area

You must create a backbone area if your network consists of multiple areas. An ABR must have at least one interface in the backbone area, or it must have a virtual link to a router in the backbone area. The backbone comprises all area border routers and all routers that are not included in any other area. You configure all these routers by including the `area 0.0.0.0` statement:

```
(ospf | ospf3) {
  area 0.0.0.0;
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for the statement.

Configuring a Nonbackbone Area

Each OSPF area consists of routers configured with the same area number. To configure a router to be in an area, include the `area` statement. The area ID can be any number except 0.0.0.0, which is reserved for the backbone area.

```
(ospf | ospf3) {
  area area-id;
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for the statement.

Configuring a Stub Area

Stub areas are areas into which OSPF does not flood AS external advertisements. You might want to configure stub areas when much of the topological database consists of AS external advertisements and you want to minimize the size of the topological databases on an area's routers.

You cannot configure an area as being both a stub area and an NSSA.

To configure a stub area, include the **stub** statement:

```
(ospf | ospf3) {
  area area-id {
    stub <default-metric metric> <(no-summaries | summaries)>;
  }
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

To inject a default route with a specified metric value into the area, include the **default-metric** option and a metric value. The default route matches any destination that is not explicitly reachable from within the area.

To have the stub areas not advertise summary routes into the stub area, include the **no-summaries** option. Only the default route is advertised, and only if you include the **default-metric** option. The default route injected into the not-so-stubby area (NSSA) is a Type 3 LSA.

You must include the **stub** statement when configuring all routers that are in the stub area.



NOTE: Beginning with JUNOS Release 8.5, a router-identifier interface that is not configured to run OSPF is no longer advertised as a stub network in OSPF link-state advertisements. For more information about how to configure a router identifier, see “Configuring the Router Identifier” on page 103.

Configuring a Not-So-Stubby Area

An OSPF stub area has no external routes, so you cannot redistribute from another protocol into a stub area. An NSSA allows external routes to be flooded within the area. These routes are then leaked into other areas. However, external routes from other areas still do not enter the NSSA.

You cannot configure an area to be both a stub area and an NSSA.

To configure an NSSA, include the **nssa** statement:

```

(ospf | ospf3) {
  area area-id {
    nssa {
      area-range network/mask-length <restrict> <exact> <override-metric metric>;
      default-lsa {
        default-metric metric;
        metric-type type;
        type-7;
      }
      (no-summaries | summaries);
    }
  }
}

```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

By default, a default route is not advertised. To advertise a default route with the specified metric within the area, include the **default-metric** statement. You can configure this option only on area border routers.

To prevent an ABR from advertising summary routes into an NSSA, include the **no-summaries** statement. If you include the **default-metric** option in addition to the **no-summaries** statement, only the default route is advertised. The default route is a Type 3 LSA injected into the NSSA. To flood summary LSAs into the NSSA area, include the **summaries** statement. When **summaries** is configured (which is the default if the **no-summaries** statement is not specified), a Type 7 LSA is sent. To define the type of metric, include the **metric-type** statement.

To aggregate external routes learned within the area when a route is advertised to other areas, include one or more **area-range** statements. If you also include the **restrict** option, the aggregate is not advertised, effectively creating a route filter. All external routes learned within the area that do not fall into the range of one of the prefixes are advertised individually to other areas. To restrict an exact area range, include the **exact** option. For an example, you can suppress the exact 0/0 prefix from being advertised from a NSSA area into the backbone area by including both the **exact** and **restrict** options. To override the metric for the IP address range and configure a specific metric value, include the **override-metric** option.

Configuring an OSPF Virtual Link

If any router on the backbone is not physically connected to the backbone itself, you must establish a virtual connection between that router and the backbone. You can establish a virtual connection between area border routers by configuring a OSPF virtual link.

To configure an OSPF virtual link, include the **virtual-link** statement when configuring the backbone area (area 0):

```
virtual-link neighbor-id router-id transit-area area-id;
```

To configure an OSPFv3 virtual link, include the **virtual-link** statement when configuring the backbone area (area 0):

```
virtual-link neighbor-id router-id transit-area area-id;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Specify the router ID (as an IPv4 address) of the router at the other end of the virtual link. This router must be an area border router that is physically connected to the backbone. Also, specify the number of the area through which the virtual link transits.

For the virtual connection to work, you also must configure a link to the backbone area on the remote area border router (the router at the other end of the LSP).

Example: Configuring an OSPF Virtual Link

Configure an OSPF virtual link on the local router. This router must be an area border router that is physically connected to the backbone.

```
[edit protocols ospf]
area 0.0.0.0 {
  virtual-link neighbor-id 192.168.0.3 transit-area 1.1.1.1;
  interface t3-1/0/0 {
    hello-interval 1;
    dead-interval 3;
  }
}
```

You must also configure an OSPF virtual link on the remote area border router:

```
[edit protocols ospf]
area 0.0.0.0 {
  virtual-link neighbor-id 192.168.0.5 transit-area 1.1.1.1;
}
```

Disabling NSSA Support on an ASBR ABR

When an autonomous-system boundary router (ASBR) is also an ABR with an NSSA area attached to it, a Type 7 LSA is exported into the NSSA area by default. If the ABR is attached to multiple NSSA areas, a separate Type 7 LSA is exported into each NSSA area by default.



NOTE: Type 7 LSAs are not exported into an NSSA if there is only one NSSA and backbone area connected to the ABR.

To disable exporting Type 7 LSAs into NSSAs, include the **no-nssa-abr** statement:

```
no-nssa-abr;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Disabling Compatibility with RFC 1583

By default, the JUNOS implementation of OSPFv2 is compatible with RFC 1583, *OSPF Version 2*. This means that the JUNOS software maintains a single best route to an AS boundary router in the OSPF routing table, rather than multiple intra-AS paths, if they are available. You can now disable compatibility with RFC 1583. It is preferable to do so when the same external destination is advertised by AS boundary routers that belong to different OSPF areas. When you disable compatibility with RFC 1583, the OSPF routing table maintains the multiple intra-AS paths that are available, which the router uses to calculate AS external routes as defined in RFC 2328, *OSPF Version 2*. Being able to use multiple, available paths to calculate an AS external route can prevent routing loops.

To disable OSPF v2 compatibility with RFC 1583, include the **no-rfc-1583** statement:

```
no-rfc-1583;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Configuring OSPF on Router Interfaces

To enable OSPF on the router, you must configure OSPF on at least one of the router's interfaces. How you configure an interface depends on whether the interface is connected to a broadcast or point-to-point network, a point-to-multipoint network, or a nonbroadcast, multiaccess network.



NOTE: When you configure OSPFv2 on an interface, you must also include the **family inet** statement at the [edit interfaces *interface-name* unit *logical-unit-number*] hierarchy level. When you configure OSPFv3 on an interface, you must also include the **family inet6** statement at the [edit interfaces *interface-name* unit *logical-unit-number*] hierarchy level. For more information about the **family inet** statement, see the *JUNOS Network Interfaces Configuration Guide*. Beginning with JUNOS Release 9.2, you can configure OSPFv3 to support address families other than unicast IPv6. For more information, see “Configuring Multiple Address Families for OSPFv3” on page 427.

To configure OSPF on an interface, you can perform the following tasks:

- Configuring an Interface on a Broadcast or Point-to-Point Network on page 423
- Configuring an Interface on a Point-to-Multipoint Network on page 424
- Configuring an Interface on a Nonbroadcast, Multiaccess Network on page 424
- Configuring an OSPF Demand Circuit Interface on page 425

Configuring an Interface on a Broadcast or Point-to-Point Network

If the interface on which you are configuring OSPF supports broadcast mode (such as a LAN), or if the interface supports point-to-point mode (such as a PPP interface or a point-to-point logical interface on Frame Relay), include the following form of the **interface** statement:

```
(ospf | ospf3) {
  area area-id {
    interface interface-name;
  }
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Specify the interface by IP address or interface name for OSPFv2, or only the interface name for OSPFv3. Beginning with JUNOS Release 9.3, an OSPF point-to-point interface supports an Ethernet interface without a subnet. For more information about interface names, see the *JUNOS Network Interfaces Configuration Guide*.

Configuring an Interface on a Point-to-Multipoint Network

When you configure OSPFv2 on a nonbroadcast multiaccess (NBMA) network, such as a multipoint ATM or Frame Relay, OSPFv2 operates by default in point-to-multipoint mode. In this mode, OSPFv2 treats the network as a set of point-to-point links. Because there is no autodiscovery mechanism, each neighbor must be configured.

To configure OSPFv2 in point-to-multipoint mode, include the following statement:

```
interface interface-name {
  neighbor address;
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Specify the interface by IP address or interface name. For more information about interface names, see the *JUNOS Network Interfaces Configuration Guide*.

To configure multiple neighbors, include a **neighbor** statement for each neighbor.

Configuring an Interface on a Nonbroadcast, Multiaccess Network

When configuring OSPFv2 on an NBMA network, you can use nonbroadcast mode rather than point-to-multipoint mode. Using this mode offers no advantages over point-to-multipoint mode, but it has more disadvantages than point-to-multipoint mode. Nevertheless, you might occasionally find it necessary to configure nonbroadcast mode to interoperate with other equipment.

Nonbroadcast mode treats the NBMA network as a partially connected LAN, electing designated and backup designated routers. All routers must have a direct connection to both the designated and backup designated routers, or unpredictable results occur.

To configure nonbroadcast mode, include the following statements:

```
interface interface-name {
  interface-type nbma;
  neighbor address <eligible>;
  poll-interval seconds;
```



```
}
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Specify the interface by IP address or interface name. For more information about interface names, see the *JUNOS Network Interfaces Configuration Guide*.



NOTE: For nonbroadcast interfaces, specify the IP address of the nonbroadcast interface as the *interface-name*.

To configure multiple neighbors, include a **neighbor** statement for each neighbor.

OSPF routers normally discover their neighbors dynamically by listening to the broadcast or multicast hello packets on the network. Because an NBMA network does not support broadcast (or multicast), the router cannot discover its neighbors dynamically, so you must configure all the neighbors statically. Do this by including the **neighbor** statement and specifying the IP address of each neighboring router in the **address** option. To configure multiple neighbors, include multiple **neighbor** statements. If the neighbor is allowed to become the designated router, include the **eligible** keyword.

By default, the router sends hello packets out the interface every 120 seconds before it establishes adjacency with a neighbor. To modify this interval, include the **poll-interval** statement.

Configuring an OSPF Demand Circuit Interface

A demand circuit is a connection on which you can limit traffic based on user agreements. The demand circuit can limit bandwidth or access time based upon agreements between the provider and user.

Demand circuits can be used to implement Integrated Services Digital Network (ISDN). For this application, demand circuits are configured on point-to-point and point-to-multipoint interfaces. For more information on ISDN, see the *J-series Services Router Advanced WAN Access Configuration Guide*.

Demand circuits can be configured on an OSPF interface. When the interface becomes a demand circuit, all hello packets and link-state advertisements are suppressed as soon as OSPF synchronization is achieved. Hello packets and link-state advertisements are sent and received on a demand-circuit interface only when there is a change in the network topology. This reduces the amount of traffic through the OSPF interface.

To configure an OSPF interface as a demand circuit, include the **demand-circuit** statement:

```
(ospf | ospf3) {
  area area-id {
    demand-circuit;
  }
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

A demand-circuit interface automatically negotiates demand-circuit connection with its OSPF neighbor. If the neighbor does not support demand circuits, then no demand circuit connection is established.

Configuring Multiarea Adjacency in OSPFv2

By default, a single interface can belong to only one OSPF area. However, in some situations, you might want to configure an interface to belong to more than one area. Doing so allows the corresponding link to be considered an intra-area link in multiple areas and to be preferred over other higher-cost intra-area paths. For example, you configure an interface to belong to multiple areas with a high-speed backbone link between two area border routers to enable you to create multiarea adjacencies that belong to different areas.

Beginning with JUNOS Release 9.2, you can configure a logical interface to belong to more than one OSPF area. As defined in RFC 5185, *OSPF Multi-Area Adjacency*, the area border routers establish multiple adjacencies belonging to different areas over the same logical interface. Each multiarea adjacency is announced as a point-to-point unnumbered link in the configured area by the routers connected to the link. For each area, one of the logical interfaces is treated as primary, and the remaining interfaces that are configured for the area are designated as secondary.

To configure a secondary logical interface for an OSPF area, include the **secondary** statement:

```
ospf {
  area area-id {
    interface interface-name
      secondary;
  }
}
```

Any logical interface not configured as a secondary interface for an area is treated as a primary interface for that area. A logical interface can be configured as primary interface only for one area. For any other area for which you configure the interface, you must configure it as a secondary interface.



NOTE: You cannot configure the **secondary** statement with the **interface all** statement. You also cannot configure as secondary an interface by its IP address.

For a list of hierarchy levels at which you can configure the statement, see the statement summary section for this statement.

Configuring Multiple Address Families for OSPFv3

By default, OSPFv3 supports only unicast IPv6 routes. Beginning with JUNOS Release 9.2, you can configure OSPFv3 to support multiple address families, including IPv4 unicast, IPv4 multicast, and IPv6 multicast. The JUNOS software maps each address family to a separate realm as defined in Internet draft *draft-ietf-ospf-af-alt-06.txt*, *Support for Address Families in OSPFv3*. Each realm maintains a separate set of neighbors and link-state database.

To configure an OSPFv3 realm, include the realm (ipv4-unicast | ipv4-multicast | ipv6-multicast) statement:

```
ospf3 {
  realm (ipv4-unicast | ipv4-multicast | ipv6-multicast)
    area area-id {
      interface interface-name;
    }
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

You configure each realm independently. We recommend that you configure an area and at least one interface for each realm.

These are the default import and export routing tables for each of the four address families:

- IPv6 unicast: inet6.0
- IPv6 multicast: inet6.2
- IPv4 unicast: inet.0
- IPv4 mulcast: inet.2

With the exception of virtual links, all configuration supported for the default IPv6 unicast family is supported for the address families that have to be configured as realms.

Configuring Authentication for OSPFv2

All OSPFv2 protocol exchanges can be authenticated to guarantee that only trusted routers participate in the autonomous system's routing. By default, OSPFv2 authentication is disabled. JUNOS software supports MD5 and simple authentication, and beginning with JUNOS Release 8.3, IPsec authentication. You can configure IPsec authentication for the OSPFv2 interface, the remote endpoint of a sham link, and the OSPFv2 virtual link.



NOTE: You can configure IPsec authentication together with either MD5 or simple authentication.

- To enable IPsec authentication for an OSPFv2 interface, include the `ipsec-sa name` statement for a specific interface:

```
interface interface-name ipsec-sa name;
```

- To enable IPsec authentication for a remote sham link, include the `ispec-sa name` statement for the remote end point of the sham link:

```
sham-link-remote address ipsec-sa name;
```



NOTE: If a Layer 3 VPN configuration has multiple sham links with the same remote endpoint IP address, you must configure the same IPsec security association for all the remote endpoints. You configure a Layer 3 VPN at the `[edit routing-instances routing-instance-name instance-type]` hierarchy level. For more information about Layer 3 VPNs, see the *JUNOS VPNs Configuration Guide*.

- To enable IPsec authentication for a virtual link, include the `ipsec-sa name` statement for a specific virtual link:

```
virtual-link neighbor-id router-id transit-area area-id ipsec-sa name;
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

You specify the IPsec authentication name by including the `ipsec-sa name` statement where *name* is the name of the IPsec security association. You configure the actual IPsec authentication separately. Only manual security associations (SAs) are supported for OSPFv2 authentication using IPsec. Dynamic IKE SAs are not supported. For more information about IPsec, see the *JUNOS System Basics Configuration Guide*, the *JUNOS Services Interfaces Configuration Guide*, and the *JUNOS Feature Guide*.

The following restrictions also apply to IPsec authentication for OSPFv2:

- Only IPsec transport mode is supported. Tunnel mode is not supported.
- Because only bidirectional manual SAs are supported, all OSPFv2 peers must be configured with the same IPsec SA. You configure a manual bidirectional SA at the `[edit security ipsec]` hierarchy level.
- You must also configure the same IPsec SA for all virtual links with the same remote endpoint address, for all neighbors on OSPF nonbroadcast multiaccess (NBMA) or point-to-multipoint (P2MP) links, and for every subnet that is part of a broadcast link.
- OSPFv2 peer interfaces are not supported.

Simple authentication uses a text password that is included in the transmitted packet. The receiving router uses an authentication key (password) to verify the packet.

The MD5 algorithm creates an encoded checksum that is included in the transmitted packet. The receiving router uses an authentication key (password) to verify the packet.

For MD5 authentication to work, both the receiving and transmitting routers must have the same MD5 key. Define an MD5 key for each interface. If MD5 is enabled on an interface, that interface accepts routing updates only if MD5 authentication succeeds; otherwise, updates are rejected. The key ID can be set to any value between 0 and 255, with a default value of 0. The router only accepts OSPFv2 packets sent using the same key ID that is defined for that interface.

To enable authentication and specify an authentication method as well as a key (password) for an OSPF interface or virtual link, include the **authentication** statement:

```
authentication {
  md5 key {
    key [ key-values ] {
      start-time time;
    }
  }
  simple-password key;
}
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

The simple key (password) can be from 1 through 8 characters long. Each MD5 key is identified by a key identifier. The MD5 key value can be from 1 through 16 characters long. Characters can include ASCII strings. If you include spaces, enclose all characters in quotation marks (" ").

A simple password and MD5 key are mutually exclusive.

You can configure only one simple password. However, you can configure multiple MD5 keys.

As part of your security measures, you can change MD5 keys. You can do this by configuring multiple MD5 keys, each with a unique key ID, and setting the date and time to switch to the new key. Each unique MD5 key has a unique ID. The ID is used by the receiver of the OSPF packet to determine which key to use for authentication. The key identifier, which is required for MD5 authentication, specifies the identifier associated with the MD5 key.

The start time specifies when to start using the MD5 key. This is optional. The **start-time** option enables you to configure a smooth transition mechanism for multiple keys. The start time is relevant for transmission but not for receiving OSPF packets.

See the following sections:

- Example: Configuring IPsec Authentication for an OSPFv2 Interface on page 429
- Example: Configuring a Transition of MD5 Keys on page 430
- Example: Configuring MD5 Authentication on page 430

Example: Configuring IPsec Authentication for an OSPFv2 Interface

Configure IPsec authentication for OSPFv2 interface **so-0/2/0.0**. Include the name of the manual SA **sa1** that you configure at the [edit security ipsec] hierarchy level.

```
[edit protocols ospf]
area 0.0.0.0 {
  interface so-0/2/0.0 {
    ipsec-sa sa-1;
  }
}
```

Example: Configuring a Transition of MD5 Keys

Configure new keys to take effect at 12:01 AM on the first day of the next three months:

```
[edit protocols ospf area 0.0.0.0 interface fe-0/0/1]
authentication {
  md5 1 {
    key $2001HaL;
  }
}
authentication {
  md5 2 {
    key NeWpsswdFEB {
      start-time 2006-02-01.00:01;
    }
  }
}
authentication {
  md5 3 {
    key NeWpsswdMAR {
      start-time 2006-03-01.00:01;
    }
  }
}
authentication {
  md5 4 {
    key NeWpsswdAPR {
      start-time 2006-04-01.00:01;
    }
  }
}
```

Set the same passwords and transition dates and times on all the routers in the area so that OSPF adjacencies remain active.

Example: Configuring MD5 Authentication

Configure MD5 authentication for OSPF:

```
[edit protocols ospf]
area 0.0.0.0 {
  interface fxp0.0 {
    disable;
  }
  interface t1-0/2/1.0 {
    authentication {
```

```

md5 3 key "$9$6gBqCtOW87YgJEcyKW8Vb" start-time 2002-11-19.10:00;
# SECRET-DATA
md5 2 key "$9$DJHkP5T3/AOUj6A0Irl"; # SECRET-DATA
}
}
reference-bandwidth 4g;
traceoptions {
  file ospf size 5m world-readable;
  flag error;
}
}

```

Configuring Authentication for OSPFv3

OSPF version 3 (OSPFv3) provides a method for protecting and securing the OSPF traffic through the router. OSPFv3 uses the IP Authentication Header (AH) and the IP Encapsulating Security Payload (ESP) to authenticate routing information.

Use ESP with NULL encryption to provide authentication to the OSPFv3 protocol headers only. Use AH to provide authentication to the OSPFv3 protocol headers, portions of the IPv6 header, and portions of the extension headers. Use ESP with non-NUL encryption for full confidentiality.

OSPFv3 authentication uses static keyed IP security protocol (IPsec) security associations (SAs) similar to BGP IPsec. Tunnel mode SAs and dynamic IPsec SAs using Internet Key Exchange (IKE) authentication are not supported. Dynamic keyed IPsec SAs run on the Routing Engine and do not require a services PIC.

To apply authentication, include the `ipsec-sa` statement for a specific OSPFv3 interface:

```
interface interface-name ipsec-sa name;
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

You specify the IPsec authentication name by including the *name* option. You configure the actual IPsec authentication separately.

For more information on IPsec, see the *JUNOS System Basics Configuration Guide* and the *JUNOS Services Interfaces Configuration Guide*.

Configuring a Prefix Export Limit

By default, there is no limit to the number of prefixes that can be exported into OSPF. To limit the number of prefixes, include the `prefix-export-limit` statement:

```
(ospf | ospf3) {
  prefix-export-limit number;
}
```

For a list of hierarchy levels at which you can include this statement, see the statement summary section for this statement.

The number can be a value from 0 through 4,294,967,295.

Configuring the Priority for Becoming the Designated Router

A router advertises its priority to become a designated router in its hello packets. On all multiaccess networks, the Hello protocol uses the advertised priorities to elect a designated router for the network. This router is responsible for sending network link advertisements, which describe all the routers attached to the network. These advertisements are flooded throughout a single area.

At least one router on each logical IP network or subnet must be eligible to be the designated router for OSPFv2. At least one router on each logical link must be eligible to be the designated router for OSPFv3.

A router's priority for becoming the designated router is indicated by an arbitrary number from 0 through 255, with a higher value indicating a greater likelihood of becoming the designated router. By default, routers have a priority value of 128. A value of 1 means that the router has the least chance of becoming a designated router. A value of 0 marks the router as ineligible to become the designated router.

To modify the router's priority value, include the **priority** statement:

```
(ospf | ospf3) {
  area area-id interface interface-name {
    priority number;
  }
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Configuring Route Summarization

Area border routers send summary link advertisements to describe the routes to other areas. To minimize the number of these advertisements that are flooded, you can configure the router to coalesce, or summarize, a range of IP addresses and send reachability information about these addresses in a single link-state advertisement.

To summarize a range of IP addresses, include the **area-range** statement. To summarize multiple ranges, include multiple **area-range** statements.

```
(ospf | ospf3) {
  area area-id {
    area-range network/mask-length <restrict> <exact> <override-metric metric>;
  }
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

All routes that match the specified area range are filtered at the area boundary, and the summary is advertised in their place. If you specify the **restrict** option, the routes are filtered but no summary is advertised. If you specify the **exact** option,

summarization of a route is advertised only when an exact match is made with the configured summary range. To override the metric for the IP address range and configure a specific metric value, include the **override-metric** option. If you specify the **override-metric** option, the dynamically computed metric for the IP address range is overridden by the specified value.

Modifying the Interface Metric

All OSPF interfaces have a cost, which is a routing metric that is used in the link-state calculation. Routes with lower total path metrics are preferred over those with higher path metrics.

When several equal-cost routes to a destination exist, traffic is distributed equally among them.

The cost of a route is described by a single dimensionless metric that is determined using the following formula:

$$\text{cost} = \text{reference-bandwidth} / \text{bandwidth}$$

reference-bandwidth is the reference bandwidth. Its default value is 100 Mbps (which you specify as 100,000,000), which gives a metric of 1 for any bandwidth that is 100 Mbps or greater.

To modify the metric for routes advertised from an interface, include the **metric** statement:

```
(ospf | ospf3) {
  area area-id interface interface-name {
    metric metric;
  }
}
```

To modify the reference bandwidth, include the **reference-bandwidth** statement:

```
(ospf | ospf3) {
  reference-bandwidth reference-bandwidth;
}
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

For example, if you set the reference bandwidth to 1 Gbps (that is, *reference-bandwidth* is set to 1,000,000,000), a 100-Mbps interface has a default metric of 10.

By default, the loopback interface (lo0) metric is 0. No bandwidth is associated with the loopback interface.

Configuring Route Preferences

Route preferences are used to select which route is installed in the forwarding table when several protocols calculate routes to the same destination. The route with the

lowest preference value is selected. For more information about route preferences, see “Route Preferences” on page 6.

By default, internal OSPF routes have a preference value of 10, and external OSPF routes have a value of 150. To change the preference values, include the **preference** statement (for internal routes) or the **external-preference** statement (for external routes):

```
(ospf | ospf3) {
    external-preference preference;
    preference preference;
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

The preference can be a value from 0 through 4,294,967,295 ($2^{32} - 1$).

Configuring OSPF Timers

OSPF routers constantly track the status of their neighbors, sending and receiving hello packets that indicate whether the neighbor still is functioning, and sending and receiving link-state advertisement and acknowledgment packets. OSPF sends packets and expects to receive packets at specified intervals.

You can perform the following tasks when modifying the OSPF timers:

- Modifying the Hello Interval on page 434
- Controlling the LSA Retransmission Interval on page 435
- Modifying the Router Dead Interval on page 435
- Specifying the Transit Delay on page 436

Modifying the Hello Interval

Routers send hello packets at a fixed interval on all interfaces, including virtual links, to establish and maintain neighbor relationships. This interval, which must be the same on all routers on a shared network, is advertised in the hello interval field in the hello packet. By default, the router sends hello packets every 10 seconds.

To modify how often the router sends hello packets out of an interface, include the **hello-interval** statement:

```
hello-interval seconds;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

On nonbroadcast networks, the router sends hello packets every 120 seconds until active neighbors are detected by default. This interval is long enough to minimize the bandwidth required on slow WAN links. To modify this interval, include the **poll-interval** statement:

`poll-interval seconds;`



NOTE: The `poll-interval` statement is valid for OSPFv2 only.

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Once the router detects an active neighbor, the hello packet interval changes from the time specified in the `poll-interval` statement to the time specified in the `hello-interval` statement.

Controlling the LSA Retransmission Interval

When a router sends link-state advertisements to its neighbors, the router expects to receive an acknowledgment packet from the neighbor within a certain amount of time. If the router does not receive an acknowledgment, it retransmits the advertisement.



NOTE: You must configure LSA retransmit intervals to be equal or greater than 3 seconds to avoid triggering a retransmit trap because the JUNOS software delays LSA acknowledgments by up to 2 seconds.

By default, the router waits 5 seconds for an acknowledgment before retransmitting the link-state advertisement. To modify this interval, include the `retransmit-interval` statement:

`retransmit-interval seconds;`

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Modifying the Router Dead Interval

If a router does not receive a hello packet from a neighbor within a fixed amount of time, the router modifies its topological database to indicate that the neighbor is nonoperational. The time that the router waits is called the *router dead interval*. By default, this interval is 40 seconds (four times the default hello interval).

To modify the router dead interval, include the `dead-interval` statement. This interval must be the same for all routers on a shared network.

`dead-interval seconds;`

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Specifying the Transit Delay

Before a link-state update packet is propagated out of an interface, the router must increase the age of the packet. If you have a very slow link (for example, one with an average propagation delay of multiple seconds), the age of the packet must be increased by a similar amount. Doing this ensures that you do not receive a packet back that is younger than the original copy.

The default transit delay is 1 second. You should never have to modify the default value. However, if you need to specify the approximate transit delay to use to age update packets, include the **transit-delay** statement:

```
transit-delay seconds;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Configuring the BFD Protocol

The Bidirectional Forwarding Detection (BFD) protocol is a simple hello mechanism that detects failures in a network. BFD works with a wide variety of network environments and topologies. Hello packets are sent at a specified, regular interval. A neighbor failure is detected when the router stops receiving a reply after a specified interval. The BFD failure detection timers have shorter time limits than the OSPF failure detection mechanisms, providing faster detection. These timers are also adaptive. For example, the timer can adapt to a higher value if an adjacency fails, or a neighbor can negotiate a higher value than the one configured.



NOTE: BFD is supported for OSPFv3 beginning with JUNOS Release 9.3.

To enable failure detection, include the **bfd-liveness-detection** statement:

```
bfd-liveness-detection {
  detection-time {
    threshold milliseconds;
  }
  minimum-interval milliseconds;
  minimum-receive-interval milliseconds;
  no-adaptation;
  transmit-interval {
    threshold milliseconds;
    minimum-interval milliseconds;
  }
  multiplier number;
  version (1 | automatic);
}
```

To specify the threshold for the adaptation of the detection time, include the **threshold** statement:

```
detection-time {
  threshold milliseconds;
```

```
}
```

When the BFD protocol session detection time adapts to a value equal to or greater than the threshold, a single trap and a single system message are sent.

To specify the minimum transmit and receive intervals for failure detection, include the **minimum-interval** statement:

```
minimum-interval milliseconds;
```

This value represents the minimum interval at which the local router transmits hello packets as well as the minimum interval at which the router expects to receive a reply from a neighbor with which it has established a BFD session. You can configure a number in the range from 1 through 255,000 milliseconds. You can also specify the minimum transmit and receive intervals separately.



NOTE: Specifying an interval less than 300 ms can cause undesired BFD flapping.

To specify only the minimum receive interval for failure detection, include the **minimum-receive-interval** statement:

```
minimum-receive-interval milliseconds;
```

This value represents the minimum interval at which the local router expects to receive a hello packet from a neighbor with which it has established a BFD session. You can configure a number in the range from 1 through 255,000 milliseconds.

To specify the number of hello packets not received by a neighbor that causes the originating interface to be declared down, include the **multiplier** statement:

```
multiplier number;
```

The default is 3, and you can configure a value in the range from 1 through 255.

To specify only the minimum transmit interval for failure detection, include the **transmit-interval** **minimum-interval** statement:

```
transmit-interval {
  minimum-interval milliseconds;
}
```

This value represents the minimum interval at which the local router transmits hello packets to the neighbor with which it has established a BFD session. You can configure a value in the range from 1 through 255,000 milliseconds.

To specify the threshold for detecting the adaptation of the transmit interval, include the **threshold** statement:

```
transmit-interval {
  threshold milliseconds;
}
```

The threshold value must be greater than the transmit interval.

Beginning with JUNOS Release 9.0, you can configure BFD sessions not to adapt to changing network conditions. To disable BFD adaptation, include the **no-adaptation** statement:

```
no-adaptation;
```



NOTE: We recommend that you not disable BFD adaptation unless it is preferable not to have BFD adaptation enabled in your network.

To specify the BFD version used for detection, include the **version** statement:

```
version (1 | automatic);
```

The default is to have the version detected automatically.

For a list of hierarchy levels at which you can configure these statements, see **bfd-liveness-detection**.

Configuring Label Distribution Protocol Synchronization with the IGP

The Label Distribution Protocol (LDP) is a protocol for distributing labels in non-traffic-engineered applications. Labels are distributed along the best path determined by the IGP. If synchronization between LDP and the IGP is not maintained, the label-switch path (LSP) goes down. When LDP is not fully operational on a given link (a session is not established and labels are not exchanged), the IGP advertises the link with the maximum cost metric. The link is not preferred but remains in the network topology.

LDP synchronization is supported only on active point-to-point interfaces and LAN interfaces configured as point-to-point under the IGP. LDP synchronization is not supported during graceful restart.

To advertise the maximum cost metric until LDP is operational for synchronization, include the **ldp-synchronization** statement:

```
ldp-synchronization {
  disable;
  hold-time seconds;
}
```

To disable synchronization, include the **disable** statement. To configure the time period to advertise the maximum cost metric for a link that is not fully operational, include the **hold-time** statement.



NOTE: If you do not configure the **hold-time** statement, the hold-time value will default to infinity.

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Configuring Graceful Restart

OSPF supports two types of graceful restart: planned and unplanned. During a planned restart, the restarting router informs the neighbors before restarting. The neighbors act as if the router is still within the network topology, and continue forwarding traffic to the restarting router. A grace period is set to specify the time period for which the neighbors should consider the restarting router as part of the topology. During an unplanned restart, the router restarts without warning.



NOTE: On a broadcast link with a single neighbor, when the neighbor initiates an OSPFv3 graceful restart operation, the restart might be terminated at the point when the local router assumes the role of a helper. A change in the LSA is considered a topology change, which terminates the neighbor's restart operation.

Graceful restart is disabled by default. You can globally enable graceful restart for all routing protocols at the [edit routing-options] hierarchy level.

To configure graceful restart parameters specifically for OSPF, include the `graceful-restart` statement:

```
(ospf | ospf3) {
  graceful-restart {
    disable;
    helper-disable;
    notify-duration seconds;
    restart-duration seconds;
  }
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

To disable graceful restart, specify the **disable** statement. To configure a time period for complete reacquisition of OSPF neighbors, specify the **restart-duration** statement. To configure a time period for sending out purged grace LSAs over all interfaces, specify the **notify-duration** statement. Helper mode is enabled by default. To disable the graceful restart helper capability, specify the **helper-disable** statement.

The grace period interval for OSPF graceful restart is determined as equal to or smaller than the sum of the **notify-duration** time interval and the **restart-duration** time interval. The grace period is the number of seconds that the router's neighbors continue to advertise the router as fully adjacent, regardless of the connection state between the router and its neighbors.

Configuring SPF Options for OSPF

You can configure the following shortest-path-first (SPF) options:

- The delay in the time between the detection of a topology change and when the SPF algorithm actually runs.

- The maximum number of times that the SPF algorithm can run in succession before the hold-down timer begins.
- The time to hold down, or wait, before running another SPF calculation after the SPF algorithm has run in succession the configured maximum number of times.

To configure SPF options, include the **spf-options** statement:

```
spf-options {
    delay milliseconds;
    holddown milliseconds;
    rapid-runs number;
}
```

To configure the SPF delay, include the **delay** statement when specifying the **spf-options** statement:

```
delay milliseconds;
```

By default, the SPF algorithm runs 200 milliseconds after the detection of a topology change. The range that you can configure is from 50 through 8000 milliseconds.

To configure the maximum number of times that the SPF algorithm can run in succession, include the **rapid-runs** statement when specifying the **spf-options** statement:

```
rapid-runs number;
```

The default number of SPF calculations that can occur in succession is 3. The range that you can configure is from 1 through 5. Each SPF algorithm is run after the configured SPF delay. When the maximum number of SPF calculations occurs, the hold-down timer begins. Any subsequent SPF calculation is not run until the hold-down timer expires.

To configure the SPF hold-down timer, include the **holddown** statement when specifying the **spf-options** statement:

```
holddown milliseconds;
```

The default is 5000 milliseconds, and the range that you can configure is from 2000 through 20,000 milliseconds. Use the hold-down timer to hold down, or wait, before running any subsequent SPF calculations after the SPF algorithm runs for the configured maximum number of times. If the network stabilizes during the holddown period and the SPF algorithm does not need to run again, the system reverts to the configured values for the **delay** and **rapid-runs** statements.

Advertising Interface Addresses Without Running OSPF

By default, OSPF must be configured on an interface for direct interface addresses to be advertised as interior routes. To advertise the direct interface addresses without actually running OSPF on that interface, include the **passive** statement:

```
(ospf | ospf3) {
    area area-id {
        interface interface-name {
```



```

        passive {
        }
    }
}

```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Point-to-point interfaces differ from multipoint in that only one OSPF adjacency is possible. (A LAN, for instance, can have multiple addresses and can run OSPF on each subnet simultaneously.) As such, when you configure a numbered point-to-point interface to OSPF by name, multiple OSPF interfaces are created. One, which is unnumbered, is the interface on which the protocol is run. An additional OSPF interface is created for each address configured on the interface, if any, which is automatically marked as passive.

For OSPFv3, one OSPF-specific interface must be created per interface name configured under OSPFv3. OSPFv3 does not allow interfaces to be configured by IP address.

Enabling OSPF on an interface (by including the **interface** statement), disabling it (by including the **disable** statement), and not actually having OSPF run on an interface (by including the **passive** statement) are mutually exclusive states.

You can also configure interfaces in OSPF passive traffic engineering mode. For more information, see “Configuring OSPF Passive Traffic Engineering Mode” on page 441 and the *JUNOS MPLS Applications Configuration Guide*.

Configuring OSPF Passive Traffic Engineering Mode

Ordinarily, interior routing protocols such as OSPF are not run on links between ASs. However, for inter-AS traffic engineering to function properly, information about the inter-AS link—in particular, the address on the remote interface—must be made available inside the AS. This information is not normally included either in the EBGP reachability messages or in the OSPF routing advertisements.

To flood this link address information within the AS and make it available for traffic engineering calculations, you must configure OSPF passive mode for traffic engineering on each inter-AS interface. You must also supply the remote address for OSPF to distribute and include in the traffic engineering database. OSPF TE mode allows MPLS label-switched paths (LSPs) to dynamically discover OSPF AS boundary routers and to allow routers to establish a traffic engineering LSP across multiple ASs.

To configure OSPF passive mode for traffic engineering on an inter-AS interface, include the **traffic-engineering** statement at the [edit protocols ospf area *area-id* interface *interface-name* passive] hierarchy level:

```

[edit protocols ospf area area-id interface interface-name passive]
traffic-engineering {
    remote-node-id address /* IP address at far end of inter-AS link */
}

```

For more information, see the *JUNOS MPLS Applications Configuration Guide*.

Advertising Label-Switched Paths into OSPF

You can advertise label-switched paths (LSPs) into OSPFv2 as point-to-point links so that all participating routers can take the LSP into account when performing SPF calculations. The advertisement contains a local address (the **from** address of the label-switched path), a remote address (the **to** address of the label-switched path), and a metric with the following precedence:

1. Use the label-switched path metric defined under OSPFv2.
2. Use the label-switched path metric configured for the label-switched path under MPLS.
3. If you do not configure any of the above, use the default OSPFv2 metric of 1.

To advertise LSPs, include the **label-switched-path** statement, with a specified name and metric:

```
label-switched-path name metric metric;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.



NOTE: If you want an LSP that is announced into OSPFv2 to be used in SPF calculations, there must be a reverse link (that is, a link from the tail end of the LSP to the head end). You can accomplish this by configuring an LSP in the reverse direction and also announcing it in OSPFv2.

For more information about advertising label-switched paths, see the *JUNOS MPLS Applications Configuration Guide*.

Configuring the Router to Appear Overloaded

If the time elapsed after the OSPF instance is enabled is less than the specified timeout, overload mode is set.

You can configure the local router so that it appears to be overloaded. You might do this when you want the router to participate in OSPF routing, but do not want it to be used for transit traffic. (Traffic to directly attached interfaces continues to transit the router.)

You configure or disable overload mode in OSPF with or without a timeout. Without a timeout, overload mode is set until it is explicitly deleted from the configuration. With a timeout, overload mode is set if the time elapsed since the OSPF instance started is less than the specified timeout.

A timer is started for the difference between the timeout and the time elapsed since the instance started. When the timer expires, overload mode is cleared. In overload mode, the router LSA is originated with all the transit router links (except stub) set

to a metric of 0xFFFF. The stub router links are advertised with the actual cost of the interfaces corresponding to the stub. This causes the transit traffic to avoid the overloaded router and take paths around the router. However, the overloaded router's own links are still accessible.

To mark the router as overloaded, include the **overload** statement:

```
(ospf | ospf3) {
  overload;
}
```

To specify the number of seconds at which overload is reset, include the **timeout** option when specifying the **overload** statement:

```
(ospf | ospf3) {
  overload timeout <seconds>;
}
```

The time can be a value from 60 through 1800 seconds.

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Enabling OSPF Traffic Engineering Support

When traffic engineering is enabled on the router, you can enable the OSPFv2 traffic engineering support, which allows OSPFv2 to generate LSAs that carry traffic engineering parameters. These parameters are used to create the Traffic Engineering Database, which is used by Constrained Shortest Path First (CSPF) to compute MPLS LSPs.



NOTE: Traffic engineering is not supported for OSPFv3.



NOTE: Whenever possible, use OSPF IGP shortcuts instead of traffic engineering shortcuts.

By default, traffic engineering support is disabled. To enable it, include the **traffic-engineering** statement:

```
traffic-engineering {
  advertise-unnumbered-interfaces;
  multicast-rpf-routes;
  no-topology;
  shortcuts {
    ignore-lsp-metrics;
    lsp-metric-into-summary;
  }
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

To disable the dissemination of the link-state topology information, include the **no-topology** statement. To use LSPs as next hops, specify the **shortcuts** statement.

When traffic engineering is enabled for OSPF, the SPF algorithm takes into account the various LSPs configured under MPLS. These routes are installed into the primary routing table, **inet.0**. To advertise the LSP metric for a prefix in a summary LSA, specify the **lsp-metric-into-summary** statement. To ignore RSVP LSP metrics in OSPF traffic engineering shortcut calculations, specify the **ignore-lsp-metrics** statement.

You can configure OSPF to install routes with regular IP next hops (no LSPs as next hops) into the **inet.2** routing table for a reverse-path-forwarding (RPF) check. The **inet.2** routing table consists of unicast routes used for multicast RPF lookup. RPF is an antispoofing mechanism used to check if the packet is coming in on an interface that is also sending data back to the packet source. To install routes for multicast RPF checks into the **inet.2** routing table, include the **multicast-rpf-routes** statement.



NOTE: You must enable OSPF traffic engineering shortcuts to use the **multicast-rpf-routes** statement. You must not allow LSP advertisement into OSPF when configuring the **multicast-rpf-routes** statement.

In some scenarios, you might want to advertise the link-local identifier in the link-local TE link-state advertisement packets. To advertise unnumbered interfaces in a traffic-engineering environment, include the **advertise-unnumbered-interfaces** statement.



NOTE: The **advertise-unnumbered-interfaces** statement has no effect on your configuration if Resource Reservation Protocol (RSVP) can signal unnumbered interfaces, as defined in RFC 3477, *Signalling Unnumbered Links in Resource Reservation Protocol - Traffic Engineering (RSVP-TE)*. You do not need to configure this statement in this situation.

For more information about configuring LSPs and MPLS, see the *JUNOS MPLS Applications Configuration Guide*.

Example: Enabling OSPF Traffic Engineering Support

Enable OSPF traffic engineering support by configuring a virtual link on the local router. This router must be an area border router that is physically connected to the backbone.

```
[edit protocols]
ospf {
  traffic-engineering {
    shortcuts {
      lsp-metric-into-summary;
    }
  }
}
```

```

    }
  }
[edit protocols]
mpls {
  traffic-engineering bgp-igp;
  label-switched-path xxxx {
    to yy.yy.yy.yy;
  }
}

```

Modifying the Traffic Engineering Metric

When traffic engineering is enabled on the router, you can configure an OSPF metric that is used exclusively for traffic engineering. The traffic engineering metric is used for information injected into the traffic engineering database. Its value does not affect normal OSPF forwarding.

To modify the default value, include the **te-metric** statement:

```
te-metric metric;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Configuring OSPF Routing Policy

All routing protocols store the routes that they learn in the routing table. The routing table uses this collected route information to determine the active routes to destinations. The routing table then installs the active routes into its forwarding table and also exports them back into the routing protocols. It is these exported routes that the protocols advertise.

For each protocol, you control which routes the protocol stores in the routing table and which routes the routing table exports into the protocol by defining a *routing policy* for that protocol. For information about defining a routing policy, see the *JUNOS Policy Framework Configuration Guide*.

By default, if a router has multiple OSPF areas, learned routes from other areas are automatically installed into area 0 of the routing table.

To apply routing policies that affect how the routing table exports routes into OSPF, include the **export** statement:

```

(ospf | ospf3) {
  export [ policy-names ];
}

```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

OSPF import policy allows users to define policy to prevent adding OSPF routes to the routing table. This filtering happens when OSPF installs the route in the routing

table. You can filter the routes, but not LSA flooding. The import policy can filter on any attribute of the OSPF route.

To filter OSPF routes from being added to the routing table, include the **import** statement:

```
(ospf | ospf3) {
    import [ policy-names ];
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Configuring Import and Export Policies for Network Summaries

By default, OSPF uses network-summary link-state advertisements (LSAs) to transmit route information across area boundaries. Each area border router (ABR) floods network-summary LSAs to other routers in the same area. Beginning with JUNOS Release 9.1, you can configure export and import policies for OSPFv2 and OSPFv3 that enable you to control how network-summary LSAs, which contain information about interarea OSPF prefixes, are distributed and generated. For OSPFv3, the LSA is referred to as the interarea prefix LSA and performs the same function as a network-summary LSA performs for OSPFv2. An ABR originates an interarea prefix LSA for each IPv6 prefix that must be advertised into an area.

The export policy enables you to specify which summary LSAs are flooded into an area. The import policy enables you to control which routes learned from an area are used to generate summary LSAs into other areas. You define a routing policy at the [edit **policy-options policy-statement** *policy-name*] hierarchy level. As with all OSPF export policies, the default for network-summary LSA export policies is to reject everything. Similarly, as with all OSPF import policies, the default for network-summary LSA import policies is to accept all OSPF routes. For more information about configuring policies, see the *JUNOS Policy Framework Configuration Guide*.

To apply an export routing policy for OSPFv2 that affects which network-summary LSAs are flooded into an area, include the **network-summary-export** [*policy-names*] statement:

```
ospf area area-id {
    network-summary-export [ policy-names ];
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

To apply an import routing policy for OSPFv2 that affects which routes learned from an area are used to generate network-summary LSAs, include the **network-summary-import** [*policy-names*] statement:

```
ospf area area-id {
    network-summary-import [ policy-names ];
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

To apply an export routing policy for OSPFv3 that affects which interarea prefix LSAs are flooded into an area, include the `inter-area-prefix-export [policy-names]` statement:

```
ospf3 area area-id {
  inter-area-prefix-export [ policy-names ];
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

To apply an import routing policy for OSPFv3 that affects which routes learned from an area are used to generate interarea prefix LSAs, include the `inter-area-prefix-import [policy-names]` statement:

```
ospf3 area area-id {
  inter-area-prefix-import [ policy-names ];
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Configuring Priority for Prefixes in Import Policy

In a network with a large number of OSPF routes, it can be useful to control the order in which routes are updated in response to a network topology change. Beginning with JUNOS Release 9.3, you can specify a priority of high, medium, or low for prefixes included in an OSPF import policy. In the event of an OSPF topology change, high priority prefixes are updated in the routing table first, followed by medium and then low priority prefixes.

OSPF import policy can only be used to set priority or to filter OSPF external routes. If an OSPF import policy is applied that results in a **reject** terminating action for a nonexternal route, then the **reject** action is ignored and the route is accepted anyway. By default, such a route is now installed in the routing table with a priority of low. This behavior prevents traffic black holes, that is, silently discarded traffic, by ensuring consistent routing within the OSPF domain.

In general, OSPF routes that are not explicitly assigned a priority are treated as priority medium, except for the following:

- Summary discard routes have a default priority of low.
- Local routes that are not added to the routing table are assigned a priority of low.
- External routes that are rejected by import policy and thus are not added to the routing table are assigned a priority of low.

To specify a priority for prefixes included in an import policy, include the `priority (high | medium | low)` statement at the `[edit policy-options policy statement`

`policy-statement-name term term-name then]` or `[edit policy-options policy-statement policy-statement-name then]` hierarchy level.

Any available match criteria applicable to OSPF routes can be used to determine the priority. Two of the most commonly used match criteria for OSPF are the **route-filter** and **tag** statements. For more information about configuring routing policy and match conditions, see the *JUNOS Policy Framework Configuration Guide*.

Example: Configure a Route Filter Policy to Specify Priority for Prefixes Learned Through OSPF

Configure an import routing policy, **ospf-import**, that enables you to specify a priority for specific prefixes learned through OSPF. Routes associated with these prefixes are installed in the routing table in the order of the prefixes' specified priority. Routes matching **200.3.0.0/16 orlonger** are installed first because they have a priority of **high**. Routes matching **200.2.0.0/16 orlonger** are installed next because they have a priority of **medium**. Routes matching **200.1.0.0/16 orlonger** are installed last because they have a priority of **low**. To apply the import policy to OSPF, include the **import ospf-import** statement at the `[edit protocols (ospf | ospf3)]` hierarchy level. For a complete list of hierarchy levels at which the **import** statement can be configured, see the configuration statement summary for that statement.

```

policy-options {
  policy-statement ospf-import {
    term t1 {
      from {
        route-filter 200.1.0.0/16 orlonger;
      }
      then {
        priority low;
        accept;
      }
    }
    term t2 {
      from {
        route-filter 200.2.0.0/16 orlonger;
      }
      then {
        priority medium {
          accept;
        }
      }
    }
    term t3 {
      from {
        route-filter 200.3.0.0/16 orlonger;
      }
      then {
        priority high;
        accept;
      }
    }
  }
}

```


Configuring OSPF Routing Table Groups

To install routes learned from OSPF routing instances into routing tables in the OSPF routing table group, include the **rib-group** statement:

```
(ospf | ospf3) {
    rib-group group-name;
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Configuring a Sham Link

You can create an intra-area link or sham link between two provider edge (PE) routers so that the VPN backbone is preferred over the back-door link. Each sham link is identified by the combination of a local endpoint address and a remote endpoint address.

To configure a sham link, include the **sham-link** statement:

```
sham-link {
    local address;
}
```

To configure the local endpoint address, specify the **local** option.

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

To configure the remote endpoint address, include the **sham-link-remote** statement.

```
sham-link-remote address {
    ipsec-sa name;
    demand-circuit;
    metric metric;
}
```

To configure the OSPF interface as a demand circuit, include the **demand-circuit** statement. To configure the remote endpoint metric value, include the **metric** statement. To configure IPsec authentication for the remote endpoint of a sham link, include the **ipsec-sa** *name* statement.

Configuring a Peer Interface

You can configure a peer interface for OSPF routers. Generalized Multiprotocol Label Switching (GMPLS) requires traffic engineering information to be transported through a link separate from the control channel. You establish this separate link by configuring a peer interface.

To configure a peer interface, include the **peer-interface** statement:

```
peer-interface interface-name {
```

```

    disable;
    dead-interval seconds;
    hello-interval seconds;
    retransmit-interval seconds;
    transit-delay seconds;
}

```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

To disable the peer interface, specify the **disable** statement. To modify the peer interface dead interval, specify the **dead-interval** statement. To modify how often the router sends hello packets out of the peer interface, specify the **hello-interval** statement. To modify how often the peer interface retransmits the link-state advertisement, specify the **retransmit-interval** statement. To specify the approximate transit delay to use to age update packets, include the **transit-delay** statement.

For more information about configuring GMPLS, see the *JUNOS MPLS Applications Configuration Guide*.

Tracing OSPF Protocol Traffic

To trace OSPF protocol traffic, you can specify options with the global **traceoptions** statement included at the [edit **routing-options**] hierarchy level, and you can specify OSPF-specific options by including the **traceoptions** statement:

```

(ospf | ospf3) {
  traceoptions {
    file filename <size size> <files number> <world-readable | no-world-readable>;
    flag flag <flag-modifier> <disable>;
  }
}

```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

You can specify the following OSPF-specific trace flags in the OSPF **traceoptions** statement:

- **all**—Everything
- **database-description**—All database description packets, which are used in synchronizing the OSPF topological database
- **error**—OSPF error packets
- **event**—OSPF state transitions
- **flooding**—Link-state flooding packets
- **general**—General events
- **graceful-restart**—Graceful-restart events.
- **hello**—Hello packets, which are used to establish neighbor adjacencies and to determine whether neighbors are reachable

- **lsa-ack**—Link-state acknowledgment packets, which are used in synchronizing the OSPF topological database
- **lsa-request**—Link-state request packets, which are used in synchronizing the OSPF topological database
- **lsa-update**—Link-state updates packets, which are used in synchronizing the OSPF topological database
- **normal**—Normal events
- **on-demand**—Trace demand circuit extensions
- **packets**—All OSPF packets
- **packet-dump**—Dump the contents of selected packet types
- **policy**—Policy processing
- **spf**—Shortest path first (SPF) calculations
- **state**—State transitions
- **task**—Routing protocol task processing
- **timer**—Routing protocol timer processing



NOTE: Use the trace flags **detail** and **all** with caution. These flags may cause the CPU to become very busy.

For general information about tracing and global tracing options, see “Tracing Global Routing Protocol Operations” on page 119.

Examples: Tracing OSPF Protocol Traffic

Trace only unusual or abnormal operations to the file **routing-log**, and trace detailed information about all OSPF packets to the file **ospf-log**:

```
[edit]
routing-options {
  traceoptions {
    file routing-log;
  }
}
protocols {
  ospf {
    traceoptions {
      file ospf-log size 10k files 5;
      flag lsa-ack;
      flag database-description;
      flag hello;
      flag lsa-update;
      flag lsa-request;
    }
    area 0.0.0.0 {
      interface 10.0.0.1;
```

```
    }
  }
}
```

Trace SPF calculations:

```
[edit]
protocols {
  ospf {
    traceoptions {
      file ospf-log;
      flag spf;
    }
    area 0.0.0.0 {
      interface 10.0.0.1;
    }
  }
}
```

Trace the creation, receipt, and retransmission of all link-state advertisements:

```
[edit]
protocols {
  ospf {
    traceoptions {
      file ospf-log;
      flag lsa-request;
      flag lsa-update;
      flag lsa-ack;
      area 0.0.0.0 {
        interface 10.0.0.1;
      }
    }
  }
}
```

Chapter 22

Summary of OSPF Configuration Statements

The following sections explain each of the Open Shortest Path First (OSPF) configuration statements, which are organized alphabetically. The term OSPF refers to both OSPF version 2 (OSPFv2) and OSPF version 3 (OSPFv3).

area

Syntax	<code>area area-id;</code>
Hierarchy Level	<p>[edit logical-systems <i>logical-system-name</i> protocols (ospf ospf3)], [edit logical-systems <i>logical-system-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (ospf ospf3)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)], [edit protocols (ospf ospf3)], [edit protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)], [edit routing-instances <i>routing-instance-name</i> protocols (ospf ospf3)], [edit routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)]</p>
Release Information	<p>Statement introduced before JUNOS Release 7.4. Support for the realm statement introduced in JUNOS Release 9.2.</p>
Description	<p>Specify the area identifier for this router to use when participating in OSPF routing. All routers in an area must use the same area identifier to establish adjacencies.</p> <p>Specify multiple area statements to configure the router as an area border router. An area border router does not automatically summarize routes between areas; use the area-range statement to configure route summarization. By definition, an area border router must be connected to the backbone area either through a physical link or through a virtual link. To create a virtual link, use the virtual-link statement.</p> <p>To specify that the router is directly connected to the OSPF and OSPFv3 backbone, include the area 0.0.0.0 statement.</p> <p>All routers on the backbone must be contiguous. If they are not, use the virtual-link statement to create the appearance of connectivity to the backbone.</p>
Options	<p>area-id—Area identifier. The identifier can be up to 32 bits. It is common to specify the area number as a simple integer or an IP address. Area number 0.0.0.0 is reserved for the OSPF and OSPFv3 backbone area.</p>
Usage Guidelines	<p>See “Configuring the Backbone Area and Other Areas” on page 418 and “Configuring Multiple Address Families for OSPFv3” on page 427.</p>
Required Privilege Level	<p>routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.</p>

area-range

Syntax	<code>area-range network/mask-length <restrict> <exact> <override-metric metric>;</code>
Hierarchy Level	<p>[edit logical-systems <i>logical-system-name</i> protocols (ospf ospf3) area <i>area-id</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> protocols (ospf ospf3) area <i>area-id</i> nssa],</p> <p>[edit logical-systems <i>logical-system-name</i> realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> nssa],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i>],</p> <p>[edit protocols (ospf ospf3) area <i>area-id</i>],</p> <p>[edit protocols (ospf ospf3) area <i>area-id</i> nssa],</p> <p>[edit protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i>],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i>],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> nssa],</p> <p>[edit routing-instances <i>routing-instance-name</i> realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i>]</p>
Release Information	<p>Statement introduced before JUNOS Release 7.4.</p> <p>Support for the realm statement introduced in JUNOS Release 9.2.</p>
Description	<p>(Area border routers only) For an area, summarize a range of IP addresses when sending summary link advertisements (within an area). To summarize multiple ranges, include multiple area-range statements.</p> <p>For an NSSA, summarize a range of IP addresses when sending NSSA LSAs. The specified prefixes are used to aggregate external routes learned within the area when the routes are advertised to other areas. To specify multiple prefixes, include multiple area-range statements. All external routes learned within the area that do not fall into one of the prefixes are advertised individually to other areas.</p>
Default	By default, area border routers do not summarize routes being sent from one area to other areas, but rather send all routes explicitly.
Options	<p><i>network</i>—IP address. You can specify one or more IP addresses.</p> <p><i>mask-length</i>—Number of significant bits in the network mask.</p> <p><i>restrict</i>—(Optional) Do not advertise the configured summary. This hides all routes that are contained within the summary, effectively creating a route filter.</p> <p><i>exact</i>—(Optional) Summarization of a route is advertised only when an exact match is made with the configured summary range.</p> <p><i>override-metric metric</i>—(Optional) Override the metric for the IP address range and configure a specific metric value.</p> <p>Range: 1 through 16777215</p>

Usage Guidelines See “Configuring Route Summarization” on page 432 and “Configuring a Not-So-Stubby Area” on page 420.

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

authentication

Syntax authentication {
 md5 *key-identifier* {
 key *key-value*
 start-time *YYYY-MM-DD.HH:MM*
 }
 simple-password *key*;
}

Hierarchy Level [edit logical-systems *logical-system-name* protocols ospf area *area-id* interface *interface-name*],
[edit logical-systems *logical-system-name* protocols ospf area *area-id* virtual-link],
[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols ospf area *area-id* interface *interface-name*],
[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols ospf area *area-id* virtual-link],
[edit protocols ospf area *area-id* interface *interface-name*],
[edit protocols ospf area *area-id* virtual-link],
[edit routing-instances *routing-instance-name* protocols ospf area *area-id* interface *interface-name*],
[edit routing-instances *routing-instance-name* protocols ospf area *area-id* virtual-link]

Release Information Statement introduced before JUNOS Release 7.4.

Description Configure an authentication key (password). Neighboring routers use the password to verify the authenticity of packets sent from this interface.

All routers that are connected to the same IP subnet must use the same authentication scheme and password.

Options The statements are explained separately.

Usage Guidelines See “Configuring Authentication for OSPFv2” on page 427.

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

bfd-liveness-detection

Syntax	<pre> bfd-liveness-detection { detection-time { threshold <i>milliseconds</i>; } minimum-interval <i>milliseconds</i>; minimum-receive-interval <i>milliseconds</i>; no-adaptation; transmit-interval { threshold <i>milliseconds</i>; minimum-interval <i>milliseconds</i>; } multiplier <i>number</i>; version (1 automatic); }</pre>
Hierarchy Level	<p>[edit logical-systems <i>logical-system-name</i> protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>],</p> <p>[edit protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> interface <i>interface-name</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> interface <i>interface-name</i>],</p> <p>[edit protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> interface <i>interface-name</i>],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> interface <i>interface-name</i>]</p>
Release Information	<p>Statement introduced before JUNOS Release 7.4.</p> <p>detection-time threshold and transmit-interval threshold options added in JUNOS Release 8.2.</p> <p>Support for logical routers introduced in JUNOS Release 8.3.</p> <p>no-adaptation statement introduced in JUNOS Release 9.0.</p> <p>Support for OSPFv3 introduced in JUNOS Release 9.3.</p>
Description	Configure bidirectional failure detection timers.
Options	<p>detection-time threshold <i>milliseconds</i>—Configure a threshold. When the BFD session detection time adapts to a value equal to or greater than the threshold, a single trap and a single system log message are sent.</p> <p>minimum-interval <i>milliseconds</i>—Configure the minimum intervals at which the local router transmits a hello packet and then expects to receive a reply from the neighbor with which it has established a BFD session.</p> <p>Range: 1 through 255,000 milliseconds</p>

minimum-receive-interval *milliseconds*—Configure only the minimum interval at which the router expects to receive a reply from a neighbor with which it has established a BFD session.

Range: 1 through 255,000 milliseconds

multiplier *number*—Configure the number of hello packets not received by a neighbor that causes the originating interface to be declared down.

Range: 1 through 255

Default: 3

no-adaptation—Specify that BFD sessions should not adapt to changing network conditions. We recommend that you not disable BFD adaptation unless it is preferable not to have BFD adaptation enabled in your network.

transmit-interval threshold *milliseconds*—Configure a threshold. When the BFD session transmit interval adapts to a value greater than the threshold, a single trap and a single system log message are sent. The interval threshold must be greater than the minimum transmit interval.

Range: 0 through 4,294,967,295

transmit-interval minimum-interval *milliseconds*—Configure the minimum interval at which the router transmits hello packets to a neighbor with which it has established a BFD session.

Range: 1 through 255,000

version—Specify the BFD version to detect.

Range: 1 (BFD version 1) or **automatic** (autodetect version)

Default: automatic

Usage Guidelines See “Configuring the BFD Protocol” on page 436.

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

dead-interval

Syntax	dead-interval <i>seconds</i> ;
Hierarchy Level	<pre>[edit logical-systems <i>logical-system-name</i> protocols ospf area <i>area-id</i> peer-interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> protocols (ospf ospf3) area <i>area-id</i> virtual-link], [edit logical-systems <i>logical-system-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> virtual-link], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> interface <i>interface-name</i>], [edit protocols ospf area <i>area-id</i> peer-interface <i>interface-name</i>], [edit protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>], [edit protocols (ospf ospf3) area <i>area-id</i> virtual-link], [edit protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> virtual-link], [edit routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> interface <i>interface-name</i>]</pre>
Release Information	<p>Statement introduced before JUNOS Release 7.4.</p> <p>Support for the realm statement introduced in JUNOS Release 9.2.</p>
Description	Specify how long OSPF waits before declaring that a neighboring router is unavailable. This is an interval during which the router receives no hello packets from the neighbor.
Options	<p><i>seconds</i>—Interval to wait.</p> <p>Range: 1 through 65,535 seconds</p> <p>Default: 40 seconds (four times the hello interval)</p>
Usage Guidelines	See “Modifying the Router Dead Interval” on page 435.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>
Related Topics	hello-interval

default-lsa

Syntax	<pre>default-lsa { default-metric <i>metric</i>; metric-type <i>type</i>; type-7; }</pre>
Hierarchy Level	<pre>[edit logical-systems <i>logical-system-name</i> protocols (ospf ospf3) area <i>area-id</i> nssa], [edit logical-systems <i>logical-system-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> nssa], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> nssa], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> nssa], [edit protocols (ospf ospf3) area <i>area-id</i> nssa], [edit protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> nssa], [edit routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> nssa], [edit routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> nssa]</pre>
Release Information	<p>Statement introduced before JUNOS Release 7.4.</p> <p>Support for the realm statement introduced in JUNOS Release 9.2.</p>
Description	<p>On area border routers only, for an NSSA, inject a default LSA with a specified metric value into the area. The default route matches any destination that is not explicitly reachable from within the area.</p>
Options	<p>The statements are explained separately.</p>
Usage Guidelines	<p>See “Configuring a Not-So-Stubby Area” on page 420.</p>
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>
Related Topics	<p>nssa, stub</p>

default-metric

Syntax	default-metric <i>metric</i> ;
Hierarchy Level	<p>[edit logical-systems <i>logical-system-name</i> protocols (ospf ospf3) area <i>area-id</i> nssa default-lsa],</p> <p>[edit logical-systems <i>logical-system-name</i> protocols (ospf ospf3) area <i>area-id</i> stub],</p> <p>[edit logical-systems <i>logical-system-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> nssa default-lsa],</p> <p>[edit logical-systems <i>logical-system-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> stub],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> nssa default-lsa],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> stub],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> nssa default-lsa],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> stub],</p> <p>[edit protocols (ospf ospf3) area <i>area-id</i> nssa default-lsa],</p> <p>[edit protocols (ospf ospf3) area <i>area-id</i> stub],</p> <p>[edit protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> nssa default-lsa],</p> <p>[edit protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> stub],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> nssa default-lsa],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> stub],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> nssa default-lsa],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> stub]</p>
Release Information	<p>Statement introduced before JUNOS Release 7.4.</p> <p>Support for the realm statement introduced in JUNOS Release 9.2.</p>
Description	On area border routers only, for a stub area, inject a default route with a specified metric value into the area. The default route matches any destination that is not explicitly reachable from within the area.
Options	<p><i>metric</i>—Metric value.</p> <p>Range: 1 through 16,777,215</p>
Usage Guidelines	See “Configuring a Stub Area” on page 420.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>
Related Topics	nssa, stub

demand-circuit

Syntax	demand-circuit;
Hierarchy Level	<pre>[edit logical-systems <i>logical-system-name</i> protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf area <i>area-id</i> sham-link-remote], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> interface <i>interface-name</i>], [edit protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>], [edit protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols ospf area <i>area-id</i> sham-link-remote], [edit routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> interface <i>interface-name</i>]</pre>
Release Information	<p>Statement introduced before JUNOS Release 7.4.</p> <p>Support for the realm statement introduced in JUNOS Release 9.2.</p>
Description	Configure an interface as a demand circuit.
Usage Guidelines	See “Configuring an OSPF Demand Circuit Interface” on page 425 and “Configuring a Sham Link” on page 449.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

disable

See the following sections:

- disable (LDP Synchronization) on page 463
- disable (OSPF) on page 464

disable (LDP Synchronization)

Syntax disable;

Hierarchy Level [edit logical-systems *logical-system-name* protocols (ospf | ospf3) area *area-id* interface *interface-name*],
 [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols (ospf | ospf3) area *area-id* interface *interface-name*],
 [edit protocols (ospf | ospf3) area *area-id* interface *interface-name*],
 [edit routing-instances *routing-instance-name* protocols (ospf | ospf3) area *area-id* interface *interface-name*]

Release Information Statement introduced in Release 7.5.

Description Disable the Label Distribution Protocol (LDP) for OSPF.

Usage Guidelines See “Configuring Label Distribution Protocol Synchronization with the IGP” on page 438.

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

disable (OSPF)

Syntax disable;

Hierarchy Level [edit logical-systems *logical-system-name* protocols (ospf | ospf3)],
 [edit logical-systems *logical-system-name* protocols (ospf | ospf3) area *area-id* interface *interface-name*],
 [edit logical-systems *logical-system-name* protocols (ospf | ospf3) virtual-link],
 [edit logical-systems *logical-system-name* protocols ospf3 realm (ipv4-unicast | ipv4-multicast | ipv6-multicast)],
 [edit logical-systems *logical-system-name* protocols ospf3 realm (ipv4-unicast | ipv4-multicast | ipv6-multicast) area *area-id* interface *interface-name*],
 [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols (ospf | ospf3)],
 [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols (ospf | ospf3) area *area-id* interface *interface-name*],
 [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols (ospf | ospf3) virtual-link],
 [edit logical-systems *logical-system-name* routing-instances *routing-instances* protocols ospf3 realm (ipv4-unicast | ipv4-multicast | ipv6-multicast)],
 [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols ospf3 realm (ipv4-unicast | ipv4-multicast | ipv6-multicast) area *area-id* interface *interface-name*],
 [edit protocols (ospf | ospf3)],
 [edit protocols (ospf | ospf3) area *area-id* interface *interface-name*],
 [edit protocols (ospf | ospf3) virtual-link],
 [edit protocols ospf3 realm (ipv4-unicast | ipv4-multicast | ipv6-multicast)],
 [edit protocols ospf3 realm (ipv4-unicast | ipv4-multicast | ipv6-multicast) area *area-id* interface *interface-name*],
 [edit routing-instances *routing-instance-name* protocols (ospf | ospf3)],
 [edit routing-instances *routing-instance-name* protocols (ospf | ospf3) area *area-id* interface *interface-name*],
 [edit routing-instances *routing-instance-name* protocols (ospf | ospf3) virtual-link],
 [edit routing-instances *routing-instance-name* protocols ospf3 realm (ipv4-unicast | ipv4-multicast | ipv6-multicast)],
 [edit routing-instances *routing-instance-name* protocols ospf3 realm (ipv4-unicast | ipv4-multicast | ipv6-multicast) area *area-id* interface *interface-name*]

Release Information Statement introduced before JUNOS Release 7.4.
 Support for the *realm* statement introduced in JUNOS Release 9.2.

Description Disable OSPF, an OSPF interface, or an OSPF virtual link.

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

Usage Guidelines See “Minimum OSPF Configuration” on page 418.

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

domain-id

Syntax	<code>domain-id <i>domain-id</i>;</code>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (ospf ospf3)], [edit routing-instances <i>routing-instance-name</i> protocols (ospf ospf3)]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Specify a domain ID for a route. The domain ID identifies the OSPFv2 domain from which the route originated.
Options	<i>domain-id</i> —IP address. Default: If the router ID is not configured in the routing instance, the router ID is derived from an interface address belonging to the routing instance.
Usage Guidelines	See “Configuring an OSPF Domain ID” on page 246.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

domain-vpn-tag

Syntax	<code>domain-vpn-tag <i>number</i>;</code>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (ospf ospf3)], [edit routing-instances <i>routing-instance-name</i> protocols (ospf ospf3)]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Set a virtual private network (VPN) tag for OSPFv2 external routes generated by the provider edge (PE) router.
Options	<i>number</i> —VPN tag.
Usage Guidelines	See “Configuring an OSPF Domain ID” on page 246.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

export

Syntax	<code>export [<i>policy-names</i>];</code>
Hierarchy Level	<pre>[edit logical-systems <i>logical-system-name</i> protocols (ospf ospf3)], [edit logical-systems <i>logical-system-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (ospf ospf3)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)], [edit protocols (ospf ospf3)], [edit protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)], [edit routing-instances <i>routing-instance-name</i> protocols (ospf ospf3)], [edit routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)]</pre>
Release Information	<p>Statement introduced before JUNOS Release 7.4.</p> <p>Support for the realm statement introduced in JUNOS Release 9.2.</p>
Description	Apply one or more policies to routes being exported from the routing table into OSPF.
Options	<i>policy-names</i> —Name of one or more policies.
Usage Guidelines	See “Configuring OSPF Routing Policy” on page 445 and the <i>JUNOS Policy Framework Configuration Guide</i> .
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

external-preference

Syntax	external-preference <i>preference</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols (ospf ospf3)], [edit logical-systems <i>logical-system-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (ospf ospf3)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)], [edit protocols (ospf ospf3)], [edit protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)], [edit routing-instances <i>routing-instance-name</i> protocols (ospf ospf3)], [edit routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast } ipv4-multicast ipv6-multicast)]
Release Information	Statement introduced before JUNOS Release 7.4. Support for the realm statement introduced in JUNOS Release 9.2.
Description	Set the route preference for OSPF external routes.
Options	<i>preference</i> —Preference value. Range: 0 through 4,294,967,295 ($2^{32} - 1$) Default: 150
Usage Guidelines	See “Configuring Route Preferences” on page 433.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	preference

graceful-restart

Syntax	<pre>graceful-restart { disable; helper-disable; notify-duration <i>seconds</i>; restart-duration <i>seconds</i>; }</pre>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols (ospf ospf3)], [edit protocols (ospf ospf3)]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure graceful restart for OSPF.
Options	<p>disable—Disable graceful restart for OSPF.</p> <p>notify-duration <i>seconds</i>—Estimated time to send out purged grace LSAs over all the interfaces. Range: 1 through 3600 seconds Default: 30 seconds</p> <p>restart-duration <i>seconds</i>—Estimated time to reacquire a full OSPF neighbor from each area. Range: 1 through 3600 seconds Default: 180 seconds</p> <p>helper-disable—Disable graceful restart helper capability. Helper mode is enabled by default.</p>
Usage Guidelines	See “Configuring Graceful Restart” on page 439 and the <i>JUNOS High Availability Configuration Guide</i> .
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

hello-interval

Syntax	hello-interval <i>seconds</i> ;
Hierarchy Level	<pre>[edit logical-systems <i>logical-system-name</i> protocols ospf area <i>area-id</i> peer-interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> protocols (ospf ospf3) area <i>area-id</i> virtual-link], [edit logical-systems <i>logical-system-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> virtual-link], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> interface <i>interface-name</i>], [edit protocols ospf area <i>area-id</i> peer-interface <i>interface-name</i>], [edit protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>], [edit protocols (ospf ospf3) area <i>area-id</i> virtual-link], [edit protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> virtual-link], [edit routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> interface <i>interface-name</i>]</pre>
Release Information	<p>Statement introduced before JUNOS Release 7.4.</p> <p>Support for the realm statement introduced in JUNOS Release 9.2.</p>
Description	Specify how often the router sends hello packets out the interface. The hello interval must be the same for all routers on a shared logical IP network.
Options	<p><i>seconds</i>—Time between hello packets, in seconds.</p> <p>Range: 1 through 255 seconds</p> <p>Default: 10 seconds; 120 seconds (nonbroadcast networks)</p>
Usage Guidelines	See “Modifying the Hello Interval” on page 434.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>
Related Topics	dead-interval

hold-time

Syntax	hold-time <i>seconds</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols ospf area <i>area-id</i> interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf area <i>area-id</i> interface <i>interface-name</i>], [edit protocols ospf area <i>area-id</i> interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols ospf area <i>area-id</i> interface <i>interface-name</i>]
Release Information	Statement introduced in Release 7.5.
Description	Configure the time period to advertise the maximum cost metric for a link that is not fully operational.
Options	<i>seconds</i> —Hold-time value. Range: 1 through 65,535 seconds Default: Infinity
Usage Guidelines	See “Configuring Label Distribution Protocol Synchronization with the IGP” on page 438.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

ignore-lsp-metrics

Syntax	ignore-lsp-metrics;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols ospf traffic-engineering shortcuts], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf traffic-engineering shortcuts], [edit protocols ospf traffic-engineering shortcuts], [edit routing-instances <i>routing-instance-name</i> protocols ospf traffic-engineering shortcuts]
Release Information	Statement introduced in JUNOS Release 7.5.
Description	Ignore RSVP LSP metrics in OSPF traffic engineering shortcut calculations.
Usage Guidelines	See “Enabling OSPF Traffic Engineering Support” on page 443.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

import

Syntax	<code>import [<i>policy-names</i>];</code>
Hierarchy Level	<code>[edit logical-systems <i>logical-system-name</i> protocols (ospf ospf3)],</code> <code>[edit logical-systems <i>logical-system-name</i> protocols ospf3 realm (ipv4-unicast </code> <code> ipv4-multicast ipv6-multicast)],</code> <code>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols</code> <code> (ospf ospf3)],</code> <code>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols</code> <code> ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)],</code> <code>[edit protocols (ospf ospf3)],</code> <code>[edit protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)],</code> <code>[edit routing-instances <i>routing-instance-name</i> protocols (ospf ospf3)],</code> <code>[edit routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast </code> <code> ipv4-multicast ipv6-multicast)]</code>
Release Information	<p>Statement introduced before JUNOS Release 7.4.</p> <p>Support for the realm statement introduced in JUNOS Release 9.2.</p>
Description	Filter OSPF routes from being added to the routing table.
Options	<i>policy-names</i> —Name of one or more policies.
Usage Guidelines	See “Configuring OSPF Routing Policy” on page 445 and the <i>JUNOS Policy Framework Configuration Guide</i> .
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

inter-area-prefix-export

Syntax	<code>inter-area-prefix-export [<i>policy-names</i>];</code>
Hierarchy Level	<code>[edit logical-systems <i>logical-system-name</i> protocols ospf3 area <i>area-id</i>],</code> <code>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols</code> <code>ospf3 area <i>area-id</i>],</code> <code>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols</code> <code>ospf3 realm (ip4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i></code> <code>[edit protocols ospf3 area <i>area-id</i>],</code> <code>[edit protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i>],</code> <code>[edit routing-instances <i>routing-instance-name</i> protocols ospf3 area <i>area-id</i>],</code> <code>[edit routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast </code> <code>ipv4-multicast ipv6-multicast) area <i>area-id</i>]</code>
Release Information	Statement introduced in JUNOS Release 9.1. Support for the <code>realm</code> statement introduced in JUNOS Release 9.2.
Description	Apply an export policy for OSPFv3 to specify which interarea prefix link-state advertisements (LSAs) are flooded into an area.
Options	<i>policy-name</i> —Name of a policy configured at the <code>[edit policy-options policy-statement <i>policy-name</i> term <i>term-name</i>]</code> hierarchy level.
Usage Guidelines	See “Configuring Import and Export Policies for Network Summaries” on page 446.
Required Privilege Level	<code>routing</code> —To view this statement in the configuration. <code>routing-control</code> —To add this statement to the configuration.
Related Topics	<code>inter-area-prefix-import</code> , <i>JUNOS Policy Framework Configuration Guide</i>

inter-area-prefix-import

Syntax	<code>inter-area-prefix-import [<i>policy-names</i>];</code>
Hierarchy Level	<p>[edit logical-systems <i>logical-system-name</i> protocols ospf3 area <i>area-id</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf3 area <i>area-id</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i>],</p> <p>[edit protocols ospf3 area <i>area-id</i>],</p> <p>[edit protocols ospf3 realm (ip4-unicast ipv4-multicast ipv6-multicast)], area <i>area-id</i>],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols ospf3 area <i>area-id</i>],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i>]</p>
Release Information	<p>Statement introduced in JUNOS Release 9.1.</p> <p>Support for the realm statement introduced in JUNOS Release 9.2.</p>
Description	Apply an import policy for OSPFv3 to specify which routes learned from an area are used to generate interarea prefixes into other areas.
Options	<i>policy-name</i> —Name of a policy configured at the [edit policy-options policy-statement <i>policy-name</i> term <i>term-name</i>] hierarchy level.
Usage Guidelines	See “Configuring Import and Export Policies for Network Summaries” on page 446.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>
Related Topics	inter-area-prefix-export, <i>JUNOS Policy Framework Configuration Guide</i>

interface

Syntax `interface interface-name {
 disable;
 authentication key <key-id identifier>;
 bfd-liveness-detection {
 detection-time {
 threshold milliseconds;
 }
 minimum-interval milliseconds;
 minimum-receive-interval milliseconds;
 transmit-interval {
 threshold milliseconds;
 minimum-interval milliseconds;
 }
 multiplier number;
 }
 dead-interval seconds;
 demand-circuit;
 hello-interval seconds;
 ipsec-sa name;
 interface-type type;
 ldp-synchronization {
 disable;
 hold-time seconds;
 }
 metric metric;
 neighbor address <eligible>;
 passive;
 poll-interval seconds;
 priority number;
 retransmit-interval seconds;
 te-metric metric;
 topology (ipv4-multicast | name) {
 metric metric;
 }
 transit-delay seconds;
 transmit-interval seconds;
}`

Hierarchy Level [edit logical-systems *logical-system-name* protocols (ospf | ospf3) area *area-id*],
 [edit logical-systems *logical-system-name* protocols ospf3 realm (ipv4-unicast |
 ipv4-multicast | ipv6-multicast) area *area-id*],
 [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols
 (ospf | ospf3) area *area-id*],
 [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols
 ospf3 realm (ipv4-unicast | ipv4-multicast | ipv6-multicast) area *area-id*],
 [edit protocols (ospf | ospf3) area *area-id*],
 [edit protocols ospf3 realm (ipv4-unicast | ipv4-multicast | ipv6-multicast) area *area-id*],
 [edit routing-instances *routing-instance-name* protocols (ospf | ospf3) area *area-id*],
 [edit routing-instances *routing-instance-name* protocols ospf3 realm (ipv4-unicast |
 ipv4-multicast | ipv6-multicast) area *area-id*]

Release Information Statement introduced before JUNOS Release 7.4.
 Support for the **topology** statement introduced in JUNOS Release 9.0.
 Support for the **realm** statement introduced in JUNOS Release 9.2.

Description Enable OSPF routing on a router interface.

You must include at least one **interface** statement in the configuration to enable OSPF on the router.

Options *interface-name*—Name of the interface. To configure all interfaces, you can specify **all**. For details about specifying interfaces, see interface naming in the *JUNOS Network Interfaces Configuration Guide*.



NOTE: For nonbroadcast interfaces, specify the IP address of the nonbroadcast interface as *interface-name*.

The remaining statements are explained separately.

Usage Guidelines See “Minimum OSPF Configuration” on page 418, “Configuring an Interface on a Broadcast or Point-to-Point Network” on page 423, “Configuring Interface Properties for MT-OSPF” on page 272, and “Configuring Multiple Address Families for OSPFv3” on page 427.

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

Related Topics neighbor

interface-type

Syntax	interface-type (nbma p2mp p2p);
Hierarchy Level	<p>[edit logical-systems <i>logical-system-name</i> protocols ospf area <i>area-id</i> interface <i>interface-name</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf area <i>area-id</i> interface <i>interface-name</i>],</p> <p>[edit protocols ospf area <i>area-id</i> interface <i>interface-name</i>],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols ospf area <i>area-id</i> interface <i>interface-name</i>]</p>
Release Information	Statement introduced before JUNOS Release 7.4.
Description	<p>Specify the type of interface.</p> <p>By default, the software chooses the correct interface type based on the type of physical interface. Therefore, you should never have to set the interface type. The exception to this is for NBMA interfaces, which default to an interface type of point-to-multipoint. To have these interfaces explicitly run in NBMA mode, configure the nbma interface type, using the IP address of the local ATM interface.</p> <p>Beginning with JUNOS Release 9.3, a point-to-point interface supports an Ethernet interface without a subnet. For more information about configuring interfaces, see the <i>JUNOS Software Network Interfaces Configuration Guide</i>.</p>
Default	The software chooses the correct interface type based on the type of physical interface.
Options	<p>nbma—Nonbroadcast multiaccess (NBMA) interface.</p> <p>p2mp—Point-to-multipoint interface.</p> <p>p2p—Point-to-point interface.</p>
Usage Guidelines	See “Configuring an Interface on a Broadcast or Point-to-Point Network” on page 423.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

ipsec-sa

Syntax	<code>ipsec-sa name;</code>
Hierarchy Level	<p>[edit logical-systems <i>logical-system-name</i> protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> protocols (ospf ospf3) area <i>area-id</i> virtual-link],</p> <p>[edit logical-systems <i>logical-system-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> interface <i>interface-name</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf area <i>area-id</i> sham-link-remote <i>address</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> virtual-link],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> interface <i>interface-name</i>],</p> <p>[edit protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>],</p> <p>[edit protocols (ospf ospf3) area <i>area-id</i> virtual-link],</p> <p>[edit protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> interface <i>interface-name</i>],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols ospf area <i>area-id</i> sham-link-remote <i>address</i>],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> virtual-link],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> interface <i>interface-name</i>]</p>
Release Information	<p>Statement introduced before JUNOS Release 7.4.</p> <p>Support for OSPFv2 authentication added in JUNOS Release 8.3.</p> <p>Support for the realm statement introduced in JUNOS Release 9.2.</p>
Description	Apply IPsec authentication to an OSPF interface or virtual link or to an OSPFv2 remote sham link.
Options	<i>name</i> —Name of the IPsec authentication scheme.
Usage Guidelines	See “Configuring Authentication for OSPFv2” on page 427 and “Configuring Authentication for OSPFv3” on page 431.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>
Related Topics	<i>JUNOS System Basics Configuration Guide</i> , <i>JUNOS Services Interfaces Configuration Guide</i> , and <i>JUNOS Feature Guide</i>

label-switched-path

Syntax	label-switched-path <i>name</i> metric <i>metric</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols ospf area <i>area-id</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf area <i>area-id</i>], [edit protocols ospf area <i>area-id</i>], [edit routing-instances <i>routing-instance-name</i> protocols ospf area <i>area-id</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Advertise label-switched paths into OSPF as point-to-point links. The label-switched path is advertised in the appropriate OSPF levels as a point-to-point link and contains a local address and a remote address.
Options	<i>name</i> —Name of the label-switched path. <i>metric</i> —Metric value. Range: 1 through 65,535 Default: 1
Usage Guidelines	See “Advertising Label-Switched Paths into OSPF” on page 442.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

ldp-synchronization

Syntax	ldp-synchronization { disable; hold-time <i>seconds</i> ; }
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols ospf area <i>area-id</i> interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> protocols ospf3 realm ipv4-unicast area <i>area-id</i> interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf area <i>area-id</i> interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf3 realm ipv4-unicast area <i>area-id</i> interface <i>interface-name</i>], [edit protocols ospf area <i>area-id</i> interface <i>interface-name</i>], [edit protocols ospf3 realm ipv4-unicast area <i>area-id</i> interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols ospf area <i>area-id</i> interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols ospf3 realm ipv4-unicast area <i>area-id</i> interface <i>interface-name</i>]
Release Information	Statement introduced in Release 7.5. Support for the realm statement introduced in JUNOS Release 9.2. Only the ipv4-unicast option is supported with this statement.
Description	Enable synchronization by advertising the maximum cost metric until LDP is operational on the link.
Options	The statements are explained separately.
Usage Guidelines	See “Configuring Label Distribution Protocol Synchronization with the IGP” on page 438.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

lsp-metric-into-summary

Syntax	lsp-metric-into-summary;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols ospf traffic-engineering shortcuts], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf traffic-engineering shortcuts], [edit protocols ospf traffic-engineering shortcuts], [edit routing-instances <i>routing-instance-name</i> protocols ospf traffic-engineering shortcuts]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Advertise the LSP metric in summary LSAs.
Usage Guidelines	See “Enabling OSPF Traffic Engineering Support” on page 443.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

md5

Syntax md5 *key-identifier* {
 key *key-values*;
 start-time *time*;
 }

Hierarchy Level [edit logical-systems *logical-system-name* protocols ospf area *area-id* interface *interface-name* authentication],
 [edit logical-systems *logical-system-name* protocols ospf area *area-id* virtual-link authentication],
 [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols ospf area *area-id* interface *interface-name* authentication],
 [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols ospf area *area-id* virtual-link authentication],
 [edit protocols ospf area *area-id* interface *interface-name* authentication],
 [edit protocols ospf area *area-id* virtual-link authentication],
 [edit routing-instances *routing-instance-name* protocols ospf area *area-id* interface *interface-name* authentication],
 [edit routing-instances *routing-instance-name* protocols ospf area *area-id* virtual-link authentication]

Release Information Statement introduced before JUNOS Release 7.4.

Description Configure an MD5 authentication key (password).

Options *key-id*—MD5 key identifier.

Default: 0

Range: 0-255

key-values—One or more MD5 key strings. The MD5 key values can be from 1 through 16 characters long. You can specify more than one key value within the list. Characters can include ASCII strings. If you include spaces, enclose all characters in quotation marks (" ").

time—MD5 start time.

Usage Guidelines See “Configuring Authentication for OSPFv2” on page 427.

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

metric

Syntax	<code>metric <i>metric</i>;</code>
Hierarchy Level	<pre> [edit logical-systems <i>logical-system-name</i> protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> protocols ospf area <i>area-id</i> interface <i>interface-name</i> topology (ipv4-multicast <i>name</i>)], [edit logical-systems <i>logical-system-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf area <i>area-id</i> sham-link-remote], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf area <i>area-id</i> interface <i>interface-name</i> topology (ipv4-multicast <i>name</i>)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> interface <i>interface-name</i>], [edit protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>], [edit protocols ospf area <i>area-id</i> interface <i>interface-name</i> topology (ipv4-multicast <i>name</i>)], [edit protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols ospf area <i>area-id</i> sham-link-remote], [edit routing-instances <i>routing-instance-name</i> protocols ospf area <i>area-id</i> interface <i>interface-name</i> topology (ipv4-multicast <i>name</i>)], [edit routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> interface <i>interface-name</i>] </pre>
Release Information	<p>Statement introduced before JUNOS Release 7.4.</p> <p>Support for Multitopology Routing introduced in JUNOS Release 9.0.</p> <p>Support for the realm statement introduced in JUNOS Release 9.2.</p>
Description	<p>Specify the cost of an OSPF interface. The cost is a routing metric that is used in the link-state calculation.</p> <p>To set the cost of routes exported into OSPF, configure the appropriate routing policy.</p>
Options	<p><i>metric</i>—Cost of the route.</p> <p>Range: 1 through 65,535</p> <p>Default: 1</p>
Usage Guidelines	See “Modifying the Interface Metric” on page 433, “Configuring a Sham Link” on page 449 and “Configuring Interface Properties for MT-OSPF” on page 272.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

metric-type

Syntax	metric-type <i>type</i> ;
Hierarchy Level	<p>[edit logical-systems <i>logical-system-name</i> protocols (ospf ospf3) area <i>area-id</i> nssa default-lsa],</p> <p>[edit logical-systems <i>logical-system-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)) area <i>area-id</i> nssa default-lsa],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> nssa default-lsa],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)) area <i>area-id</i> nssa default-lsa],</p> <p>[edit protocols (ospf ospf3) area <i>area-id</i> nssa default-lsa],</p> <p>[edit protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)) area <i>area-id</i> nssa default-lsa],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> nssa default-lsa],</p> <p>[edit routing-instances <i>routing-instances</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)) area <i>area-id</i> nssa default-lsa]</p>
Release Information	<p>Statement introduced before JUNOS Release 7.4.</p> <p>Support for the realm statement introduced in JUNOS Release 9.2.</p>
Description	Specify the external metric type for the default LSA.
Options	<p><i>type</i>—Metric type.</p> <p>Range: 1 or 2</p>
Usage Guidelines	See “Configuring a Not-So-Stubby Area” on page 420.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

neighbor

Syntax	<code>neighbor address <eligible>;</code>
Hierarchy Level	<p>[edit logical-systems <i>logical-system-name</i> protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>],</p> <p>[edit protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>]</p>
Release Information	Statement introduced before JUNOS Release 7.4.
Description	<p>For nonbroadcast interfaces only, specify neighboring routers. On a nonbroadcast interface, you must specify neighbors explicitly because OSPF does not send broadcast packets to dynamically discover their neighbors. To specify multiple neighbors, include multiple neighbor statements.</p>
Options	<p><i>address</i>—IP address of a neighboring router.</p> <p><i>eligible</i>—(Optional) Allow the neighbor to become a designated router. Default: If you omit this option, the neighbor is not considered eligible to become a designated router.</p>
Usage Guidelines	See “Configuring an Interface on a Nonbroadcast, Multiaccess Network” on page 424.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

network-summary-export

Syntax	<code>network-summary-export <i>policy-name</i>;</code>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols ospf area <i>area-id</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf area <i>area-id</i>], [edit protocols ospf area <i>area-id</i>], [edit routing-instances <i>routing-instance-name</i> protocols ospf area <i>area-id</i>]
Release Information	Statement introduced in JUNOS Release 9.1.
Description	Apply an export policy that specifies which network-summary link-state advertisements (LSAs) are flooded into an OSPFv2 area.
Options	<i>policy-name</i> —Name of a policy configured at the [edit policy-options policy-statement <i>policy-name</i> term <i>term-name</i>] hierarchy level.
Usage Guidelines	See “Configuring Import and Export Policies for Network Summaries” on page 446.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	<i>JUNOS Policy Framework Configuration Guide</i>

network-summary-import

Syntax	<code>network-summary-import <i>policy-name</i>;</code>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols ospf area <i>area-id</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf area <i>area-id</i>], [edit protocols ospf area <i>area-id</i>], [edit routing-instances <i>routing-instance-name</i> protocols ospf area <i>area-id</i>]
Release Information	Statement introduced in JUNOS Release 9.1.
Description	Apply an import policy to specify which routes learned from an OSPFv2 area are used to generate network-summary LSAs to other areas.
Options	<i>policy-name</i> —Name of a policy configured at the [edit policy-options policy-statement <i>policy-name</i> term <i>term-name</i>] hierarchy level.
Usage Guidelines	See “Configuring Import and Export Policies for Network Summaries” on page 446.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	<i>JUNOS Policy Framework Configuration Guide</i>

no-nssa-abr

Syntax	no-nssa-abr;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols (ospf ospf3)], [edit logical-systems <i>logical-system-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (ospf ospf3)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)], [edit protocols (ospf ospf3)], [edit protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)], [edit routing-instances <i>routing-instance-name</i> protocols (ospf ospf3)], [edit routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)]
Release Information	Statement introduced in JUNOS Release 7.6. Support for the realm statement introduced in JUNOS Release 9.2.
Description	Disable exporting Type 7 LSAs into NSSAs for an autonomous system border router (ASBR) area border router (ABR).
Usage Guidelines	See “Disabling NSSA Support on an ASBR ABR” on page 422.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

no-rfc-1583

Syntax	no-rfc-1583;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols (ospf ospf3)], [edit logical-systems <i>logical-system-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (ospf ospf3)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)], [edit protocols (ospf ospf3)], [edit protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)], [edit routing-instances <i>routing-instance-name</i> protocols (ospf ospf3)], [edit routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)]
Release Information	Statement introduced in JUNOS Release 8.5. Support for the realm statement introduced in JUNOS Release 9.2.
Description	Disable compatibility with RFC 1583, <i>OSPF Version 2</i> . If the same external destination is advertised by AS boundary routers that belong to different OSPF areas, disabling compatibility with RFC 1583 can prevent routing loops.
Default	Compatibility with RFC 1583 is enabled by default.
Usage Guidelines	See “Disabling Compatibility with RFC 1583” on page 423
Required Privilege Level	routing—To view this statement in the configuration. routing-control-level—To add this statement to the configuration.

no-summaries

See summaries

nssa

Syntax `nssa {
 area-range network/mask-length <restrict> <exact> <override-metric metric>;
 default-lsa {
 default-metric metric;
 metric-type type;
 type-7;
 }
 (no-summaries | summaries);
}`

Hierarchy Level [edit logical-systems *logical-system-name* protocols (ospf | ospf3) area *area-id*],
 [edit logical-systems *logical-system-name* protocols ospf3 realm (ipv4-unicast |
 ipv4-multicast | ipv6-multicast)],
 [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols
 (ospf | ospf3) area *area-id*],
 [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols
 ospf3 realm (ipv4-unicast | ipv4-multicast | ipv6-multicast)],
 [edit protocols (ospf | ospf3) area *area-id*],
 [edit protocols ospf3 realm (ipv4-unicast | ipv4-multicast | ipv6-multicast)],
 [edit routing-instances *routing-instance-name* protocols (ospf | ospf3) area *area-id*],
 [edit routing-instances *routing-instance-name* protocols ospf3 realm (ipv4-unicast |
 ipv4-multicast | ipv6-multicast)]

Release Information Statement introduced before JUNOS Release 7.4.
 Support for the **realm** statement introduced in JUNOS Release 9.2.

Description Configure a not-so-stubby area (NSSA). An NSSA allows external routes to be flooded within the area. These routes are then leaked into other areas.

You cannot configure an area as being both a stub area and an NSSA.

Options The statements are explained separately in this chapter.

Usage Guidelines See “Configuring a Not-So-Stubby Area” on page 420.

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

Related Topics stub

ospf

Syntax	ospf { ... }
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols], [edit protocols], [edit routing-instances <i>routing-instance-name</i> protocols]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Enable OSPF routing on the router. You must include the ospf statement to enable OSPF on the router.
Default	OSPF is disabled on the router.
Usage Guidelines	See “Minimum OSPF Configuration” on page 418.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

ospf3

Syntax	ospf3 { ... }
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols], [edit protocols], [edit routing-instances <i>routing-instance-name</i> protocols]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Enable OSPFv3 routing on the router. You must include the ospf statement to enable OSPFv3.
Default	OSPFv3 is disabled.
Usage Guidelines	See “Minimum OSPF Configuration” on page 418.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

overload

Syntax `overload {
 timeout seconds;
 }`

Hierarchy Level [edit logical-systems *logical-system-name* protocols (ospf | ospf3)],
[edit logical-systems *logical-system-name* protocols ospf topology (default | ipv4-multicast | *name*)],
[edit logical-systems *logical-system-name* protocols ospf3 realm (ipv4-unicast | ipv4-multicast | ipv6-multicast)],
[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols (ospf | ospf3)],
[edit logical systems *logical-system-name* routing-instances *routing-instance-name* protocols ospf topology (default | ipv4-multicast | *name*)],
[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols ospf3 realm (ipv4-unicast | ipv4-multicast | ipv6-multicast)],
[edit protocols (ospf | ospf3)],
[edit protocols ospf topology (default | ipv4-multicast | *name*)],
[edit protocols ospf3 realm (ipv4-unicast | ipv4-multicast | ipv6-multicast)],
[edit routing-instances *routing-instance-name* protocols (ospf | ospf3)],
[edit routing-instances *routing-instance-name* protocols ospf topology (default | ipv4-multicast | *name*)],
[edit routing-instances *routing-instance-name* protocols ospf3 realm (ipv4-unicast | ipv4-multicast | ipv6-multicast)],

Release Information Statement introduced before JUNOS Release 7.4.
Support for Multitopology Routing introduced in JUNOS Release 9.0.
Support for the **realm** statement introduced in JUNOS Release 9.2.

Description Configure the local router so that it appears to be overloaded. You might do this when you want the router to participate in OSPF routing, but do not want it to be used for transit traffic. Note that traffic destined to immediately attached interfaces continues to reach the router.

Options **timeout** *seconds*—(Optional) Number of seconds at which the overloading is reset. If no timeout interval is specified, the router will remain in overload state until the overload statement is deleted or a timeout is set.
 Range: 60 through 1800 seconds
 Default: 0 seconds



NOTE: Multitopology Routing does not support the **timeout** option.

Usage Guidelines See “Configuring the Router to Appear Overloaded” on page 442 and “Configuring a Topology to Appear Overloaded” on page 272.

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

passive

Syntax `passive {
 traffic-engineering {
 remote-node-id address;
 }
 }`

Hierarchy Level [edit logical-systems *logical-system-name* protocols (ospf | ospf3) area *area-id* interface *interface-name*],
[edit logical-systems *logical-system-name* protocols ospf3 realm (ipv4-unicast | ipv4-multicast | ipv6-multicast) area *area-id* interface *interface-name*],
[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols (ospf | ospf3) area *area-id* interface *interface-name*],
[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols ospf3 realm (ipv4-unicast | ipv4-multicast | ipv6-multicast) area *area-id* interface *interface-name*],
[edit protocols (ospf | ospf3) area *area-id* interface *interface-name*],
[edit protocols ospf3 realm (ipv4-unicast | ipv4-multicast | ipv6-multicast) area *area-id* interface *interface-name*],
[edit routing-instances *routing-instance-name* protocols (ospf | ospf3) area *area-id* interface *interface-name*],
[edit routing-instances *routing-instance-name* protocols ospf3 realm (ipv4-unicast | ipv4-multicast | ipv6-multicast) area *area-id* interface *interface-name*]

Release Information Statement introduced before JUNOS Release 7.4.
traffic-engineering and remote-node-id *address* statements introduced in JUNOS Release 8.0.
Support for the realm statement introduced in JUNOS Release 9.2.

Description Advertise the direct interface addresses on an interface without actually running OSPF on that interface. A passive interface is one for which the address information is advertised as an internal route in OSPF, but on which the protocol does not run.

To configure an interface in OSPF passive traffic engineering mode, include the traffic-engineering statement. Configuring OSPF passive traffic engineering mode enables the dynamic discovery of OSPF AS boundary routers.

Enable OSPF on an interface by including the interface statement at the [edit protocols (ospf | ospf3) area *area-id*] or the [edit routing-instances *routing-instance-name* protocols ospf area *area-id*] hierarchy levels. Disable it by including the disable statement. To prevent OSPF from running on an interface, include the passive statement. These three states are mutually exclusive.

Usage Guidelines See “Advertising Interface Addresses Without Running OSPF” on page 440 and “Configuring OSPF Passive Traffic Engineering Mode” on page 441.

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

peer-interface

Syntax peer-interface *interface-name* {
 disable;
 dead-interval *seconds*;
 hello-interval *seconds*;
 retransmit-interval *seconds*;
 transit-delay *seconds*;
 }

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

Release Information Statement introduced before JUNOS Release 7.4.

Description Configure a peer interface.

Options *interface-name*—Name of the peer interface. To configure all interfaces, you can specify *all*. For details about specifying interfaces, see the *JUNOS Network Interfaces Configuration Guide*.

The remaining statements are explained separately.

Usage Guidelines See “Configuring a Peer Interface” on page 449.

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

poll-interval

Syntax	poll-interval seconds;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>], [edit protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	For nonbroadcast interfaces only, specify how often the router sends hello packets out of the interface before it establishes adjacency with a neighbor.
Options	<i>seconds</i> —Frequency at which to send hello packets. Range: 1 through 255 seconds Default: 120 seconds
Usage Guidelines	See “Configuring an Interface on a Nonbroadcast, Multiaccess Network” on page 424.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

preference

Syntax	<code>preference <i>preference</i>;</code>
Hierarchy Level	<pre>[edit logical-systems <i>logical-system-name</i> protocols (ospf ospf3)], [edit logical-systems <i>logical-system-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (ospf ospf3)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)], [edit protocols (ospf ospf3)], [edit protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)], [edit routing-instances <i>routing-instance-name</i> protocols (ospf ospf3)], [edit routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)]</pre>
Release Information	Statement introduced before JUNOS Release 7.4. Support for the realm statement introduced in JUNOS Release 9.2.
Description	Set the route preference for OSPF internal routes.
Options	<p><i>preference</i>—Preference value.</p> <p>Range: 0 through 4,294,967,295 ($2^{32} - 1$)</p> <p>Default: 10</p>
Usage Guidelines	See “Configuring Route Preferences” on page 433.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>
Related Topics	external-preference

prefix-export-limit

Syntax	prefix-export-limit <i>number</i> ;
Hierarchy Level	<pre>[edit logical-systems <i>logical-system-name</i> protocols (ospf ospf3)], [edit logical-systems <i>logical-system-name</i> protocols ospf topology (default ipv4-multicast <i>name</i>)], [edit logical-systems <i>logical-system-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (ospf ospf3)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf topology (default ipv4-multicast <i>name</i>)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)], [edit protocols (ospf ospf3)], [edit protocols ospf topology (default ipv4-multicast <i>name</i>)], [edit protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)], [edit routing-instances <i>routing-instance-name</i> protocols (ospf ospf3)], [edit routing-instances <i>routing-instance-name</i> protocols ospf topology (default ipv4-multicast <i>name</i>)], [edit routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)]</pre>
Release Information	<p>Statement introduced before JUNOS Release 7.4.</p> <p>Support for Multitopology Routing introduced in JUNOS Release 9.0.</p> <p>Support for the realm statement introduced in JUNOS Release 9.2.</p>
Description	Configure a limit to the number of prefixes exported into OSPF.
Options	<p><i>number</i>—Prefix limit.</p> <p>Range: 0 through 4,294,967,295</p> <p>Default: None</p>
Usage Guidelines	See “Configuring a Prefix Export Limit” on page 431 and “Configuring a Prefix Export Limit for MT-OSPF” on page 272.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

priority

Syntax	<code>priority number;</code>
Hierarchy Level	<pre>[edit logical-systems <i>logical-system-name</i> protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)] area <i>area-id</i> interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)] area <i>area-id</i> interface <i>interface-name</i>], [edit protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>], [edit protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)] area <i>area-id</i> interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)] area <i>area-id</i> interface <i>interface-name</i>]</pre>
Release Information	<p>Statement introduced before JUNOS Release 7.4.</p> <p>Support for the realm statement introduced in JUNOS Release 9.2.</p>
Description	Specify the router's priority for becoming the designated router. The router that has the highest priority value on the logical IP network or subnet becomes the network's designated router. You must configure at least one router on each logical IP network or subnet to be the designated router. You also should specify a router's priority for becoming the designated router on point-to-point interfaces.
Options	<p>number—Router's priority for becoming the designed router. A priority value of 0 means that the router never will become the designated router. A value of 1 means that the router has the least chance of becoming a designated router.</p> <p>Range: 0 through 255</p> <p>Default: 128</p>
Usage Guidelines	See "Designated Router" on page 411 and "Configuring the Priority for Becoming the Designated Router" on page 432.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>


realm

Syntax	<pre> realm (ipv4-unicast ipv4-multicast ipv6-unicast) { area <i>area-id</i> { interface <i>interface-name</i>; } } </pre>
Hierarchy Level	<pre> [edit logical-systems <i>logical-system-name</i> protocols ospf3], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf3], [edit protocols ospf3], [edit routing-instances <i>routing-instance-name</i> protocols ospf3] </pre>
Release Information	Statement introduced in JUNOS Release 9.2.
Description	Configure OSPFv3 to advertise address families other than unicast IPv6. The JUNOS software maps each address family you configure to a separate realm with its own set of neighbors and link-state database.
Options	<p>ipv4-unicast—Configure a realm for IPv4 unicast routes.</p> <p>ipv4-multicast—Configure a realm for IPv4 multicast routes.</p> <p>ipv6-multicast—Configure a realm for IPv6 multicast routes.</p>
Usage Guidelines	See “Configuring Multiple Address Families for OSPFv3” on page 427.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

reference-bandwidth

Syntax	<code>reference-bandwidth <i>reference-bandwidth</i>;</code>
Hierarchy Level	<pre>[edit logical-systems <i>logical-system-name</i> protocols (ospf ospf3)], [edit logical-systems <i>logical-system-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (ospf ospf3)], [edit logical-systems <i>logical-system-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)], [edit protocols (ospf ospf3)], [edit protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)], [edit routing-instances <i>routing-instance-name</i> protocols (ospf ospf3)], [edit routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)]</pre>
Release Information	<p>Statement introduced before JUNOS Release 7.4.</p> <p>Support for the realm statement introduced in JUNOS Release 9.2.</p>
Description	<p>Set the reference bandwidth used in calculating the default interface cost. The cost is calculated using the following formula:</p> $\text{cost} = \text{ref-bandwidth} / \text{bandwidth}$
Options	<i>ref-bandwidth</i> —Reference bandwidth, in bits per second.
Usage Guidelines	See “Modifying the Interface Metric” on page 433.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

retransmit-interval

Syntax	retransmit-interval <i>seconds</i> ;
Hierarchy Level	<pre>[edit logical-systems <i>logical-system-name</i> protocols ospf area <i>area-id</i> peer-interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> protocols (ospf ospf3) area <i>area-id</i> virtual-link], [edit logical-systems <i>logical-system-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> virtual-link], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> interface <i>interface-name</i>], [edit protocols ospf area <i>area-id</i> peer-interface <i>interface-name</i>], [edit protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>], [edit protocols (ospf ospf3) area <i>area-id</i> virtual-link], [edit protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> virtual-link], [edit routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> interface <i>interface-name</i>]</pre>
Release Information	<p>Statement introduced before JUNOS Release 7.4.</p> <p>Support for the realm statement introduced in JUNOS Release 9.2.</p>
Description	Specify how long the router waits to receive a link-state acknowledgment packet before retransmitting link-state advertisements to an interface's neighbors.
Options	<p><i>seconds</i>—Interval to wait.</p> <p>Range: 1 through 65,535 seconds</p> <p>Default: 5 seconds</p>
	<p>NOTE: You must configure LSA retransmit intervals to be equal to or greater than 3 seconds to avoid triggering a retransmit trap, because the JUNOS software delays LSA acknowledgments by up to 2 seconds.</p>
Usage Guidelines	See “Controlling the LSA Retransmission Interval” on page 435.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

rib-group

Syntax	<code>rib-group group-name;</code>
Hierarchy Level	<pre>[edit logical-systems <i>logical-system-name</i> protocols (ospf ospf3)], [edit logical-systems <i>logical-system-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (ospf ospf3)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)], [edit protocols (ospf ospf3)], [edit protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)], [edit routing-instances <i>routing-instance-name</i> protocols (ospf ospf3)], [edit routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)]</pre>
Release Information	<p>Statement introduced before JUNOS Release 7.4.</p> <p>Support for the realm statement introduced in JUNOS Release 9.2.</p>
Description	Install routes learned from OSPF routing instances into routing tables in the OSPF routing table group.
Options	<i>group-name</i> —Name of the routing table group.
Usage Guidelines	See “Creating Routing Table Groups” on page 104, “Configuring How Interface Routes Are Imported into Routing Tables” on page 106, and “Configuring BGP Routing Table Groups” on page 686.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>
Related Topics	interface-routes, rib-group

route-type-community

Syntax	route-type-community (iana vendor);
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (ospf ospf3)], [edit routing-instances <i>routing-instance-name</i> protocols (ospf ospf3)]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Specify an extended community value to encode the OSPF route type. Each extended community is coded as an eight-octet value. This statement sets the most significant bit to either an IANA or vendor-specific route type.
Options	iana—Encode a route type with the value 0x0306. This is the default value. vendor—Encode the route type with the value 0x8000.
Usage Guidelines	See “Configuring an OSPF Domain ID” on page 246.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

secondary

Syntax	secondary;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols ospf area <i>area-id</i> interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf area <i>area-id</i> interface <i>interface-name</i>], [edit protocols ospf area <i>area-id</i> interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols ospf area <i>area-id</i> interface <i>interface-name</i>]
Release Information	Statement introduced in JUNOS Release 9.2.
Description	Configure an interface to belong to another OSPF area. A logical interface can be configured as primary interface only for one area. For any other area for which you configure the interface, you must configure it as a secondary interface.
Usage Guidelines	See “Configuring Multiarea Adjacency in OSPFv2” on page 426.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	interface

sham-link

Syntax	sham-link { local <i>address</i> ; }
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf], [edit routing-instances <i>routing-instance-name</i> protocols ospf]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure the local endpoint of a sham link.
Options	local <i>address</i> —Local endpoint address.
Usage Guidelines	See “Configuring a Sham Link” on page 449.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration

sham-link-remote

Syntax	sham-link-remote <i>address</i> { demand-circuit; ipsec-sa <i>name</i> ; metric <i>metric</i> ; }
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf area <i>area-id</i>], [edit routing-instances <i>routing-instance-name</i> protocols ospf area <i>area-id</i>]
Release Information	Statement introduced before JUNOS Release 7.4. Support for ipsec-sa statement added in JUNOS Release 8.3.
Description	Configure the remote endpoint of a sham link.
Options	The statements are explained separately.
Usage Guidelines	See “Configuring a Sham Link” on page 449 and “Configuring Authentication for OSPFv2” on page 427.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

shortcuts

Syntax	shortcuts;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols ospf traffic-engineering], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf traffic-engineering], [edit protocols ospf traffic-engineering], [edit routing-instances <i>routing-instance-name</i> protocols ospf traffic-engineering]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure OSPFv2 to use MPLS label-switched paths (LSPs) as next hops if possible when installing routing information into the <i>inet.3</i> routing table.
Usage Guidelines	See “Enabling OSPF Traffic Engineering Support” on page 443.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

simple-password

Syntax	simple-password <i>key</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols ospf area <i>area-id</i> interface <i>interface-name</i> authentication], [edit logical-systems <i>logical-system-name</i> protocols ospf area <i>area-id</i> virtual-link authentication], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf area <i>area-id</i> interface <i>interface-name</i> authentication], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf area <i>area-id</i> virtual-link authentication], [edit protocols ospf area <i>area-id</i> interface <i>interface-name</i> authentication], [edit protocols ospf area <i>area-id</i> virtual-link authentication], [edit routing-instances <i>routing-instance-name</i> protocols ospf area <i>area-id</i> interface <i>interface-name</i> authentication], [edit routing-instances <i>routing-instance-name</i> protocols ospf area <i>area-id</i> virtual-link authentication]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure a simple authentication key (password).
Options	<i>key-id</i> —Simple key identifier.
Usage Guidelines	See “Configuring Authentication for OSPFv2” on page 427.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

spf-options

Syntax	<pre> spf-options { delay <i>milliseconds</i>; holddown <i>milliseconds</i>; rapid-runs <i>number</i>; } </pre>
Hierarchy Level	<pre> [edit logical-systems <i>logical-system-name</i> protocols (ospf ospf3)], [edit logical-systems <i>logical-system-name</i> protocols ospf topology (default ipv4-multicast <i>name</i>)], [edit logical-systems <i>logical-system-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (ospf ospf3)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf topology (default ipv4-multicast <i>name</i>)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)], [edit protocols (ospf ospf3)], [edit protocols ospf topology (default ipv4-multicast <i>name</i>)], [edit protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)], [edit routing-instances <i>routing-instance-name</i> protocols (ospf ospf3)], [edit routing-instances <i>routing-instance-name</i> protocols ospf topology (default ipv4-multicast <i>name</i>)], [edit routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)] </pre>
Release Information	<p>Statement introduced in JUNOS Release 8.5.</p> <p>Support for Multitopology Routing introduced in JUNOS Release 9.0.</p> <p>Support for the realm statement introduced in JUNOS Release 9.2.</p>
Description	<p>Configure options for running the shortest-path-first (SPF) algorithm. You can configure a delay for when to run the SPF algorithm after a network topology change is detected, the maximum number of times the SPF algorithm can run in succession, and a hold-down interval after the SPF algorithm runs the maximum number of times.</p>
Options	<p>delay <i>milliseconds</i>—Time interval between the detection of a topology change and when the SPF algorithm runs.</p> <p>Range: 50 through 8000 milliseconds</p> <p>Default: 200 milliseconds</p> <p>holddown <i>milliseconds</i>—Time interval to hold down, or wait before a subsequent SPF algorithm runs after the SPF algorithm has run the configured maximum number of times in succession.</p> <p>Range: 2000 through 20,000 milliseconds</p> <p>Default: 5000 milliseconds</p> <p>rapid-runs <i>number</i>—Maximum number of times the SPF algorithm can run in succession. After the maximum is reached, the holddown interval begins.</p> <p>Range: 1 through 5</p>

Default: 3

Usage Guidelines See “Configuring SPF Options for OSPF” on page 439 and “Configuring Topologies and SPF Options for MT-OSPF” on page 270.

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

stub

Syntax stub <default-metric *metric*> <(no-summaries | summaries)>;

Hierarchy Level [edit logical-systems *logical-system-name* protocols (ospf | ospf3) area *area-id*],
[edit logical-systems *logical-system-name* protocols ospf3 realm (ipv4-unicast | ipv4-multicast | ipv6-multicast)],
[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols (ospf | ospf3) area *area-id*],
[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols ospf3 realm (ipv4-unicast | ipv4-multicast | ipv6-multicast)],
[edit protocols (ospf | ospf3) area *area-id*],
[edit protocols ospf3 realm (ipv4-unicast | ipv4-multicast | ipv6-multicast)],
[edit routing-instances *routing-instance-name* protocols (ospf | ospf3) area *area-id*],
[edit routing-instances *routing-instance-name* protocols ospf3 realm (ipv4-unicast | ipv4-multicast | ipv6-multicast)]

Release Information Statement introduced before JUNOS Release 7.4.
Support for the **realm** statement introduced in JUNOS Release 9.2.

Description Specify that this area not be flooded with AS external link-state advertisements. You must include the **stub** statement when configuring all routers that are in the stub area.

The backbone cannot be configured as a stub area.

You cannot configure an area as being both a stub area and an NSSA.

Options default-metric *metric*—(Optional) Inject a default route with a specified metric value into the area. The default route matches any destination that is not explicitly reachable from within the area.

Range: 1 through 16,777,215

no-summaries—(Optional) Do not advertise routes into the stub area. If you include the default-metric option, only the default route is advertised.

summaries—(Optional) Flood summary LSAs into the stub area.

Usage Guidelines See “Configuring a Stub Area” on page 420.

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

Related Topics nssa

summaries

Syntax	(summaries no-summaries);
Hierarchy Level	<pre>[edit logical-systems <i>logical-system-name</i> protocols (ospf ospf3) area <i>area-id</i> nssa], [edit logical-systems <i>logical-system-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> nssa], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> nssa], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> nssa], [edit protocols (ospf ospf3) area <i>area-id</i> nssa], [edit protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)] area <i>area-id</i> nssa], [edit routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> nssa], [edit routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> nssa]</pre>
Release Information	<p>Statement introduced before JUNOS Release 7.4.</p> <p>Support for the realm statement introduced in JUNOS Release 9.2.</p>
Description	<p>Configure whether area border routers advertise summary routes into an NSSA:</p> <ul style="list-style-type: none"> ■ summaries—Flood summary LSAs into the NSSA. ■ no-summaries—Prevent area border routers from advertising summaries into an NSSA. If default-metric is configured for an NSSA, a Type 3 LSA is injected into the area by default.
Usage Guidelines	See “Configuring a Not-So-Stubby Area” on page 420.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>
Related Topics	nssa, stub

te-metric

Syntax	<code>te-metric <i>metric</i>;</code>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols ospf area <i>area-id</i> interface <i>interface-name</i>], [edit protocols ospf area <i>area-id</i> interface <i>interface-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Metric value used by traffic engineering for information injected into the traffic engineering database. The value of the traffic engineering metric does not affect normal OSPF forwarding.
Options	<i>metric</i> —Metric value. Range: 1 through 65,535 Default: Value of the IGP metric
Usage Guidelines	See “Modifying the Traffic Engineering Metric” on page 445.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

traceoptions

Syntax	<pre>traceoptions { file <i>filename</i> <size <i>size</i>> <files <i>number</i>> <world-readable no-world-readable>; flag <i>flag</i> <flag-modifier> <disable>; }</pre>
Hierarchy Level	<pre>[edit logical-systems <i>logical-system-name</i> protocols (ospf ospf3)], [edit logical-systems <i>logical-system-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (ospf ospf3)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)], [edit protocols (ospf ospf3)], [edit protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)], [edit routing-instances <i>routing-instance-name</i> protocols (ospf ospf3)], [edit routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)]</pre>
Release Information	<p>Statement introduced before JUNOS Release 7.4.</p> <p>Support for the realm statement introduced in JUNOS Release 9.2.</p>
Description	<p>Configure OSPF protocol-level tracing options.</p> <p>To specify more than one tracing operation, include multiple flag statements.</p>
Default	The default OSPF protocol-level tracing options are those inherited from the routing protocols traceoptions statement included at the [edit routing-options] hierarchy level.
Options	<p>disable—(Optional) Disable the tracing operation. You can use this option to disable a single operation when you have defined a broad group of tracing operations, such as all.</p> <p>file <i>filename</i>—Name of the file to receive the output of the tracing operation. Enclose the name within quotation marks. All files are placed in the directory /var/log. We recommend that you place OSPF tracing output in the file ospf-log.</p> <p>files <i>number</i>—(Optional) Maximum number of trace files. When a trace file named trace-file reaches its maximum size, it is renamed trace-file.0, then trace-file.1, and so on, until the maximum number of trace files is reached. Then, the oldest trace file is overwritten.</p> <p>If you specify a maximum number of files, you also must specify a maximum file size with the size option.</p> <p>Range: 2 through 1000 files</p> <p>Default: 10 files</p> <p>flag—Tracing operation to perform. To specify more than one tracing operation, include multiple flag statements.</p>

- **database-description**—Database description packets, which are used in synchronizing the OSPF and OSPFv3 topological database.
- **error**—OSPF and OSPFv3 error packets.
- **event**—OSPF and OSPFv3 state transitions.
- **flooding**—Link-state flooding packets.
- **graceful-restart**—Graceful-restart events.
- **hello**—Hello packets, which are used to establish neighbor adjacencies and to determine whether neighbors are reachable.
- **lsa-ack**—Link-state acknowledgment packets, which are used in synchronizing the OSPF topological database.
- **lsa-request**—Link-state request packets, which are used in synchronizing the OSPF topological database.
- **lsa-update**—Link-state updates packets, which are used in synchronizing the OSPF topological database.
- **packets**—All OSPF packets.
- **packet-dump**—Dump the contents of selected packet types.
- **spf**—Shortest-path-first (SPF) calculations.

Global Tracing Flags

- **all**—All tracing operations.
- **general**—A combination of the **normal** and **route** trace operations.
- **normal**—All normal operations.
Default: If you do not specify this option, only unusual or abnormal operations are traced.
- **policy**—Policy operations and actions.
- **route**—Routing table changes.
- **state**—State transitions.
- **task**—Interface transactions and processing.
- **timer**—Timer usage.

flag-modifier—(Optional) Modifier for the tracing flag. You can specify one or more of these modifiers:

- **detail**—Provide detailed trace information.
- **receive**—Packets being received.
- **send**—Packets being transmitted.

no-world-readable—(Optional) Prevent any user from reading the log file.

size size—(Optional) Maximum size of each trace file, in kilobytes (KB), megabytes (MB), or gigabytes (GB). When a trace file named *trace-file* reaches this size, it is renamed *trace-file.0*. When the *trace-file* again reaches its maximum size, *trace-file.0* is renamed *trace-file.1* and *trace-file* is renamed *trace-file.0*. This renaming scheme continues until the maximum number of trace files is reached. Then, the oldest trace file is overwritten.

If you specify a maximum file size, you also must specify a maximum number of trace files with the **files** option.

Syntax: *xk* to specify KB, *xm* to specify MB, or *xg* to specify GB

Range: 10 KB through the maximum file size supported on your system

Default: 128 KB

world-readable—(Optional) Allow any user to read the log file.

Usage Guidelines See “Tracing OSPF Protocol Traffic” on page 450.

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

traffic-engineering

See the following sections:

- traffic-engineering (OSPF) on page 512
- traffic-engineering (Passive TE Mode) on page 513

traffic-engineering (OSPF)

Syntax	<pre> traffic-engineering { advertise-unnumbered-interfaces; multicast-rpf-routes; no-topology; shortcuts { ignore-lsp-metrics; lsp-metric-into-summary; } } </pre>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols ospf], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf], [edit protocols ospf], [edit routing-instances <i>routing-instance-name</i> protocols ospf]
Release Information	Statement introduced before JUNOS Release 7.4. multicast-rpf-routes option introduced in JUNOS Release 7.5. advertise-unnumbered-interfaces option introduced in JUNOS Release 8.5.
Description	Enable the OSPF traffic engineering features.
Default	Traffic engineering support is disabled.
Options	<p>advertise-unnumbered-interfaces—(Optional) Include the link-local identifier in the link-local TE link-state advertisement. You do not need to include this statement if the Resource Reservation Protocol (RSVP) is able to signal unnumbered interfaces as defined in RFC 3477.</p> <p>multicast-rpf-routes—(Optional) Install routes for multicast RPF checks into the inet.2 routing table.</p> <p>no-topology—(Optional) Disable the dissemination of the link-state topology information.</p> <p>shortcuts—(Optional) Use label-switched paths as next hops, if label-switched paths are configured.</p> <p>The remaining statements are explained separately.</p>
Usage Guidelines	See “Enabling OSPF Traffic Engineering Support” on page 443.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

traffic-engineering (Passive TE Mode)

Syntax	traffic-engineering { remote-node-id <i>address</i> ; }
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i> passive], [edit logical-systems <i>logical-system-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> interface <i>interface-name</i> passive], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i> passive], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> interface <i>interface-name</i> passive], [edit protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i> passive], [edit protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> interface <i>interface-name</i> passive], [edit routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i> passive], [edit routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> interface <i>interface-name</i> passive]
Release Information	Statement introduced in JUNOS Release 8.0. Support for the realm statement introduced in JUNOS Release 9.2.
Description	Configure an interface in OSPF passive traffic engineering mode to enable dynamic discovery of OSPF AS boundary routers.
Default	OSPF passive TE mode is disabled.
Options	remote-node-id <i>address</i> —The IP address at the far end of the inter-AS link.
Usage Guidelines	See “Configuring OSPF Passive Traffic Engineering Mode” on page 441.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	<i>JUNOS MPLS Applications Configuration Guide</i>

transit-delay

Syntax	<code>transit-delay seconds;</code>
Hierarchy Level	<pre>[edit logical-systems <i>logical-system-name</i> protocols ospf area <i>area-id</i> peer-interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> protocols (ospf ospf3) area <i>area-id</i> virtual-link], [edit logical-systems <i>logical-system-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf area <i>area-id</i> interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf area <i>area-id</i> virtual-link], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> interface <i>interface-name</i>], [edit protocols ospf area <i>area-id</i> peer-interface <i>interface-name</i>], [edit protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>], [edit protocols (ospf ospf3) area <i>area-id</i> virtual-link], [edit protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast)] area <i>area-id</i> interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols ospf area <i>area-id</i> interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols ospf area <i>area-id</i> virtual-link], [edit routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> interface <i>interface-name</i>]</pre>
Release Information	<p>Statement introduced before JUNOS Release 7.4.</p> <p>Support for the <code>realm</code> statement introduced in JUNOS Release 9.2.</p>
Description	<p>Set the estimated time required to transmit a link-state update on the interface. When calculating this time, make sure to account for transmission and propagation delays.</p> <p>You should never have to modify the transit delay time.</p>
Options	<p><code>seconds</code>—Estimated time, in seconds.</p> <p>Range: 1 through 65,535 seconds</p> <p>Default: 1 second</p>
Usage Guidelines	See “Specifying the Transit Delay” on page 436.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

transmit-interval

Syntax	<code>transmit-interval <i>milliseconds</i>;</code>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>], [edit protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> interface <i>interface-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Set the interval at which OSPF packets are transmitted on an interface.
Options	<i>milliseconds</i> —Transmission interval, in milliseconds. Range: 1 through 4,294,967 milliseconds Default: 30 milliseconds
Usage Guidelines	See “Controlling the LSA Retransmission Interval” on page 435.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

type-7

Syntax	type-7;
Hierarchy Level	<p>[edit logical-systems <i>logical-system-name</i> protocols (ospf ospf3) area <i>area-id</i> nssa default-lsa],</p> <p>[edit logical-systems <i>logical-system-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> nssa default-lsa],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> nssa default-lsa],</p> <p>[edit logical-systems <i>logical-system-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> nssa default-lsa],</p> <p>[edit protocols (ospf ospf3) area <i>area-id</i> nssa default-lsa],</p> <p>[edit protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> nssa default-lsa],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols (ospf ospf3) area <i>area-id</i> nssa default-lsa],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols ospf3 realm (ipv4-unicast ipv4-multicast ipv6-multicast) area <i>area-id</i> nssa default-lsa]</p>
Release Information	<p>Statement introduced before JUNOS Release 7.4.</p> <p>Support for the realm statement introduced in JUNOS Release 9.2.</p>
Description	<p>Flood Type 7 default LSAs if the no-summaries statement is configured.</p> <p>By default, when the no-summaries statement is configured, a Type 3 LSA is injected into NSSA areas for JUNOS Release 5.0 and later. To support backward compatibility with earlier JUNOS releases, include the type-7 statement. This statement enables NSSA ABRs to advertise a Type 7 default LSA into the NSSA if you have also included the no-summaries statement in the configuration.</p>
Usage Guidelines	See “Configuring a Not-So-Stubby Area” on page 420.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

virtual-link

Syntax	<pre>virtual-link neighbor-id router-id transit-area area-id { disable; authentication key <key-id identifier>; dead-interval seconds; hello-interval seconds; ipsec-sa name; retransmit-interval seconds; transit-delay seconds; }</pre>
Hierarchy Level	<pre>[edit logical-systems logical-system-name protocols (ospf ospf3) area area-id], [edit logical-systems logical-system-name routing-instances routing-instance-name protocols ospf area area-id], [edit protocols (ospf ospf3) area area-id], [edit routing-instances routing-instance-name protocols ospf area area-id]</pre>
Release Information	Statement introduced before JUNOS Release 7.4.
Description	<p>For backbones only, create a virtual link to use in place of an actual physical link. All area border routers and other routers on the backbone must be contiguous. If this is not possible and there is a break in OSPF connectivity, use virtual links to create connectivity to the OSPF backbone. When configuring virtual links, you must configure links on the two routers that form the end points of the link, and both these two routers must be area border routers. You cannot configure links through stub areas.</p>
Options	<p>neighbor-id router-id—IP address of the router at the remote end of the virtual link.</p> <p>transit-area area-id—Area identifier of the area through which the virtual link transits. Virtual links are not allowed to transit the backbone area.</p> <p>The remaining statements are explained separately.</p>
Usage Guidelines	See “Configuring an OSPF Virtual Link” on page 421.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

Chapter 23

RIP Overview

The Routing Information Protocol (RIP) is an interior gateway protocol (IGP) that uses a distance-vector algorithm to determine the best route to a destination, using the hop count as the metric.

This chapter discusses the following topics that provide background information about RIP:

- RIP Overview on page 519
- RIP Standards on page 520
- RIP Packets on page 520

RIP Overview

The RIP IGP uses the Bellman-Ford, or *distance-vector*, algorithm to determine the best route to a destination. RIP uses the hop count as the metric. RIP allows hosts and routers to exchange information for computing routes through an IP-based network. RIP is intended to be used as an IGP in reasonably homogeneous networks of moderate size.

The JUNOS software supports RIP versions 1 and 2.



NOTE: RIP is not supported for multipoint interfaces.

RIP version 1 packets contain the minimal information necessary to route packets through a network. However, this version of RIP does not support authentication or subnetting.

RIP uses User Datagram Protocol (UDP) port 520.

RIP has the following architectural limitations:

- The longest network path cannot exceed 15 hops (assuming that each network, or hop, has a cost of 1).
- RIP depends on counting to infinity to resolve certain unusual situations—When the network consists of several hundred routers, and when a routing loop has formed, the amount of time and network bandwidth required to resolve a next hop might be great.

- RIP uses only a fixed metric to select a route. Other IGPs use additional parameters, such as measured delay, reliability, and load.

RIP Standards

RIP is defined in the following documents:

- RFC 1058, *Routing Information Protocol*
- RFC 2082, *RIP-2 MD-5 Authentication*
- RFC 2453, *RIP Version 2*

To access Internet Requests for Comments (RFCs) and drafts, go to the Internet Engineering Task Force (IETF) Web site at <http://www.ietf.org>.

RIP Packets

RIP packets contain the following fields:

- Command—Indicates whether the packet is a request or response message. Request messages seek information for the router's routing table. Response messages are sent periodically and also when a request message is received. Periodic response messages are called *update messages*. Update messages contain the command and version fields and 25 destinations (by default), each of which includes the destination IP address and the metric to reach that destination.
- Version number—Version of RIP that the originating router is running.
- Address family identifier—Address family used by the originating router. The family is always IP.
- Address—IP address included in the packet.
- Metric—Value of the metric advertised for the address.
- Mask—Mask associated with the IP address (RIP version 2 only).
- Next hop—IP address of the next-hop router (RIP version 2 only).

Chapter 24

RIP Configuration Guidelines

To configure the Routing Information Protocol (RIP), you include the following statements:

```
protocols {
  rip {
    any-sender;
    authentication-key password;
    authentication-type type;
    (check-zero | no-check-zero);
    graceful-restart {
      disable;
      restart-time seconds;
    }
    holddown seconds;
    import [ policy-names ];
    message-size number;
    metric-in metric;
    receive receive-options;
    rib-group group-name;
    route-timeout seconds;
    send send-options;
    update-interval seconds;
    traceoptions {
      file filename <size size> <files number>
        <(world-readable | no-world-readable)>;
      flag flag <flag-modifier> <disable>;
    }
    group group-name {
      bfd-liveness-detection {
        detection-time {
          threshold milliseconds;
        }
        minimum-interval milliseconds;
        minimum-receive-interval milliseconds;
        multiplier number;
        no-adaptation;
        transmit-interval {
          threshold milliseconds;
          minimum-interval milliseconds;
        }
        version (1 | automatic);
      }
    }
    export [ policy-names ];
  }
}
```

```

metric-out metric;
preference number;
route-timeout seconds;
update-interval seconds;
neighbor neighbor-name {
    authentication-key password;
    authentication-type type;
    bfd-liveness-detection {
        detection-time {
            threshold milliseconds;
        }
        minimum-interval milliseconds;
        minimum-receive-interval milliseconds;
        multiplier number;
        transmit-interval {
            threshold milliseconds;
            minimum-interval milliseconds;
        }
        version (1 | automatic);
    }
    (check-zero | no-check-zero);
    import [ policy-names ];
    message-size number;
    metric-in metric;
    metric-out metric;
    receive receive-options;
    route-timeout seconds;
    send send-options;
    update-interval seconds;
}
}
}
}

```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

By default, RIP is disabled.

To have a router exchange routes with other routers, you must configure RIP groups and neighbors. RIP routes received from routers not configured as RIP neighbors are ignored. Likewise, RIP routes are advertised only to routers configured as RIP neighbors, with an appropriate RIP export policy applied.

This chapter discusses the following topics:

- Minimum RIP Configuration on page 523
- Defining RIP Global Properties on page 523
- Defining RIP Neighbor Properties on page 524
- Configuring Authentication on page 524
- Modifying the Incoming Metric on page 525
- Configuring RIP Timers on page 525
- Configuring the Number of Route Entries in an Update Message on page 526

- Accepting Packets Whose Reserved Fields Are Nonzero on page 526
- Configuring Update Messages on page 527
- Configuring Routing Table Groups on page 527
- Applying Import Policy on page 527
- Configuring Group-Specific Properties on page 527
- Configuring Graceful Restart on page 529
- Configuring the BFD Protocol on page 530
- Disabling Strict Address Check on page 532
- Tracing RIP Protocol Traffic on page 532
- Example: Configuring RIP on page 533

Minimum RIP Configuration

For a router to accept RIP routes, you must include at least the **rip**, **group**, and **neighbor** statements. Routes received from routers that are not configured as neighbors are ignored. All other RIP configuration statements are optional. This minimum configuration defines one neighbor. Include one **neighbor** statement for each interface on which you want to receive routes. The local router imports all routes by default from this neighbor and does not advertise routes. The router can receive both version 1 and version 2 update messages, with 25 route entries per message. For routing instances, include the statements at the [edit routing-instances *routing-instance-name* protocols rip] hierarchy level.

```
protocols {
  rip {
    group group-name {
      neighbor interface-name {
      }
    }
  }
}
```



NOTE: When you configure RIP on an interface, you must also include the **family inet** statement at the [edit interfaces *interface-name* unit *logical-unit-number*] hierarchy level. For more information about the **family inet** statement, see the *JUNOS Network Interfaces Configuration Guide*.

Defining RIP Global Properties

To define RIP global properties, which apply to all RIP neighbors, include one or more of the following statements. These statements are explained in separate sections.

```
authentication-key password;
authentication-type type;
(check-zero | no-check-zero);
import [ policy-names ];
```

```

message-size number;
metric-in metric;
receive receive-options;
rib-group group-name;
send send-options;

```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Defining RIP Neighbor Properties

To define neighbor-specific properties, include one or more of the following statements. The statements are explained in separate sections.

```

neighbor neighbor-name {
  authentication-key password;
  authentication-type type;
  bfd-liveness-detection {
    detection-time {
      threshold milliseconds;
    }
    minimum-interval milliseconds;
    minimum-receive-interval milliseconds;
    transmit-interval {
      threshold milliseconds;
      minimum-interval milliseconds;
    }
    multiplier number;
    version (0 | 1 | automatic);
  }
  (check-zero | no-check-zero);
  import [ policy-names ];
  message-size number;
  metric-in metric;
  receive receive-options;
  send send-options;
}

```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Configuring Authentication

You can configure the router to authenticate RIP route queries. By default, authentication is disabled. You can use the following authentication method:

- Simple authentication—Uses a text password that is included in the transmitted packet. The receiving router uses an authentication key (password) to verify the packet.
- MD5 authentication—Creates an encoded checksum that is included in the transmitted packet. The receiving router uses an authentication key (password) to verify the packet's MD5 checksum.

To enable authentication and specify an authentication method and password, include the `authentication-key` and `authentication-type` statements:

```
authentication-key password;  
authentication-type type;
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

The password can be up to 16 contiguous characters and can include any ASCII strings.

Modifying the Incoming Metric

By default, RIP imports routes from the neighbors configured with the `neighbor` statement. These routes include those learned from RIP as well as those learned from other protocols. By default, routes that RIP imports from its neighbors have a metric of 1 added to the current route metric.

To change the default metric to be added to incoming routes, include the `metric-in` statement:

```
metric-in metric;
```

metric can be a value from 1 through 16.

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Configuring RIP Timers

You can configure various timers for RIP.

RIP routes expire when either a route timeout limit is met or a route metric reaches infinity, and the route is no longer valid. However, the expired route is retained in the routing table for a time period so that neighbors can be notified that the route has been dropped. This time period is set by configuring the hold-down timer. Upon expiration of the hold-down timer, the route is removed from the routing table.

To configure the hold-down timer for RIP, include the `holddown` statement:

```
holddown seconds;
```

seconds can be a value from 10 through 180. The default value is 120 seconds.

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

You can set a route timeout interval. If a route is not refreshed after being installed into the routing table by the specified time interval, the route is removed from the routing table.

To configure the route timeout for RIP, include the `route-timeout` statement:

`route-timeout seconds;`

seconds can be a value from 30 through 360. The default value is 180 seconds.

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

You can set an update time interval to periodically send out routes learned by RIP to neighbors.

To configure the update time interval, include the `update-interval` statement:

`update-interval seconds;`

seconds can be a value from 10 through 60. The default value is 30 seconds.

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Configuring the Number of Route Entries in an Update Message

By default, RIP includes 25 route entries in each update message. To change the number of route entries in an update message, include the `message-size` statement:

`message-size number;`

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement



NOTE: To ensure interoperability with routers from other vendors, do not change the default number of route entries in a RIP update message.

Accepting Packets Whose Reserved Fields Are Nonzero

Some of the reserved fields in RIP version 1 packets must be zero, while in RIP version 2 packets most of these reserved fields can contain nonzero values. By default, RIP discards version 1 packets that have nonzero values in the reserved fields and version 2 packets that have nonzero values in the fields that must be zero. This default behavior implements the RIP version 1 and version 2 specifications.

If you find that you are receiving RIP version 1 packets with nonzero values in the reserved fields or RIP version 2 packets with nonzero values in the fields that must be zero, you can configure RIP to receive these packets in spite of the fact that they are being sent in violation of the specifications in RFC 1058 and RFC 2453. To receive packets whose reserved fields are nonzero, include the `no-check-zero` statement:

`no-check-zero;`

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Configuring Update Messages

You can configure whether the RIP update messages conform to RIP version 1 only, to RIP version 2 only, or to both versions. You can also disable the sending or receiving of update messages. To configure the sending and receiving of update messages, include the **receive** and **send** statements:

```
receive receive-options;  
send send-options;
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Configuring Routing Table Groups

You can install routes learned through RIP into multiple routing tables by configuring a routing table group. RIP routes are installed into each routing table that belongs to that routing table group. To configure a routing table group for RIP routes, include the **rib-group** statement:

```
rib-group group-name;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Applying Import Policy

To filter routes being imported by the local router from its neighbors, include the **import** statement and list the names of one or more policies to be evaluated. If you specify more than one policy, they are evaluated in order (first to last) and the first matching policy is applied to the route. If no match is found, the local router does not import any routes.

```
import [ policy-names ];
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

For more information about creating policies, see the *JUNOS Policy Framework Configuration Guide*.

Configuring Group-Specific Properties

You can group together neighbors that share the same export policy and export metric defaults. You configure group-specific RIP properties by including the **group** statement at the **[edit protocols rip]** hierarchy level. Each group must contain at least one neighbor. You should create a group for every export policy you have. To configure neighbors, see “Defining RIP Global Properties” on page 523.

```
[edit protocols rip]  
group group-name {
```

```

bfd-liveness-detection {
  detection-time {
    threshold milliseconds;
  }
  minimum-interval milliseconds;
  minimum-receive-interval milliseconds;
  transmit-interval {
    threshold milliseconds;
    minimum-interval milliseconds;
  }
  multiplier number;
  version (0 | 1 | automatic);
}
export [ policy-names ];
preference number;
metric-out metric;
neighbor neighbor-options;
}

```

This section discusses the following tasks:

- Applying Export Policy on page 528
- Controlling Route Preference on page 529
- Modifying the Outgoing Metric on page 529

Applying Export Policy

By default, RIP does not export routes it has learned to its neighbors. To have RIP export routes, apply one or more export policies. To apply export policies and to filter routes being exported from the local router to its neighbors, include the **export** statement and list the name of the policy to be evaluated:

```
export [ policy-names ];
```

To configure export policy globally for all RIP neighbors, include the **export** statement.

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

You can define one or more export policies. If no routes match the policies, the local router does not export any routes to its neighbors. Export policies override any metric values determined through calculations involving the **metric-in** and **metric-out** values.



NOTE: The export policy on RIP does not support manipulating routing information of the next hop.

For more information about creating policies, see the *JUNOS Policy Framework Configuration Guide*.

Controlling Route Preference

By default, the JUNOS software assigns a preference of 100 to routes that originate from RIP. When the JUNOS software determines a route's preference to become the active route, the software selects the route with the lowest preference and installs this route into the forwarding table. (For more information about preferences, see "Route Preferences" on page 6.)

To modify the default RIP preference value, include the **preference** statement:

```
preference preference;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

preference can be a value from 0 through 4,294,967,295 ($2^{32} - 1$).

Modifying the Outgoing Metric

If you have included the **export** statement, RIP exports routes it has learned to the neighbors configured with the **neighbor** statement.

The metric associated with a RIP route (unless modified by an export policy) is the normal RIP metric. For example, a RIP route with a metric of 5 learned from a neighbor configured with a **metric-in** value of 2 is advertised with a combined metric of 7 when advertised to RIP neighbors in the same group. However, if this route was learned from a RIP neighbor in a different group or from a different protocol, the route is advertised with the metric value configured for that group with the **metric-out** statement. The default value for **metric-out** is 1.

The metric for a route may be modified with an export policy. That metric is seen when the route is exported to the next hop.

To increase the metric for routes advertised outside a group, include the **metric-out** statement:

```
metric-out metric;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Configuring Graceful Restart

Graceful restart is disabled by default. You can globally enable graceful restart for all routing protocols at the **[edit routing-options]** hierarchy level.

You can configure graceful restart parameters specifically for RIP. To do this, include the **graceful-restart** statement:

```
graceful-restart {
  restart-time seconds;
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

To disable graceful restart for RIP, specify the **disable** statement. To configure a time period for the restart to finish, specify the **restart-time** statement.

Configuring the BFD Protocol

The Bidirectional Forwarding Detection (BFD) protocol is a simple hello mechanism that detects failures in a network. Hello packets are sent at a specified, regular interval. A neighbor failure is detected when the router stops receiving a reply after a specified interval. BFD works with a wide variety of network environments and topologies. BFD failure detection times are shorter than RIP detection times, providing faster reaction times to various kinds of failures in the network. These timers are also adaptive. For example, a timer can adapt to a higher value if the adjacency fails, or a neighbor can negotiate a higher value for a timer than the one configured.



NOTE: To enable BFD for RIP, both sides of the connection must receive an update message from the peer. By default, RIP does not export any routes. Therefore you must enable update messages to be sent by configuring an export policy for routes before a BFD session is triggered.

To enable failure detection, include the **bfd-liveness-detection** statement:

```
bfd-liveness-detection {
  detection-time {
    threshold milliseconds;
  }
  minimum-interval milliseconds;
  minimum-receive-interval milliseconds;
  multiplier number;
  no-adaptation;
  transmit-interval {
    threshold milliseconds;
    minimum-interval milliseconds;
  }
  version (1 | automatic);
}
```

To specify the threshold for the adaptation of the detection time, include the **threshold** statement:

```
detection-time {
  threshold milliseconds;
}
```

When the BFD session detection time adapts to a value equal to or higher than the threshold, a single trap and a system log message are sent.

To specify the minimum transmit and receive interval for failure detection, include the **minimum-interval** statement:

```
minimum-interval milliseconds;
```

This value represents the minimum interval at which the local router transmits hello packets as well as the minimum interval at which the router expects to receive a reply from a neighbor with which it has established a BFD session. You can configure a value in the range from 1 through 255,000 milliseconds. You can also specify the minimum transmit and receive intervals separately.



NOTE: Specifying an interval less than 300 ms can cause undesired BFD flapping.

To specify only the minimum receive intervals for failure detection, include the `minimum-receive-interval` statement:

```
minimum-receive-interval milliseconds;
```

This value represents the minimum interval at which the local router expects to receive a reply from a neighbor with which it has established a BFD session. You can configure a value in the range from 1 through 255,000 milliseconds.

To specify the number of hello packets not received by a neighbor that causes the originating interface to be declared down, include the `multiplier` statement:

```
multiplier number;
```

The default is 3, and you can configure a value in the range from 1 through 255.

To specify only the minimum transmit interval for failure detection, include the `minimum-interval` statement:

```
transmit-interval {
    minimum-interval milliseconds;
}
```

This value represents the minimum interval at which the local router transmits hello packets to the neighbor with which it has established a BFD session. You can configure a value in the range from 1 through 255,000 milliseconds.

To specify the threshold for detecting the adaptation of the transmit interval, include the `threshold` statement:

```
transmit-interval {
    threshold milliseconds;
}
```

The threshold value must be greater than the transmit interval.

To specify the BFD version used for detection, include the `version` statement:

```
version (1 | automatic);
```

The default is to have the version detected automatically.

Beginning with JUNOS Release 9.0, you can configure BFD sessions not to adapt to changing network conditions. To disable BFD adaptation, include the **no-adaptation** statement:

```
no-adaptation;
```



NOTE: We recommend that you not disable BFD adaptation unless it is preferable not to have BFD adaptation enabled in your network.

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Disabling Strict Address Check

If the sender of a RIP message does not belong to the subnet of the interface, the message is discarded. This situation may cause problems with dropped packets when RIP is running on point-to-point interfaces, or when the addresses on the interfaces do not fall in the same subnet. You can resolve this by disabling strict address checks on the RIP traffic.

To disable strict address checks, include the **any-sender** statement:

```
any-sender;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.



NOTE: The **any-sender** statement is supported only for peer-to-peer interfaces.

Tracing RIP Protocol Traffic

To trace RIP protocol traffic, you can specify options in the global **traceoptions** statement included at the [edit routing-options] hierarchy level, and you can specify RIP-specific options by including the **traceoptions** statement:

```
traceoptions {
  file filename <size size> <files number> <(world-readable | no-world-readable)>;
  flag flag <flag-modifier> <disable>;
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

You can specify the following RIP-specific options in the RIP **traceoptions** statement:

- **auth**—Trace RIP authentication.
- **error**—Trace RIP errors.
- **expiration**—Trace RIP route expiration processing.

- holddown—Trace RIP hold-down processing.
- packets—Trace all RIP packets.
- request—Trace RIP information packets.
- trigger—Trace RIP triggered updates.
- update—Trace RIP update packets.



NOTE: Use the trace flags **detail** and **all** with caution. These flags may cause the CPU to become very busy.

For general information about tracing and global tracing options, see “Tracing Global Routing Protocol Operations” on page 119.

Example: Tracing RIP Protocol Traffic

Trace only unusual or abnormal operations to `/var/log/routing-log`, and trace detailed information about all RIP packets to `/var/log/rip-log`:

```
[edit]
routing-options {
  traceoptions {
    file /var/log/routing-log;
    flag errors;
  }
}
protocols {
  rip {
    traceoptions {
      file /var/log/rip-log;
      flag packets detail;
    }
  }
}
```

Example: Configuring RIP

Configure RIP (for routing instances, include the statements at the `[edit routing-instances routing-instance-name protocols rip]` hierarchy level):

```
[edit policy-options]
policy-statement redist-direct {
  from protocol direct;
  then accept;
}
[edit]
interfaces {
  so-0/0/0 {
    unit 0 {
      family inet;
```

```

    }
  }
  at-1/1/0 {
    unit 0 {
      family inet;
    }
  }
  at-1/1/0 {
    unit 42 {
      family inet;
    }
  }
  at-1/1/1 {
    unit 42 {
      family inet;
    }
  }
}
policy-statement redist-direct {
  from protocol direct;
  then accept;
}
[edit protocols rip]
metric-in 3;
receive both;
group wan {
  metric-out 2;
  export redist-direct;
  neighbor so-0/0/0.0;
  neighbor at-1/1/0.0;
  neighbor at-1/1/0.42;
  neighbor at-1/1/1.42 {
    receive version-2;
  }
}
group local {
  neighbor ge-2/3/0.0 {
    metric-in 1;
    send broadcast;
  }
}

```

Chapter 25

Summary of RIP Configuration Statements

The following sections explain each of the individual Routing Information Protocol (RIP) statements in the [edit protocols rip] hierarchy. The statements are organized alphabetically.

any-sender

Syntax	any-sender;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols rip group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols rip group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit protocols rip group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols rip group <i>group-name</i> neighbor <i>neighbor-name</i>]
Release Information	Statement introduced in JUNOS Release 8.0.
Description	Disable strict sender address checks.
Usage Guidelines	See “Disabling Strict Address Check” on page 532.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

authentication-key

Syntax	<code>authentication-key password;</code>
Hierarchy Level	<p>[edit logical-systems <i>logical-system-name</i> protocols rip], [edit logical-systems <i>logical-system-name</i> protocols rip group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols rip], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols rip group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit protocols rip], [edit protocols rip group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols rip], [edit routing-instances <i>routing-instance-name</i> protocols rip group <i>group-name</i> neighbor <i>neighbor-name</i>]</p>
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Require authentication for RIP route queries received on an interface.
Options	<i>password</i> —Authentication password. If the password does not match, the packet is rejected. The password can be from 1 through 16 contiguous characters long and can include any ASCII strings.
Usage Guidelines	See “Configuring Authentication” on page 524.
Required Privilege Level	<p>routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.</p>

authentication-type

Syntax	authentication-type <i>type</i> ;
Hierarchy Level	<pre>[edit logical-systems <i>logical-system-name</i> protocols rip], [edit logical-systems <i>logical-system-name</i> protocols rip group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols rip], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols rip group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit protocols rip], [edit protocols rip group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols rip], [edit routing-instances <i>routing-instance-name</i> protocols rip group <i>group-name</i> neighbor <i>neighbor-name</i>]</pre>
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure the type of authentication for RIP route queries received on an interface.
Default	If you do not include this statement and the <code>authentication-key</code> statement, RIP authentication is disabled.
Options	<p><i>type</i>—Authentication type:</p> <ul style="list-style-type: none"> ■ md5—Use the MD5 algorithm to create an encoded checksum of the packet. The encoded checksum is included in the transmitted packet. The receiving router uses the authentication key to verify the packet, discarding it if the digest does not match. This algorithm provides a more secure authentication scheme. ■ none—Disable authentication. If none is configured, the configured authentication key is ignored. ■ simple—Use a simple password. The password is included in the transmitted packet, which makes this method of authentication relatively insecure. The password can be from 1 through 16 contiguous letters or digits long.
Usage Guidelines	See “Configuring Authentication” on page 524.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	authentication-key

bfd-liveness-detection

Syntax	<pre> bfd-liveness-detection { detection-time { threshold <i>milliseconds</i>; } minimum-interval <i>milliseconds</i>; minimum-receive-interval <i>milliseconds</i>; transmit-interval { threshold <i>milliseconds</i>; minimum-interval <i>milliseconds</i>; } multiplier <i>number</i>; no-adaptation; version (1 automatic); } </pre>
Hierarchy Level	<pre> [edit protocols rip group <i>group-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols rip group <i>group-name</i> neighbor <i>neighbor-name</i>] [edit logical-systems <i>logical-system-name</i> protocols rip group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols rip group <i>group-name</i> neighbor <i>neighbor-name</i>] </pre>
Release Information	<p>Statement introduced in JUNOS Release 8.0.</p> <p><code>detection-time threshold</code> and <code>transmit-interval threshold</code> options introduced in JUNOS Release 8.2.</p> <p>Support for logical routers introduced in JUNOS Release 8.3.</p> <p><code>no-adaptation</code> statement introduced in JUNOS Release 9.0.</p>
Description	Configure bidirectional failure detection timers.
Options	<p><code>detection-time threshold <i>milliseconds</i></code>—Configure a threshold. When the BFD session detection time adapts to a value equal to or greater than the threshold, a single trap and a single system log message are sent.</p> <p><code>minimum-interval <i>milliseconds</i></code>—Configure the minimum intervals at which the local router transmits a hello packet and then expects to receive a reply from the neighbor with which it has established a BFD session. Range: 1 through 255,000 milliseconds</p> <p><code>minimum-receive-interval <i>milliseconds</i></code>—Configure only the minimum interval at which the local router expects to receive a reply from a neighbor with which it has established a BFD session. Range: 1 through 255,000 milliseconds</p> <p><code>multiplier <i>number</i></code>—Configure the number of hello packets not received by a neighbor that causes the originating interface to be declared down. Range: 1 through 255 Default: 3</p>

no-adaptation—Configure BFD sessions not to adapt to changing network conditions. We recommend that you not disable BFD adaptation unless it is preferable not to have BFD adaptation enabled in your network.

transmit-interval threshold *milliseconds*—Configure a threshold. When the BFD session transmit interval adapts to a value greater than the threshold, a single trap and a single system log message are sent. The interval threshold must be greater than the minimum transmit interval.

Range: 0 through 4,294,967,295

transmit-interval minimum-interval *milliseconds*—Configure only a minimum interval at which the local router transmits hello packets to a neighbor.

Range: 1 through 255,000

version—Specify the BFD version to detect.

Range: (BFD version 1), or **automatic** (autodetect the version)

Default: automatic

Usage Guidelines See “Configuring the BFD Protocol” on page 530.

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

check-zero

Syntax	(check-zero no-check-zero);
Hierarchy Level	<pre>[edit logical-systems <i>logical-system-name</i> protocols rip], [edit logical-systems <i>logical-system-name</i> protocols rip group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols rip], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols rip group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit protocols rip], [edit protocols rip group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols rip], [edit routing-instances <i>routing-instance-name</i> protocols rip group <i>group-name</i> neighbor <i>neighbor-name</i>]</pre>
Release Information	Statement introduced before JUNOS Release 7.4.
Description	<p>Check whether the reserved fields in a RIP packet are zero:</p> <ul style="list-style-type: none"> ■ check-zero—Discard version 1 packets that have nonzero values in the reserved fields and version 2 packets that have nonzero values in the fields that must be zero. This default behavior implements the RIP version 1 and version 2 specifications. ■ no-check-zero—Receive RIP version 1 packets with nonzero values in the reserved fields or RIP version 2 packets with nonzero values in the fields that must be zero. This is in spite of the fact that they are being sent in violation of the specifications in RFC 1058 and RFC 2453.
Default	check-zero
Usage Guidelines	See “Accepting Packets Whose Reserved Fields Are Nonzero” on page 526.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

export

Syntax	export [<i>policy-names</i>];
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols rip group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols rip group <i>group-name</i>], [edit protocols rip group <i>group-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols rip group <i>group-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Apply a policy to routes being exported to the neighbors.
Options	<i>policy-names</i> —Name of one or more policies.
Usage Guidelines	See “Applying Export Policy” on page 528 and the <i>JUNOS Policy Framework Configuration Guide</i> .
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	import

graceful-restart

Syntax	graceful-restart { disable; restart-time <i>seconds</i> ; }
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols rip], [edit protocols rip]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure graceful restart for RIP.
Options	disable—Disables graceful restart for RIP. <i>seconds</i> —Estimated time for the restart to finish, in seconds. Range: 1 through 600 seconds Default: 60 seconds
Usage Guidelines	See “Configuring Graceful Restart” on page 113 and “Configuring Graceful Restart” on page 529.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

group

Syntax `group group-name {`
 `bfd-liveness-detection {`
 `detection-time {`
 `threshold milliseconds;`
 `}`
 `minimum-interval milliseconds;`
 `minimum-receive-interval milliseconds;`
 `transmit-interval {`
 `threshold milliseconds;`
 `minimum-interval milliseconds;`
 `}`
 `multiplier number;`
 `version (0 | 1 | automatic);`
 `}`
 `preference number;`
 `metric-out metric;`
 `export policy;`
 `route-timeout seconds;`
 `update-interval seconds;`
 `neighbor neighbor-name {`
 `authentication-key password;`
 `authentication-type type;`
 `bfd-liveness-detection {`
 `detection-time {`
 `threshold milliseconds;`
 `}`
 `minimum-interval milliseconds;`
 `minimum-receive-interval milliseconds;`
 `transmit-interval {`
 `threshold milliseconds;`
 `minimum-interval milliseconds;`
 `}`
 `multiplier number;`
 `version (0 | 1 | automatic);`
 `}`
 `(check-zero | no-check-zero);`
 `import policy-name;`
 `number;`
 `metric-in metric;`
 `metric-out metric;`
 `receive receive-options;`
 `route-timeout seconds;`
 `send send-options;`
 `update-interval seconds;`
 `}`
 `}`

Hierarchy Level [edit logical-systems *logical-system-name* protocols rip],
 [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols
 rip],

[edit protocols rip],
 [edit routing-instances *routing-instance-name* protocols rip]

Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure a set of RIP neighbors that share an export policy and metric. The export policy and metric govern what routes to advertise to neighbors in a given group.
Options	<i>group-name</i> —Name of a group, up to 16 characters long. The remaining statements are explained separately in this chapter.
Usage Guidelines	See “Configuring Group-Specific Properties” on page 527.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

holddown

Syntax	holddown <i>seconds</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols rip], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols rip], [edit protocols rip], [edit routing-instances <i>routing-instance-name</i> protocols rip]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure the time period the expired route is retained in the routing table before being removed.
Options	<i>seconds</i> —Estimated time to wait before making updates to the routing table. Range: 10 through 180 seconds Default: 180 seconds
Usage Guidelines	See “Configuring RIP Timers” on page 525.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

import

Syntax	import [<i>policy-names</i>];
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols rip], [edit logical-systems <i>logical-system-name</i> protocols rip group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols rip], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols rip group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit protocols rip], [edit protocols rip group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols rip], [edit routing-instances <i>routing-instance-name</i> protocols rip group <i>group-name</i> neighbor <i>neighbor-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Apply one or more policies to routes being imported into the local router from the neighbors.
Options	<i>policy-names</i> —Name of one or more policies.
Usage Guidelines	See “Applying Import Policy” on page 527 and the <i>JUNOS Policy Framework Configuration Guide</i> .
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	export

message-size

Syntax	<code>message-size number;</code>
Hierarchy Level	<pre>[edit logical-systems <i>logical-system-name</i> protocols rip], [edit logical-systems <i>logical-system-name</i> protocols rip group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols rip], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols rip group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit protocols rip], [edit protocols rip group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols rip], [edit routing-instances <i>routing-instance-name</i> protocols rip group <i>group-name</i> neighbor <i>neighbor-name</i>]</pre>
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Number of route entries to be included in every RIP update message. To ensure interoperability with other vendors' equipment, use the standard of 25 route entries per message.
Options	<p><i>number</i>—Number of route entries per update message.</p> <p>Range: 25 through 255 entries</p> <p>Default: 25 entries</p>
Usage Guidelines	See “Configuring the Number of Route Entries in an Update Message” on page 526.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

metric-in

Syntax	<code>metric-in <i>metric</i>;</code>
Hierarchy Level	<p>[edit logical-systems <i>logical-system-name</i> protocols rip],</p> <p>[edit logical-systems <i>logical-system-name</i> protocols rip group <i>group-name</i> neighbor <i>neighbor-name</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols rip],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols rip group <i>group-name</i> neighbor <i>neighbor-name</i>],</p> <p>[edit protocols rip],</p> <p>[edit protocols rip group <i>group-name</i> neighbor <i>neighbor-name</i>],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols rip],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols rip group <i>group-name</i> neighbor <i>neighbor-name</i>]</p>
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Metric to add to incoming routes when advertising into RIP routes that were learned from other protocols. Use this statement to configure the router to prefer RIP routes learned through a specific neighbor.
Options	<p><i>metric</i>—Metric value.</p> <p>Range: 1 through 16</p> <p>Default: 1</p>
Usage Guidelines	See “Modifying the Incoming Metric” on page 525.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

metric-out

Syntax	<code>metric-out <i>metric</i>;</code>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols rip group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols rip group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit protocols rip group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols rip group <i>group-name</i> neighbor <i>neighbor-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Metric value to add to routes transmitted to the neighbor. Use this statement to control how other routers prefer RIP routes sent from this neighbor.
Options	<i>metric</i> —Metric value. Range: 1 through 16 Default: 1
Usage Guidelines	See “Modifying the Outgoing Metric” on page 529.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

neighbor

Syntax `neighbor neighbor-name {
authentication-key password;
authentication-type type;
bfd-liveness-detection {
detection-time {
threshold milliseconds;
}
minimum-interval milliseconds;
minimum-receive-interval milliseconds;
transmit-interval {
threshold milliseconds;
minimum-interval milliseconds;
}
multiplier number;
version (0 | 1 | automatic);
}
(check-zero | no-check-zero);
import policy-name;
message-size number;
metric-in metric;
metric-out metric;
receive receive-options;
route-timeout seconds;
send send-options;
update-interval seconds;
}`

Hierarchy Level `[edit logical-systems logical-system-name protocols rip group group-name],
[edit logical-systems logical-system-name routing-instances routing-instance-name protocols
rip group group-name],
[edit protocols rip group group-name],
[edit routing-instances routing-instance-name protocols rip group group-name]`

Release Information Statement introduced before JUNOS Release 7.4.

Description Configure neighbor-specific RIP parameters, thereby overriding the defaults set for the router.

Options *neighbor-name*—Name of an interface over which a router communicates to its neighbors.

The remaining statements are explained separately.

Usage Guidelines See “Defining RIP Neighbor Properties” on page 524.

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

no-check-zero

See check-zero

preference

Syntax preference *preference*;

Hierarchy Level [edit logical-systems *logical-system-name* protocols rip group *group-name*],
[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols
rip group *group-name*],
[edit protocols rip group *group-name*],
[edit routing-instances *routing-instance-name* protocols rip group *group-name*]

Release Information Statement introduced before JUNOS Release 7.4.

Description Preference of external routes learned by RIP as compared to those learned from other routing protocols.

Options *preference*—Preference value. A lower value indicates a more preferred route.

Range: 0 through 4,294,967,295 ($2^{32} - 1$)

Default: 100

Usage Guidelines See “Controlling Route Preference” on page 529.

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

receive

Syntax	<code>receive receive-options;</code>
Hierarchy Level	<pre>[edit logical-systems <i>logical-system-name</i> protocols rip], [edit logical-systems <i>logical-system-name</i> protocols rip group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols rip], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols rip group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit protocols rip], [edit protocols rip group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols rip], [edit routing-instances <i>routing-instance-name</i> protocols rip group <i>group-name</i> neighbor <i>neighbor-name</i>]</pre>
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure RIP receive options.
Options	<p><i>receive-options</i>—One of the following:</p> <ul style="list-style-type: none"> ■ <i>both</i>—Accept both RIP version 1 and version 2 packets. ■ <i>none</i>—Do not receive RIP packets. ■ <i>version-1</i>—Accept only RIP version 1 packets. ■ <i>version-2</i>—Accept only RIP version 2 packets. <p>Default: <i>both</i></p>
Usage Guidelines	See “Configuring Update Messages” on page 527.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>
Related Topics	<code>send</code>

rib-group

Syntax	<code>rib-group group-name;</code>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols rip], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols rip], [edit protocols rip], [edit routing-instances <i>routing-instance-name</i> protocols rip]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Install RIP routes into multiple routing tables by configuring a routing table group.
Options	<i>group-name</i> —Name of the routing table group.
Usage Guidelines	See “Configuring Routing Table Groups” on page 527.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

rip

Syntax	<code>rip {...}</code>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols], [edit protocols], [edit routing-instances <i>routing-instance-name</i> protocols]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Enable RIP routing on the router.
Default	RIP is disabled on the router.
Usage Guidelines	See “Minimum RIP Configuration” on page 523.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

route-timeout

Syntax	route-timeout <i>seconds</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols rip], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols rip], [edit protocols rip], [edit routing-instances <i>routing-instance-name</i> protocols rip], [edit logical-systems <i>logical-system-name</i> protocols rip group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols rip group <i>group-name</i>], [edit protocols rip group <i>group-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols rip group <i>group-name</i>]
Release Information	Statement introduced in JUNOS Release 7.6.
Description	Configure the route timeout interval for RIP.
Options	<i>seconds</i> —Estimated time to wait before making updates to the routing table. Range: 30 through 360 seconds Default: 180 seconds
Usage Guidelines	See “Configuring RIP Timers” on page 525.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

send

Syntax	<code>send <i>send-options</i>;</code>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols rip], [edit logical-systems <i>logical-system-name</i> protocols rip group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols rip], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols rip group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit protocols rip], [edit protocols rip group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols rip], [edit routing-instances <i>routing-instance-name</i> protocols rip group <i>group-name</i> neighbor <i>neighbor-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure RIP send options.
Options	<i>send-options</i> —One of the following: <ul style="list-style-type: none"> ■ broadcast—Broadcast RIP version 2 packets (RIP version 1 compatible). ■ multicast—Multicast RIP version 2 packets. This is the default. ■ none—Do not send RIP updates. ■ version-1—Broadcast RIP version 1 packets. <p>Default: multicast</p>
Usage Guidelines	See “Configuring Update Messages” on page 527.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	receive

traceoptions

Syntax	<pre>traceoptions { file <i>name</i> <size <i>size</i>> <files <i>number</i>> <(world-readable no-world-readable)>; flag <i>flag</i> <flag-modifier> <disable>; }</pre>
Hierarchy Level	<pre>[edit logical-systems <i>logical-system-name</i> protocols rip], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols rip], [edit protocols rip], [edit routing-instances <i>routing-instance-name</i> protocols rip]</pre>
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Set RIP protocol-level tracing options.
Default	The default RIP protocol-level trace options are inherited from the global traceoptions statement.
Options	<p>disable—(Optional) Disable the tracing operation. One use of this option is to disable a single operation when you have defined a broad group of tracing operations, such as all.</p> <p>file <i>filename</i>—Name of the file to receive the output of the tracing operation. Enclose the name in quotation marks. We recommend that you place RIP tracing output in the file <code>/var/log/rip-log</code>.</p> <p>files <i>number</i>—(Optional) Maximum number of trace files. When a trace file named <i>trace-file</i> reaches its maximum size, it is renamed <i>trace-file.0</i>, then <i>trace-file.1</i>, and so on, until the maximum number of trace files is reached. Then, the oldest trace file is overwritten.</p> <p>If you specify a maximum number of files, you must also specify a maximum file size with the size option.</p> <p>Range: 2 through 1000 files</p> <p>Default: 1 trace file only</p> <p>flag—Tracing operation to perform. To specify more than one tracing operation, include multiple flag statements. These are the RIP-specific tracing options:</p> <ul style="list-style-type: none"> ■ auth—RIP authentication ■ error—RIP errors ■ expiration—RIP route expiration processing ■ hold-down—RIP hold-down processing ■ packets—All RIP packets ■ request—RIP information packets such as request, poll, and poll entry packets

- **trigger**—RIP triggered updates
- **update**—RIP update packets

The following are the global tracing options:

- **all**—All tracing operations
- **general**—A combination of the **normal** and **route** trace operations
- **normal**—All normal operations
Default: If you do not specify this option, only unusual or abnormal operations are traced.
- **policy**—Policy operations and actions
- **route**—Routing table changes
- **state**—State transitions
- **task**—Interface transactions and processing
- **timer**—Timer usage

flag-modifier—(Optional) Modifier for the tracing flag. You can specify one or more of these modifiers:

- **detail**—Provide detailed trace information
- **receive**—Packets being received
- **receive-detail**—Provide detailed trace information for packets being received
- **send**—Packets being transmitted
- **send-detail**—Provide detailed trace information for packets being transmitted

no-world-readable—(Optional) Prevent any user from reading the log file.

size size—(Optional) Maximum size of each trace file, in kilobytes (KB) or megabytes (MB). When a trace file named *trace-file* reaches this size, it is renamed *trace-file.0*. When the *trace-file* again reaches its maximum size, *trace-file.0* is renamed *trace-file.1* and *trace-file* is renamed *trace-file.0*. This renaming scheme continues until the maximum number of trace files is reached. Then, the oldest trace file is overwritten.

If you specify a maximum file size, you must also specify a maximum number of trace files with the **files** option.

Syntax: *xk* to specify KB, *xm* to specify MB, or *xg* to specify GB

Range: 10 KB through the maximum file size supported on your system

Default: 1 MB

world-readable—(Optional) Allow any user to read the log file.

Usage Guidelines See “Tracing RIP Protocol Traffic” on page 532.

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

update-interval

Syntax update-interval *seconds*;

Hierarchy Level [edit logical-systems *logical-system-name* protocols rip],
[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols
rip],
[edit protocols rip],
[edit routing-instances *routing-instance-name* protocols rip]

Release Information Statement introduced in JUNOS Release 7.6.

Description Configure an update time interval to periodically send out routes learned by RIP to neighbors.

Options *seconds*—Estimated time to wait before making updates to the routing table.

Range: 10 through 60 seconds

Default: 30 seconds

Usage Guidelines See “Configuring RIP Timers” on page 525.

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

Chapter 26

RIPng Overview

The Routing Information Protocol next generation (RIPng) is an interior gateway protocol (IGP) that uses a distance-vector algorithm to determine the best route to a destination, using the hop count as the metric. RIPng is a routing protocol that exchanges routing information used to compute routes and is intended for Internet Protocol version 6 (IPv6)-based networks.

This chapter discusses the following topics that provide background information about RIPng:

- RIPng Overview on page 557
- RIPng Standards on page 558
- RIPng Packets on page 558

RIPng Overview

The RIPng IGP uses the Bellman-Ford *distance-vector* algorithm to determine the best route to a destination. RIPng uses the hop count as the metric. RIPng allows hosts and routers to exchange information for computing routes through an IP-based network. RIPng is intended to act as an IGP for moderately-sized autonomous systems (ASs).

The JUNOS software implementation of RIPng is similar to RIPv2. However, RIPng is a distinct routing protocol from RIPv2 and has the following differences:

- RIPng does not need to implement authentication on packets.
- There is no support for multiple instances of RIPng.
- There is no support for RIPng routing table groups.

RIPng is a User Datagram Protocol (UDP)-based protocol and uses UDP port 521.

RIPng has the following architectural limitations:

- The longest network path cannot exceed 15 hops (assuming that each network, or hop, has a cost of 1).
- RIPng depends on counting to infinity to resolve certain unusual situations. When the network consists of several hundred routers, and when a routing loop has formed, the amount of time and network bandwidth required to resolve a next hop might be great.

- RIPng uses only a fixed metric to select a route. Other IGPs use additional parameters, such as measured delay, reliability, and load.

RIPng Standards

RIPng is defined in the following documents:

- RFC 2080, *RIPng for IPv6*
- RFC 2081, *RIPng Protocol Applicability Statement*

To access Internet Requests for Comments (RFCs) and drafts, go to the Internet Engineering Task Force (IETF) Web site at <http://www.ietf.org>.

RIPng Packets

A RIPng packet header contains the following fields:

- Command—Indicates whether the packet is a request or response message. Request messages seek information for the router's routing table. Response messages are sent periodically or when a request message is received. Periodic response messages are called *update messages*. Update messages contain the command and version fields and a set of destinations and metrics.
- Version number—Specifies the version of RIPng that the originating router is running. This is currently set to Version 1.

The rest of the RIPng packet contains a list of routing table entries that contain the following fields:

- Destination prefix—128-bit IPv6 address prefix for the destination.
- Prefix length—Number of significant bits in the prefix.
- Metric—Value of the metric advertised for the address.
- Route tag—A route attribute that must be advertised and redistributed with the route. Primarily, the route tag distinguishes external RIPng routes from internal RIPng routes in cases where routes must be redistributed across an exterior gateway protocol (EGP).

Chapter 27

RIPng Configuration Guidelines

To configure Routing Information Protocol next generation (RIPng), you include the following statements:

```
protocols {
  ripng {
    graceful-restart {
      disable;
      restart-time seconds;
    }
    holddown seconds;
    import [ policy-names ];
    metric-in metric;
    receive <none>;
    route-timeout seconds;
    send <none>;
    update-interval seconds;
    traceoptions {
      file filename <size size> <files number> <(world-readable | no-world-readable)>;
      flag flag <flag-modifier> <disable>;
    }
    group group-name {
      export [ policy-names ];
      metric-out metric;
      preference number;
      route-timeout seconds;
      update-interval seconds;
      neighbor neighbor-name {
        import [ policy-names ];
        metric-in metric;
        receive <none>;
        route-timeout seconds;
        send <none>;
        update-interval seconds;
      }
    }
  }
}
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

By default, RIPng is disabled.



NOTE: By default, RIPng routes are not redistributed. You must configure export policy needs to redistribute RIPng routes.

To have a router exchange routes with other routers, you must configure RIPng groups and neighbors. RIPng routes received from routers not configured as RIPng neighbors are ignored. Likewise, RIPng routes are advertised only to routers configured as RIPng neighbors.

This chapter discusses the following topics that provide information for configuring and monitoring RIPng:

For a configuration example, see “Example: Configuring RIPng” on page 566.

- Minimum RIPng Configuration on page 560
- Defining RIPng Global Properties on page 561
- Defining RIPng Neighbor Properties on page 561
- Modifying the Incoming Metric on page 561
- Configuring RIPng Timers on page 562
- Configuring Update Messages on page 562
- Applying Import Policy on page 563
- Configuring Group-Specific Properties on page 563
- Configuring Graceful Restart on page 565
- Tracing RIPng Protocol Traffic on page 565
- Example: Configuring RIPng on page 566

Minimum RIPng Configuration

For a router to accept RIPng routes, you must configure at least one RIPng group and the associated neighbor. Routes received from routers that are not configured as neighbors are ignored. All other RIPng configuration statements are optional. Include one **neighbor** statement for each interface on which you want to receive routes. The local router imports all routes by default from this neighbor and does not advertise routes.

```
[edit]
protocols {
  ripng {
    group group-name {
      neighbor interface-name;
    }
  }
}
```




NOTE: When you configure RIPng on an interface, you must also include the family inet statement at the [edit interfaces *interface-name* unit *logical-unit-number*] hierarchy level.

Defining RIPng Global Properties

To define RIPng global properties, which apply to all RIPng neighbors, include one or more of the following statements. The statements are explained in separate sections.

```
import [ policy-names ];
metric-in metric;
receive receive-options;
send send-options;
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Defining RIPng Neighbor Properties

To define neighbor-specific properties, include one or more of the following statements. The statements are explained in separate sections.

```
neighbor neighbor-name {
  import [ policy-names ];
  metric-in metric;
  receive receive-options;
  send send-options;
}
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Modifying the Incoming Metric

By default, RIPng imports routes from the neighbors configured with the **neighbor** statement. These routes include those learned from RIPng as well as those learned from other protocols. By default, routes that RIPng imports from its neighbors have a metric of 1 added to the current route metric.

To change the default metric to be added to incoming routes, include the **metric-in** statement:

```
metric-in metric;
```

metric can be a value from 1 through 15. A value of 16 indicates infinity, or unreachable.

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Configuring RIPng Timers

You can configure various timers for RIPng.

RIPng routes expire when either a route timeout limit is met or a route metric reaches infinity, and the route is no longer valid. However, the expired route is retained in the routing table for a time period so that neighbors can be notified that the route has been dropped. This time period is set by configuring the hold-down timer. Upon expiration of the hold-down timer, the route is removed from the routing table.

To configure the hold-down timer for RIPng, include the **holddown** statement:

```
holddown seconds;
```

seconds can be a value from 10 through 180. The default value is 120 seconds.

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

You can set a route timeout interval. If a route is not refreshed after being installed into the routing table by the specified time interval, the route is removed from the routing table.

To configure the route timeout for RIPng, include the **route-timeout** statement:

```
route-timeout seconds;
```

seconds can be a value from 30 through 360. The default value is 180 seconds.

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

You can set an update time interval to periodically send out routes learned by RIPng to neighbors.

To configure the update time interval, include the **update-interval** statement:

```
update-interval seconds;
```

seconds can be a value from 10 through 60. The default value is 30 seconds.

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Configuring Update Messages

You can enable and disable the sending or receiving of update messages. By default, sending and receiving update messages is enabled. To disable the sending and receiving of update messages, include the **receive none** and **send none** statements:

```
receive none;  
send none;
```

To enable the sending and receiving of update messages, include the **receive** and **send** statements:

```
receive;
send;
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Applying Import Policy

To filter routes being imported by the local router from its neighbors, include the **import** statement and list the names of one or more policies to be evaluated. If you specify more than one policy, they are evaluated in order (first to last) and the first matching policy is applied to the route. If no match is found, the local router does not import any routes.

```
import [ policy-names ];
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Configuring Group-Specific Properties

You can group together neighbors that share the same export policy and export metric defaults. You configure group-specific RIPng properties by including the **group** statement:

```
group group-name {
  export [ policy-names ];
  metric-out metric;
  neighbor {
    ... neighbor-options ...
  }
  preference number;
}
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Each group must contain at least one neighbor. You should create a group for each export policy that you have. For information about configuring neighbors, see “Defining RIPng Global Properties” on page 561.

This section discusses the following tasks:

- Applying Export Policy on page 564
- Controlling Route Preference on page 564
- Modifying the Outgoing Metric on page 564

Applying Export Policy

By default, RIPng does not export routes it has learned to its neighbors. To have RIPng export routes, apply one or more export policies. To apply export policies and to filter routes being exported from the local router to its neighbors, include the **export** statement and list the name of the policy to be evaluated:

```
export [ policy-names ];
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

You can define one or more export policies. If no routes match the policies, the local router does not export any routes to its neighbors. Export policies override any metric values determined through calculations involving the **metric-in** and **metric-out** values.

Controlling Route Preference

By default, the JUNOS software assigns a preference of 100 to routes that originate from RIPng. When the JUNOS software determines that a route preference will become the active route, the software selects the route with the lowest preference and installs this route into the forwarding table.

To modify the default RIPng preference value, include the **preference** statement:

```
preference preference;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

preference can be a value from 0 through 4,294,967,295 ($2^{32} - 1$).

Modifying the Outgoing Metric

If you configure an export policy, RIPng exports routes it has learned to the neighbors configured with the **neighbor** statement.

If a route being exported was learned from a member of the same RIPng group, the metric associated with that route (unless modified by an export policy) is the normal RIPng metric. For example, a RIPng route with a metric of 5 learned from a neighbor configured with a **metric-in** value of 2 is advertised with a combined metric of 7 when advertised to RIPng neighbors in the same group. However, if this route was learned from a RIPng neighbor in a different group or from a different protocol, the route is advertised with the metric value configured for that group with the **metric-out** statement. The default value for **metric-out** is 1.

To modify the metric for routes advertised outside a group, include the **metric-out** statement:

```
metric-out metric;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Configuring Graceful Restart

Graceful restart is disabled by default. You can globally enable graceful restart for all routing protocols under the `[edit routing-options]` hierarchy level.

You can configure graceful restart parameters specifically for RIPng. To do this, include the `graceful-restart` statement:

```
graceful-restart {
  restart-time seconds;
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

To disable graceful restart for RIPng, specify the `disable` statement. To configure a time period for the restart to finish, specify the `restart-time` statement.

Tracing RIPng Protocol Traffic

To trace RIPng protocol traffic, you can specify options in the global `traceoptions` statement at the `[edit routing-options]` hierarchy level, and you can specify RIPng-specific options by including the `traceoptions` statement:

```
traceoptions {
  file filename <size size> <files number>
    <(world-readable | no-world-readable)>;
  flag flag <flag-modifier> <disable>;
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

You can specify the following RIPng-specific options in the RIPng `traceoptions` statement:

- `all`—Trace everything.
- `error`—Trace RIPng errors.
- `expiration`—Trace RIPng route expiration processing.
- `general`—Trace general events.
- `holddown`—Trace RIPng hold-down processing.
- `normal`—Trace normal events.
- `packets`—Trace all RIPng packets.
- `policy`—Trace policy processing.
- `request`—Trace RIPng information packets.
- `route`—Trace routing information.
- `state`—Trace state transitions.

- task—Trace routing protocol task processing.
- timer—Trace routing protocol timer processing.
- trigger—Trace RIPng triggered updates.
- update—Trace RIPng update packets.



NOTE: Use the trace flags **detail** and **all** with caution. These flags may cause the CPU to become very busy.

Example: Configuring RIPng

Configure RIPng:

```
[edit policy-options]
policy-statement redist-direct {
  from protocol direct;
  then accept;
}
[edit protocols ripng]
metric-in 3;
group wan {
  metric-out 2;
  export redist-direct;
  neighbor so-0/0/0.0;
  neighbor at-1/1/0.0;
  neighbor at-1/1/0.42;
  neighbor at-1/1/1.42 {
    receive version-2;
  }
}
group local {
  neighbor ge-2/3/0.0 {
    metric-in 1;
    send broadcast;
  }
}
```

Chapter 28

Summary of RIPng Configuration Statements

The following sections explain each of the individual Routing Information Protocol next generation (RIPng) statements in the [edit protocols ripng] hierarchy. The statements are organized alphabetically.

export

Syntax	export [<i>policy-names</i>];
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols ripng group <i>group-name</i>], [edit protocols ripng group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ripng group <i>group-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols ripng group <i>group-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4. Support for routing instances introduced in JUNOS Release 9.0.
Description	Apply a policy or list of policies to routes being exported to the neighbors.
Options	<i>policy-names</i> —Name of one or more policies.
Usage Guidelines	See “Applying Export Policy” on page 564.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	import

graceful-restart

Syntax	graceful-restart { disable; restart-time <i>seconds</i> ; }
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols ripng], [edit protocols ripng], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ripng], [edit routing-instances <i>routing-instance-name</i> protocols ripng]
Release Information	Statement introduced before JUNOS Release 7.4. Support for routing instances introduced in JUNOS Release 9.0.
Description	Configure graceful restart for RIPng.
Options	<p>disable—Disables graceful restart for RIPng.</p> <p><i>seconds</i>—Estimated time period for the restart to finish. Range: 1 through 600 seconds Default: 60 seconds</p>
Usage Guidelines	See “Configuring Graceful Restart” on page 113 and “Configuring Graceful Restart” on page 565.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

group

Syntax `group group-name {
 export [policy-names];
 metric-out metric;
 preference number;
 route-timeout seconds;
 update-interval seconds;
 neighbor neighbor-name {
 import policy-name;
 metric-in metric;
 receive <none>;
 route-timeout seconds;
 send <none>;
 update-interval seconds;
 }
 }`

Hierarchy Level [edit logical-systems *logical-system-name* protocols ripng],
 [edit protocols ripng],
 [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols
 ripng],
 [edit routing-instances *routing-instance-name* protocols ripng]

Release Information Statement introduced before JUNOS Release 7.4.
 Support for routing instances introduced in JUNOS Release 9.0.

Description Configure a set of RIPng neighbors that share an export policy and metric. The export policy and metric govern what routes to advertise to neighbors in a given group.

Options *group-name*—Name of a group, up to 16 characters long.

The remaining statements are explained separately.

Usage Guidelines See “Configuring Group-Specific Properties” on page 563.

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

holddown

Syntax	holddown seconds;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols ripng], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ripng], [edit protocols ripng], [edit routing-instances <i>routing-instance-name</i> protocols ripng]
Release Information	Statement introduced before JUNOS Release 7.4. Support for routing instances introduced in JUNOS Release 9.0.
Description	Configure the time period the expired route is retained in the routing table before being removed.
Options	<i>seconds</i> —Estimated time to wait before making updates to the routing table. Default: 180 seconds Range: 10 through 180 seconds
Usage Guidelines	See “Configuring RIPng Timers” on page 562.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

import

Syntax	<code>import [<i>policy-names</i>];</code>
Hierarchy Level	<pre>[edit logical-systems <i>logical-system-name</i> protocols ripng], [edit logical-systems <i>logical-system-name</i> protocols ripng group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit protocols ripng], [edit protocols ripng group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ripng], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ripng group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols ripng], [edit routing-instances <i>routing-instance-name</i> protocols ripng group <i>group-name</i> neighbor <i>neighbor-name</i>]</pre>
Release Information	Statement introduced before JUNOS Release 7.4. Support for routing instances introduced in JUNOS Release 9.0.
Description	Apply one or more policies to routes being imported into the local router from the neighbors.
Options	<i>policy-names</i> —Name of one or more policies.
Usage Guidelines	See “Applying Import Policy” on page 563.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	export

metric-in

Syntax	<code>metric-in metric;</code>
Hierarchy Level	<p>[edit logical-systems <i>logical-system-name</i> protocols ripng], [edit logical-systems <i>logical-system-name</i> protocols ripng group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit protocols ripng], [edit protocols ripng group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ripng], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ripng group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols ripng], [edit routing-instances <i>routing-instance-name</i> protocols ripng group <i>group-name</i> neighbor <i>neighbor-name</i>]</p>
Release Information	<p>Statement introduced before JUNOS Release 7.4. Support for routing instances introduced in JUNOS Release 9.0.</p>
Description	Metric to add to incoming routes when advertising into RIPng routes that were learned from other protocols. Use this statement to configure the router to prefer RIPng routes learned through a specific neighbor.
Options	<p><i>metric</i>—Metric value. Range: 1 through 16 Default: 1</p>
Usage Guidelines	See “Modifying the Incoming Metric” on page 561.
Required Privilege Level	<p>routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.</p>

metric-out

Syntax	<code>metric-out <i>metric</i>;</code>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols ripng group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit protocols ripng group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ripng group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols ripng group <i>group-name</i> neighbor <i>neighbor-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4. Support for routing instances introduced in JUNOS Release 9.0.
Description	Metric value to add to routes transmitted to the neighbor. Use this statement to control how other routers prefer RIPng routes sent from this neighbor.
Options	<i>metric</i> —Metric value. Range: 1 through 16 Default: 1
Usage Guidelines	See “Modifying the Outgoing Metric” on page 564.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

neighbor

Syntax	<pre>neighbor <i>neighbor-name</i> { import [<i>policy-names</i>]; metric-in <i>metric</i>; receive <none>; route-timeout <i>seconds</i>; send <none>; update-interval <i>seconds</i>; }</pre>
Hierarchy Level	<pre>[edit logical-systems <i>logical-system-name</i> protocols ripng group <i>group-name</i>], [edit protocols ripng group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ripng group <i>group-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols ripng group <i>group-name</i>]</pre>
Release Information	<p>Statement introduced before JUNOS Release 7.4.</p> <p>Support for routing instances introduced in JUNOS Release 9.0.</p>
Description	Configure neighbor-specific RIPng parameters, thereby overriding the defaults set for the router.
Options	<p><i>neighbor-name</i>—Name of an interface over which a router communicates to its neighbors.</p> <p>The remaining statements are explained separately.</p>
Usage Guidelines	See “Defining RIPng Neighbor Properties” on page 561.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

preference

Syntax	<code>preference <i>preference</i>;</code>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols ripng group <i>group-name</i>], [edit protocols ripng group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ripng group <i>group-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols ripng group <i>group-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4. Support for routing instances introduced in JUNOS Release 9.0.
Description	Preference of external routes learned by RIPng as compared to those learned from other routing protocols.
Options	<i>preference</i> —Preference value. A lower value indicates a more preferred route. Range: 0 through 4,294,967,295 ($2^{32} - 1$) Default: 100
Usage Guidelines	See “Controlling Route Preference” on page 564.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

receive

Syntax	receive <none>;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols ripng], [edit logical-systems <i>logical-system-name</i> protocols ripng group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit protocols ripng], [edit protocols ripng group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ripng], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ripng group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols ripng], [edit routing-instances <i>routing-instance-name</i> protocols ripng group <i>group-name</i> neighbor <i>neighbor-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4. Support for routing instances introduced in JUNOS Release 9.0.
Description	Enable or disable receiving of update messages.
Options	none—(Optional) Disable receiving update messages. Default: Enabled by default.
Usage Guidelines	See “Configuring Update Messages” on page 562.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	send

ripng

Syntax	ripng {...}
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols], [edit protocols], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols], [edit routing-instances <i>routing-instance-name</i> protocols]
Release Information	Statement introduced before JUNOS Release 7.4. Support for routing instances introduced in JUNOS Release 9.0.
Description	Enable RIPng routing on the router.
Default	RIPng is disabled on the router.
Usage Guidelines	See “Minimum RIPng Configuration” on page 560.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

route-timeout

Syntax	route-timeout <i>seconds</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols ripng], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ripng], [edit protocols ripng], [edit routing-instances <i>routing-instance-name</i> protocols ripng]
Release Information	Statement introduced in JUNOS Release 7.6. Support for routing instances introduced in JUNOS Release 9.0.
Description	Configure the route timeout interval for RIP.
Options	<i>seconds</i> —Estimated time to wait before making updates to the routing table. Range: 30 through 360 seconds Default: 180 seconds
Usage Guidelines	See “Configuring RIPng Timers” on page 562.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

send

Syntax	send <none>;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols ripng], [edit logical-systems <i>logical-system-name</i> protocols ripng group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit protocols ripng], [edit protocols ripng group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instances-name</i> protocols ripng], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ripng group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols ripng], [edit routing-instances <i>routing-instance-name</i> protocols ripng group <i>group-name</i> neighbor <i>neighbor-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4. Support for routing instances introduced in JUNOS Release 9.0.
Description	Enable or disable sending of update messages.
Options	none—(Optional) Disable sending of update messages. Default: Enabled by default.
Usage Guidelines	See “Configuring Update Messages” on page 562.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	receive

traceoptions

Syntax	<pre> traceoptions { file <i>name</i> <size <i>size</i>> <files <i>number</i>> <(world-readable no-world-readable)>; flag <i>flag</i> <flag-modifier> <disable>; } </pre>
Hierarchy Level	<pre> [edit logical-systems <i>logical-system-name</i> protocols ripng], [edit protocols ripng], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols ripng], [edit routing-instances <i>routing-instance-name</i> protocols ripng] </pre>
Release Information	Statement introduced before JUNOS Release 7.4. Support for routing instances introduced in JUNOS Release 9.0.
Description	Set RIPng protocol-level tracing options.
Default	The default RIPng protocol-level trace options are inherited from the global <code>traceoptions</code> statement.
Options	<p>disable—(Optional) Disable the tracing operation. One use of this option is to disable a single operation when you have defined a broad group of tracing operations, such as <code>all</code>.</p> <p>file <i>filename</i>—Name of the file to receive the output of the tracing operation. Enclose the name in quotation marks. We recommend that you place RIPng tracing output in the file <code>/var/log/ripng-log</code>.</p> <p>files <i>number</i>—(Optional) Maximum number of trace files. When a trace file named <i>trace-file</i> reaches its maximum size, it is renamed <i>trace-file.0</i>, then <i>trace-file.1</i>, and so on, until the maximum number of trace files is reached. Then, the oldest trace file is overwritten.</p> <p>If you specify a maximum number of files, you must also specify a maximum file size with the size option.</p> <p>Range: 2 through 1000 files Default: 1 trace file only</p> <p>flag <i>flag</i>—Tracing operation to perform. To specify more than one tracing operation, include multiple flag statements. The following are the RIPng-specific tracing options:</p> <ul style="list-style-type: none"> ■ error—RIPng errors ■ expiration—RIPng route expiration processing ■ holddown—RIPng hold-down processing ■ packets—All RIPng packets

- **request**—RIPng information packets such as request, poll, and poll entry packets
- **trigger**—RIPng triggered updates
- **update**—RIPng update packets

The following are the global tracing options:

- **all**—All tracing operations
- **general**—A combination of the **normal** and **route** trace operations
- **normal**—All normal operations
Default: If you do not specify this option, only unusual or abnormal operations are traced.
- **policy**—Policy operations and actions
- **route**—Routing table changes
- **state**—State transitions
- **task**—Interface transactions and processing
- **timer**—Timer usage

flag-modifier—(Optional) Modifier for the tracing flag. You can specify one or more of these modifiers:

- **detail**—Provide detailed trace information
- **receive**—Packets being received
- **receive-detail**—Provide detailed trace information for packets being received
- **send**—Packets being transmitted
- **send-detail**—Provide detailed trace information for packets being transmitted

no-world-readable—(Optional) Disallow any user to read the log file.

size size—(Optional) Maximum size of each trace file, in kilobytes (KB), megabytes (MB), or gigabytes (GB). When a trace file named **trace-file** reaches this size, it is renamed **trace-file.0**. When the **trace-file** again reaches its maximum size, **trace-file.0** is renamed **trace-file.1** and **trace-file** is renamed **trace-file.0**. This renaming scheme continues until the maximum number of trace files is reached. Then, the oldest trace file is overwritten.

If you specify a maximum file size, you must also specify a maximum number of trace files with the **files** option.

Syntax: **xk** to specify KB, **xm** to specify MB, or **xg** to specify GB

Range: 10 KB through the maximum file size supported on your system

Default: 1 MB

world-readable—(Optional) Allow any user to read the log file.

Usage Guidelines See “Tracing RIPng Protocol Traffic” on page 565.

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

update-interval

Syntax update-interval *seconds*;

Hierarchy Level [edit logical-systems *logical-system-name* protocols ripng],
[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols
ripng],
[edit protocols ripng],
[edit routing-instances *routing-instance-name* protocols ripng]

Release Information Statement introduced in JUNOS Release 7.6.
Support for routing instances introduced in JUNOS Release 9.0.

Description Configure an update time interval to periodically send out routes learned by RIP to neighbors.

Options *seconds*—Estimated time to wait before making updates to the routing table.
Range: 10 through 60 seconds
Default: 30 seconds

Usage Guidelines See “Configuring RIP Timers” on page 525.

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

Chapter 29

ICMP Router Discovery Overview

Router discovery uses Internet Control Message Protocol (ICMP) router advertisements and router solicitation messages to allow a host to discover the addresses of operational routers on the subnet. Hosts must discover routers before they can send IP datagrams outside their subnet.

Router discovery allows a host to discover the addresses of operational routers on the subnet. The JUNOS software implementation of router discovery supports server mode only.

Each router periodically multicasts a router advertisement from each of its multicast interfaces, announcing the IP address of that interface. Hosts listen for advertisements to discover the addresses of their neighboring routers. When a host starts, it can send a multicast router solicitation to ask for immediate advertisements.

The router discovery messages do not constitute a routing protocol. They enable hosts to discover the existence of neighboring routers, but do not determine which router is best to reach a particular destination.

This chapter discusses the following topics that provide background information about ICMP router discovery:

- ICMP Router Discovery Standards on page 583
- Operation of a Router Discovery Server on page 583
- Router Advertisement Messages on page 584

ICMP Router Discovery Standards

Router discovery is defined in RFC 1256, *ICMP Router Discovery Messages*.

To access Internet Requests for Comments (RFCs) and drafts, go to the Internet Engineering Task Force (IETF) Web site at <http://www.ietf.org>.

Operation of a Router Discovery Server

The router discovery server distributes information about the addresses of all routers on directly connected networks and about their preferences for becoming the default router. (A host sends a packet to the default router if the host does not have a route to a destination in its routing table.) The server does this by periodically sending router advertisement packets out each interface on which router discovery is enabled.

In addition to containing the router addresses, these packets also announce the existence of the server itself.

The server can either transmit broadcast or multicast router advertisement packets. Multicast packets are sent to **224.0.0.1**, which is the all-hosts multicast address. When packets are sent to the all-hosts multicast address, or when an interface is configured for the limited-broadcast address **255.255.255.255**, all IP addresses configured on the physical interface are included in the router advertisement. When the packets are being sent to a network or subnet broadcast address, only the address associated with that network or subnet is included in the router advertisement.

When the routing protocol process first starts on the server router, the server sends router advertisement packets every few seconds. Then, the server sends these packets less frequently, commonly every 10 minutes.

The server responds to route solicitation packets it receives from a client. The response is sent unicast unless a router advertisement packet is due to be sent out momentarily.



NOTE: The JUNOS software does not support the ICMP router solicitation message with the source address as 0.0.0.0.

Router Advertisement Messages

Router advertisement messages include a preference level and a lifetime field for each advertised router address.

The preference level specifies the router's preference to become the default router. When a host chooses a default router address, it chooses the address with the highest preference. You can configure the preference level with the **priority** statement.

The lifetime field indicates the maximum length of time that the advertised addresses are to be considered valid by hosts in the absence of further advertisements. You can configure the advertising rate with the **max-advertisement-interval** and **min-advertisement-interval** statements, and you can configure the lifetime with the **lifetime** statement.

Chapter 30

ICMP Router Discovery Configuration Guidelines

To configure a router as a server for Internet Control Message Protocol (ICMP) router discovery, you can include the following statements in the configuration:

```
protocols {
  router-discovery {
    disable;
    traceoptions {
      file filename <size size> <files number>
        <(world-readable | no-world-readable)>;
      flag flag <detail> <disable>;
    }
    interface interface-name {
      min-advertisement-interval seconds;
      max-advertisement-interval seconds;
      lifetime seconds;
    }
    address address {
      (advertise | ignore);
      (broadcast | multicast);
      (priority number | ineligible);
    }
  }
}
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

By default, router discovery is disabled.

This chapter describes the following tasks for configuring ICMP router discovery:

- Minimum Router Discovery Server Configuration on page 586
- Configuring the Addresses to Include in Router Advertisements on page 586
- Configuring the Frequency of Router Advertisements on page 587
- Modifying the Router Advertisement Lifetime on page 587
- Tracing ICMP Protocol Traffic on page 587

Minimum Router Discovery Server Configuration

To configure the router to be a router discovery server, you must include at least the following statement in the configuration. All other router discovery configuration statements are optional.

```
protocols {
  router-discovery;
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.



NOTE: When you configure ICMP on an interface, you must also include the **family inet** statement at the [edit interfaces *interface-name* unit *logical-unit-number*] hierarchy level. For more information about the **family inet** statement, see the *JUNOS Network Interfaces Configuration Guide*.

Configuring the Addresses to Include in Router Advertisements

To specify which addresses the router should include in its router advertisements, include the **address** statement:

```
address address {
  (advertise | ignore);
  (broadcast | multicast);
  (priority number | ineligible);
}
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Specify the IP address of the router, and optionally specify the following information about the router:

- Whether the server should include this address in its router advertisements—By default, the address is advertised. To disable this function, include the **ignore** statement.
- Whether the server should broadcast or multicast router advertisements—By default, advertisements are multicast if the router supports IP multicast; otherwise, they are broadcast. To modify the default functionality, include the **broadcast** or **multicast** statement.
- Preference of the address to become the default router—In the **priority** statement, a higher value for *number* indicates that the address has a greater preference for becoming the default router. The default value is 0, which means that the address has the least chance of becoming the default router. If the router at this address should never become the default router, include the **ineligible** statement. To modify the preference, include the **preference** statement. *number* can be a value in the range from 0 through 0x80000000. The default is 0.

Configuring the Frequency of Router Advertisements

The router discovery server sends router advertisement messages, which include route information and indicate to network hosts that the router is still operational. The server sends these messages periodically, with a time range defined by minimum and maximum values. By default, the server sends router advertisements every 400 to 600 seconds. To modify these times, include the `min-advertisement-interval` and `max-advertisement-interval` statements:

```
min-advertisement-interval seconds;
max-advertisement-interval seconds;
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Modifying the Router Advertisement Lifetime

The lifetime field in router advertisement messages indicates how long a host should consider the advertised address to be valid. If this amount of time passes and the host has not received a router advertisement from the server, the route marks the advertised addresses as invalid. By default, addresses are considered to be valid for 1800 seconds (30 minutes).

To modify the router lifetime timer, include the `lifetime` statement:

```
lifetime seconds;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Tracing ICMP Protocol Traffic

To trace ICMP protocol traffic, you can specify options in the global `traceoptions` statement included at the `[edit routing-options]` hierarchy level, and you can specify ICMP-specific options by including the `traceoptions` statement:

```
traceoptions {
  file filename <size size> <files number> <(world-readable | no-world-readable)>;
  flag flag <flag-modifier> <disable>;
}
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

You can specify the following ICMP-specific options in the ICMP `flag` statement:

- `error`—Trace error packets.
- `info`—Trace information packets.
- `routerdiscovery`—Trace all ICMP packets.
- `redirect`—Trace redirect packets.

You can specify the following global flag options:

- **all**—Trace everything.
- **general**—Trace general events.
- **normal**—Trace normal events.
- **policy**—Trace policy processing.
- **route**—Trace routing information.
- **state**—Trace state transitions.
- **task**—Trace routing protocol task processing.
- **timer**—Trace routing protocol timer processing.



NOTE: Use the trace flags **detail** and **all** with caution. These flags may cause the CPU to become very busy.

For general information about tracing and global tracing options, see “Tracing Global Routing Protocol Operations” on page 119.

Example: Tracing ICMP Protocol Traffic

Trace only unusual or abnormal operations to a file called **routing-log**, and trace router discovery state transitions to a file called **icmp-log**:

```
[edit]
routing-options {
  traceoptions {
    file routing-log;
  }
}
protocols {
  router-discovery {
    traceoptions {
      file icmp-log;
      flag state;
    }
  }
}
```

Chapter 31

Summary of ICMP Router Discovery Configuration Statements

The following sections explain each of the Internet Control Message Protocol (ICMP) router discovery configuration statements. The statements are organized alphabetically.

address

Syntax `address address {
 (advertise | ignore);
 (broadcast | multicast);
 (priority number | ineligible);
 }`

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

Release Information Statement introduced before JUNOS Release 7.4.

Description IP addresses to include in router advertisement packets.

Options *address*—IP address. To specify more than one address, specify multiple addresses or include multiple *address* statements.

The remaining statements are explained separately.

Usage Guidelines See “Configuring the Addresses to Include in Router Advertisements” on page 586.

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

advertise

Syntax	(advertise ignore);
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols router-discovery address <i>address</i>], [edit protocols router-discovery address <i>address</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Specify whether the server should advertise the IP address in its router advertisement packets: <ul style="list-style-type: none"> ■ advertise—Advertise the IP address in its router advertisement packets. ■ ignore—Do not advertise the IP addresses in router advertisement packets.
Default	advertise
Usage Guidelines	See “Configuring the Addresses to Include in Router Advertisements” on page 586.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

broadcast

Syntax	(broadcast multicast);
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols router-discovery address <i>address</i>], [edit protocols router-discovery address <i>address</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Specify when the server should include the IP addresses in router advertisement packets. On the same physical interfaces, some addresses might be included only in multicast packets, while others might be included only in broadcast packets. If you specify broadcast , the server includes the addresses in router advertisement packets only if the packets are broadcast.
Default	multicast if the router supports IP multicast; broadcast if the router does not support IP multicast.
Usage Guidelines	See “Configuring the Addresses to Include in Router Advertisements” on page 586.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	multicast

disable

Syntax	disable;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols router-discovery], [edit protocols router-discovery]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Disable router discovery.
Default	The configured object is enabled (operational) unless explicitly disabled.
Usage Guidelines	See “Minimum Router Discovery Server Configuration” on page 586.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

ignore

See advertise

ineligible

See priority

interface

Syntax interface *interface-name* {
 min-advertisement-interval *seconds*;
 max-advertisement-interval *seconds*;
 lifetime *seconds*;
 }

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

Release Information Statement introduced before JUNOS Release 7.4.

Description Specify physical interfaces on which to configure timers for router advertisement messages.

Options *interface-name*—Name of an interface. Specify the full interface name, including the physical and logical address components. To configure all interfaces, specify **all**. For details about specifying interfaces, see the *JUNOS Network Interfaces Configuration Guide*.

The remaining statements are explained separately.

Usage Guidelines See “Configuring the Frequency of Router Advertisements” on page 587 and “Modifying the Router Advertisement Lifetime” on page 587.

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

lifetime

Syntax	lifetime <i>seconds</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols router-discovery interface <i>interface-name</i>], [edit protocols router-discovery interface <i>interface-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	How long the addresses sent by the server in its router advertisement packets are valid. This time must be long enough so that another router advertisement packet is sent before the lifetime has expired. The lifetime value is placed in the advertisement lifetime field of the router advertisement packet.
Options	<p><i>seconds</i>—Lifetime value. A value of 0 indicates that one or more addresses are no longer valid.</p> <p>Range: 3,max-advertisement-interval value through 2 hours, 30 minutes (9000 seconds), specified in seconds</p> <p>Default: 1800 seconds (30 minutes; three times the default max-advertisement-interval value)</p>
Usage Guidelines	See “Modifying the Router Advertisement Lifetime” on page 587.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	max-advertisement-interval

max-advertisement-interval

Syntax	max-advertisement-interval <i>seconds</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols router-discovery interface <i>interface-name</i>], [edit protocols router-discovery interface <i>interface-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Maximum time the router waits before sending periodic router advertisement packets out the interface. These packets are broadcast or multicast, depending on how the address corresponding to this physical interface is configured.
Options	<i>seconds</i> —Maximum time between router advertisement packets. Range: 4 through 1800 seconds Default: 600 seconds (10 minutes)
Usage Guidelines	See “Configuring the Frequency of Router Advertisements” on page 587.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	broadcast, lifetime, min-advertisement-interval, multicast

min-advertisement-interval

Syntax	min-advertisement-interval <i>seconds</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols router-discovery interface <i>interface-name</i>], [edit protocols router-discovery interface <i>interface-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Minimum time the router waits before sending router advertisement packets out the interface in response to route solicitation packets it receives from a client. These packets are broadcast or multicast, depending on how the address corresponding to this physical interface is configured.
Options	<i>seconds</i> —Minimum time between router advertisement packets. Range: 3 seconds through 1800 seconds Default: 400 seconds (0.75 times the default max-advertisement-interval value)
Usage Guidelines	See “Configuring the Frequency of Router Advertisements” on page 587.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	broadcast, max-advertisement-interval, multicast

multicast

Syntax	(multicast broadcast);
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols router-discovery address <i>address</i>], [edit protocols router-discovery address <i>address</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	<p>Specify when the server should include the IP addresses in router advertisement packets. On the same physical interfaces, some addresses might be included only in multicast packets, while others might be included only in broadcast packets.</p> <p>If you specify multicast, the server includes the addresses in router advertisement packets only if the packets are multicast. If the router supports IP multicast, and if the interface supports IP multicast, multicast is the default. Otherwise, the addresses are included in broadcast router advertisement packets. If the router does not support IP multicast, the addresses are not included.</p>
Default	multicast if the router supports IP multicast; broadcast if the router does not support IP multicast.
Usage Guidelines	See “Configuring the Addresses to Include in Router Advertisements” on page 586.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	broadcast

priority

Syntax	(priority <i>number</i> ineligible);
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols router-discovery address <i>address</i>], [edit protocols router-discovery address <i>address</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Preference of the address to become a default router. This preference is set relative to the preferences of other router addresses on the same subnet.
Options	ineligible—Address can never become the default router. priority <i>number</i> —Preference of the addresses for becoming the default router. A higher value indicates that the address has a greater preference for becoming the default router. Range: 0 through 0x80000000 Default: 0 (This address has the least chance of becoming the default router.)
Usage Guidelines	See “Configuring the Addresses to Include in Router Advertisements” on page 586.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

router-discovery

Syntax	router-discovery { ... }
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols], [edit protocols]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Enable ICMP router discovery (server mode) on the router.
Default	Router discovery is disabled on the router.
Usage Guidelines	See “Minimum Router Discovery Server Configuration” on page 586.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

traceoptions

Syntax	<pre>traceoptions { file <i>filename</i> <size <i>size</i>> <files <i>number</i>> <(world-readable no-world-readable)>; flag <i>flag</i> <flag-modifier> <disable>; }</pre>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols router-discovery], [edit protocols router-discovery]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	<p>Configure ICMP protocol-level tracing options.</p> <p>To specify more than one tracing operation, include multiple flag statements.</p>
Default	The default ICMP protocol-level tracing options are inherited from the routing protocols traceoptions statement included at the [edit routing-options] hierarchy level.
Options	<p>disable—(Optional) Disable the tracing operation. One use of this option is to disable a single operation when you have defined a broad group of tracing operations, such as all.</p> <p>file <i>filename</i>—Name of the file to receive the output of the tracing operation. Enclose the name within quotation marks. All files are placed in the directory /var/log. We recommend that you place ICMP tracing output in the file icmp-log.</p> <p>files <i>number</i>—(Optional) Maximum number of trace files. When a trace file named trace-file reaches its maximum size, it is renamed trace-file.0, then trace-file.1, and so on, until the maximum number of trace files is reached. Then, the oldest trace file is overwritten.</p> <p>If you specify a maximum number of files, you also must specify a maximum file size with the size option.</p> <p>Range: 2 through 1000 files</p> <p>Default: 2 files</p> <p>flag <i>flag</i>—Tracing operation to perform. To specify more than one tracing operation, include multiple flag statements. These are the ICMP-specific tracing options:</p> <ul style="list-style-type: none"> ■ error—Errored ICMP packets ■ info—ICMP information packets ■ packets—All packets ■ router-discovery—All ICMP packets ■ redirect—ICMP redirect packets

These are the global tracing options:

- **all**—All tracing operations
- **general**—A combination of the **normal** and **route** trace operations
- **normal**—All normal operations

Default: If you do not specify this option, only unusual or abnormal operations are traced.
- **policy**—Policy operations and actions
- **route**—Routing table changes
- **state**—State transitions
- **task**—Interface transactions and processing
- **timer**—Timer usage

flag-modifier—(Optional) Modifier for the tracing flag. You can specify one or more of these modifiers:

- **detail**—Provide detailed trace information
- **receive**—Packets being received
- **send**—Packets being transmitted

no-world-readable—(Optional) Prevent any user from reading the log file.

size size—(Optional) Maximum size of each trace file, in kilobytes (KB), megabytes (MB), or gigabytes (GB). When a trace file named *trace-file* reaches this size, it is renamed *trace-file.0*. When the *trace-file* again reaches its maximum size, *trace-file.0* is renamed *trace-file.1* and *trace-file* is renamed *trace-file.0*. This renaming scheme continues until the maximum number of trace files is reached. Then, the oldest trace file is overwritten.

If you specify a maximum file size, you also must specify a maximum number of trace files with the **files** option.

Syntax: *xk* to specify KB, *xm* to specify MB, or *xg* to specify GB

Range: 10 KB through the maximum file size supported on your system

Default: 1 MB

world-readable—(Optional) Allow any user to read the log file.

Usage Guidelines See “Tracing ICMP Protocol Traffic” on page 587.

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

Chapter 32

Neighbor Discovery Overview

Neighbor discovery is a protocol that allows different nodes on the same link to advertise their existence to their neighbors, and to learn about the existence of their neighbors.

A router periodically multicasts a router advertisement from each of its multicast interfaces, announcing its availability. Hosts listen for these advertisements for address autoconfiguration and discovery of link-local addresses of the neighboring routers. When a host starts, it multicasts a router solicitation to ask for immediate advertisements.

The router discovery messages do not constitute a routing protocol. They enable hosts to discover the existence of neighboring routers, but are not used to determine which router is best to reach a particular destination.

Neighbor discovery uses the following Internet Control Message Protocol version 6 (ICMPv6) messages: router solicitation, router advertisement, neighbor solicitation, neighbor advertisement, and redirect.

Neighbor discovery for IPv6 replaces the following IPv4 protocols: router discovery (RDISC), Address Resolution Protocol (ARP), and ICMPv4 redirect.

Beginning with JUNOS Release 9.3, Secure Neighbor Discovery (SEND) is supported. SEND enables you to secure Neighbor Discovery protocol (NDP) messages. It is applicable in environments where physical security on a link is not assured and attacks on NDP messages are a concern. The JUNOS software secures NDP messages through cryptographically generated addresses (CGAs).

This chapter discusses the following topics that provide background information about neighbor discovery:

- Neighbor Discovery Standards on page 599
- Router Discovery on page 600

Neighbor Discovery Standards

Neighbor discovery is defined in the following documents:

- RFC 2461, *Neighbor Discovery for IP Version 6*
- RFC 2462, *IPv6 Stateless Address Autoconfiguration*

- RFC 2463, *Internet Control Message Protocol (ICMPv6) for the Internet Protocol Version 6 Specification*

To access Internet Requests for Comments (RFCs) and drafts, go to the Internet Engineering Task Force (IETF) Web site at <http://www.ietf.org>.

Router Discovery

Router advertisements can contain a list of prefixes. These prefixes are used for address autoconfiguration, to maintain a database of onlink (on the same data link) prefixes, and for duplication address detection. If a node is onlink, the router forwards packets to that node. If the node is not onlink, the packets are sent to the next router for consideration. For IPv6, each prefix in the prefix list can contain a prefix length, a valid lifetime for the prefix, a preferred lifetime for the prefix, an onlink flag, and an autoconfiguration flag. This information enables address autoconfiguration and the setting of link parameters such as maximum transmission unit (MTU) size and hop limit.

Address Resolution

For IPv6, ICMPv6 neighbor discovery replaces ARP for resolving network addresses to link-level addresses. Neighbor discovery also handles changes in link-layer addresses, inbound load balancing, anycast addresses, and proxy advertisements.

Nodes requesting the link-layer address of a target node multicast a neighbor solicitation message with the target address. The target sends back a neighbor advertisement message containing its link-layer address.

Neighbor solicitation and advertisement messages are used for detecting duplicate unicast addresses on the same link. Autoconfiguration of an IP address depends on whether there is a duplicate address on that link. Duplicate address detection is a requirement for autoconfiguration.

Neighbor solicitation and advertisement messages are also used for neighbor unreachability detection. Neighbor unreachability detection involves detecting the presence of a target node on a given link.

Redirect

Redirect messages are sent to inform a host of a better next-hop router to a particular destination or an onlink neighbor. This is similar to ICMPv4 redirect.

Chapter 33

Neighbor Discovery Configuration Guidelines

To configure neighbor discovery, you include the following statements. You configure router advertisement on a per-interface basis.

```
protocols {
  router-advertisement {
    interface interface-name {
      current-hop-limit number;
      default-lifetime seconds;
      (managed-configuration | no-managed-configuration);
      max-advertisement-interval seconds;
      min-advertisement-interval seconds;
      (other-stateful-configuration | no-other-stateful-configuration);
      prefix prefix {
        (autonomous | no-autonomous);
        (on-link | no-on-link);
        preferred-lifetime seconds;
        valid-lifetime seconds;
      }
      reachable-time milliseconds;
      retransmit-timer milliseconds;
      traceoptions {
        file filename <size size> <files number> <(world-readable | no-world-readable)>;
        flag flag <detail> <disable>;
      }
    }
  }
}
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

This chapter describes the following tasks for configuring and monitoring neighbor discovery router advertisement messages:

- Minimum Neighbor Discovery Configuration on page 602
- Configuring Router Advertisement on an Interface on page 602
- Configuring the Hop Limit on page 603
- Modifying the Default Router Lifetime on page 603
- Enabling Stateful Autoconfiguration on page 603

- Configuring the Frequency of Router Advertisements on page 604
- Modifying the Reachable Time Limit on page 604
- Modifying the Frequency of Neighbor Solicitation Messages on page 604
- Configuring Prefix Information on page 605
- Tracing Router Advertisement Traffic on page 606

Minimum Neighbor Discovery Configuration

To configure the router to send router advertisement messages, you must include at least the following statements in the configuration. All other router advertisement configuration statements are optional.

```
protocols {
  router-advertisement {
    interface interface-name {
      prefix prefix;
    }
  }
}
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.



NOTE: When you configure neighbor discovery router advertisement on an interface, you must also include the **family inet6** statement at the [edit interfaces *interface-name* unit *logical-unit-number*] hierarchy level. For more information about the **family inet6** statement, see the *JUNOS Network Interfaces Configuration Guide*.

Configuring Router Advertisement on an Interface

To configure an interface to send router advertisement messages, include the **interface** statement:

```
interface interface-name;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Specify the interface name in the following format:

```
physical<:channel>.logical
```

For more information about interface names, see the *JUNOS Network Interfaces Configuration Guide*.



NOTE: JUNOS enters the Neighbor Discovery Protocol packets into the routing platform cache, even if there is no known route to the source.

Configuring the Hop Limit

The current hop limit field in the router advertisement messages indicates the default value placed in the hop count field of the IP header for outgoing packets. To configure the hop limit, include the **current-hop-limit** statement:

```
current-hop-limit number;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

The default hop limit is 64.

Modifying the Default Router Lifetime

The default lifetime in router advertisement messages indicates the lifetime associated with the default router. To modify the default lifetime timer, include the **default-lifetime** statement:

```
default-lifetime seconds;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

By default, the default router lifetime is three times the maximum advertisement interval. For more information about the maximum advertisement interval, see “Configuring the Frequency of Router Advertisements” on page 604.

Enabling Stateful Autoconfiguration

You can set two fields in the router advertisement message to enable stateful autoconfiguration on a host: the managed configuration field and the other stateful configuration field. Setting the managed configuration field enables the host to use a stateful autoconfiguration protocol for address autoconfiguration, along with any stateless autoconfiguration already configured. Setting the other stateful configuration field enables autoconfiguration of other nonaddress-related information.

By default, stateful autoconfiguration is disabled.

To set the managed configuration field and enable address autoconfiguration, include the **managed-configuration** statement:

```
managed-configuration;
```

To disable managed configuration field, include the **no-managed-configuration** statement:

```
no-managed-configuration;
```

To set the other stateful configuration field and enable autoconfiguration of other types of information, include the **other-stateful-configuration** statement:

```
other-stateful-configuration;
```

To disable other stateful configuration, include the `no-other-stateful-configuration` statement:

```
no-other-stateful-configuration;
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Configuring the Frequency of Router Advertisements

The router sends router advertisements on each interface configured to transmit messages. The advertisements include route information and indicate to network hosts that the router is operational. The router sends these messages periodically, with a time range defined by minimum and maximum values.

To modify the router advertisement interval, include the `min-advertisement-interval` and `max-advertisement-interval` statements:

```
min-advertisement-interval seconds;
max-advertisement-interval seconds;
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

By default, the maximum advertisement interval is 600 seconds and the minimum advertisement interval is one-third the maximum interval, or 200 seconds.

Modifying the Reachable Time Limit

After receiving a reachability confirmation from a neighbor, a node considers that neighbor reachable for a certain amount of time without receiving another confirmation. This mechanism is used for neighbor unreachability detection, a mechanism for finding link failures to a target node.

To modify the reachable time limit, include the `reachable-time` statement:

```
reachable-time milliseconds;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

By default, the reachable time period is 0 milliseconds.

Modifying the Frequency of Neighbor Solicitation Messages

The retransmit timer determines the retransmission frequency of neighbor solicitation messages. This timer is used to detect when a neighbor has become unreachable and to resolve addresses. To modify the retransmit timer, include the `retransmit-timer` statement:

`retransmit-timer milliseconds;`

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

By default, the retransmit timer is 0 milliseconds.

Configuring Prefix Information

Router advertisement messages carry prefixes and information about them. A prefix is onlink when it is assigned to an interface on a specified link. The prefixes specify whether they are onlink or not onlink. A node considers a prefix to be onlink if it is represented by one of the link's prefixes, a neighboring router specifies the address as the target of a redirect message, a neighbor advertisement message is received for the (target) address, or any neighbor discovery message is received from the address. These prefixes are also used for address autoconfiguration. The information about the prefixes specifies the lifetime of the prefixes, whether the prefix is autonomous, and whether the prefix is onlink.

You can perform the following tasks when configuring the prefix information:

- Setting the Prefix for Onlink Determination on page 605
- Setting the Prefix for Stateless Address Autoconfiguration on page 605
- Configuring the Preferred Lifetime on page 606
- Configuring the Valid Lifetime on page 606

Setting the Prefix for Onlink Determination

You can specify prefixes in the router advertisement messages as onlink. When set as onlink, the prefixes are used for onlink determination. By default, prefixes are onlink.

To explicitly set prefixes as onlink, include the `on-link` statement:

`on-link;`

To set prefixes as not onlink, include the `no-on-link` statement:

`no-on-link;`

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Setting the Prefix for Stateless Address Autoconfiguration

You can specify prefixes in the router advertisement messages as autonomous. When set as autonomous, the prefixes are used for stateless address autoconfiguration. By default, prefixes are autonomous.

To explicitly specify prefixes as autonomous, include the `autonomous` statement:

```
autonomous;
```

To specify prefixes as not autonomous, include the **no-autonomous** statement:

```
no-autonomous;
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Configuring the Preferred Lifetime

The preferred lifetime for the prefixes in the router advertisement messages specifies how long the prefix generated by stateless autoconfiguration remains preferred. By default, the preferred lifetime is set to 604,800 seconds.

To configure the preferred lifetime, include the **preferred-lifetime** statement:

```
preferred-lifetime seconds;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

If you set the preferred lifetime to **0xffffffff**, the lifetime is infinite.

The preferred lifetime value must never exceed the valid lifetime value.

Configuring the Valid Lifetime

The valid lifetime for the prefixes in the router advertisement messages specifies how long the prefix remains valid for onlink determination. By default, the valid lifetime is set to 2,592,000 seconds.

To configure the valid lifetime, include the **valid-lifetime** statement:

```
valid-lifetime seconds;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

If you set the valid lifetime to **0xffffffff**, the lifetime is infinite.

The valid lifetime value must never be smaller than the preferred lifetime value.

Tracing Router Advertisement Traffic

To trace router advertisement traffic, you can specify options in the global **traceoptions** statement included at the **[edit routing-options]** hierarchy level, and you can specify router advertisement options by including the **traceoptions** statement:

```
traceoptions {
  file filename <size size> <files number> <(world-readable | no-world-readable)>;
  flag flag <flag-modifier> <disable>;
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.



NOTE: Use the trace flags **detail** and **all** with caution. These flags may cause the CPU to become very busy.

Chapter 34

Summary of Neighbor Discovery Router Advertisement Configuration Statements

The following sections explain each of the neighbor discovery router advertisement configuration statements. The statements are organized alphabetically.

autonomous

Syntax	(autonomous no-autonomous);
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols router-advertisement interface <i>interface-name</i> prefix <i>prefix</i>], [edit protocols router-advertisement interface <i>interface-name</i> prefix <i>prefix</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Specify whether prefixes in the router advertisement messages are used for stateless address autoconfiguration: <ul style="list-style-type: none">■ autonomous—Use prefixes for address autoconfiguration.■ no-autonomous—Do not use prefixes for address autoconfiguration.
Default	autonomous
Usage Guidelines	See “Setting the Prefix for Stateless Address Autoconfiguration” on page 605.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

current-hop-limit

Syntax	current-hop-limit <i>number</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols router-advertisement interface <i>interface-name</i>], [edit protocols router-advertisement interface <i>interface-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Default value placed in the hop count field of the IP header for outgoing packets.
Options	<i>number</i> —Hop limit. A value of 0 means the limit is unspecified by this router. Range: 0 through 255 Default: 64
Usage Guidelines	See “Configuring the Hop Limit” on page 603.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

default-lifetime

Syntax	default-lifetime <i>seconds</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols router-advertisement interface <i>interface-name</i>], [edit protocols router-advertisement interface <i>interface-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Lifetime associated with a default router.
Options	<i>seconds</i> —Default lifetime. A value of 0 means this router is not the default router. Range: Maximum advertisement interval value through 9000 seconds Default: Three times the maximum advertisement interval value
Usage Guidelines	See “Modifying the Default Router Lifetime” on page 603.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	max-advertisement-interval

interface

Syntax `interface interface-name {
 current-hop-limit number;
 default-lifetime seconds;
 (managed-configuration | no-managed-configuration);
 max-advertisement-interval seconds;
 min-advertisement-interval seconds;
 (other-stateful-configuration | no-other-stateful-configuration);
 prefix prefix {
 (autonomous | no-autonomous);
 (on-link | no-on-link);
 preferred-lifetime seconds;
 valid-lifetime seconds;
 }
 reachable-time milliseconds;
 retransmit-timer milliseconds;
 traceoptions {
 file filename <size size> <files number> <(world-readable | no-world-readable)>;
 flag flag <detail> <disable>;
 }
 }`

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

Release Information Statement introduced before JUNOS Release 7.4.

Description Configure router advertisement properties on an interface. To configure more than one interface, include the **interface** statement multiple times.

Options *interface-name*—Name of an interface. Specify the full interface name, including the physical and logical address components.

The remaining statements are explained separately.

Usage Guidelines See “Configuring Router Advertisement on an Interface” on page 602.

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

managed-configuration

Syntax	(managed-configuration no-managed-configuration);
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols router-advertisement interface <i>interface-name</i>], [edit protocols router-advertisement interface <i>interface-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Specify whether to enable the host to use a stateful autoconfiguration protocol for address autoconfiguration, along with any stateless autoconfiguration already configured: <ul style="list-style-type: none"> ■ managed-configuration—Enable host to use stateful autoconfiguration. ■ no-managed-configuration—Disable host from using stateful autoconfiguration.
Default	The configured object is disabled unless explicitly enabled.
Usage Guidelines	See “Enabling Stateful Autoconfiguration” on page 603.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

max-advertisement-interval

Syntax	max-advertisement-interval <i>seconds</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols router-advertisement interface <i>interface-name</i>], [edit protocols router-advertisement interface <i>interface-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Maximum interval between each router advertisement message.
Options	<i>seconds</i> —Maximum interval. Range: 4 through 1800 seconds Default: 600 seconds
Usage Guidelines	See “Configuring the Frequency of Router Advertisements” on page 604.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	min-advertisement-interval

min-advertisement-interval

Syntax	<code>min-advertisement-interval seconds;</code>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols router-advertisement interface <i>interface-name</i>], [edit protocols router-advertisement interface <i>interface-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Minimum interval between each router advertisement message.
Options	<i>seconds</i> —Minimum interval. Range: 3 seconds through three-quarter times the maximum advertisement interval value Default: One-third the maximum advertisement interval value
Usage Guidelines	See “Configuring the Frequency of Router Advertisements” on page 604.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	max-advertisement-interval

no-autonomous

See autonomous

no-managed-configuration

See managed-configuration

no-on-link

See on-link

no-other-stateful-configuration

See other-stateful-configuration

on-link

Syntax	(on-link no-on-link);
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols router-advertisement interface <i>interface-name</i> prefix <i>prefix</i>], [edit protocols router-advertisement interface <i>interface-name</i> prefix <i>prefix</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Specify whether to enable prefixes to be used for onlink determination: <ul style="list-style-type: none"> ■ no-on-link—Disable prefixes from being used for onlink determination. ■ on-link—Enable prefixes to be used for onlink determination.
Default	The configured object is enabled unless explicitly disabled.
Usage Guidelines	See “Configuring Prefix Information” on page 605.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

other-stateful-configuration

Syntax	(other-stateful-configuration no-other-stateful-configuration);
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols router-advertisement interface <i>interface-name</i>], [edit protocols router-advertisement interface <i>interface-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Specify whether to enable autoconfiguration of other nonaddress-related information: <ul style="list-style-type: none"> ■ no-other-stateful-configuration—Disable autoconfiguration of other nonaddress-related information. ■ other-stateful-configuration—Enable autoconfiguration of other nonaddress-related information.
Default	The configured object is disabled unless explicitly enabled.
Usage Guidelines	See “Enabling Stateful Autoconfiguration” on page 603.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

preferred-lifetime

Syntax	<code>preferred-lifetime seconds;</code>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols router-advertisement interface <i>interface-name</i> prefix <i>prefix</i>], [edit protocols router-advertisement interface <i>interface-name</i> prefix <i>prefix</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Specify how long the prefix generated by stateless autoconfiguration remains preferred.
Options	<i>seconds</i> —Preferred lifetime, in seconds. If you set the preferred lifetime to 0xffffffff, the lifetime is infinite. The preferred lifetime is never greater than the valid lifetime. Default: 604,800 seconds
Usage Guidelines	See “Configuring the Preferred Lifetime” on page 606.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	valid-lifetime

prefix

Syntax	<code>prefix <i>prefix</i> { (autonomous no-autonomous); (on-link no-on-link); preferred-lifetime <i>seconds</i>; valid-lifetime <i>seconds</i>; }</code>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols router-advertisement interface <i>interface-name</i>], [edit protocols router-advertisement interface <i>interface-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure prefix properties in router advertisement messages.
Options	<i>prefix</i> —Prefix name. The remaining statements are explained separately.
Usage Guidelines	See “Configuring Prefix Information” on page 605.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

reachable-time

Syntax	<code>reachable-time <i>milliseconds</i>;</code>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols router-advertisement interface <i>interface-name</i>], [edit protocols router-advertisement interface <i>interface-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	A length of time that a node considers a neighbor reachable until another reachability confirmation is received from that neighbor.
Options	<i>milliseconds</i> —Reachability time limit. Range: 0 through 3,600,000 milliseconds Default: 0 milliseconds
Usage Guidelines	See “Modifying the Reachable Time Limit” on page 604.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

retransmit-timer

Syntax	<code>retransmit-timer <i>milliseconds</i>;</code>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols router-advertisement interface <i>interface-name</i>], [edit protocols router-advertisement interface <i>interface-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Retransmission frequency of neighbor solicitation messages.
Options	<i>milliseconds</i> —Retransmission frequency. Default: 0 milliseconds
Usage Guidelines	See “Modifying the Frequency of Neighbor Solicitation Messages” on page 604.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

router-advertisement

Syntax	router-advertisement {...}
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols], [edit protocols]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Enable router advertisement.
Options	The statements are explained separately.
Usage Guidelines	See “Configuring Router Advertisement on an Interface” on page 602.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

traceoptions

Syntax traceoptions {
 file *filename* <size *size*> <files *number*> <(world-readable | no-world-readable)>;
 flag *flag* <flag-modifier> <disable>;
 }

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

Release Information Statement introduced before JUNOS Release 7.4.

Description Specify router advertisement protocol-level tracing options.

Default The default trace options are inherited from the global **traceoptions** statement.

Options **disable**—(Optional) Disable the tracing operation. One use of this option is to disable a single operation when you have defined a broad group of tracing operations, such as **all**.

file *filename*—Name of the file to receive the output of the tracing operation. Enclose the name in quotation marks. We recommend that you place router advertisement tracing output in the file `/var/log/router-advertisement-log`.

files *number*—(Optional) Maximum number of trace files. When a trace file named *trace-file* reaches its maximum size, it is renamed *trace-file.0*, then *trace-file.1*, and so on, until the maximum number of trace files is reached. Then, the oldest trace file is overwritten.

If you specify a maximum number of files, you must also specify a maximum file size with the **size** option.

Range: 2 through 1000 files

Default: 1 trace file only

flag *flag*—Tracing operation to perform. To specify more than one tracing operation, include multiple **flag** statements. The following are the router advertisement-specific tracing options:

- **error**—Router advertisement errors
- **expiration**—Router advertisement route expiration processing
- **holddown**—Router advertisement hold-down processing
- **packets**—All router advertisement packets
- **request**—Router advertisement information packets such as request, poll, and poll entry packets
- **trigger**—Router advertisement triggered updates

- **update**—Router advertisement update packets

The following are the global tracing options:

- **all**—All tracing operations
- **general**—A combination of the **normal** and **route** trace operations
- **normal**—All normal operations.
Default: If you do not specify this option, only unusual or abnormal operations are traced.
- **policy**—Policy operations and actions
- **route**—Routing table changes
- **state**—State transitions
- **task**—Interface transactions and processing
- **timer**—Timer usage

flag-modifier—(Optional) Modifier for the tracing flag. You can specify one or more of these modifiers:

- **detail**—Provide detailed trace information
- **receive**—Packets being received
- **receive-detail**—Provide detailed trace information for packets being received
- **send**—Packets being transmitted
- **send-detail**—Provide detailed trace information for packets being transmitted

no-world-readable—(Optional) Prevent any user from reading the log file.

size size—(Optional) Maximum size of each trace file, in kilobytes (KB) or megabytes (MB). When a trace file named *trace-file* reaches this size, it is renamed *trace-file.0*. When the *trace-file* again reaches its maximum size, *trace-file.0* is renamed *trace-file.1* and *trace-file* is renamed *trace-file.0*. This renaming scheme continues until the maximum number of trace files is reached. Then, the oldest trace file is overwritten.

If you specify a maximum file size, you must also specify a maximum number of trace files with the **files** option.

Syntax: *xk* to specify KB, *xm* to specify MB, or *xg* to specify GB

Range: 10 KB through the maximum file size supported on your system

Default: 1 MB

world-readable—(Optional) Allow any user to read the log file.

Usage Guidelines See “Tracing Router Advertisement Traffic” on page 606.

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

valid-lifetime

Syntax	valid-lifetime <i>seconds</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols router-advertisement interface <i>interface-name</i> prefix <i>prefix</i>], [edit protocols router-advertisement interface <i>interface-name</i> prefix <i>prefix</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	How long the prefix remains valid for onlink determination.
Options	<i>seconds</i> —Valid lifetime, in seconds. If you set the valid lifetime to 0xffffffff, the lifetime is infinite. Default: 2,592,000 seconds
Usage Guidelines	See “Configuring the Valid Lifetime” on page 606.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	preferred-lifetime

Chapter 35

Secure Neighbor Discovery Configuration Guidelines

The Secure Neighbor Discovery (SEND) Protocol provides support for protecting Neighbor Discovery Protocol messages. SEND is applicable in environments where physical security on a link is not ensured and attacks on Neighbor Discovery Protocol messages are a concern. The JUNOS implementation secures Neighbor Discovery Protocol messages through cryptographically generated addresses (CGAs).

You must also enable IPv6 on at least one interface. Because SEND relies on dynamically generated CGAs, it does not support static IPv6 addresses. For more information about configuring an IPv6 interface and address, see the *JUNOS Network Interfaces Configuration Guide*.

To configure Secure Neighbor Discovery, include the following statements:

```
protocols {
  neighbor-discovery {
    secure {
      security-level {
        (default | secure-messages-only);
      }
      cryptographic-address {
        key-length number;
        key-pair pathname;
      }
      timestamp {
        clock-drift number;
        known-peer-window seconds;
        new-peer-window seconds;
      }
      traceoptions {
        file filename <files number> <match> <size size> <world-readable |
          no-world-readable>;
        flag flag;
        no-remote-trace <file filename> <files number> <match> <size size> <
          world-readable no-world-readable>;
        <flag flag>;
      }
    }
  }
}
```

This chapter discusses the following topics that describe how to configure Secure Neighbor Discovery:

- Enabling Secure Neighbor Discovery on page 622
- Configuring Cryptographic Address Parameters on page 622
- Configuring Timestamp Parameters on page 623
- Tracing Secure Neighbor Discovery Traffic on page 624

Enabling Secure Neighbor Discovery

To enable Secure Neighbor Discovery (SEND), include the following statements:

```
protocols {
  neighbor-discovery {
    secure {
      security-level {
        (default | secure-messages-only);
      }
    }
  }
}
```

Specify **default** to send and receive both secure and unsecured Neighbor Discovery Protocol packets. To configure SEND to accept secured NDP messages only and to drop unsecured ones, specify **secure-messages-only**.

Configuring Cryptographic Address Parameters

Secure Neighbor Discovery uses cryptographically generated addresses (CGAs), as defined in RFC 3972, *Cryptographically Generated Addresses*, to ensure that the sender of a Neighbor Discovery Protocol (NDP) message is the “owner” of the claimed address. Each node must generate a public-private key pair before it can claim an address. The CGA is included in all outgoing neighbor solicitation and neighbor advertisement messages.

To configure parameters for CGAs, include the following statements:

```
protocols {
  neighbor-discovery {
    secure {
      cryptographic-address {
        key-length number;
        key-pair pathname;
      }
    }
  }
}
```

For information about how to configure parameters for cryptographic addresses, see the following sections:

- Specifying the Pathname for the Key File on page 623
- Specifying the RSA Key Length on page 623

Specifying the Pathname for the Key File

A cryptographic address is dynamically generated based on a public key and a subnet prefix. The private-public key file that is generated is placed by default the `/var/etc/rsa_key` directory. You can specify a pathname for that file. Include the `key-pair pathname` statement:

```
key-pair pathname;
```

For a complete list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Specifying the RSA Key Length

You can specify the length of the RSA key used to generate the CGA public-private pair. The default is 1024 bits, and you can specify a value from 1024 through 2048. Include the `key-length number` statement:

```
key-length number;
```

For a complete list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Configuring Timestamp Parameters

Secure Neighbor Discovery supports several timestamp options, which are used to ensure that unsolicited solicitation and redirect messages are not being replayed. To configure timestamp parameters, include the following statements:

```
protocols {
  neighbor-discovery {
    secure {
      timestamp {
        new-peer-window seconds;
        known-peer-window seconds;
        clock-drift value;
      }
    }
  }
}
```

Use the `new-peer-window seconds` statement to specify the maximum allowable difference in the amount of time between the timestamp of a SEND message from a new peer and when it can be accepted. The default is 300 seconds.

Use the `known-peer-window seconds` statement to specify the expected interval between subsequent incoming SEND messages. The default is 1 second. A message from a known peer that arrives after the specified interval is discarded.

Use the `clock drift value` statement to specify a fractional value of 100 for the allowable drift in time between the synchronization of peers. The default is 0.01, or 1 percent.

Tracing Secure Neighbor Discovery Traffic

To trace Secure Neighbor Discovery traffic, you can specify options in the global `traceoptions` statement at the `[edit routing-options]` hierarchy level, and you can specify Secure Neighbor Discovery options by including the `traceoptions` statement at the `[edit protocols neighbor-discovery secure]` hierarchy level:

```
traceoptions {
  file filename <match> <size size> <files number> <world-readable |
    no-world-readable>;
  flag flag;
  no-remote-trace <file filename> <flag flag>;
}
```

You can specify the following `flag` options with the Secure Neighbor Discovery `traceoptions` statement:

- `all`—All tracing operations.
- `configuration`—All configuration events.
- `cryptographic-address`—Cryptographically generated address events.
- `protocol`—All protocol processing events.
- `rsa`—RSA events.

For a complete list of hierarchy levels at which you can configure this statement, see the statement hierarchy section for this statement.

Chapter 36

Summary of Secure Neighbor Discovery Configuration Statements

The following sections explain each of the Secure Neighbor Discovery configuration statements. The statements are organized alphabetically.

cryptographic-address

Syntax cryptographic-address {
 key-length *number*;
 key-pair *pathname*;
 }

Hierarchy Level [edit protocols neighbor-discovery secure]

Release Information Statement introduced in JUNOS Release 9.3.

Description Configure parameters for cryptographically generated addresses for Secure Neighbor Discovery.

Options The remaining statements are explained separately.

Usage Guidelines See “Configuring Cryptographic Address Parameters” on page 622.

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

key-length

Syntax	<code>key-length <i>number</i> {</code>
Hierarchy Level	<code>[edit protocols neighbor-discovery secure cryptographic-address]</code>
Release Information	Statement introduced in JUNOS Release 9.3.
Description	Specify the length of the RSA key used to generate the private-key pair for the cryptographic address.
Default	1024
Options	<i>number</i> —RSA key length. Range: 1024 through 2048
Usage Guidelines	See “Specifying the RSA Key Length” on page 623.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

key-pair

Syntax	<code>key-pair <i>pathname</i>;</code>
Hierarchy Level	<code>[edit protocols neighbor-discovery secure cryptographic-address]</code>
Release Information	Statement introduced in JUNOS Release 9.3.
Description	Specify the directory path of the public-private key file generated for the cryptographic address.
Options	<i>pathname</i> —Directory path of the public-private key file. The default location of the file is <code>/var/etc/rsa_key</code> directory.
Usage Guidelines	See “Specifying the Pathname for the Key File” on page 623.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

neighbor-discovery

```

Syntax  neighbor-discovery {
            secure {
                security-level {
                    (default | secure-messages-only);
                }
                cryptographic-address {
                    key-length number;
                    key-pair pathname;
                }
                timestamp {
                    clock-drift number;
                    known-peer-window number;
                    new-peer-window number;
                }
                traceoptions {
                    file filename <match> <size size> <files number> <world-readable |
                        no-world-readable>;
                    flag flag;
                    no-remote-trace <file filename> <flag flag>;
                }
            }
        }

```

Hierarchy Level [edit protocols]

Release Information Statement introduced in JUNOS Release 9.3.

Description Enable Secure Neighbor Discovery.

Default Disabled

Options The remaining statements are explained separately.

Usage Guidelines See “Enabling Secure Neighbor Discovery” on page 622.

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

secure

Syntax secure {
 security-level (default | secure-messages-only):
 cryptographic-address {
 key-length *number*;
 key-pair *pathname*;
 security-parameter *number*;
 }
 timestamp {
 clock-drift *number*;
 known-peer-window *seconds*;
 new-peer-window *seconds*;
 }
 traceoptions {
 file *filename* <match> <size *size*> <files *number*> <world-readable |
 no-world-readable>;
 flag *flag*;
 no-remote-trace <file *filename*> <flag *flag*>;
 }
 }

Hierarchy Level [edit protocols neighbor-discovery]

Release Information Statement introduced in JUNOS Release 9.3.

Description Configure parameters for Secure Neighbor Discovery.

Options The remaining statements are explained separately.

Usage Guidelines See “Configuring Cryptographic Address Parameters” on page 622, “Configuring Timestamp Parameters” on page 623, and “Tracing Secure Neighbor Discovery Traffic” on page 624.

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

security-level

Syntax	security-level { (default secure-messages-only); }
Hierarchy Level	[edit protocols neighbor-discovery secure]
Release Information	Statement introduced in JUNOS Release 9.3.
Description	Configure the type of security mode for Secure Neighbor Discovery.
Options	default—Accept and transmit both secure and unsecured messages. secure-messages-only—Accept secure messages only. Discard unsecured messages.
Usage Guidelines	See “Enabling Secure Neighbor Discovery” on page 622.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

timestamp

Syntax	timestamp { clock-drift <i>value</i> ; known-peer-window <i>seconds</i> ; new-peer-window <i>seconds</i> ; }
Hierarchy Level	[edit protocols neighbor-discovery secure]
Release Information	Statement introduced in JUNOS Release 9.3.
Description	Configure timestamp options, which are used to ensure that solicitation and redirect messages are not being replayed.
Options	<p>clock-drift <i>value</i>—Specify the allowable drift in time between the synchronization of peers. For <i>value</i>, specify a fractional value of 100. Default: 0.01</p> <p>known-peer-window <i>seconds</i>—Specify the expected interval in seconds between Secure Neighbor Discovery messages from an established peer. Default: 1 second</p> <p>new-peer-window <i>seconds</i>—Specify the maximum allowable time in seconds between the timestamp of a Secure Neighbor Discovery message from a new peer and when it can be accepted. Default: 300 seconds</p>
Usage Guidelines	See “Configuring Timestamp Parameters” on page 623.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

traceoptions

Syntax traceoptions {
 file *filename* <files *number*> <match> <size *size*> <world-readable | no-world-readable>;
 flag *flag*;
 no-remote-trace <file *filename*> <files *number*> <match> <size *size*> <world-readable
 | no-world-readable>;
 <flag *flag*>;
 }

Hierarchy Level [edit protocols neighbor-discovery secure]

Release Information Statement introduced in JUNOS Release 9.3.

Description Configure tracing operations for Secure Neighbor Discovery events. To specify more than one tracing operation, include multiple flag statements.

Options file *filename*—Name of the file to receive the tracing operation. Enclose the name within quotation marks. All files are placed in the directory */var/log*.

files *number*—(Optional) Maximum number of trace files. When a trace file named *trace-file* reaches its maximum size, it is renamed *trace-file.0*, then *trace-file.1* and so on, until the maximum number of trace files is reached. Then the oldest trace file is overwritten.



NOTE: If you specify a maximum number of files, you must also specify a maximum file size with the **size** option.

Range: 2 through 1000 files

Default: 10 files

flag—Tracing operation to perform. To specify more than one tracing operation, include multiple **flag** statements.

- all—All tracing operations.
- configuration—All configuration events.
- cryptographic-address—Cryptographically generated address events.
- protocol—All protocol processing events.
- rsa—RSA events.

match—(Optional) Specify a regular expression to match the output of the trace file you want to log.

no-remote-trace—Disable remote tracing globally or for a specific tracing operation.

no-world-readable—(Optional) Prevent any user from reading this log file.

size *size*—(Optional) Maximum size of each trace file, in kilobytes (KB) or megabytes (MB). When a trace file named *trace-file* reaches this size, it is renamed *trace-file.0*. When the *trace-file* again reaches its maximum size, *trace-file.0* is renamed *trace-file.1*, and *trace-file* is renamed *trace-file.0*. This renaming scheme continues until the maximum number of trace files is reached. Then the oldest trace file is overwritten.

world-readable—(Optional) Allow any user to read this log file.

Usage Guidelines See “Tracing Secure Neighbor Discovery Traffic” on page 624.

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

Part 6

BGP

- BGP Overview on page 635
- BGP Configuration Guidelines on page 641
- Summary of BGP Configuration Statements on page 709

Chapter 37

BGP Overview

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

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

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

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

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

This chapter discusses the following topics that provide background information about BGP:

- BGP Standards on page 636
- Autonomous Systems on page 636
- AS Paths and Attributes on page 637
- External and Internal BGP on page 637
- BGP Routes on page 638
- BGP Messages on page 638

BGP Standards

The JUNOS software supports BGP version 4 and several extensions to the protocol, which are defined in the following documents:

- RFC 1772, *Application of the Border Gateway Protocol in the Internet*
- RFC 1965, *Autonomous System Confederations for BGP*
- RFC 1966, *BGP Route Reflection: An Alternative to Full-Mesh IBGP*
- RFC 1997, *BGP Communities Attribute*
- RFC 2270, *Using a Dedicated AS for Sites Homed to a Single Provider*
- RFC 2283, *Multiprotocol Extensions for BGP-4*
- RFC 2385, *Protection of BGP Sessions via the TCP MD5 Signature Option*
- RFC 2439, *BGP Route Flap Damping*
- RFC 2545, *Use of BGP-4 Multiprotocol Extensions for IPv6 Inter-Domain Routing*
- RFC 2796, *BGP Route Reflection*
- RFC 2858, *Multiprotocol Extensions for BGP-4*
- RFC 2918, *Route Refresh Capability for BGP-4*
- RFC 3065, *Autonomous System Confederations for BGP*
- RFC 3107, *Carrying Label Information in BGP-4*
- RFC 3392, *Capabilities Advertisement with BGP-4*
- RFC 4271, *A Border Gateway Protocol 4 (BGP-4)*
- RFC 4724, *Graceful Restart Mechanism for BGP*
- RFC 4781, *Graceful Restart Mechanism for BGP with MPLS*
- RFC 4893, *BGP Support for Four-octet AS Number Space*
- Internet draft draft-ietf-ppvpn-rfc2547bis-00.txt, *BGP/MPLS VPNs* (expires January 2002)
- Internet draft draft-kato-bgp-ipv6-link-local-00.txt, *BGP4 + Peering Using IPv6 Link-local Address* (expires April 2002)
- Internet draft draft-ietf-ngtrans-bgp-tunnel-04.txt, *Connecting IPv6 Islands across IPv4 Clouds with BGP* (only MP-BGP over IPv4 Approach) (expires July 2002)
- Internet draft draft-ietf-idr-flow-spec-00.txt, *Dissemination of Flow Specification Rules*

To access Internet Requests for Comments (RFCs) and drafts, go to the Internet Engineering Task Force (IETF) Web site at <http://www.ietf.org>.

Autonomous Systems

An *autonomous system* (AS) is a set of routers that are under a single technical administration and normally use a single interior gateway protocol and a common set of metrics to propagate routing information within the set of routers. To other

ASs, an AS appears to have a single, coherent interior routing plan and presents a consistent picture of what destinations are reachable through it.

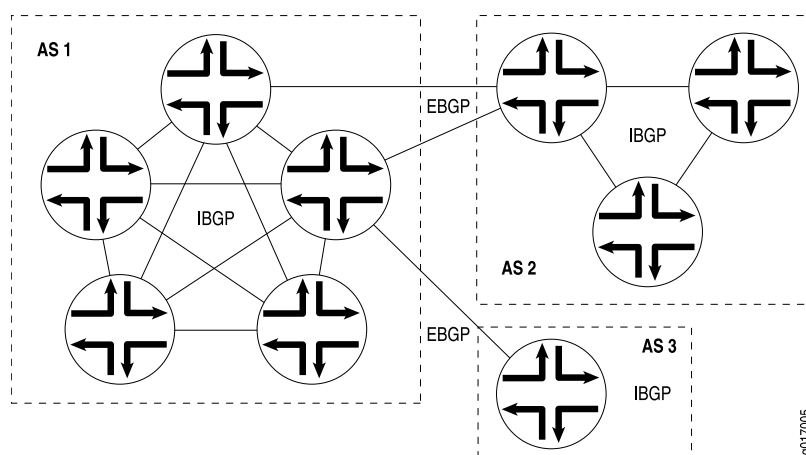
AS Paths and Attributes

The routing information that BGP systems exchange includes the complete route to each destination, as well as additional information about the route. The route to each destination is called the *AS path*, and the additional route information is included in *path attributes*. BGP uses the AS path and the path attributes to completely determine the network topology. Once BGP understands the topology, it can detect and eliminate routing loops and select among groups of routes to enforce administrative preferences and routing policy decisions.

External and Internal BGP

BGP supports two types of exchanges of routing information: exchanges between different ASs and exchanges within a single AS. When used between ASs, BGP is called *external BGP* (EBGP) and BGP sessions perform *inter-AS routing*. When used within an AS, BGP is called *internal BGP* (IBGP) and BGP sessions perform *intra-AS routing*. Figure 8 on page 637 illustrates ASs, IBGP, and EBGP.

Figure 8: ASs, External BGP, and Internal BGP



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

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

In an external BGP group, the peers in the group—called *external peers*—are in different ASs and normally share a subnet. In an external group, the next hop is

computed with respect to the interface that is shared between the external peer and the local router.

BGP Routes

A BGP route consists of the following:

- A destination, described as an IP address prefix.
- Information that describes the path to the destination, including the following:
 - AS path, which is a list of numbers of the ASs that a route passes through to reach the local router. The first number in the path is that of the last AS in the path—the AS closest to the local router. The last number in the path is the AS farthest from the local router, which is generally the origin of the path.
 - Path attributes, which contain additional information about the AS path that is used in routing policy.

BGP peers advertise routes to each other in update messages.

BGP stores its routes in the JUNOS software routing table. The routing table stores the following information about BGP routes:

- Routing information learned from update messages received from peers
- Local routing information that the BGP system selects by applying local policies to routes received in update messages
- Information that the BGP system selects to advertise to its BGP peers in the update messages it sends

For each prefix in the routing table, the routing protocol process selects a single best path, called the active path. The algorithm for determining the active path is described in “How the Active Route Is Determined” on page 7.

BGP Messages

BGP systems send four types of messages:

- Open
- Update
- Keepalive
- Notification

All BGP messages have the same fixed-size header, which contains a marker field indicating the total length of the message and a type field indicating the message type.

Open Messages

After a TCP connection is established between two BGP systems, they exchange BGP open messages to create a BGP connection between them. Once the connection is established, the two systems can exchange BGP messages and data traffic.

Open messages consist of the BGP header plus the following fields:

- Version—The current BGP version number is 4.
- Local AS number—You configure this by including the `autonomous-system` statement at the `[edit routing-options]` or `[edit logical-systems logical-system-name routing-options]` hierarchy levels.
- Hold time—Proposed hold-time value. You configure the local hold time with the BGP `hold-time` statement.
- BGP identifier—IP address of the BGP system. This address is determined when the system starts up and is the same for every local interface and every BGP peer. You can configure the BGP identifier with the `router-id` statement at the `[edit routing-options]` or `[edit logical-systems logical-system-name routing-options]` hierarchy levels. By default, BGP uses the IP address of the first interface it finds in the router.
- Parameter field length and the parameter itself—These are optional fields.

Update Messages

BGP systems send update messages to exchange network reachability information. BGP systems use this information to construct a graph that describes the relationships among all known ASs.

Update messages consist of the BGP header plus the following optional fields:

- Unfeasible routes length—Length of the field that lists the routes being withdrawn from service because they are no longer deemed reachable
- Withdrawn routes—IP address prefixes for the routes being withdrawn from service
- Total path attribute length—Length of the field that lists the path attributes for a feasible route to a destination
- Path attributes—Properties of the routes, including the path origin, the multiple exit discriminator (MED), the originating system's preference for the route, and information about aggregation, communities, confederations, and route reflection
- Network layer reachability information (NLRI)—IP address prefixes of feasible routes being advertised in the update message

Keepalive Messages

BGP systems exchange keepalive messages to determine whether a link or host has failed or is no longer available. Keepalive messages are exchanged often enough so that the hold timer does not expire. These messages consist only of the BGP header.

Notification Messages

BGP systems send notification messages when an error condition is detected. After the message is sent, the BGP session and the TCP connection between the BGP systems are closed. Notification messages consist of the BGP header plus the error code and subcode, and data that describes the error.

Chapter 38

BGP Configuration Guidelines

To configure the Border Gateway Protocol (BGP), you can include the following statements. Three portions of the **bgp** statement—those in which you configure global BGP, group-specific, and peer-specific options—contain many of the same statements. The following simplified version of the **bgp** statement omits these repeated statements to present a high-level, readable overview:

```
protocols {
  bgp {
    ...global-bgp-configuration ...
    group group-name {
      peer-as autonomous-system;
      type type;
      [network/mask-length ];
      ... peer-specific-configuration ...
      neighbor address {
        ... peer-specific-configuration ...
      }
    }
  }
}
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

For a list of global BGP statements, see “Defining BGP Global Properties” on page 645.
For a list of group-specific statements, see “Defining Group Properties” on page 650.
For a list of peer-specific statements, see “Defining Peer Properties” on page 652.



NOTE: Changing configuration statements that affect BGP peerings, such as enabling or disabling **remove-private** or renaming a BGP group, resets the BGP sessions. Changes that affect BGP peerings should only be made when resetting a BGP session is acceptable.

Many of the global BGP, group-specific, and peer-specific statements are identical. For statements that you can configure at more than one level in the hierarchy, the more-specific statement overrides the less-specific statement. That is, a group-specific statement overrides a global BGP statement, and a peer-specific statement overrides a global BGP or group-specific statement.

By default, BGP is disabled.

This chapter describes the following tasks for configuring BGP:

- Minimum BGP Configuration on page 643
- Enabling BGP on page 644
- Modifying the Hold-Time Value on page 658
- Configuring MTU Discovery on page 659
- Configuring Graceful Restart on page 659
- Advertising an Explicit Null Label on page 659
- Configuring Aggregate Labels for VPNs on page 660
- Configuring Authentication on page 660
- Applying IPsec Security Association on page 662
- Opening a Peer Connection Passively on page 663
- Configuring the Local IP Address on page 663
- Configuring the Multiple Exit Discriminator Metric on page 663
- Controlling the Aggregator Path Attribute on page 667
- Configuring an EBGP Multihop Session on page 667
- Configuring a Single-Hop EBGP Peer to Accept a Remote Next Hop on page 667
- Configuring the BGP Local Preference on page 669
- Controlling Route Preference on page 669
- Configuring Routing Table Path Selection on page 671
- Configuring BGP to Select Multiple BGP Paths on page 672
- Configuring a Local AS on page 673
- Removing Private AS Numbers from AS Paths on page 675
- Configuring Route Reflection on page 676
- Enabling Route Flap Damping on page 681
- Enabling Multiprotocol BGP on page 682
- Enabling BGP to Carry Flow-Specification Routes on page 687
- Enabling BGP to Carry Connectionless Network Services Routes on page 689
- Enabling Route Target Filtering on page 693
- Configuring Prefix-Based Outbound Route Filtering on page 694
- Enabling Layer 2 VPN and VPLS Signaling on page 695
- Configuring BGP Routing Policy on page 696
- Configuring EBGP Peering Using IPv6 Link-Local Address on page 700
- Configuring IPv6 BGP Routes over IPv4 Transport on page 701
- Configuring BGP to Log System Log Messages on page 702
- Describing BGP Router Configuration on page 702
- Blocking Nonpeer TCP Connection Attempts on page 702
- Applying BGP Export Policy to VRF Routes on page 703

- Enabling Next-Hop Reachability Information on page 703
- Configuring the BFD Protocol on page 703
- Configuring the Segment Size for TCP on page 706
- Tracing BGP Protocol Traffic on page 706

Minimum BGP Configuration

For BGP to run on the router, you must define the local autonomous system (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). There are several ways you can configure this information; a few are shown in this section.

Configure a BGP group, specify the group type, and configure an explicit peer:

```
[edit]
routing-options {
  autonomous-system autonomous-system;
}
protocols {
  bgp {
    group group-name {
      peer-as autonomous-system;
      type type;
      neighbor address;
    }
  }
}
```

Configure a BGP group and type and allow all BGP systems to be peers:

```
[edit]
routing-options {
  autonomous-system autonomous-system;
}
protocols {
  bgp {
    group group-name {
      type type;
      peer-as autonomous-system;
      all;
    }
  }
}
```



NOTE: When you configure BGP on an interface, you must also include the `family inet` statement at the `[edit interfaces interface-name unit logical-unit-number]` hierarchy level. For more information about the `family inet` statement, see the *JUNOS Network Interfaces Configuration Guide*.

Enabling BGP

To enable BGP on the router, perform the following tasks:

- Specifying the Local Router's AS Number on page 644
- Defining an AS Confederation and Its Members on page 644
- Assigning a BGP Identifier on page 645
- Defining BGP Global Properties on page 645
- Defining BGP Groups and Peers on page 647
- Examples: Enabling BGP on page 654

For examples of enabling BGP, see the following sections:

Specifying the Local Router's AS Number

Each router running BGP must be configured with its AS number. This number is included in the local AS number field in BGP open messages, which are sent between BGP peers to establish a connection.

To specify an AS number, include the `autonomous-system` statement:

```
autonomous-system autonomous-system <loops number>;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

You must specify an AS number to enable BGP.

For more information about configuring the AS number, see “Configuring the AS Number” on page 102.

Defining an AS Confederation and Its Members

To enable the local system to participate as a member of an AS confederation, you must define the AS confederation identifier and specify the AS numbers that are members of the confederation. To do this, include the `confederation` statement:

```
confederation confederation-autonomous-system members [ autonomous-systems ];
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Defining an AS confederation and its members is optional.

For more information about configuring confederations, see “Configuring AS Confederation Members” on page 103.

Assigning a BGP Identifier

Each router running BGP must have a BGP identifier. This identifier is included in the BGP identifier field of open messages, which are sent between two BGP peers when establishing a BGP session.

Explicitly assigning a BGP identifier is optional. If you do not assign one, the IP address of the first interface encountered in the router is used.

To assign a BGP identifier explicitly, include the **router-id** statement:

```
router-id address;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Assigning a BGP identifier is optional.

For more information, see “Configuring the Router Identifier” on page 103.

Defining BGP Global Properties

To define BGP global properties, which apply to all BGP groups and peers, include one or more of the following statements. These statements are explained in separate sections.

```
accept-remote-nexthop;
advertise-external <conditional>;
advertise-inactive;
advertise-peer-as;
authentication-algorithm algorithm;
authentication-key key;
authentication-key-chain key-chain;
cluster cluster-identifier;
damping;
description text-description;
disable;
family {
    (iso-vpn | inet | inet6 | inet-vpn | inet6-vpn | inet-mvpn | inet6-mvpn | l2-vpn) {
        (any | flow | multicast | unicast | signaling) {
            accepted-prefix-limit {
                maximum number;
                teardown <percentage> <idle-timeout (forever | minutes)>;
            }
            prefix-limit {
                maximum number;
                teardown <percentage> <idle-timeout (forever | minutes)>;
            }
            rib-group group-name;
        }
    }
    labeled-unicast {
        aggregate-label {
            community community-name;
        }
    }
}
```

```

        explicit-null {
            connected-only;
        }
        accepted-prefix-limit {
            maximum number;
            teardown <percentage> <idle-timeout (forever | minutes)>;
        }
        prefix-limit {
            maximum number;
            teardown <percentage> <idle-timeout (forever | minutes)>;
        }
        resolve-vpn;
        rib inet.3;
        rib-group group-name;
    }
}
route-target {
    advertise-default;
    external-paths number;
    accepted-prefix-limit {
        maximum number;
        teardown <percentage> <idle-timeout (forever | minutes)>;
    }
    prefix-limit {
        maximum number;
        teardown <percentage> <idle-timeout (forever | minutes)>;
    }
}
signaling {
    accepted-prefix-limit {
        maximum number;
        teardown <percentage> <idle-timeout (forever | minutes)>;
    }
    prefix-limit {
        maximum number;
        teardown <percentage> <idle-timeout (forever | minutes)>;
    }
}
}
export [ policy-names ];
graceful-restart {
    disable;
    restart-time seconds;
    stale-routes-time seconds;
}
hold-time seconds;
import [ policy-names ];
include-mp-next-hop;
ipsec-sa ipsec-sa;
keep (all | none);
local-address address;
local-as autonomous-system <private>;
local-preference local-preference;
log-updown;
metric-out (metric | minimum-igp <offset> | igp <offset>);
multihop <ttl-value>;

```

```

no-advertise-peer-as;
no-aggregator-id;
no-client-reflect;
out-delay seconds;
passive;
path-selection {
    (always-compare-med | cisco-non-deterministic | external-router-id);
    med-plus-igp {
        igp-multiplier number;
        med-multiplier number;
    }
}
peer-as autonomous-system;
preference preference;
remove-private;
tcp-mss segment-size;
traceoptions {
    file filename <size size> <files number> <(world-readable | no-world-readable)>;
    flag flag <flag-modifier> <disable>;
}
vpn-apply-export;

```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

You must configure BGP global properties to enable BGP.

Defining BGP Groups and Peers

A BGP system must know which routers are its peers (neighbors). You define the peer relationships explicitly by configuring the neighboring routers that are the peers of the local BGP system. After peer relationships have been established, the BGP peers exchange update messages to advertise network reachability information.

You arrange BGP routers into groups of peers. Different peer groups must have different group types, AS numbers, or router reflector cluster identifiers.

Each group must contain at least one peer.

To define BGP groups and peers, see the following sections:

- Defining a Group with Static Peers on page 647
- Defining a Group with Dynamic Peers on page 649
- Defining the Group Type on page 649
- Specifying the Peer's AS Number on page 650
- Defining Group Properties on page 650
- Defining Peer Properties on page 652

Defining a Group with Static Peers

To define a BGP group that recognizes only the specified BGP systems as peers, statically configure all the system's peers by including one or more **neighbor**

statements. The peers on at least one side of each BGP connection must be configured statically. The peer neighbor's address can be either an IPv6 or IPv4 address.

```
group group-name {
  peer-as autonomous-system;
  type type;
  neighbor address; # One "neighbor" statement for each peer
}
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

As the number of external BGP (EBGP) groups increases, the ability to support a large number of BGP sessions may become a scaling issue. The preferred way to configure a large number of BGP neighbors is to configure a few groups consisting of multiple neighbors per group. Supporting fewer EBGP groups generally scales better than supporting a large number of EBGP groups. This becomes more evident in the case of hundreds of EBGP groups when compared with a few EBGP groups with multiple peers in each group. The following examples illustrate this point.

For sample configurations, see the following sections:

- Example: Defining a Large Number of Groups with Static Peers on page 648
- Example: Defining a Small Number of Groups with Static Peers for Better Scalability on page 649

Example: Defining a Large Number of Groups with Static Peers

Enable BGP and define three EBGP groups that recognize BGP systems in AS 56, AS 57, and AS 58 as peers:

```
[edit]
routing-options {
  autonomous-system 23;
}
protocols {
  bgp {
    group G1 {
      type external;
      peer-as 56;
      neighbor 10.0.0.1;
    }
    group G2 {
      type external;
      peer-as 57;
      neighbor 10.0.10.1;
    }
    group G3 {
      type external;
      peer-as 58;
      neighbor 10.0.20.1;
    }
  }
}
```


Example: Defining a Small Number of Groups with Static Peers for Better Scalability

For improved scalability, configure only one EBGp group consisting of the three BGP neighbors:

```
[edit]
routing-options {
  autonomous-system 23;
}
protocols {
  bgp {
    group G {
      type external;
      neighbor 10.0.0.1 {
        peer-as 56;
      }
      neighbor 10.0.10.1 {
        peer-as 57;
      }
      neighbor 10.0.20.1 {
        peer-as 58;
      }
    }
  }
}
```

Defining a Group with Dynamic Peers

To define a BGP group in which the local system's peers are dynamic and change over time, include the **allow** statement. To recognize all BGP systems as peers, include the **allow-all** statement. To recognize BGP systems within specified address ranges, specify a set of addresses in the **allow network/mask-length** statement. These addresses can be IPv6 or IPv4 addresses.

```
group group-name {
  peer-as autonomous-system;
  type type;
  (allow [ network/mask-length ] | all);
}
```



NOTE: You cannot define a BGP group with dynamic peers with authentication enabled.

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Defining the Group Type

When configuring a BGP group, you can indicate whether the group is an internal BGP (IBGP) group or an external BGP (EBGP) group. All peers in an IBGP group are in the same AS, while peers in an EBGp group are in different ASs and normally share a subnet.

To configure an IBGP group, which allows intra-AS BGP routing, include the following form of the **type** statement:

```
type internal;
```

To configure an EBGP group, which allows inter-AS BGP routing, include the following form of the **type** statement:

```
type external;
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Specifying the Peer's AS Number

When configuring a peer, you must specify the peer system's AS. To do this, include the **peer-as** statement:

```
peer-as autonomous-system;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

For *autonomous-system*, you can specify a number of 1 through 4,294,967,295 in plain-number format. Beginning with JUNOS Release 9.1, the range for autonomous system (AS) numbers is extended to provide BGP support for 4-byte AS numbers as defined in RFC 4893, *BGP Support for Four-octet AS Number Space*. The JUNOS software continues to support 2-byte AS numbers.

Beginning with JUNOS Release 9.2, you can also configure a 4-byte AS number using the AS-dot notation format of two integer values joined by a period: *< 16-bit high-order value in decimal > . < 16-bit low-order value in decimal > .* For example, the 4-byte AS number of 65,546 in plain-number format is represented as 1.10 in the AS-dot notation format. You can specify a value in the range from 0.0 through 65535.65535 in AS-dot notation format.

For EBGP, the peer is in another AS, so the AS number you specify in the **peer-as** statement must be different from the local router's AS number, which you specify in the **autonomous-system** statement. For IBGP, the peer is in the same AS, so the two AS numbers that you specify in the **autonomous-system** and **peer-as** statements must be the same. For more information about configuring the AS number of the local router, see "Configuring the AS Number" on page 102.

Defining Group Properties

To define group-specific properties, include one or more of the following statements. For more information, see "Summary of BGP Configuration Statements" on page 709.

```
accept-remote-nexthop;
advertise-external <conditional>;
advertise-inactive;
advertise-peer-as;
[ network/mask-length ];
as-override;
```

```

authentication-algorithm algorithm;
authentication-key key;
authentication-key-chain key-chain;
cluster cluster-identifier;
damping;
description text-description;
export [ policy-names ];
family {
    (inet | inet6 | inet-vpn | inet6-vpn | inet-mpvn | inet6mpvn | l2-vpn) {
        (any | flow | multicast | unicast | signaling) {
            accepted-prefix-limit {
                maximum number;
                teardown <percentage> <idle-timeout (forever | minutes)>;
            }
            prefix-limit {
                maximum number;
                teardown <percentage> <idle-timeout (forever | minutes)>;
            }
            rib-group group-name;
        }
        flow {
            no-validate policy-name;
        }
        labeled-unicast {
            explicit-null {
                connected-only;
            }
            accepted-prefix-limit {
                maximum number;
                teardown <percentage> <idle-timeout (forever | minutes)>;
            }
            prefix-limit {
                maximum number;
                teardown <percentage> <idle-timeout (forever | minutes)>;
            }
            resolve-vpn;
            rib inet.3;
            rib-group group-name;
        }
    }
}
route-target {
    advertise-default;
    external-paths number;
    accepted-prefix-limit {
        maximum number;
        teardown <percentage> <idle-timeout (forever | minutes)>;
    }
    prefix-limit {
        maximum number;
        teardown <percentage> <idle-timeout (forever | minutes)>;
    }
}
signaling {
    accepted-prefix-limit {
        maximum number;
        teardown <percentage> <idle-timeout (forever | minutes)>;
    }
}

```

```

    }
    prefix-limit {
        maximum number;
        teardown <percentage> <idle-timeout (forever | minutes)>;
    }
}
graceful-restart {
    disable;
    restart-time seconds;
    stale-routes-time seconds;
}
hold-time seconds;
import [ policy-names ];
ipsec-sa ipsec-sa;
keep (all | none);
local-address address;
local-as autonomous-system <private>;
local-preference local-preference;
log-updown;
metric-out (metric | minimum-igp <offset> | igp <offset>);
mtu-discovery;
multihop <ttl-value>;
multipath {
    multiple-as;
}
neighbor address {
    ... peer-specific-options ...
}
no-advertise-peer-as;
no-agggregator-id;
no-client-reflect;
out-delay seconds;
passive;
peer-as autonomous-system;
preference preference;
remove-private;
tcp-mss segment-size;
traceoptions {
    file filename <size size> <files number> <(world-readable | no-world-readable)>;
    flag flag <flag-modifier> <disable>;
}
type type;
vpn-apply-export;

```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Defining Peer Properties

When you use the **neighbor** statement to configure BGP peers statically, you also can define peer-specific properties. For more information, see “Summary of BGP Configuration Statements” on page 709.

```
accept-remote-nexthop;
```

```

advertise-external <conditional>;
advertise-inactive;
advertise-peer-as;
as-override;
authentication-algorithm algorithm;
authentication-key key;
authentication-key-chain key-chain;
cluster cluster-identifier;
damping;
description text-description;
export [ policy-names ];
family {
    (iso-vpn | inet | inet6 | inet-vpn | inet6-vpn | inet-mvpn | inet6-mvpn | l2-vpn) {
        (any | flow | multicast | unicast | signaling) {
            accepted-prefix-limit {
                maximum number;
                teardown <percentage> <idle-timeout (forever | minutes)>;
            }
            prefix-limit {
                maximum number;
                teardown <percentage> <idle-timeout (forever | minutes)>;
            }
            rib-group group-name;
        }
        flow {
            no-validate policy-name;
        }
        labeled-unicast {
            explicit-null {
                connected-only;
            }
            accepted-prefix-limit {
                maximum number;
                teardown <percentage> <idle-timeout (forever | minutes)>;
            }
            prefix-limit {
                maximum number;
                teardown <percentage> <idle-timeout (forever | time-in-minutes)>;
            }
            resolve-vpn;
            rib inet.3;
            rib-group group-name;
        }
    }
}
route-target {
    advertise-default;
    external-paths number;
    accepted-prefix-limit {
        maximum number;
        teardown <percentage> <idle-timeout (forever | minutes)>;
    }
    prefix-limit {
        maximum number;
        teardown <percentage> <idle-timeout (forever | minutes)>;
    }
}

```

```

    signaling {
        prefix-limit {
            maximum number;
            teardown <percentage> <idle-timeout (forever | minutes)>;
        }
    }
}
graceful-restart {
    disable;
    restart-time seconds;
    stale-routes-time seconds;
}
hold-time seconds;
import [ policy-names ];
ipsec-sa ipsec-sa;
keep (all | none);
local-address address;
local-as autonomous-system <private>;
local-interface interface-name;
local-preference preference;
log-updown;
metric-out (metric | minimum-igp <offset> | igp <offset>);
mtu-discovery
multihop <ttl-value>;
multipath {
    multiple-as;
}
no-advertise-peer-as;
no-aggregator-id;
no-client-reflect;
out-delay seconds;
passive;
peer-as autonomous-system;
preference preference;
tcp-mss segment-size;
traceoptions {
    file filename <size size> <files number> <(world-readable | no-world-readable)>;
    flag flag <flag-modifier> <disable>;
}
vpn-apply-export;

```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Examples: Enabling BGP

Enable BGP and define an EBGP group that recognizes all BGP systems in AS 56 as peers:

```

[edit]
routing-options {
    autonomous-system 23;
}
protocols {
    bgp {

```

```

group 23 {
    type external;
    peer-as 56;
    0.0.0.0/0;
}
}

```

Enable BGP and define an IBGP group that recognizes only the specified addresses as BGP peers.

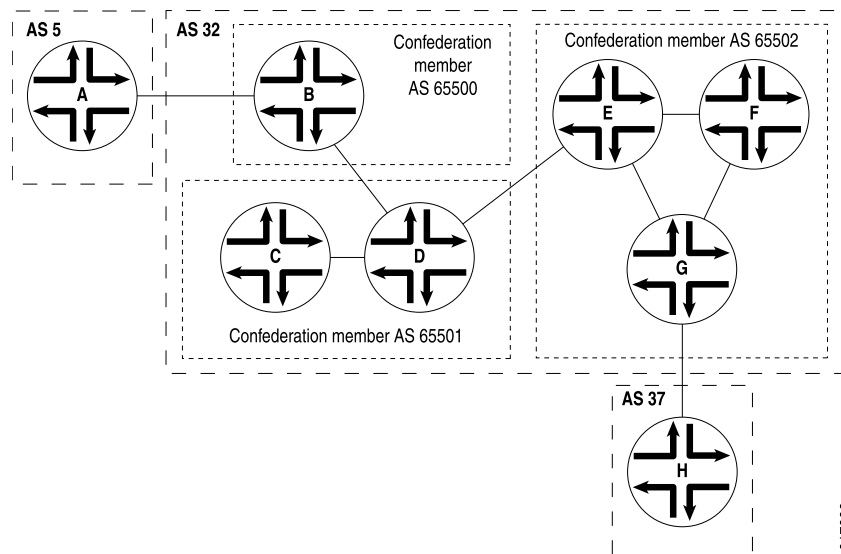
```

[edit]
routing-options {
    autonomous-system 23;
    router-id 10.0.0.1;
}
protocols {
    bgp {
        group 23 {
            type internal;
            peer-as 23;
            neighbor 10.0.0.2;
            neighbor 10.0.0.3;
        }
    }
}

```

Configure a BGP confederation. Figure 9 on page 655 illustrates the confederation topology used in this example. For AS 32 to be a valid confederation, all routers in the AS must be members of the confederation. For example, Router B must have a confederation member AS number as well as a confederation AS number. Within a confederation, the links between the confederation member ASs must be EBGP links, not IBGP links.

Figure 9: Example: BGP Confederation Topology



On Router A:[edit]

```

routing-options {
    autonomous-system 5;
}
protocols {
    bgp {
        group AtoB {
            type external;
            peer-as 32;
            neighbor 10.0.0.2;
        }
    }
}

```

On Router B:

[edit]

```

routing-options {
    autonomous-system 65500;
    confederation 32 members [65500 65501 65502];
}
protocols {
    bgp {
        group BtoA {
            type external;
            peer-as 5;
            neighbor 10.0.0.1;
        }
        group BtoD {
            type external;
            peer-as 65501;
            neighbor 10.0.10.2;
        }
    }
}

```

On Router C:

[edit]

```

routing-options {
    autonomous-system 65501;
    confederation 32 members [65500 65501 65502];
}
protocols {
    bgp {
        group CtoD {
            type internal;
            neighbor 10.0.10.3;
        }
    }
}

```

On Router D:

[edit]

```

routing-options {
    autonomous-system 65501;
    confederation 32 members [65500 65501 65502];
}
protocols {
    bgp {
        group DtoC {

```



```

        type internal;
        neighbor 10.0.10.1;
    }
    group DtoB {
        type external;
        peer-as 65500;
        neighbor 10.0.10.1;
    }
    group DtoE {
        type external;
        peer-as 65502;
        neighbor 10.0.30.1;
    }
}

On Router E:
[edit]
routing-options {
    autonomous-system 65502;
    confederation 32 members [65500 65501 65502];
}
protocols {
    bgp {
        group EtoD {
            type external;
            peer-as 65501;
            neighbor 10.0.10.4;
        }
        group EtoFandG {
            type internal;
            neighbor 10.0.30.2;
            neighbor 10.0.30.5;
        }
    }
}

On Router F:
[edit]
routing-options {
    autonomous-system 65502;
    confederation 32 members [65500 65501 65502];
}
protocols {
    bgp {
        group FtoEandG {
            type internal;
            neighbor 10.0.30.3;
            neighbor 10.0.30.7;
        }
    }
}

On Router G:
[edit]
routing-options {
    autonomous-system 65502;
    confederation 32 members [65500 65501 65502];
}

```

```

protocols {
  bgp {
    group GtoH {
      type external;
      peer-as 37;
      neighbor 10.0.40.1;
    }
    group GtoEandF {
      type internal;
      neighbor 10.0.30.4;
      neighbor 10.0.30.5;
    }
  }
}

```

On Router H:

```

[edit]
routing-options {
  autonomous-system 37;
}
protocols {
  bgp {
    group HtoG {
      type external;
      peer-as 32;
      neighbor 10.0.30.8;
    }
  }
}

```

Modifying the Hold-Time Value

The hold time is the maximum number of seconds allowed to elapse between successive keepalive or update messages that BGP receives from a peer. When establishing a BGP connection with the local router, a peer sends an open message, which contains a hold-time value. BGP on the local router uses the smaller of either the local hold-time value or the peer's hold-time value received in the open message as the hold time for the BGP connection between the two peers.

To modify the hold-time value on the local BGP system, include the **hold-time** statement:

```
hold-time seconds;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

The default hold-time value is 90 seconds.

The range is 20 through 65,535 seconds.

The hold time is three times the interval at which keepalive messages are sent.

Configuring MTU Discovery

You can configure Transmission Control Protocol (TCP) path maximum transmission unit (MTU) discovery. MTU discovery improves convergence times for internal BGP sessions.

To configure MTU discovery, include the `mtu-discovery` statement:

```
mtu-discovery;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Configuring Graceful Restart

Graceful restart is disabled by default. You can globally enable graceful restart for all routing protocols at the [edit routing-options] or [edit logical-systems *logical-system-name* routing-options] hierarchy levels.

To configure graceful restart specifically for BGP, include the `graceful-restart` statement:

```
graceful-restart {
  restart-time;
  stale-routes-time;
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.



NOTE: Configuring graceful restart for BGP resets the BGP peer routing statistics to zero.

To disable graceful restart for BGP, specify the `disable` statement. To configure a time period to complete restart, specify the `restart-time` statement. To configure a time period over which to keep stale routes during a restart, specify the `stale-routes-time` statement.

Advertising an Explicit Null Label

You can advertise an explicit null label (label 0) out of the egress for a label-switch path (LDP). By default, the router advertises label 3. Enabling explicit null allows the router to send out label 0. Advertising explicit null labels is used for peers in the same BGP group.

Configure the `labeled-unicast` statement with the `explicit-null` option. As with regular BGP configuration, the `family` statement can be specified.

Configure the `labeled-unicast` statement as follows:

```
family inet {
```

```

labeled-unicast {
  aggregate-label {
    community community-name;
  }
  explicit-null {
    connected-only;
  }
}

```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Specify the **connected-only** statement to advertise explicit null labels between connected routes only (direct routes and loopback routes).



NOTE: The **connected-only** statement is required to advertise explicit null labels.



NOTE: Explicit null labels are supported for the IPv4 (**inet**) family only.

Configuring Aggregate Labels for VPNs

Aggregate labels for VPNs allow a Juniper Networks routing platform to aggregate a set of incoming labels (labels received from a peer router) into a single forwarding label that is selected from the set of incoming labels. The single forwarding label corresponds to a single next hop for that set of labels.

For a set of labels to share a single forwarding label, they must belong to the same forwarding equivalence class (FEC). The labeled packets must have the same destination egress interface.

To configure aggregate labels for VPNs, include the **aggregate-label** statement:

```

aggregate-label {
  community community-name;
}

```

For a list of hierarchy levels at which you can include the **aggregate-label** statement, see the statement summary for this statement.

Configuring Authentication

All BGP protocol exchanges can be authenticated to guarantee that only trusted routers participate in the AS's routing. By default, authentication is disabled on the router. You can configure MD5 authentication on the router. The MD5 algorithm creates an encoded checksum that is included in the transmitted packet. The receiving router uses an authentication key (password) to verify the packet's MD5 checksum.

To configure an MD5 authentication key, include the **authentication-key** statement:

authentication-key key;

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

If you configure authentication for all peers, each individual peer in that group inherits the group's authentication.

The key (password) can be up to 126 characters long. Characters can include any ASCII strings. If you include spaces, enclose all characters in quotation marks (double quotes).

You can update MD5 authentication keys without resetting any BGP peering sessions. This is referred to as hitless authentication key rollover. Hitless authentication key rollover uses authentication key chains, which consist of the authentication keys that are being updated.

Hitless authentication key rollover also allows users to choose the algorithm through which authentication is established. The user associates a key chain and an authentication algorithm with a BGP neighboring session. The key chain includes multiple keys. Each key contains an identifier and a secret. The key is also configured with a unique start time and an end time.

The sending peer chooses the active key based on the system time. The receiving peer determines the key with which it authenticates based upon the incoming key identifier.

To configure the authentication key, include the **key-chain** statement at the [edit **security authentication-key-chains**] hierarchy level, and specify the **key** option to create a key chain consisting of several authentication keys.

```
[edit security]
authentication-key-chains {
  key-chain key-chain-name {
    key key {
      secret secret-data;
      start-time yyyy-mm-dd.hh:mm:ss;
    }
  }
}
```

You can configure multiple keys within the key chain.

Each key within a key chain must be identified by a unique integer value configured in the **key** statement. The range of valid identifier values is from 0 through 63. Each key must specify a secret. This secret can be entered in either encrypted or plain text format in the **secret** statement. It is always displayed in encrypted format.

Each key must specify a start time with the **start-time** statement. Start times are specified in the local time zone for a router and must be unique within the key chain.

For more information on configuring authentication key chains, see the *JUNOS System Basics Configuration Guide*.

To apply an authentication key chain to the router, include the `authentication-key-chain` statement:

```
authentication-key-chain key-chain;
```

To specify the authentication algorithm type to use for key chains, include the `authentication-algorithm` statement:

```
authentication-algorithm algorithm;
```

You can choose either `md5` or `hmac-sha-1-96` as the type of algorithm.



NOTE: BGP authentication is not supported with promiscuous mode BGP sessions. If you include the `allow` statement, you cannot include `authentication-key` or `authentication-key-chain` at the same hierarchy level or any higher hierarchy level. When configuring authentication for all peers in a group, you cannot include the `allow` statement in the configuration because BGP keys require a destination address.

For a list of hierarchy levels at which you can include the previous statements, see the statement summary for those statements.

Applying IPsec Security Association

You can apply IPsec to BGP traffic. IPsec is a protocol suite used for protecting IP traffic at the packet level. IPsec is based on security associations (SAs). A security association is a simplex connection that provides security services to the packets carried by the SA. After configuring the security association, you can apply the SA to BGP peers.

To apply a security association, include the `ipsec-sa` statement:

```
ipsec-sa ipsec-sa;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement. The security association is identified by the SA name.



NOTE: Tunnel mode requires the ES PIC.

In transport mode, the JUNOS software does not support authentication header (AH) or encapsulating security payload (ESP) header bundles.

The JUNOS software supports only BGP in transport mode.

A more specific security association overrides a less general SA. For example, if a specific SA is applied to a specific peer, that SA overrides the SA applied to the whole peer group.

For more detailed information about configuring IPsec security associations, see the *JUNOS System Basics Configuration Guide*.

Opening a Peer Connection Passively

You can configure a router not to send Open requests to a peer. Once you configure the router to be passive, the router does not originate the TCP connection. However, when the router receives a connection from the peer and an Open message, it replies with another BGP Open message. Each router declares its own capabilities.

To configure the router so that it does not send Open requests to a peer, include the **passive** statement:

```
passive;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Configuring the Local IP Address

You can specify the address of the local end of a BGP session. You generally do this to explicitly configure the system's IP address from BGP's point of view. This IP address can be either an IPv6 or IPv4 address. Typically, an IP address is assigned to a loopback interface, and that IP address is configured here. This address is used to accept incoming connections to the peer and to establish connections to the remote peer. To assign a local address, include the **local-address** statement:

```
local-address address;
```



NOTE: A BGP session can still be established when only one of the paired routers has a local address configured.

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

If you include the **default-address-selection** statement in the configuration, the software chooses the system default address as the source for most locally generated IP packets. For more information, see the *JUNOS System Basics Configuration Guide*. For protocols in which the local address is unconstrained by the protocol specification, for example IBGP and multihop EBGP, if you do not configure a specific local address when configuring the protocol, the local address is chosen using the same methods as other locally generated IP packets.

Configuring the Multiple Exit Discriminator Metric

The BGP multiple exit discriminator (MED, or MULTI_EXIT_DISC) is an optional path attribute that can be included in BGP update messages. This attribute is used on external BGP links (that is, on inter-AS links) to select among multiple exit points to a neighboring AS. The MED attribute has a value that is referred to as a *metric*. If all

other factors in determining an exit point are equal, the exit point with the lowest metric is preferred.

If a MED is received over an external BGP link, it is propagated over internal links to other BGP systems within the AS.

BGP update messages include a MED metric if the route was learned from BGP and already had a MED metric associated with it, or if you configure the MED metric in the configuration file in one of the following ways:

- Defining a MED Metric Directly on page 664
- Using Routing Policy to Define a MED Metric on page 665
- Examples: Configuring the MED Metric on page 666

For configuration examples, see “Examples: Configuring the MED Metric” on page 666.

A MED metric is advertised with a route according to the following general rules:

- A more specific metric overrides a less specific metric. That is, a group-specific metric overrides a global BGP metric and a peer-specific metric overrides a global BGP or group-specific metric.
- A metric defined with routing policy overrides a metric defined with the `metric-out` statement.
- If any metric is defined, it overrides a metric received in a route.
- If the received route does not have an associated MED metric, and if you do not explicitly configure a metric value, no metric is advertised. When you do not explicitly configure a metric value, the MED is equivalent to zero (0) when advertising an active route.

For a description of the algorithm used to determine the active path, see “How the Active Route Is Determined” on page 7.

Defining a MED Metric Directly

To directly configure a MED metric to advertise in BGP update messages, include the `metric-out` statement:

```
metric-out (metric | minimum-igp offset | igp delay-med-update | offset);
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

metric is the primary metric on all routes sent to peers. It can be a value in the range from 0 through $2^{32} - 1$.

Specify `minimum-igp` to set the metric to the minimum metric value calculated in the IGP to get to the BGP next hop. If a newly calculated metric is greater than the minimum metric value, the metric value remains unchanged. If a newly calculated metric is lower, the metric value is lowered to that value.

Specify **igp** to set the metric to the most recent metric value calculated in the IGP to get to the BGP next hop.

Beginning with JUNOS Release 9.0, you can also specify for a BGP group or peer configured with the **metric-out igp** statement to delay sending MED updates when the MED value increases. Include the **delay-med-update** statement when you configure the **igp** statement. The default interval to delay sending updates unless the MED is lower or another attribute associated with the route has changed is 10 minutes. Include the **med-igp-update-interval minutes** statement at the [edit routing-options] hierarchy level to modify the default interval. For information, see “Configuring a Timer to Delay Multiple Exit Discriminator IGP Updates” on page 122.

Specify a value for **offset** to increase or decrease the metric that is used from the metric value calculated in the IGP. The metric value is offset by the value specified. The metric calculated in the IGP (by specifying either **igp** or **igp-minimum**) is increased if the **offset** value is positive. The metric calculated in the IGP (by specifying either **igp** or **igp-minimum**) is decreased if the **offset** value is negative.

offset can be a value in the range from -2^{31} through $2^{31} - 1$. Note that the adjusted metric can never go below 0 or above $2^{32} - 1$.

Using Routing Policy to Define a MED Metric

To use routing policy to define a MED metric to advertise, define the routing policy by including the **policy-statement** statement at the [edit policy-options] hierarchy level, and then apply the filter by including the **import** and **export** statements when configuring BGP.

When defining the routing policy filter, include an action that specifies the desired metric value:

```
policy-statement policy-name {
  term term-name {
    from {
      match-conditions;
      route-filter destination-prefix match-type <actions>;
      prefix-list name;
    }
    to {
      match-conditions;
    }
    then actions;
  }
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

For information about defining routing policy, see the *JUNOS Policy Framework Configuration Guide*. For information about applying filters in BGP, see “Configuring BGP Routing Policy” on page 696.

Examples: Configuring the MED Metric

Set the MED metric to 20 for all routes advertised in BGP update messages except for those sent to the peer system 192.168.0.1; the MED for this peer is 10:

```
[edit]
routing-options {
  router-id 10.0.0.1;
  autonomous-system 23;
}
protocols {
  bgp {
    metric-out 20;
    group 23 {
      type external;
      peer-as 56;
      neighbor 192.168.0.1 {
        traceoptions {
          file bgp-log-peer;
          flag packets;
        }
        log-updown;
        metric-out 10;
      }
    }
  }
}
```

Set the MED metric to 20 for all routes from a particular community:

```
[edit]
routing-options {
  router-id 10.0.0.1;
  autonomous-system 23;
}
policy-options {
  policy-statement from-otago {
    from community otago;
    then metric 20;
  }
  community otago members [56:2379 23:46944];
}
protocols {
  bgp {
    import from-otago;
    group 23 {
      type external;
      peer-as 56;
      neighbor 192.168.0.1 {
        traceoptions {
          file bgp-log-peer;
          flag packets;
        }
        log-updown;
      }
    }
  }
}
```

```
}
}
```

Controlling the Aggregator Path Attribute

The JUNOS implementation of BGP performs route aggregation, which is the process of combining the characteristics of different routes so that only a single route is advertised. Aggregation reduces the amount of information that BGP must store and exchange with other BGP systems.

BGP adds the aggregator path attribute to BGP update messages. This attribute contains the local system's AS number and IP address (router ID).

To prevent different routers within an AS from creating aggregate routes that contain different AS paths, set the IP address in the aggregator path attribute to 0 by including the `no-aggregator-id` statement:

```
no-aggregator-id;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Configuring an EBGP Multihop Session

If an EBGP peer is more than one hop away from the local router, you must specify the next hop to the peer so that the two systems can establish a BGP session. This type of session is called a *multihop* BGP session. To configure a multihop session, include the `multihop` statement:

```
multihop {
  <ttl-value>;
  no-nexthop-change;
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

To configure the maximum time-to-live (TTL) value for the TTL in the IP header of BGP packets, specify *ttl-value*. If you do not specify a TTL value, the system's default maximum TTL value is used. To specify not to change the BGP next-hop value for route advertisements, specify the `no-nexthop-change` option.

Configuring a Single-Hop EBGP Peer to Accept a Remote Next Hop

In some situations, it is necessary to configure a single-hop EBGP peer to accept a remote next hop with which it does not share a common subnet. The default behavior is for any next-hop address received from a single-hop EBGP peer that is not recognized as sharing a common subnet to be discarded. The ability to have a single-hop EBGP peer accept a remote next hop to which it is not directly connected also prevents you from having to configure the single-hop EBGP neighbor as a multihop session. When you configure a multihop session in this situation, all next-hop routes learned through this EBGP peer are labeled indirect even when they do share

a common subnet. This situation breaks multipath functionality for routes that are recursively resolved over routes that include these next-hop addresses. Configuring the `accept-remote-nexthop` statement allows next-hop routes that share a common subnet to be installed as direct, which restores multipath functionality for routes that are resolved over these next-hop addresses. Both the remote next-hop and the EBGp peer must support BGP route refresh as defined in RFC 2918, *Route Refresh Capability in BGP-4*. If the remote peer does not support BGP route refresh, the session is reset.



NOTE: You cannot configure both the `multihop` and `accept-remote-nexthop` statements for the same EBGp peer.

When you enable a single-hop EBGp peer to accept a remote next hop, you must also configure an import routing policy on the EBGp peer that specifies the remote next-hop address. For more information about how to configure a BGP routing policy, see “Configuring BGP Routing Policy” on page 696 and the *JUNOS Policy Framework Configuration Guide*.

To enable a single-hop EBGp peer to accept a remote next hop, include the `accept-remote-nexthop` statement:

```
accept-remote-nexthop;
```

You can configure this statement at the global, group, and neighbor hierarchy levels for BGP. The statement is also supported on logical systems and the VPN routing and forwarding (VRF) routing instance type. For a complete list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Example: Configure an Import Routing Policy for an EBGp Peer to Accept a Remote Next Hop

Configure an import routing policy, `agg_route`, that enables a single-hop external BGP peer to accept the remote next-hop 1.1.10.10. At the `[edit protocols bgp]` hierarchy level, include the `import agg_route` statement to apply the policy to the external BGP peer and include the `accept-remote-nexthop` statement to enable the single-hop EBGp peer to accept the remote next hop.

```
policy-options {
  policy-statement agg_route {
    term 1 {
      from {
        protocol bgp;
        route-filter 1.1.230.0/23 exact;
      }
      then {
        next-hop 1.1.10.10;
        accept;
      }
    }
  }
}
protocols {
```

```

bgp {
    accept-remote-nexthop;
    group ext {
        type external;
        import agg_route;
        peer-as 65001;
        multipath;
        neighbor 1.1.0.1;
        neighbor 1.1.1.1;
    }
    group int {
        type internal;
        local-address 10.255.71.24;
        neighbor 10.255.14.177;
    }
}

```

Configuring the BGP Local Preference

Internal BGP sessions use a metric called the *local preference*, which is carried in internal BGP update packets in the path attribute **LOCAL_PREF**. This metric indicates the degree of preference for an external route. The route with the highest local preference value is preferred.

The **LOCAL_PREF** path attribute is always advertised to internal BGP peers and to neighboring confederations. It is never advertised to external BGP peers. The default behavior is to not modify the **LOCAL_PREF** path attribute if it is present.



NOTE: The **LOCAL_PREF** path attribute applies at export time only.

By default, if a received route contains a **LOCAL_PREF** path attribute value, the value is not modified. If a BGP route is received without a **LOCAL_PREF** attribute, the route is handled locally (that is, it is stored in the routing table and advertised by BGP) as if it were received with a **LOCAL_PREF** value of 100. A non-BGP route that is advertised by BGP is advertised with a **LOCAL_PREF** value of 100 by default.

To change the local preference metric advertised in the path attribute, include the **local-preference** statement, specifying a value from 0 through 4,294,967,295 ($2^{32}-1$):

```
local-preference local-preference;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Controlling Route Preference

When the JUNOS software determines a route's preference to become the active route, it selects the route with the lowest preference as the active route and installs this route into the forwarding table. By default, the routing software assigns a preference of 170 to routes that originated from BGP. Of all the routing protocols,

BGP has the highest default preference value, which means that routes learned by BGP are the least likely to become the active route. (For more information about preferences, see “Route Preferences” on page 6.)

To modify the default BGP preference value, include the **preference** statement, specifying a value from 0 through 4,294,967,295 ($2^{32} - 1$):

```
preference preference;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Examples: Controlling Route Preference

Assign a preference of 160 to routes learned from the BGP system 192.168.1.1. The routing protocol process will prefer these routes over routes learned from other BGP systems, which have the default preference of 170.

```
[edit]
routing-options {
  autonomous-system 23;
}
protocols {
  bgp {
    group 23 {
      type external;
      peer-as 56;
      neighbor 192.168.1.1 {
        preference 160;
      }
    }
  }
}
```

Assign a preference of 140 to all routes learned by BGP systems. Because the default OSPF preference is 150, BGP routes will be preferred over those learned from OSPF.

```
[edit]
routing-options {
  autonomous-system 23;
}
protocols {
  bgp {
    preference 140;
    group 23 {
      type external;
      peer-as 56;
      neighbor 192.168.1.1;
    }
  }
}
```

Configuring Routing Table Path Selection

By default, only the MEDs of routes that have the same peer ASs are compared. You can configure routing table path selection options to get different behaviors. To configure routing table path selection behavior, include the `path-selection` statement:

```
path-selection {
  (cisco-non-deterministic | always-compare-med | external-router-id);
  med-plus-igp {
    igp-multiplier number;
    med-multiplier number;
  }
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Routing table path selection can be configured in one of the following ways:

- Using the same nondeterministic behavior as does the Cisco IOS software (`cisco-non-deterministic`). This behavior has two effects:
 - The active path is always first. All nonactive, but eligible, paths follow the active path and are maintained in the order in which they were received, with the most recent path first. Ineligible paths remain at the end of the list.
 - When a new path is added to the routing table, path comparisons are made without removing from consideration those paths that should never be selected because those paths lose the MED tie-breaking rule.

These two effects cause the system to only sometimes compare the MEDs between paths that it should otherwise compare. Because of this, we recommend that you not configure nondeterministic behavior.

- Always comparing MEDs whether or not the peer ASs of the compared routes are the same (`always-compare-med`).

For an example of always comparing MEDs, see “Example: Always Comparing MEDs” on page 671.

- Comparing the router ID between external BGP paths to determine the active path (`external-router-id`). By default, router ID comparison is not performed if one of the external paths is active.
- Adding the IGP cost to the next-hop destination to the MED before comparing MED values for path selection.

For a description of the algorithm used to determine the active path, see “How the Active Route Is Determined” on page 7.

Example: Always Comparing MEDs

In this example, paths learned from 208.197.169.15 have their MED values compared to the sum of 4 and the MED values of the same paths learned from 208.197.169.14:

```
[edit]
protocols {
  bgp {
    path-selection always-compare-med;
    group ref {
      type external;
      import math;
      peer-as 10458;
      neighbor 208.197.169.14;
    }
    group ref {
      type external;
      peer-as 10;
      neighbor 208.197.169.15;
    }
  }
}
policy-options {
  policy-statement math {
    then {
      metric add 4;
    }
  }
}
```

Configuring BGP to Select Multiple BGP Paths

You can configure BGP to select multiple equal-cost EBGP or IBGP paths as active paths. Selecting multiple paths allows BGP peerings to load-balance traffic across an AS-confederation boundary. The JUNOS BGP multipath supports the following:

- Load-balancing across multiple links between two routers belonging to different ASs
- Load-balancing across a common subnet or multiple subnets to different routers belonging to the same peer AS
- Load-balancing across multiple links between two routers belonging to different external confederation peers
- Load-balancing across a common subnet or multiple subnets to different routers belonging to external confederation peers

To configure a BGP multipath, include the **multipath** statement:

```
multipath {
  multiple-as;
}
```

To disable the default check requiring that paths accepted by BGP multipath must have the same neighboring AS, include the **multiple-as** option.

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Configuring a Local AS

You can configure BGP with a different local AS number for each EBGP session, which allows BGP to configure a local AS for each EBGP session. Configuring a local AS simulates a virtual AS for the router. The AS paths for the routes from that EBGP peer have the configured **local-as** prepended before the peer AS for that session. This is useful if ISP A has acquired another ISP B, but does not want to change the configurations of ISP B's customer routers. ISP B's AS is the AS that is configured as the local AS.



NOTE: If the local AS for the EBGP/IBGP peer is the same as the current AS, do not use the **local-as** statement to specify the local AS number.

To configure a local AS, include the **local-as** statement:

```
local-as autonomous-system <private>;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

For **autonomous-system**, you can specify a number from 1 through 4,294,967,295 in plain-number format. Beginning with JUNOS Release 9.1, the range for autonomous system (AS) numbers is extended to provide BGP support for 4-byte AS numbers as defined in RFC 4893, *BGP Support for Four-octet AS Number Space*. The JUNOS software continues to support 2-byte AS numbers.

Beginning with JUNOS Release 9.2, you can also configure a 4-byte AS number using the AS-dot notation format of two integer values joined by a period: *< 16-bit high-order value in decimal > . < 16-bit low-order value in decimal > .* For example, the 4-byte AS number of 65,546 in plain-number format is represented as 1.10 in the AS-dot notation format. You can specify a value in the range from 0.0 through 65535.65535. in AS-dot notation format.

If you include the **private** keyword, the local AS is not prepended before the peer AS. This means that the AS paths do not show details of such a configuration, and ISP A's EBGP peers and IBGP peers do not see any difference from before the local AS configuration.

Examples: Configuring a Local AS

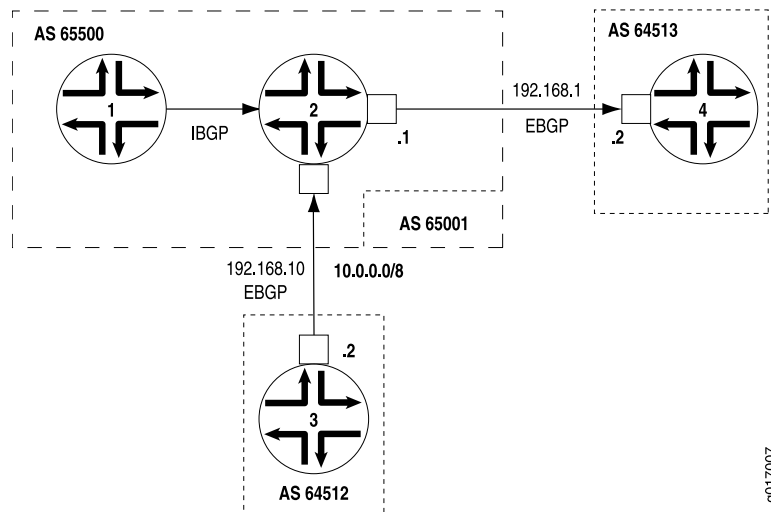
You can include the **local-as** statement to configure a router to use a different AS number than the one for which the router is configured. The local AS is used in all BGP protocol exchanges with the routers that are configured for simulating a virtual AS.



NOTE: If you configure the local AS values for any BGP group, the detection of routing loops is performed using both the AS and the local AS values for all BGP groups.

Use the `local-as` statement when ISPs merge and want to preserve a customer's configuration, particularly the AS the customer is configured to peer with. Use the `local-as` statement to simulate the AS number already in place in customer routers, even if the ISP's router is in a different AS now.

Figure 10: Local AS Configuration



In Figure 10 on page 674, Router 1 and Router 2 are in AS 65500, Router 4 is in AS 64513, and Router 3 is in AS 64512. Router 2 uses AS 65001 as its local AS.

Router 2 adds AS 65001 when announcing Router 1's routes to Router 3. Router 3 sees an AS path of 65001 65500 64512 for the prefix 10/8. To prevent Router 2 from adding the virtual AS number in its announcements to other peers, use the `local-as autonomous-system private` statement. The `local-as autonomous-system private` statement configures Router 2 to not include the virtual AS number configured in `local-as` when announcing Router 1's routes to Router 3. In this case, Router 3 sees an AS path of 65500 64512 for the prefix 10/8.

The configuration for each router follows.

On Router 1:

```

routing-options {
  autonomous-system 65500;
}
protocols {
  bgp {
    group internal-AS65500 {
      type internal;
      local-address 10.1.1.1;
      neighbor 10.1.1.2;
    }
  }
}

```

On Router 2:

```

routing-options {
  autonomous-system 65500;
}

```

```

}
protocols {
  bgp {
    group internal-AS65500 {
      type internal;
      local-address 10.1.1.2;
      neighbor 10.1.1.1;
    }
    group external-AS64513 {
      type external;
      peer-as 64513;
      neighbor 192.168.1.2;
    }
    group external-AS64512 {
      type external;
      peer-as 64512;
      neighbor 192.168.10.2;
    }
  }
}
}

On Router 3:
routing-options {
  autonomous-system 64512;
}
protocols {
  bgp {
    group external-AS65001 {
      type external;
      peer-as 65001;
      neighbor 192.168.10.1;
    }
  }
}

On Router 4:
routing-options {
  autonomous-system 64513;
}
protocols {
  bgp {
    group external-65500 {
      peer-as 65500;
      neighbor 192.168.1.1;
    }
  }
}
}

```

Removing Private AS Numbers from AS Paths

By default, when BGP advertises AS paths to remote systems, it includes all AS numbers, including private AS numbers. You can configure the software so that it removes private AS numbers from AS paths. Doing this is useful when all the following circumstances are true:

- A remote AS for which you provide connectivity is multihomed, but only to the local AS.

- The remote AS does not have an officially allocated AS number.
- It is not appropriate to make the remote AS a confederation member AS of the local AS.

To have the local system strip private AS numbers from the AS path, include the `remove-private` statement:

```
remove-private;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.



CAUTION: Changing configuration statements that affect BGP peerings, such as enabling or disabling `remove-private` or renaming a BGP group, resets the BGP sessions. Changes that affect BGP peerings should only be made when resetting a BGP session is acceptable.



NOTE: The `remote-private` statement is applicable only when advertising routers to another neighbor.

The AS numbers are stripped from the AS path starting at the left end of the AS path (the end where AS paths have been most recently added). This operation takes place after any confederation member ASs have already been removed from the AS path, if applicable.

The software is preconfigured with knowledge of the set of AS numbers that is considered private, a range that is defined in the Internet Assigned Numbers Authority (IANA) assigned numbers document. The set of AS numbers reserved as private are in the range from 64,512 through 65,534, inclusive.

Configuring Route Reflection

In standard internal BGP implementations, all BGP systems within the AS are fully meshed so that any external routing information is redistributed among all routers within the AS. This type of implementation can present scaling issues when an AS has a large number of internal BGP systems because of the amount of identical information that BGP systems must share with each other. Route reflection provides one means of decreasing BGP control traffic and minimizing the number of update messages sent within the AS.

In route reflection, BGP systems are arranged in *clusters*. Each cluster consists of at least one system that acts as a *route reflector*, along with any number of *client peers*. BGP peers outside the cluster are called *nonclient peers*. The route reflector reflects (redistributes) routing information to each client peer (*intracluster reflection*) and to all nonclient peers (*intercluster reflection*). Because the route reflector redistributes routes within the cluster, the BGP systems within the cluster do not have to be fully meshed.

When the route reflector receives a route, it selects the best path. Then, if the route came from a nonclient peer, the route reflector sends the route to all client peers within the cluster. If the route came from a client peer, the route reflector sends it to all nonclient peers and to all client peers except the originator. In this process, none of the client peers send routes to other client peers.

To configure route reflection, you specify a cluster identifier only on the BGP systems that are to be the route reflectors. These systems then determine, from the network reachability information they receive, which BGP systems are part of its cluster and are client peers, and which BGP systems are outside the cluster and are nonclient peers.

To configure a router to be a route reflector, you must do the following:

- Configure multiple IBGP groups.
- Configure a cluster identifier (using the `cluster` statement) for groups that are members of the cluster.
- Configure all the groups with the same IBGP AS number.

To configure the route reflector, include the following statements in the configuration:

```
group group-name {
    type internal;
    peer-as autonomous-system;
    neighbor address1;
    neighbor address2;
}
group group-name {
    type internal;
    peer-as autonomous-system;
    cluster cluster-identifier;
    neighbor address3;
    neighbor address4;
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

By default, the BGP route reflector performs intracluster reflection because it assumes that all the client peers are not fully meshed. However, if the client peers are fully meshed, intracluster reflection results in the sending of redundant route advertisements. In this case, you can disable intracluster reflection by including the `no-client-reflect` statement within the `group` statement:

```
group group-name {
    type internal;
    peer-as autonomous-system;
    cluster cluster-identifier;
    no-client-reflect;
    neighbor address3;
    neighbor address4;
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.



NOTE: BGP route reflection is not supported for VPN routing and forwarding (VRF) routing instances.

Examples: Configuring Route Reflection

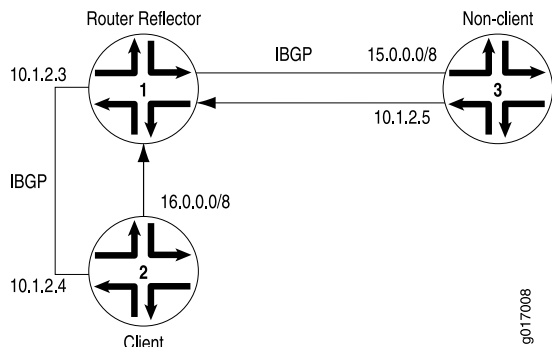
This example shows how to configure a simple route reflector. The configuration shown in Figure 11 on page 678 contains three routes: Router 1, which is the route reflector; Router 2, which is a client; and Router 3, which is a nonclient.

The routers have the following loopback addresses:

- Router 1—10.1.2.3
- Router 2—10.1.2.4
- Router 3—10.1.2.5

You must configure all routers to run a common IGP or to have static configuration, so that they learn each other's loopback addresses.

Figure 11: Simple Route Reflector



Configure Router 1 to be a route reflector for Router 2 and a regular IBGP neighbor for Router 3:

```
[edit]
routing-options {
  autonomous-system 65534;
}
protocols {
  bgp {
    group 13 {
      type internal;
      local-address 10.1.2.3;
      neighbor 10.1.2.5;
    }
    group 12 {
```

```

        type internal;
        local-address 10.1.2.3;
        cluster 1.2.3.4;
        neighbor 10.1.2.4;
    }
}

```

Configure Router 2 to be an IBGP neighbor to Router 1 and announce 16.0.0.0/8 to Router 1. Configure route 16.0.0.0/8 as a static route on Router 2.

```

[edit]
routing-options {
    static {
        route 16.0.0.0/8 nexthop 172.16.1.2;
    }
    autonomous-system 65534;
}
protocols {
    bgp {
        group 21 {
            type internal;
            local-address 10.1.2.4;
            export dist-static;
            neighbor 10.1.2.3;
        }
    }
}
policy-options {
    policy-statement dist-static {
        from protocol static;
        then accept;
    }
}

```

Configure Router 3 to be an IBGP neighbor to Router 1 and announce 15.0.0.0/8 to Router 1. Configure route 15.0.0.0/8 as a static route on Router 3.

```

[edit]
routing-options {
    static {
        route 15.0.0.0/8 nexthop 172.16.1.2;
    }
    autonomous-system 65534;
}
protocols {
    bgp {
        group 31 {
            type internal;
            local-address 10.1.2.5;
            export dist-static;
            neighbor 10.1.2.3;
        }
    }
}
policy-options {

```

```

policy-statement dist-static {
    from protocol static;
    then accept;
}

```

The following is the output of the **show route detail** command for route 16.0.0.0/8 on Router 1 and Router 3. Note that Router 1 learns 16.0.0.0/8 from its client, Router 2, and reflects it to Router 3. On Router 3, the output of the **show route** commands include the cluster list and originator ID attributes, which are added by Router 1 when the route is reflected.

Router 1 user@router1> **show route 16.0.0.0/8 detail**
inet.0: 1 destinations, 1 routes (1 active, 0 holddown, 0 hidden)
+ = Active Route, - = Last Active, * = Both
16.0.0.0/8 (1 entry, 1 announced)
*BGP Preference: 170/-101
Source: 10.1.2.4
Nexthop: 172.16.1.2 via fxp0.0, selected
State: <Active Int Ext>
Local AS: 65534 Peer AS: 65534
Age: 11:55 Metric2: 0
Task: BGP_65534.10.1.2.4+4327
Announcement bits (3): 2-KRT 3-BGP.0.0.0.0+179 4-BGP_Sync_Any
AS path: I
BGP next hop: 172.16.1.2
Localpref: 100
Router ID: 10.1.2.4

Router 3 user@router3> **show route 16.0.0.0/8 detail**
inet.0: 1 destinations, 1 routes (1 active, 0 holddown, 0 hidden)
+ = Active Route, - = Last Active, * = Both
16.0.0.0/8 (1 entry, 1 announced)
*BGP Preference: 170/-101
Source: 10.1.2.3
Nexthop: 172.16.1.2 via fxp0.0, selected
State: <Active Int Ext>
Local AS: 65534 Peer AS: 65534
Age: 11:57 Metric2: 0
Task: BGP_65534.10.1.2.3+4619
Announcement bits (2): 2-KRT 4-BGP_Sync_Any
AS path: I <Originator>
Cluster list: 1.2.3.4
Originator ID: 10.1.2.4
BGP next hop: 172.16.1.2
Localpref: 100
Router ID: 10.1.2.3

The following is the output of the **show route detail** command for route 15.0.0.0/8 on router 1 and router 2. Similar to when routes are reflected from client peers to nonclient peers, router 1 reflects a route it learns from a regular IBGP neighbor to its client. Cluster list and Originator ID attributes are added during the reflection process.

Router 1 user@router1> **show route 15.0.0.0/8 detail**
inet.0: 1 destinations, 1 routes (1 active, 0 holddown, 0 hidden)
+ = Active Route, - = Last Active, * = Both
15.0.0.0/8 (1 entry, 1 announced)


```
*BGP Preference: 170/-101
Source: 10.1.2.5
Nexthop: 172.16.1.2 via fxp0.0, selected
State: <Active Int Ext>
Local AS: 65534 Peer AS: 65534
Age: 11:14 Metric2: 0
Task: BGP_65534.10.1.2.5+179
Announcement bits (3): 2-KRT 3-BGP.0.0.0.0+179 4-BGP_Sync_Any
AS path: I
BGP next hop: 172.16.1.2
Localpref: 100
Router ID: 10.1.2.5
```

```
Router 2 user@router2> show route 15.0.0.0/8 detail
inet.0: 1 destinations, 1 routes (1 active, 0 holddown, 0 hidden)
+ = Active Route, - = Last Active, * = Both
15.0.0.0/8 (1 entry, 1 announced)
*BGP Preference: 170/-101
Source: 10.1.2.3
Nexthop: 172.16.1.2 via fxp0.0, selected
State: <Active Int Ext>
Local AS: 65534 Peer AS: 65534
Age: 11:23 Metric2: 0
Task: BGP_65534.10.1.2.3+179
Announcement bits (2): 2-KRT 4-BGP_Sync_Any
AS path: I <Originator>
Cluster list: 1.2.3.4
Originator ID: 10.1.2.5
BGP next hop: 172.16.1.2
Localpref: 100
Router ID: 10.1.2.3
```

Enabling Route Flap Damping

BGP *route flapping* describes the situation in which BGP systems send an excessive number of update messages to advertise network reachability information. BGP *flap damping* is a method of reducing the number of update messages sent between BGP peers, thereby reducing the load on these peers, without adversely affecting the route convergence time for stable routes.

By default, route flap damping is disabled. To enable it, include the **damping** statement:

```
damping;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Damping is applied to external peers and to peers at confederation boundaries. For finer control over which peers have damping enabled, include the **damping** statement at the [edit protocols bgp group *group-name*] hierarchy level.

By default, route flap damping uses the following parameters:

- Decay half-life while reachable—15 minutes
- Maximum hold-down time—60 minutes

- Reuse threshold—750
- Cutoff threshold—3000

To change these default parameters, you must define the flap damping parameters by including the **damping** statement at the [edit policy-options] hierarchy level and then apply them by including an **import** statement when configuring BGP. For more information about flap damping and defining flap damping parameters, see the *JUNOS Policy Framework Configuration Guide*. For more information about applying policy filters in BGP, see “Configuring BGP Routing Policy” on page 696.

Enabling Multiprotocol BGP

Multiprotocol BGP (MP-BGP) is an extension to BGP that enables BGP to carry routing information for multiple network layers and address families. MP-BGP can carry the unicast routes used for multicast routing separately from the routes used for unicast IP forwarding.

To enable MP-BGP, you configure BGP to carry network layer reachability information (NLRI) for address families other than unicast IPv4 by including the **family inet** statement:

```
family inet {
  (any | flow | labeled-unicast | multicast | unicast) {
    prefix-limit {
      maximum number;
      teardown <percentage> <idle-timeout (forever | minutes)>;
    }
    accepted-prefix-limit {
      maximum number;
      teardown <percentage> <idle-timeout (forever | minutes)>;
    }
    rib-group group-name;
  }
}
```

To enable MP-BGP to carry NLRI for the IPv6 address family, include the **family inet6** statement:

```
family inet6 {
  (any | labeled-unicast | multicast | unicast) {
    accepted-prefix-limit {
      maximum number;
      teardown <percentage> <idle-timeout (forever | minutes)>;
    }
    prefix-limit {
      maximum number;
      teardown <percentage> <idle-timeout (forever | minutes)>;
    }
    rib-group group-name;
  }
}
```

To enable MP-BGP to carry Layer 3 VPN NLRI for the IPv4 address family, include the `family inet-vpn` statement:

```
family inet-vpn {
  (any | flow | multicast | unicast) {
    accepted-prefix-limit {
      maximum number;
      teardown <percentage> <idle-timeout (forever | minutes)>;
    }
    prefix-limit {
      maximum number;
      teardown <percentage> <idle-timeout (forever | minutes)>;
    }
    rib-group group-name;
  }
}
```

To enable MP-BGP to carry Layer 3 VPN NLRI for the IPv6 address family, include the `family inet6-vpn` statement:

```
family inet6-vpn {
  (any | multicast | unicast) {
    accepted-prefix-limit {
      maximum number;
      teardown <percentage> <idle-timeout (forever | minutes)>;
    }
    prefix-limit {
      maximum number;
      teardown <percentage> <idle-timeout (forever | minutes)>;
    }
    rib-group group-name;
  }
}
```

To enable MP-BGP to carry multicast VPN NLRI for the IPv4 address family and to enable VPN signaling, include the `family inet-mvpn` statement:

```
family inet-mvpn {
  signaling {
    accepted-prefix-limit {
      maximum number;
      teardown <percentage> <idle-timeout (forever | minutes)>;
    }
    prefix-limit {
      maximum number;
      teardown <percentage> <idle-timeout (forever | minutes)>;
    }
  }
}
```

To enable MP-BGP to carry multicast VPN NLRI for the IPv6 address family and to enable VPN signaling, include the `family inet6-mvpn` statement:

```
family inet6-mvpn {
  signaling {
    accepted-prefix-limit {
```

```

        maximum number;
        teardown <percentage> <idle-timeout (forever | minutes)>;
    }
    prefix-limit {
        maximum number;
        teardown <percentage> <idle-timeout <forever | minutes>;
    }
}

```

For more information about multiprotocol BGP-based multicast VPNs, see the *JUNOS VPNs Configuration Guide* and the *JUNOS Multicast Protocols Configuration Guide*.

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.



NOTE: If you change the address family specified in the [edit bgp family inet] hierarchy level, the BGP sessions are dropped and then reestablished.

By default, BGP peers carry only unicast routes used for unicast forwarding purposes. To configure BGP peers to carry only multicast routes, specify the **multicast** option. To configure BGP peers to carry both unicast and multicast routes, specify the **any** option.

When MP-BGP is configured, BGP installs the MP-BGP routes into different routing tables. Each routing table is identified by the protocol family or address family indicator (AFI) and a subaddress family indicator (SAFI).

The JUNOS software supports all unicast and multicast SAFIs (1 and 2) for both AFI 1 (IPv4) and AFI 2 (IPv6). The following table shows all possible AFI and SAFI combinations and routing tables populated with this information:

	SAFI 1	SAFI 2
AFI 1 (IPv4)	inet.0	inet.2
AFI 2 (IPv6)	inet6.0	inet6.2

If peers are not MP-BGP, you cannot export routes from inet.2 to them, only routes in the inet.0 routing table. Routes in inet.2 can be sent only to MP-BGP peers, since they are sent with subaddress family information that identifies them as routes to multicast sources. The inet.2 table should be a subset of the routes that you have in inet.0, since it is unlikely that you would have a route to a multicast source to which you could not send unicast traffic.

The inet.2 routing table is used to keep the unicast routes that are used for multicast reverse-path-forwarding checks. You automatically get an inet.2 routing table when you configure MP-BGP (by setting NLRI to any). The additional reachability information learned by MP-BGP from the NLRI multicast updates are placed in inet.2.

When you enable multiprotocol BGP, you can do the following:

- Limiting the Number of Prefixes Received on a BGP Peering Session on page 685
- Limiting the Number of Prefixes Accepted on a BGP Peering Session on page 685
- Configuring BGP Routing Table Groups on page 686
- Resolving Routes to PE Routers Located in Other ASs on page 687
- Allowing Labeled and Unlabeled Routes on page 687

Limiting the Number of Prefixes Received on a BGP Peering Session

You can limit the number of prefixes received on a BGP peering session, and log rate-limited messages when the number of injected prefixes exceeds a set limit. You can also tear down the peering when the number of prefixes exceeds the limit.

To configure a limit to the number of prefixes that can be received on a BGP session, include the `prefix-limit` statement:

```
prefix-limit {
    maximum number;
    teardown <percentage> <idle-timeout (forever | minutes)>;
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

For `maximum number`, specify a value in the range from 1 through 4,294,967,295. When the specified maximum number of prefixes is exceeded, a system log message is sent.

If you include the `teardown` statement, the session is torn down when the maximum number of prefixes is exceeded. If you specify a percentage, messages are logged when the number of prefixes exceeds that percentage of the specified maximum limit. After the session is torn down, it is reestablished in a short time (unless you include the `idle-timeout` statement). Then the session can be kept down for a specified amount of time, or forever. If you specify `forever`, the session is reestablished only after the you issue a `clear bgp neighbor` command.



NOTE: Beginning with JUNOS Release 9.2, you can alternatively configure a limit to the number of prefixes that can be accepted on a BGP peering session. For more information, see “Limiting the Number of Prefixes Accepted on a BGP Peering Session” on page 685.

Limiting the Number of Prefixes Accepted on a BGP Peering Session

Beginning with JUNOS Release 9.2, you can set a limit to the number of prefixes that can be accepted on a BGP peering session. When that specified limit is exceeded, a system log message is sent. You can also specify to reset the BGP session if the limit to the number of specified prefixes is exceeded.

To configure a limit to the number of prefixes that can be accepted on a BGP peering session, include the **accepted-prefix-limit** statement:

```
accepted-prefix-limit {
    maximum number;
    teardown <percentage> <idle-timeout (forever | minutes)>;
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

For maximum *number*, specify a value in the range from 1 through 4,294,967,295.

Include the **teardown** statement to specify to the reset the BGP peering session when the number of accepted prefixes exceeds the configured limit. You can also include a percentage value from 1 through 100 to have a system log message sent when the number of accepted prefixes exceeds that percentage of the maximum limit. By default a BGP session that is reset is reestablished within a short time. Include the **idle-timeout** statement to prevent the BGP session from being reestablished for a specified period of time. You can configure a timeout value from 1 through 2400 minutes. Include the **forever** option to prevent the BGP session from being reestablished until you issue the **clear bgp neighbor** command.



NOTE: When nonstop routing is enabled and a switchover to a backup Routing Engine occurs, BGP peers that are down are automatically restarted. The peers are restarted even if the **idle-timeout forever** statement is configured.



NOTE: Alternatively, you can configure a limit to the number of prefixes that can be received on a BGP peering session. For more information, see “Limiting the Number of Prefixes Received on a BGP Peering Session” on page 685.

Configuring BGP Routing Table Groups

When a BGP session receives a unicast or multicast NLRI, it installs the route in the appropriate table (**inet.0** or **inet6.0** for unicast, and **inet.2** or **inet6.2** for multicast). To add unicast prefixes to both the unicast and multicast tables, you can configure BGP routing table groups. This is useful if you cannot perform multicast NLRI negotiation.

To configure BGP routing table groups, include the **rib-group** statement:

```
rib-group group-name;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Resolving Routes to PE Routers Located in Other ASs

You can allow labeled routes to be placed in the `inet.3` routing table for route resolution. These routes are then resolved for provider edge (PE) router connections where the remote PE is located across another AS. For a PE router to install a route in the VRF routing instance, the next hop must resolve to a route stored within the `inet.3` table.

To resolve routes into the `inet.3` routing table, include the `resolve-vpn` statement:

```
resolve-vpn group-name;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Allowing Labeled and Unlabeled Routes

You can allow both labeled and unlabeled routes to be exchanged in a single session. The labeled routes are placed in the `inet.3` routing table, and both labeled and unlabeled unicast routes can be sent or received by the router.

To allow both labeled and unlabeled routes to be exchanged, include the `rib inet.3` statement:

```
rib inet.3;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Enabling BGP to Carry Flow-Specification Routes

You can allow BGP to carry flow-specification NLRI messages. Flow routes are encapsulated into the flow-specification NLRI and propagated through a network or VPNs, sharing filter-like information. Flow routes are an aggregation of match conditions and resulting actions for packets. They provide you with traffic filtering and rate-limiting capabilities much like firewall filters.

When you enable flow-specification routes, you can do the following:

- Configuring Flow-Specification Routes for IPv4 Unicast on page 687
- Configuring Flow-Specification Routes for Layer 3 VPNs on page 688

Configuring Flow-Specification Routes for IPv4 Unicast

To enable MP-BGP to carry flow-specification NLRI for the `inet` address family, include the `flow` statement:

```
flow;
```



NOTE: Unicast flow routes are supported for the default instance, VRF instances, and virtual-router instances only. Instance type is configured by including the `instance-type` statement at the `[edit routing-instance instance-name]` hierarchy level.

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Flow routes received using the BGP NLRI messages are validated before they are installed into the flow routing table `instance-name.inetflow.0`. The validation procedure is described in the Internet draft `draft-ietf-idr-flow-spec-00.txt`, *Dissemination of Flow Specification Rules*. You can bypass the validation process and use your own specific import policy.

To disable the validation procedure and use an import policy instead, include the `no-validate` statement at the `[edit protocols bgp group group-name family inet flow]` hierarchy level:

```
no-validate policy-name;
```

Configuring Flow-Specification Routes for Layer 3 VPNs

The VPN compares the route target extended community in the NLRI to the import policy. If there is a match, the VPN can start using the flow routes to filter and rate-limit packet traffic. Received flow routes are installed into the flow routing table `instance-name.inetflow.0`.

Flow routes can also be propagated throughout a VPN network and shared among VPNs, providing filter and rate-limiting capabilities.

To enable MP-BGP to carry flow-specification NLRI for the `inet-vpn` address family, include the `flow` statement at the `[edit protocols bgp group group-name family inet-vpn]` hierarchy level:

```
flow;
```



NOTE: VPN flow routes are supported for the default instance only. Instance type is configured by including the `instance-type` statement at the `[edit routing-instance instance-name]` hierarchy level.

Flow routes configured for VPNs with family `inet-vpn` are not automatically validated, so the `no-validate` statement is not supported at the `[edit protocols bgp group group-name family inet-vpn]` hierarchy level.

For more information on flow routes, see “Configuring a Flow Route” on page 95 and the Internet draft `draft-marques-idr-flow-spec-02.txt`, *Dissemination of Flow Specification Rules*.

Enabling BGP to Carry Connectionless Network Services Routes

Connectionless Network Services (CLNS) is a Layer 3 protocol similar to Internet Protocol version 4 (IPv4). CLNS uses network service access points (NSAPs) to address end systems. This allows for a seamless AS based on ISO NSAPs.



NOTE: CLNS is supported for the J-series Services Router only.

A single routing domain consisting of ISO NSAP devices are considered to be CLNS islands. CLNS islands are connected together by VPNs.

You can configure BGP to exchange ISO CLNS routes between PE routers connecting various CLNS islands in a VPN using multiprotocol BGP extensions. These extensions are the ISO VPN NLRIs.

To enable MP-BGP to carry CLNS VPN NLRIs, include the **iso-vpn** statement:

```
iso-vpn {
  unicast {
    prefix-limit number;
    rib-group group-name;
  }
}
```

To limit the number of prefixes from a peer, include the **prefix-limit** statement. To specify a routing table group, include the **rib-group** statement.

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Each CLNS network island is treated as a separate VRF instance on the PE router.

You can configure CLNS on the global level, group level, and neighbor level.

For information on CLNS, see “Configuring Support for Connectionless Network Services” on page 324 and the *J-series Services Router Advanced WAN Access Configuration Guide*.

For sample configurations, see the following sections:

- Example: Enabling CLNS Between Two Routers on page 689
- Example: Configuring CLNS Within a VPN on page 691

Example: Enabling CLNS Between Two Routers

Configure CLNS between two routers through a route reflector:

On Router 1:

```
[edit protocols bgp]
protocols {
  bgp {
    local-address 10.255.245.195;
```

```

    group pe-pe {
      type internal;
      neighbor 10.255.245.194 {
        family iso-vpn {
          unicast;
        }
      }
    }
  }
}
[edit routing-instances]
routing-instances {
  aaaa {
    instance-type vrf;
    interface fe-0/0/0.0;
    interface so-1/1/0.0;
    interface lo0.1;
    route-distinguisher 10.255.245.194:1;
    vrf-target target:11111:1;
    protocols {
      isis {
        export dist-bgp;
        no-ipv4-routing;
        no-ipv6-routing;
        clns-routing;
        interface all;
      }
    }
  }
}

```

On Router 2:

```

[edit protocols bgp]
protocols {
  bgp {
    group pe-pe {
      type internal;
      local-address 10.255.245.198;
      family route-target;
      neighbor 10.255.245.194 {
        family iso-vpn {
          unicast;
        }
      }
    }
  }
}
[edit routing-instances]
routing-instances {
  aaaa {
    instance-type vrf;
    interface lo0.1;
    interface so-0/1/2.0;
    interface so-0/1/3.0;
    route-distinguisher 10.255.245.194:1;
    vrf-target target:11111:1;
    routing-options {

```

```

        rib aaaa.iso.0 {
            static {
                iso-route 47.0005.80ff.f800.0000.bbbb.1022/104 next-hop
                    47.0005.80ff.f800.0000.aaaa.1000.1921.6800.4196.00;
            }
        }
    }
    protocols {
        isis {
            export dist-bgp;
            no-ipv4-routing;
            no-ipv6-routing;
            clns-routing;
            interface all;
        }
    }
}

On Route Reflector:
[edit protocols bgp]
protocols {
    bgp {
        group pe-pe {
            type internal;
            local-address 10.255.245.194;
            family route-target;
            neighbor 10.255.245.195 {
                cluster 0.0.0.1;
            }
            neighbor 10.255.245.198 {
                cluster 0.0.0.1;
            }
        }
    }
}

```

Example: Configuring CLNS Within a VPN

Configure CLNS on three PE routers within a VPN:

```

On PE Router 1:
[edit protocols bgp]
protocols {
    mpls {
        interface all;
    }
    bgp {
        group asbr {
            type external;
            local-address 10.245.245.3;
            neighbor 10.245.245.1 {
                multihop;
                family iso-vpn {
                    unicast;
                }
            }
        }
    }
}

```

```

        peer-as 200;
    }
}
}
[edit routing-instances]
routing-instances {
  aaaa {
    instance-type vrf;
    interface lo0.1;
    interface t1-3/0/0.0;
    interface fe-5/0/1.0;
    route-distinguisher 10.245.245.1:1;
    vrf-target target:11111:1;
    protocols {
      isis {
        export dist-bgp;
        no-ipv4-routing;
        no-ipv6-routing;
        clns-routing;
        interface all;
      }
    }
  }
}

```

On PE Router 2:

```

[edit protocols bgp]
protocols {
  bgp {
    group asbr {
      type external;
      multihop;
      family iso-vpn {
        unicast;
      }
      neighbor 10.245.245.2 {
        peer-as 300;
      }
      neighbor 10.245.245.3 {
        peer-as 100;
      }
    }
  }
}
[edit routing-instances]
routing-instances {
  aaaa {
    instance-type vrf;
    interface lo0.1;
    route-distinguisher 10.245.245.1:1;
    vrf-target target:11111:1;
  }
}

```

On PE Router 3:

```

[edit protocols bgp]
protocols {

```

```

bgp {
  group asbr {
    type external;
    multihop;
    local-address 10.245.245.2;
    neighbor 10.245.245.1 {
      family iso-vpn {
        unicast;
      }
    }
    peer-as 200;
  }
}
[edit routing-instances]
routing-instances {
  aaaa {
    instance-type vrf;
    interface lo0.1;
    interface fe-0/0/1.0;
    interface t1-3/0/0.0;
    route-distinguisher 10.245.245.1:1;
    vrf-target target:11111:1;
    protocols {
      isis {
        export dist-bgp;
        no-ipv6-routing;
        clns-routing;
        interface all;
      }
    }
  }
}

```

Enabling Route Target Filtering

You can limit the number of prefixes advertised on BGP peerings specifically to the peers that need the updates.

In a VPN provider network, a BGP speaker advertises all VPN routes to the peers in the same VPN. Peers that are configured either as a route reflector or border router for a VPN must store all routes within the network. While PE routers automatically discard routes that do not affect them, these route updates must still be generated and received.

Enabling route target filtering allows you to limit these route updates.

To enable route target filtering, include the **route-target** statement:

```

route-target {
  advertise-default;
  external-paths number;
  prefix-limit {
    maximum number;
  }
}

```

```

        teardown <percentage> <idle-timeout (forever | minutes)>;
    }
}

```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

If you include the **advertise-default** statement, the router advertises the default route-target route (0:0:0/0) and suppresses any specific route-target routes. This is useful for a route reflector in a BGP group consisting of neighbor PE routers only. If you include the **external-paths** statement, the router limits the number of external paths accepted for route filtering. The range is from 1 through 16. The default is 1. If you include the **teardown** statement, the session is torn down when the maximum number of prefixes is reached. If you specify a percentage, messages are logged when the number of prefixes reaches that percentage. Once the session is torn down, it is reestablished in a short time. Include the **idle-timeout** statement to keep the session down for a specified amount of time, or forever. If you specify **forever**, the session is reestablished only after you use the **clear bgp neighbor** command.

For more information about VPNs, see the *JUNOS VPNs Configuration Guide*.

Configuring Prefix-Based Outbound Route Filtering

You can configure a BGP peer to accept route filters from remote peers and perform outbound route filtering using the received filters. By filtering out unwanted updates, the sending peer saves resources needed to generate and transmit updates, and the receiving peer saves resources needed to process updates. This feature can be useful, for example, in a virtual private network (VPN) in which subsets of customer edge (CE) devices are not capable of processing all the routes in the VPN. The CE's can use prefix-based outbound route filtering to communicate to the Provider Edge (PE) router to transmit only a subset of routes, such as routes to the main data centers only.

To configure prefix-based outbound route filtering, include the following statements:

```

outbound-route-filter {
  <bgp-orf-cisco-mode>;
  prefix-based {
    accept {
      (inet | inet6);
    }
  }
}

```

For a complete list of hierarchy levels at which you can configure these statements, see the statement summaries for these statements.



NOTE: The maximum number of prefix-based outbound route filters that a BGP peer can accept is 5000. If a remote peer sends more than 5000 outbound route filters to a peer address, the additional filters are discarded and a system log message is generated.

You can also enable interoperability with routers that use the vendor-specific compatibility code of 130 for outbound router filters and the code type of 128. The standard code is 3, and the standard code type is 64. You can configure interoperability for the router as a whole or for specific BGP groups or peers only.

To configure BGP peers to interoperate with routers that use vendor-specific compatibility codes for outbound routing filters, include the **bgp-orf-cisco-mode** statement:

```
outbound-route-filter {
    bgp-orf-cisco-mode;
}
```

Enabling Layer 2 VPN and VPLS Signaling

You can enable BGP to carry Layer 2 VPN and VPLS NLRI messages.

To enable VPN and VPLS signaling, include the **family** statement:

```
family {
    l2vpn {
        signaling {
            prefix-limit {
                maximum number;
                teardown <percentage> <idle-timeout (forever | minutes)>;
            }
        }
    }
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

To configure a maximum number of prefixes, include the **prefix-limit** statement:

```
prefix-limit {
    maximum number;
    teardown <percentage> <idle-timeout (forever | minutes)>;
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

When you set the maximum number of prefixes, a message is logged when that number is reached. If you include the **teardown** statement, the session is torn down when the maximum number of prefixes is reached. If you specify a percentage, messages are logged when the number of prefixes reaches that percentage. Once the session is torn down, it is reestablished in a short time. Include the **idle-timeout** statement to keep the session down for a specified amount of time, or forever. If you specify **forever**, the session is reestablished only after you use the **clear bgp neighbor** command.

For more information about VPNs, see the *JUNOS VPNs Configuration Guide*. For a detailed VPLS example configuration, see the *JUNOS Feature Guide*.

Configuring BGP Routing Policy

All routing protocols use the JUNOS software routing table to store the routes that they learn and to determine which routes they should advertise in their protocol packets. Routing policy allows you to control which routes the routing protocols store in and retrieve from the routing table. For information about routing policy, see the *JUNOS Policy Framework Configuration Guide*.

When configuring BGP routing policy, you can perform the following tasks:

- Applying Routing Policy on page 696
- Setting BGP to Advertise Inactive Routes on page 697
- Configuring BGP to Advertise the Best External Route to Internal Peers on page 697
- Configuring How Often BGP Exchanges Routes with the Routing Table on page 699
- Disabling Suppression of Route Advertisements on page 699

Applying Routing Policy

You define routing policy at the [edit policy-options] hierarchy level. To apply policies you have defined for BGP, include the **import** and **export** statements within the BGP configuration. For information about defining policy, see the *JUNOS Policy Framework Configuration Guide*.

You can apply policies as follows:

- BGP global **import** and **export** statements—Include these statements at the [edit protocols bgp] hierarchy level (for routing instances, include these statements at the [edit routing-instances *routing-instance-name* protocols bgp] hierarchy level).
- Group **import** and **export** statements—Include these statements at the [edit protocols bgp group *group-name*] hierarchy level (for routing instances, include these statements at the [edit routing-instances *routing-instance-name* protocols bgp group *group-name*] hierarchy level).
- Peer **import** and **export** statements—Include these statements at the [edit protocols bgp group *group-name* neighbor *address*] hierarchy level (for routing instances, include these statements at the [edit routing-instances *routing-instance-name* protocols bgp group *group-name* neighbor *address*] hierarchy level). (A peer uses its group's **export** statement.)

A peer-level **import** or **export** statement overrides a group **import** or **export** statement. A group-level **import** or **export** statement overrides a global BGP **import** or **export** statement.

To apply policies, see the following sections:

- Applying Policies to Routes Being Imported into the Routing Table from BGP on page 697
- Applying Policies to Routes Being Exported from the Routing Table into BGP on page 697

Applying Policies to Routes Being Imported into the Routing Table from BGP

To apply policy to routes being imported into the routing table from BGP, include the `import` statement, listing the names of one or more policies to be evaluated:

```
import [ policy-names ];
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

If you specify more than one policy, they are evaluated in the order specified, from first to last, and the first matching filter is applied to the route. If no match is found, BGP places into the routing table only those routes that were learned from BGP routers.

Applying Policies to Routes Being Exported from the Routing Table into BGP

To apply policy to routes being exported from the routing table into BGP, include the `export` statement, listing the names of one or more policies to be evaluated:

```
export [ policy-names ];
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

If you specify more than one policy, they are evaluated in the order specified, from first to last, and the first matching filter is applied to the route. If no routes match the filters, the routing table exports into BGP only the routes that it learned from BGP.

Setting BGP to Advertise Inactive Routes

By default, BGP stores the route information it receives from update messages in the JUNOS routing table, and the routing table exports only active routes into BGP, which BGP then advertises to its peers. To have the routing table export to BGP the best route learned by BGP even if the JUNOS software did not select it to be an active route, include the `advertise-inactive` statement:

```
advertise-inactive;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Configuring BGP to Advertise the Best External Route to Internal Peers

In general, deployed BGP implementations do not advertise the external route with the highest local preference value to internal peers unless it is the best route. Although this behavior was required by an earlier version of the BGP version 4 specification, RFC 1771, it was typically not followed in order to minimize the amount of advertised information and to prevent routing loops. However, there are scenarios in which

advertising the best external route is beneficial, in particular, situations that can result in IBGP route oscillation.

Beginning with JUNOS Release 9.3, you can configure BGP to advertise the best external route into an IBGP mesh group, a route reflector cluster, or an AS confederation, even when the best route is an internal route.



NOTE: In order to configure the `advertise-external` statement on a route reflector, you must disable intracluster reflection with the `no-client-reflect` statement.

When a router is configured as a route reflector for a cluster, a route advertised by the route reflector is considered internal only if it is received from an internal peer with the same cluster identifier or no cluster identifier. A route received from an internal peer that belongs to a another cluster, that is, with a different cluster identifier, is considered external.

In a confederation, when advertising a route to a confederation border router, any route from a different confederation sub-AS is considered internal.

You can also configure BGP only to advertise the external route if the route selection process reaches the point where the multiple exit discriminator (MED) metric is evaluated. As a result, an external route with an AS path worse (that is, longer) than that of the active path is not advertised.

The JUNOS software also provides support for configuring a BGP export policy that matches on the state of an advertised route. You can match on either active or inactive routes. For more information, see the *JUNOS Policy Framework Configuration Guide*.

To configure BGP to advertise the best external path to internal peers, include the `advertise-external` statement:

```
advertise-external;
```



NOTE: The `advertise-external` statement is supported at both the group and neighbor level. If you configure the statement at the neighbor level, you must configure it for all neighbors in a group. Otherwise, the group is automatically split into different groups.

For a complete list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

To configure BGP to advertise the best external path only if the route selection process reaches the point where the MED is evaluated, include the `conditional` statement:

```
advertise-external {
  conditional;
}
```

For a complete list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Configuring How Often BGP Exchanges Routes with the Routing Table

BGP stores the route information it receives from update messages in the routing table, and the routing table exports active routes from the routing table into BGP. BGP then advertises the exported routes to its peers. By default, the exchange of route information between BGP and the routing table occurs immediately after the routes are received. This immediate exchange of route information might cause instabilities in the network reachability information. To guard against this, you can delay the time between when BGP and the routing table exchange route information.

To configure how often BGP and the routing table exchange route information, include the **out-delay** statement:

```
out-delay seconds;
```

By default, the routing table retains some of the route information learned from BGP. To have the routing table retain all or none of this information, include the **keep** statement:

```
keep (all | none);
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

The routing table can retain the route information learned from BGP in one of the following ways:

- **Default** (omit the **keep** statement)—Keep all route information that was learned from BGP except for routes whose AS path is looped and the loop includes the local AS.
- **keep all**—Keep all route information that was learned from BGP.
- **keep none**—Discard routes that were received from a peer and that were rejected by import policy or other sanity checking, such as AS path or next hop. When you configure **keep none** for the BGP session and the inbound policy changes, the JUNOS software forces readvertisement of the full set of routes advertised by the peer.

In an AS path healing situation, routes with looped paths theoretically could become usable during a soft reconfiguration when the AS path loop limit is changed. However, there is a significant memory usage difference between the default and **keep all** because it is common for a peer to readvertise routes back to the peer from which it learned them. The default behavior is not to waste memory on such routes.

Disabling Suppression of Route Advertisements

The JUNOS software does not advertise the routes learned from one external BGP (EBGP) peer back to the same EBGP peer. In addition, the software does not advertise those routes back to any EBGP peers that are in the same AS as the originating peer, regardless of the routing instance. You can modify this behavior by including the **advertise-peer-as** statement in the configuration. To disable the default advertisement suppression, including the **advertise-peer-as** statement:

```
advertise-peer-as;
```



NOTE: The route suppression default behavior is disabled if the **as-override** statement is included in the configuration.

If you include the **advertise-peer-as** statement in the configuration, BGP advertises the route regardless of this check.

To restore the default behavior, include the **no-advertise-peer-as** statement in the configuration:

```
no-advertise-peer-as;
```

If you include both the **as-override** and **no-advertise-peer-as** statements in the configuration, the **no-advertise-peer-as** statement is ignored. You can include these statements at multiple hierarchy levels.

For a list of hierarchy levels at which you can configure these statements, see the statement summary section for this statement.

Configuring EBGPeering Using IPv6 Link-Local Address

The JUNOS software supports EBGPeering sessions by means of IPv6 link-local addresses. An IPv6 peering session can be configured when a 128-bit IPv6 address is specified in the **neighbor** statement. The peer address is identified as link-local by means of the **local-interface** statement.

To configure an EBGPeering peer, specify a 128-bit IPv6 link-local address in the **neighbor** statement:

```
neighbor ipv6-link-local-address;
```

To specify the interface name for the EBGPeering link-local peer, include the **local-interface** statement:

```
local-interface interface-name;
```

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

This statement is valid only for 128-bit IPv6 link-local addresses and is mandatory for configuring an IPv6 EBGPeering link-local peering session. For more information about IPv6 addressing, see “Routing Protocols Concepts” on page 3.



NOTE: Configuring EBGPeering using link-local addresses is only applicable for directly connected interfaces. There is no support for multihop peering.

Configuring IPv6 BGP Routes over IPv4 Transport

You can export both IPv6 and IPv4 prefixes over an IPv4 connection where both sides are configured with an IPv4 interface. In this case, the BGP neighbors are IPv4 prefixes. The IPv4-compatible IPv6 prefixes are configured on the interfaces to preclude the configuration of static routes.

Keep the following in mind when exporting IPv6 BGP prefixes:

- BGP derives next-hop prefixes using the IPv4-compatible IPv6 prefix. For example, the IPv4 next-hop prefix **10.19.1.1** translates to the IPv6 next-hop prefix **::10.19.1.1** (hexadecimal format **::a13:101**).



NOTE: There must be an active route to the IPv4-compatible IPv6 next hop to export IPv6 BGP prefixes.

- An IPv6 connection must be configured over the link. The connection must be either an IPv6 tunnel or a dual-stack configuration.
- When configuring IPv4-compatible IPv6 prefixes, use a mask that is longer than 96 bits.
- Configure a static route if you want to use normal IPv6 prefixes.

Example: Configuring IPv6 BGP Routes over IPv4 Transport

Configure IPv4 transport from interface **ge-0/1/0** with an IPv4 prefix **11.19.1.2/24** to interface **ge-1/1/1** with an IPv4 prefix **11.19.1.1/24** to carry IPv6 BGP routes.

Define IPv4 and IPv6 BGP groups for **11.19.1.2** with BGP neighbor **11.19.1.1**:

```
[edit protocols]
bgp {
  group ebgp_both {
    type external;
    local-address 11.19.1.2;
    family inet {
      unicast;
    }
    family inet6 {
      unicast;
    }
    peer-as 1;
    neighbor 11.19.1.1;
  }
}
```

Configure the interfaces with both an IPv4 and a corresponding IPv4-compatible IPv6 prefix:

```
[edit interfaces]
ge-0/1/0 {
  unit 0 {
```

```

        family inet {
            address 11.19.1.2/24;
        }
        family inet6 {
            address ::11.19.1.2/126;
        }
    }
}

```

Configuring BGP to Log System Log Messages

Whenever a BGP peer makes a state transition, you can configure BGP so that it generates a syslog message. To do this, include the **log-updown** statement:

```
log-updown;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.



NOTE: Enabling the **log-updown** statement causes BGP state transitions to be logged at warning level.

Describing BGP Router Configuration

You can enter plain text to describe the BGP router configuration.

To enter a description, include the **description** statement:

```
description description-text;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Blocking Nonpeer TCP Connection Attempts

You can restrict Transmission Control Protocol (TCP) connection attempts on port 179 to BGP peers only. This blocks all non-BGP connection attempts on port 179.

To restrict TCP connection attempts to BGP peers include the **apply-path** statement:

```
apply-path protocol bgp group group-name neighbor neighbor;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

For detailed information about configuring TCP connection attempts, see the *JUNOS Policy Framework Configuration Guide*.

Applying BGP Export Policy to VRF Routes

You can apply a VPN routing and forwarding (VRF) export policy in addition to applying a BGP export policy to routes before advertising the routes to provider edge (PE) routers in a VPN. The default action is to accept routes.

To apply an export policy to routes, include the `vpn-apply-export` statement:

```
vpn-apply-export;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Enabling Next-Hop Reachability Information

To enable multiprotocol updates to contain next-hop reachability information, include the `include-mp-next-hop` statement:

```
include-mp-next-hop;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Configuring the BFD Protocol

The bidirectional forwarding detection (BFD) protocol is a simple hello mechanism that detects failures in a network. Hello packets are sent at a specified, regular interval. A neighbor failure is detected when the router stops receiving a reply after a specified interval. BFD works with a wide variety of network environments and topologies. The failure detection timers for BFD have shorter time limits than default failure detection mechanisms, providing faster detection. These timers are also adaptive and can be adjusted to be more or less aggressive. For example, the timers can adapt to a higher value if the adjacency fails, or a neighbor can negotiate a higher value for a timer than the one configured.



NOTE: Beginning with JUNOS Release 8.3, BFD is also supported on IBGP and multihop EBGP sessions as well as on single-hop EBGP sessions. BFD does not support IPv6 interfaces with BGP. Beginning with JUNOS Release 9.1, BFD supports IPv6 interfaces in static routes only.

To enable failure detection, include the `bfd-liveness-detection` statement:

```
bfd-liveness-detection {
  detection-time {
    threshold milliseconds;
  }
  holddown-interval milliseconds;
  minimum-interval milliseconds;
  minimum-receive-interval milliseconds;
  no-adaptation;
```

```

transmit-interval {
    threshold milliseconds;
    minimum-interval milliseconds;
}
multiplier number;
no-adaptation;
version (1 | automatic);
}

```

To specify the threshold for the adaptation of the detection time, include the **detection-time threshold** statement:

```

detection-time {
    threshold milliseconds;
}

```

When the BFD session detection time adapts to a value equal to or higher than the threshold, a single trap and a system log message are sent.

Beginning with JUNOS 8.5, you can configure an interval to specify how long the BFD session for an EBGP peer must remain up before a state change notification is sent. When you configure the hold-down interval for the BFD protocol for EBGP, the BGP session goes down if the BFD session goes down. If you do not configure the BFD hold-down interval, the BGP session remains up even if the BFD session goes down. To specify the hold-down interval, include the **holddown-interval** statement:

```

bfd-liveness-detection {
    holddown-interval milliseconds;
}

```

You can configure a value in the range from 0 through 255,000 and the default is 0. The **holddown-interval** statement is supported only for EBGP peers at the **[edit protocols bgp group *group-name* neighbor *address*]** hierarchy level. If the BFD session goes down and then comes back up during the configured hold-down interval, the timer is restarted.



NOTE: You must configure the hold-down interval on both EBGP peers.



NOTE: If you configure the hold-down interval for a multihop EBGP session, you must also configure a local IP address by including the **local-address** statement at the **[edit protocols bgp group *group-name*]** hierarchy level. For more information about configuring an EBGP multihop session, see “Configuring an EBGP Multihop Session” on page 667. For more information about configuring the local address, see “Configuring the Local IP Address” on page 663.

To specify the minimum transmit and receive intervals for failure detection, include the **minimum-interval** statement:

```

minimum-interval milliseconds;

```


This value represents the minimum interval at which the local router transmits hello packets as well as the minimum interval that the router expects to receive a reply from a neighbor with which it has established a BFD session. You can configure a value in the range from 1 through 255,000 milliseconds. You can also specify the minimum transmit and receive intervals separately.



NOTE: If you specify a minimum interval for Bidirectional Forwarding Detection (BFD) less than 100 ms, the BFD session might transition down and up. On some routing platforms, it is safe to configure values below 100 ms. Please contact Juniper Networks customer support for more information.

To specify only the minimum receive interval for failure detection, include the `minimum-receive-interval` statement:

```
minimum-receive-interval milliseconds;
```

This value represents the minimum interval at which the local router expects to receive a reply from a neighbor with which it has established a BFD session. The values that you can configure are in the range from 1 through 255,000 milliseconds.

To specify the number of hello packets not received by a neighbor that causes the originating interface to be declared down, include the `multiplier` statement:

```
multiplier number;
```

The default is 3, and you can configure a value in the range from 1 through 255.

To specify only the minimum transmit interval for failure detection, include the `transmit-interval` statement:

```
transmit-interval {
  minimum-interval milliseconds;
}
```

This value represents the minimum interval at which the local router transmits hello packets to the neighbor with which it has established a BFD session. You can configure a value in the range from 1 through 255,000 milliseconds.

To specify the threshold for detecting the adaptation of the transmit interval, include the `transmit-interval threshold` statement:

```
transmit-interval {
  threshold milliseconds;
}
```

The threshold value must be greater than the transmit interval.

To specify the BFD version used for detection, include the `version` statement:

```
version (1 | automatic);
```

The default is to have the version detected automatically.

Beginning with JUNOS Release 9.0, you can configure BFD sessions not to adapt to changing network conditions. To disable BFD adaptation, include the **no-adaptation** statement:

```
no-adaptation;
```



NOTE: We recommend that you not disable BFD adaptation unless it is preferable not to have BFD adaptation enabled in your network.

For a list of hierarchy levels at which you can configure these statements, see the statement summary sections for these statements.

Configuring the Segment Size for TCP

TCP path MTU discovery helps avoid BGP packet fragmentation. However, enabling TCP path MTU discovery creates ICMP vulnerability. To prevent these ICMP vulnerability issues, you can configure the TCP maximum segment size (MSS) globally, or for each BGP peer. You can also configure the advertised MSS value for each BGP peer to prevent fragmentation of packets sent by the BGP peer.

To configure the TCP MSS value, include the **tcp-mss** statement:

```
tcp-mss segment-size;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Include the **tcp-mss** statement for a specific BGP neighbor to send the specified segment size to the BGP neighbor as the advertised MSS. The configured MSS value is also used as the maximum segment size for the sender. If the MSS value from the BGP neighbor is less than the MSS value configured, the MSS value from the BGP neighbor is used as the maximum segment size for the sender.

Tracing BGP Protocol Traffic

To trace BGP protocol traffic, you can specify options in the global **traceoptions** statement at the [edit routing-options] hierarchy level, and you can specify BGP-specific options by including the **traceoptions** statement at the [edit protocols bgp] hierarchy level. For routing instances, include the statement.

```
traceoptions {
  file filename <size size> <files number>
    <(world-readable | no-world-readable)>;
  flag flag <flag-modifier> <disable>;
}
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

You can specify the following BGP-specific options in the BGP **traceoptions** statement:

- **4byte-as**—Trace 4-byte AS events.
- **aspath**—Trace AS path regular expression operations.
- **damping**—Trace damping operations.
- **keepalive**—Trace BGP keepalive messages.
- **open**—Trace BGP open packets. These packets are sent between peers when they are establishing a connection.
- **packets**—Trace all BGP protocol packets.
- **update**—Trace update packets. These packets provide routing updates to BGP systems.

You can filter trace statements and output only the statement information that passes through the filter by specifying the **filter** flag modifier. The **filter** modifier is only supported for the **route** and **damping** tracing flags.



NOTE: Per-neighbor trace filtering is not supported on a BGP per-neighbor level for route and damping flags. Trace option filtering support is on a peer group level.



NOTE: Use the trace flags **detail** and **all** with caution. These flags may cause the CPU to become very busy.

The **match-on** statement specifies filter matches based on prefixes. It is used to match on route filters.

For general information about tracing, see the tracing and logging information in the *JUNOS System Basics Configuration Guide*.

Examples: Tracing BGP Protocol Traffic

Trace only unusual or abnormal operations to **routing-log**, and trace detailed information about all BGP messages to **bgp-log**:

```
[edit]
routing-options {
  traceoptions {
    file routing-log;
  }
  autonomous-system 23;
}
protocols {
  bgp {
    group 23 {
      type external;
      peer-as 56;
      traceoptions {
```

```

        file bgp-log size 10k files 5;
        flag packets detail;
    }
    0.0.0.0/0;
}
}
}

```

Trace only update messages received from the configured peer:

```

[edit]
routing-options {
    autonomous-system 23;
    router-id 10.0.0.1;
}
protocols {
    bgp {
        group 23 {
            type external;
            peer-as 56;
            neighbor boojum.snark.net {
                traceoptions {
                    file bgp-log size 10k files 2;
                    flag update detail;
                }
            }
        }
    }
}
}

```

Trace only messages that pass the policy based on prefix match:

```

[edit]
protocols {
    bgp {
        traceoptions {
            file bgp-tr size 5m files 10;
            flag route filter policy couple-route match-on prefix;
        }
    }
}
}

```

Chapter 39

Summary of BGP Configuration Statements

The following sections explain each of the Border Gateway Protocol (BGP) configuration statements. The statements are organized alphabetically.

accept-remote-nexthop

Syntax	accept-remote-nexthop;
Hierarchy Level	[edit protocols bgp], [edit logical-systems <i>logical-system-name</i> protocols bgp], [edit routing-instances <i>routing-instance-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp], [edit protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>]
Release Information	Statement introduced in JUNOS Release 8.5.
Description	Specify that a single-hop EBGP peer accept a remote next hop with which it does not share a common subnet. Configure a separate import policy on the EBGP peer to specify the remote next hop. You cannot configure the multihop statement at the same time.
Usage Guidelines	See “Configuring a Single-Hop EBGP Peer to Accept a Remote Next Hop” on page 667.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	multipath and Configuring BGP Routing Policy on page 696.

accepted-prefix-limit

Syntax `accepted-prefix-limit {
 maximum number;
 tear-down <percentage-threshold> idle-timeout (minutes | forever);
 }`

Hierarchy Level `[edit protocols bgp family (inet | inet6) (any | flow | labeled-unicast | multicast | unicast)],`
`[edit logical-systems logical-system-name protocols bgp family (inet | inet6) (any | flow |`
`labeled-unicast | multicast | unicast)],`
`[edit routing-instances routing-instance-name protocols bgp family (inet | inet6) (any |`
`flow | labeled-unicast | multicast | unicast)],`
`[edit logical-systems logical-system-name routing-instances routing-instance-name protocols`
`bgp family (inet | inet6) (any | flow | labeled-unicast | multicast | unicast)],`
`[edit protocols bgp group group-name family (inet | inet6) (any | flow | labeled-unicast |`
`multicast | unicast)],`
`[edit logical-systems logical-system-name protocols bgp group group-name family (inet |`
`inet6) (any | flow | labeled-unicast | multicast | unicast)],`
`[edit routing-instances routing-instance-name protocols bgp group group-name family`
`(inet | inet6) (any | flow | labeled-unicast | multicast | unicast)],`
`[edit logical-systems logical-system-name routing-instances routing-instance-name protocols`
`bgp group group-name family (inet | inet6) (any | flow | labeled-unicast | multicast |`
`unicast)],`
`[edit protocols bgp group group-name neighbor address family (inet | inet6) (any | flow |`
`labeled-unicast | multicast | unicast)],`
`[edit logical-systems logical-system-name protocols bgp group group-name family (inet |`
`inet6) (any | flow | labeled-unicast | multicast | unicast)],`
`[edit routing-instances routing-instance-name protocols bgp group group-name family`
`(inet | inet6) (any | flow | labeled-unicast | multicast | unicast)],`
`[edit logical-systems logical-system-name routing-instances routing-instance-name protocols`
`bgp group group-name family (inet | inet6) (any | flow | labeled-unicast | multicast |`
`unicast)],`
`[edit protocols bgp family route-target],`
`[edit logical-systems logical-system-name protocols bgp family route-target],`
`[edit routing-instances routing-instance-name protocols bgp family route-target],`
`[edit logical-systems logical-system-name routing-instances routing-instance-name protocols`
`bgp family route-target],`
`[edit protocols bgp group group-name family route-target],`
`[edit logical-systems logical-system-name protocols bgp group group-name family`
`route-target],`
`[edit routing-instances routing-instance-name protocols bgp group group-name family`
`route-target],`
`[edit logical-systems logical-system-name routing-instances routing-instance-name protocols`
`bgp group group-name family route-target],`
`[edit protocols bgp group group-name neighbor address family route-target],`
`[edit logical-systems logical-system-name protocols bgp group group-name neighbor`
`address family route-target],`
`[edit routing-instances routing-instance-name protocols bgp group group-name neighbor`
`address family route-target],`
`[edit logical-systems logical-system-name routing-instances routing-instance-name protocols`
`bgp group group-name neighbor address family route-target]`

Release Information	Statement introduced in JUNOS Release 9.2.
Description	Configure a limit to the number of prefixes that can be accepted on a BGP peering session. When that limit is exceeded, a system log message is sent. You can optionally specify to reset the BGP session when the number of accepted prefixes exceeds the specified limit.
Options	<p>maximum <i>number</i>—Limit the number of prefixes that can be accepted on a BGP peering session. A system log message is sent when that number is exceeded. Range: 1 through 4,294,967,295</p> <p>teardown <i><percentage></i>—Specify to reset the BGP peering session when the specified limit to the number of prefixes that can be accepted is exceeded. If you specify a percentage, a system log message is sent when the accepted number of prefixes on the BGP session exceeds the specified percentage of the configured limit. After a BGP session is reset, it is reestablished within a short time unless you include the idle-timeout statement. Range: 1 through 100</p> <p>idle-timeout (<i>minutes</i> <i>forever</i>)—Specify not to reestablish a BGP session that has been reset until the after the specified timeout period. Include the forever option to prevent the BGP session from being reestablished until you issue the clear bgp neighbor command. Range: 1 through 2400</p>
Usage Guidelines	See “Limiting the Number of Prefixes Accepted on a BGP Peering Session” on page 685.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>
Related Topics	prefix-limit

advertise-external

Syntax	advertise-external { <conditional>; }
Hierarchy Level	[edit protocols bgp group <i>group-name</i>], [edit protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit logical-systems <i>logical-system-name</i> bgp group <i>group-name</i>], [edit routing-instances <i>routing-instance-name</i> bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> bgp group <i>group-name</i> neighbor <i>neighbor-address</i>], [edit routing-instances <i>routing-instance-name</i> bgp group <i>group-name</i> neighbor <i>neighbor-address</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> group <i>group-name</i> neighbor <i>address</i>]
Release Information	Statement introduced in JUNOS Release 9.3.
Description	Have BGP advertise the best external route into an internal BGP mesh group, a route reflector cluster, or an AS confederation even if the best route is an internal route.
Options	conditional —Advertise the best external path only if the route selection process reaches the point where the multiple exit discriminator (MED) metric is evaluated. As a result, an external path with an AS path worse than that of the active path is not advertised.
Usage Guidelines	See “Configuring BGP to Advertise the Best External Route to Internal Peers” on page 697.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	advertise-inactive

advertise-inactive

Syntax	advertise-inactive;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit protocols bgp], [edit protocols bgp group <i>group-name</i>], [edit protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Have BGP advertise the best route even if the routing table did not select it to be an active route.
Usage Guidelines	See “Setting BGP to Advertise Inactive Routes” on page 697.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

advertise-peer-as

Syntax	advertise-peer-as;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit protocols bgp], [edit protocols bgp group <i>group-name</i>], [edit protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Disable the default behavior of suppressing AS routes.
Usage Guidelines	See “Disabling Suppression of Route Advertisements” on page 699.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.


aggregate-label

Syntax	aggregate-label { community <i>community-name</i> ; }
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols bgp family inet labeled-unicast], [edit logical-systems <i>logical-system-name</i> protocols bgp family inet-vpn labeled-unicast], [edit protocols bgp family inet labeled-unicast], [edit protocols bgp family inet-vpn labeled-unicast]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Enables aggregate labels for VPN traffic.
Options	community <i>community-name</i> —Specify the name of the community to which to apply the aggregate label.
Usage Guidelines	See “Configuring Aggregate Labels for VPNs” on page 660.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

allow

Syntax	<code>allow ([<i>network/mask-length</i>] all);</code>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit protocols bgp group <i>group-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Implicitly configure BGP peers, allowing peer connections from any of the specified networks or hosts. To configure multiple BGP peers, configure one or more networks and hosts within a single allow statement or include multiple allow statements.
Options	<i>network/mask-length</i> —IPv6 or IPv4 network number of a single address or a range of allowable addresses for BGP peers, followed by the number of significant bits in the subnet mask. all—Allow all addresses, which is equivalent to 0.0.0.0/0 (or ::/0).
Usage Guidelines	See “Minimum BGP Configuration” on page 643 and “Defining BGP Groups and Peers” on page 647.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	neighbor

as-override

Syntax	as-override;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit protocols bgp group <i>group-name</i>], [edit protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Compare the AS path of an incoming advertised route with the AS number of the BGP peer under the group and replace all occurrences of the peer AS number in the AS path with its own AS number before advertising the route to the peer.
	NOTE: The as-override statement is specific to a particular BGP group. This statement does not affect peers from the same remote AS configured in different groups.
	<p>Enabling the AS override feature allows routes originating from an AS to be accepted by a router residing in the same AS. Without AS override enabled, the router refuses the route advertisement once the AS path shows that the route originated from its own AS. This is done by default to prevent route loops. The as-override statement overrides this default behavior.</p> <p>Note that enabling the AS override feature may result in routing loops. Use this feature only for specific applications that require this type of behavior, and in situations with strict network control. One application is the IGP protocol between the provider edge router and the customer edge router in a virtual private network. For more information, see the <i>JUNOS MPLS Applications Configuration Guide</i>.</p>
Usage Guidelines	See “Defining BGP Groups and Peers” on page 647.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

authentication-algorithm

Syntax	authentication-algorithm <i>algorithm</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit protocols bgp], [edit protocols bgp group <i>group-name</i>], [edit protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>]
Release Information	Statement introduced in JUNOS Release 8.0.
Description	Configure an MD5 authentication algorithm type.
Options	<i>algorithm</i> —Type of authentication algorithm. Specify either md5 or hmac-sha-1-96 as the algorithm type.
Usage Guidelines	See “Configuring Authentication” on page 660.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

authentication-key

Syntax	authentication-key <i>key</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit protocols bgp], [edit protocols bgp group <i>group-name</i>], [edit protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure an MD5 authentication key (password). Neighboring routers use the same password to verify the authenticity of BGP packets sent from this system.
Options	<i>key</i> —Authentication password. It can be up to 126 characters. Characters can include any ASCII strings. If you include spaces, enclose all characters in quotation marks (" ").
Usage Guidelines	See “Configuring Authentication” on page 660.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

authentication-key-chain

Syntax	authentication-key-chain <i>key-chain</i> ;
Hierarchy Level	<pre> [edit logical-systems <i>logical-system-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit protocols bgp], [edit protocols bgp group <i>group-name</i>], [edit protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>] </pre>
Release Information	Statement introduced in JUNOS Release 8.0.
Description	Apply and enable an authentication keychain to the router.
Options	<i>key-chain</i> —Authentication key chain name. It can be up to 126 characters. Characters can include any ASCII strings. If you include spaces, enclose all characters in quotation marks (" ").
Usage Guidelines	See “Configuring Authentication” on page 660.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

authentication-key-chains

Syntax

```
authentication-key-chains {
  key-chain key-chain-name {
    key key {
      secret secret-data;
      start-time yyyy-mm-dd.hh:mm:ss;
    }
  }
}
```

Hierarchy Level [edit security]

Release Information Statement introduced in JUNOS Release 7.6.

Description Configure authentication key updates for the Border Gateway Protocol (BGP) and Label Distribution Protocol (LDP) routing protocols. When an **authentication-key-chain** statement is configured at the [edit security] hierarchy level, and associated with the BGP and LDP protocols at the [edit protocols] hierarchy level, authentication key updates can occur without interrupting routing and signaling protocols such as Open Shortest Path First (OSPF), and Resource Reservation Setup Protocol (RSVP).

Options **key-chain**—Keychain name. This name is also configured at the [edit protocols bgp] or the [edit protocols ldp] hierarchy level to associate unique **authentication key-chain** attributes with each protocol as specified using the following options:

- **key**—Each key within a keychain is identified by a unique integer value.

Range: 0 through 255

- **secret**—Each key must specify a secret in encrypted text or plain text format. The secret always appears in encrypted format.
- **start-time**—Start times are specified in UTC (Coordinated Universal Time), and must be unique within the keychain.

Usage Guidelines See “Configuring Authentication” on page 660.

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

bfd-liveness-detection

Syntax `bfd-liveness-detection {
 detection-time {
 threshold milliseconds;
 }
 holddown-interval milliseconds;
 minimum-interval milliseconds;
 minimum-receive-interval milliseconds;
 no-adaptation;
 transmit-interval {
 threshold milliseconds;
 minimum-interval milliseconds;
 }
 multiplier number;
 version (1 | automatic);
 }`

Hierarchy Level `[edit logical-systems logical-system-name protocols bgp],
 [edit logical-systems logical-system-name protocols bgp group group-name],
 [edit logical-systems logical-system-name protocols bgp group group-name neighbor
 address],
 [edit logical-systems logical-system-name routing-instances routing-instance-name protocols
 bgp],
 [edit logical-systems logical-system-name routing-instances routing-instance-name protocols
 bgp group group-name],
 [edit logical-systems logical-system-name routing-instances routing-instance-name protocols
 bgp group group-name neighbor address],
 [edit protocols bgp],
 [edit protocols bgp group group-name],
 [edit protocols bgp group group-name neighbor address],
 [edit routing-instances routing-instance-name protocols bgp],
 [edit routing-instances routing-instance-name protocols bgp group group-name],
 [edit routing-instances routing-instance-name protocols bgp group group-name neighbor
 address]`

Release Information Statement introduced in JUNOS Release 8.1.
 detection-time threshold and *transmit-interval threshold* options
 introduced in JUNOS Release 8.2.
 Support for logical routers introduced in JUNOS Release 8.3.
 Support for IBGP and multihop EBGP sessions introduced in JUNOS Release 8.3.
 holddown-interval statement introduced in JUNOS Release 8.5. You can configure this
 statement only for EBGP peers at the `[edit protocols bgp group group-name neighbor
 address]` hierarchy level.
 no-adaptation statement introduced in JUNOS Release 9.0.

Description Configure bidirectional failure detection timers.

For IBGP and multihop EBGP support configure the `bfd-liveness-detection` statement at the global `[edit bgp protocols]` hierarchy level. You can also configure IBGP and multihop support for a routing instance or a logical system.

Options **detection-time threshold** *milliseconds*—Configure a threshold. When the BFD session detection time adapts to a value equal to or greater than the threshold, a single trap and a single system log message are sent.

holddown-interval *milliseconds*—Configure an interval specifying how long a BFD session must remain up before a state change notification is sent.

Range: 0 through 255,000

Default: 0



NOTE: You can configure the **holddown-interval** option only for EBGp peers.

minimum-interval *milliseconds*—Configure the minimum intervals at which the local router transmits hello packets and then expects to receive a reply from a neighbor with which it has established a BFD session.

Range: 1 through 255,000

minimum-receive-interval *milliseconds*—Configure only the minimum interval at which the local router expects to receive a reply from a neighbor with which it has established a BFD session.

Range: 1 through 255,000

multiplier *number*—Configure the number of hello packets not received by a neighbor that causes the originating interface to be declared down.

Range: 1 through 255

Default: 3

no-adaptation—Configure BFD sessions not to adapt to changing network conditions. We recommend that you not disable BFD adaptation unless it is preferable to not to have BFD adaptation enabled in your network.

transmit-interval threshold *milliseconds*—Configure a threshold. When the BFD session transmit interval adapts to a value greater than the threshold, a single trap and a single system message are sent. The interval threshold must be greater than the minimum transmit interval.

Range: 0 through 4,294,967,295

transmit-interval minimum-interval *milliseconds*—Configure only the minimum interval at which the local router transmits hello packets to a neighbor with which it has established a BFD session.

Range: 1 through 255,000

version—Configure the BFD version to detect.

Range: 1 or automatic (autodetect the BFD version)

Default: automatic


Usage Guidelines See “Configuring the BFD Protocol” on page 703.

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

bgp

Syntax	bgp { ... }
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp], [edit protocols], [edit routing-instances <i>routing-instance-name</i> protocols]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Enable BGP on the router or for a routing instance.
Default	BGP is disabled.
Usage Guidelines	See “Enabling BGP” on page 644.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

bgp-orf-cisco-mode

Syntax	bgp-orf-cisco-mode;
Hierarchy Level	[edit routing-options outbound-route-filter], [edit logical-systems <i>logical-system-name</i> routing-options outbound-route-filter], [edit routing-instances <i>routing-instance-name</i> routing-options outbound-route-filter], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> routing-options outbound-route-filter], [edit protocols bgp outbound-route-filter], [edit logical-systems <i>logical-system-name</i> protocols bgp outbound-route-filter], [edit routing-instances <i>routing-instance-name</i> protocols bgp outbound-route-filter], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp outbound-route-filter], [edit protocols bgp group <i>group-name</i> outbound-route-filter], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> outbound-route-filter], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> outbound-route-filter], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> outbound-route-filter], [edit protocols bgp group <i>group-name</i> neighbor <i>address</i> outbound-route-filter], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i> outbound-route-filter], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i> outbound-route-filter], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i> outbound-route-filter]
Release Information	Statement introduced in JUNOS Release 9.2. Support for the BGP group and neighbor hierarchy levels introduced in JUNOS Release 9.3.
Description	Enable interoperability with routers that use the vendor-specific outbound route filter compatibility code of 130 and code type of 128.
<hr/> <div>  NOTE: To enable interoperability for all BGP peers configured on the router, include the statement at the [edit routing-options outbound-route-filter] hierarchy level. </div> <hr/>	
Default	Disabled
Usage Guidelines	See “Configuring Prefix-Based Outbound Route Filtering” on page 694.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

cluster

Syntax	<code>cluster <i>cluster-identifier</i>;</code>
Hierarchy Level	<p>[edit logical-systems <i>logical-system-name</i> protocols bgp],</p> <p>[edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>],</p> <p>[edit protocols bgp],</p> <p>[edit protocols bgp group <i>group-name</i>],</p> <p>[edit protocols bgp group <i>group-name</i> neighbor <i>address</i>],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols bgp],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>]</p>
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Specify the cluster identifier to be used by the route reflector cluster in an internal BGP group.
Options	<i>cluster-identifier</i> —IPv6 or IPv4 address to use as the cluster identifier.
Usage Guidelines	See “Configuring Route Reflection” on page 676.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>
Related Topics	no-client-reflect

damping

Syntax	damping;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit protocols bgp], [edit protocols bgp group <i>group-name</i>], [edit protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Enable route flap damping.
Default	Flap damping is disabled on the router.
Usage Guidelines	See “Enabling Route Flap Damping” on page 681 and the <i>JUNOS Policy Framework Configuration Guide</i> .
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

description

Syntax	<code>description <i>text-description</i>;</code>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit protocols bgp], [edit protocols bgp group <i>group-name</i>], [edit protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Text description of the global, group, or neighbor configuration.
Options	<i>text-description</i> —Text description of the configuration. Limited to 126 characters.
Usage Guidelines	See “Defining BGP Global Properties” on page 645, “Defining Group Properties” on page 650, and “Defining Peer Properties” on page 652.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

disable

Syntax	disable;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp], [edit protocols bgp], [edit routing-instances <i>routing-instance-name</i> protocols bgp]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Disable BGP on the system.
Usage Guidelines	See “Defining BGP Global Properties” on page 645.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

explicit-null

Syntax	explicit-null;
Hierarchy Level	<p>[edit logical-systems <i>logical-system-name</i> protocols bgp family inet labeled-unicast],</p> <p>[edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> family inet labeled-unicast],</p> <p>[edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i> family inet labeled-unicast],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp family inet labeled-unicast],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> family inet labeled-unicast],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i> family inet labeled-unicast],</p> <p>[edit protocols bgp family inet labeled-unicast],</p> <p>[edit protocols bgp group <i>group-name</i> family inet labeled-unicast],</p> <p>[edit protocols bgp group <i>group-name</i> neighbor <i>address</i> family inet labeled-unicast],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols bgp family inet labeled-unicast],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> family inet labeled-unicast],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i> family inet labeled-unicast]</p>
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Advertise label 0 to the egress router of an LSP.
Default	If you do not include the explicit-null statement in the configuration, label 3 (implicit null) is advertised.
Usage Guidelines	See “Advertising an Explicit Null Label” on page 659.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

export

Syntax	export [<i>policy-names</i>];
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit protocols bgp], [edit protocols bgp group <i>group-name</i>], [edit protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Apply one or more policies to routes being exported from the routing table into BGP.
Options	<i>policy-names</i> —Name of one or more policies.
Usage Guidelines	See “Configuring BGP Routing Policy” on page 696 and the <i>JUNOS Policy Framework Configuration Guide</i> .
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	import and the <i>JUNOS Policy Framework Configuration Guide</i>

family

Syntax

```
family {
  (inet | inet6 | inet-mvpn | inet6-mpvn | inet-vpn | inet6-vpn | iso-vpn | l2-vpn) {
    (any | flow | labeled-unicast | multicast | unicast | signaling) {
      prefix-limit {
        maximum number;
        teardown <percentage> <idle-timeout (forever | minutes)>;
      }
      accepted-prefix-limit {
        maximum number;
        teardown <percentage> <idle-timeout (forever | minutes)>;
      }
      rib-group group-name;
    }
  }
  flow {
    no-validate policy-name;
  }
  labeled-unicast {
    aggregate-label {
      community community-name;
    }
    explicit-null {
      connected-only;
    }
    prefix-limit {
      maximum number;
      teardown <percentage> <idle-timeout (forever | minutes)>;
    }
    resolve-vpn;
    rib inet.3;
    rib-group group-name;
  }
}
route-target {
  advertise-default;
  external-paths number;
  prefix-limit {
    maximum number;
    teardown <percentage> <idle-timeout (forever | minutes)>;
  }
  accepted-prefix-limit {
    maximum number;
    teardown <percentage> <idle-timeout (forever | minutes)>;
  }
}
```

Hierarchy Level [edit logical-systems *logical-system-name* protocols bgp],
 [edit logical-systems *logical-system-name* protocols bgp group *group-name*],
 [edit logical-systems *logical-system-name* protocols bgp group *group-name*
 neighbor *address*],

```
[edit logical-systems logical-system-name routing-instances routing-instance-name protocols
  bgp],
[edit logical-systems logical-system-name routing-instances routing-instance-name protocols
  bgp group group-name],
[edit logical-systems logical-system-name routing-instances routing-instance-name protocols
  bgp group group-name neighbor address],
[edit protocols bgp],
[edit protocols bgp group group-name],
[edit protocols bgp group group-name neighbor address],
[edit routing-instances routing-instance-name protocols bgp],
[edit routing-instances routing-instance-name protocols bgp group group-name],
[edit routing-instances routing-instance-name protocols bgp group group-name
  neighbor address]
```

Release Information Statement introduced before JUNOS Release 7.4.
inet-mvpn and inet6-mvpn introduced in JUNOS Release 8.4. Only the **signaling** option is supported with these statements.

Description Enable multiprotocol BGP (MP-BGP) by configuring BGP to carry network layer reachability information (NLRI) for address families other than unicast IPv4, to specify MP-BGP to carry NLRI for the IPv6 address family, or to carry NLRI for VPNs.

Options any—Configure the family type to be both unicast and multicast.

labeled-unicast—Configure the family type to be labeled-unicast. This means that the BGP peers are being used only to carry the unicast routes that are being used by labeled-unicast for resolving the labeled-unicast routes. This statement is supported only with **inet** and **inet6**

multicast—Configure the family type to be multicast. This means that the BGP peers are being used only to carry the unicast routes that are being used by multicast for resolving the multicast routes.

unicast—Configure the family type to be unicast. This means that the BGP peers only carry the unicast routes that are being used for unicast forwarding purposes.

Default: unicast

The remaining statements are explained separately.

Usage Guidelines See “Enabling Multiprotocol BGP” on page 682.

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

flow

Syntax flow {
 no-validate *policy-name*;
 }

Hierarchy Level [edit protocols bgp group *group-name* family (inet | inet-vpn)],
 [edit protocols bgp group *group-name* neighbor *address* family (inet | inet-vpn)],
 [edit routing-instances *routing-instance-name* protocols bgp group *group-name* family
 (inet | inet-vpn)],
 [edit routing-instances *routing-instance-name* protocols bgp group *group-name*
 neighbor *address* family (inet | inet-vpn)]

Release Information Statement introduced before JUNOS Release 7.4.

Description Enables BGP to support flow routes.



NOTE: This statement is supported for the default instance, VRF instance, and virtual-router instance only. It is configured with the **instance-type** statement at the [edit routing-instance *instance-name*] hierarchy level. For VPNs, this statement is supported for the default instance only.

Options The statements are explained separately.

Usage Guidelines See “Enabling BGP to Carry Flow-Specification Routes” on page 687.

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

graceful-restart

Syntax	<pre> graceful-restart { disable; restart-time seconds; stale-routes-time seconds; }</pre>
Hierarchy Level	<pre> [edit logical-systems <i>logical-system-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit protocols bgp], [edit protocols bgp group <i>group-name</i>], [edit protocols bgp group <i>group-name</i> neighbor <i>address</i>]</pre>
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure graceful restart for BGP.
Options	<p>disable—Disable graceful restart for BGP.</p> <p>seconds—Time period when the restart is expected to be complete. Range: 1 through 600 seconds</p> <p>seconds—Maximum time that stale routes are kept during restart. Range: 1 through 600 seconds</p>
Usage Guidelines	See “Configuring Graceful Restart” on page 113, “Configuring Graceful Restart” on page 659 and the <i>JUNOS High Availability Configuration Guide</i> .
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

group

Syntax `group group-name {`
 `advertise-inactive;`
 `[network/mask-length];`
 `authentication-key key;`
 `cluster cluster-identifier;`
 `damping;`
 `description text-description;`
 `export [policy-names];`
 `family {`
 `(inet | inet6 | inet-vpn | inet6-vpn | l2-vpn) {`
 `(any | multicast | unicast | signaling) {`
 `prefix-limit {`
 `maximum number;`
 `teardown <percentage> <idle-timeout (forever | minutes)>;`
 `}`
 `rib-group group-name;`
 `}`
 `flow {`
 `no-validate policy-name;`
 `}`
 `labeled-unicast {`
 `explicit-null {`
 `connected-only;`
 `}`
 `prefix-limit {`
 `maximum number;`
 `teardown <percentage> <idle-timeout (forever | minutes)>;`
 `}`
 `resolve-vpn;`
 `rib inet.3;`
 `rib-group group-name;`
 `}`
 `}`
 `route-target {`
 `advertise-default;`
 `external-paths number;`
 `prefix-limit {`
 `maximum number;`
 `teardown <percentage> <idle-timeout (forever | minutes)>;`
 `}`
 `}`
 `hold-time seconds;`
 `import [policy-names];`
 `ipsec-sa ipsec-sa;`
 `keep (all | none);`
 `local-address address;`
 `local-as autonomous-system <private>;`
 `local-preference local-preference;`
 `log-updown;`
 `metric-out metric;`


```

multihop <ttl-value>;
multipath {
    multiple-as;
}
no-aggregator-id;
no-client-reflect;
out-delay seconds;
passive;
peer-as autonomous-system;
preference preference;
remove-private;
tcp-mss segment-size;
traceoptions {
    file filename <size size> <files number> <(world-readable | no-world-readable)>;
    flag flag <flag-modifier> <disable>;
}
type type;
neighbor address {
    ... peer-specific-options ...
}
}

```

Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp], [edit protocols bgp], [edit routing-instances <i>routing-instance-name</i> protocols bgp]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	<p>Define a BGP peer group. BGP peer groups share a common type, peer autonomous system (AS) number, and cluster ID, if present. To configure multiple BGP groups, include multiple group statements.</p> <p>By default, the group's options are identical to the global BGP options. To override the global options, include group-specific options within the group statement.</p> <p>The group statement is one of the statements you must include in the configuration to run BGP on the router. See "Minimum BGP Configuration" on page 643.</p>
Options	<p><i>group-name</i>—Name of the BGP group.</p> <p>The remaining statements within the group statement are explained separately.</p>
Usage Guidelines	See "Defining BGP Groups and Peers" on page 647.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

hold-time

Syntax	hold-time <i>seconds</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit protocols bgp], [edit protocols bgp group <i>group-name</i>], [edit protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	<p>Hold-time value to use when negotiating a connection with the peer. The hold-time value is advertised in open packets and indicates to the peer the length of time that it should consider the sender valid. If the peer does not receive a keepalive, update, or notification message within the specified hold time, the BGP connection to the peer is closed and routers through that peer become unavailable.</p> <p>The hold time is three times the interval at which keepalive messages are sent.</p>
Options	<i>seconds</i> —Hold time. Range: 20 through 65,535 seconds Default: 90 seconds
Usage Guidelines	See “Modifying the Hold-Time Value” on page 658.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

import

Syntax	import [<i>policy-names</i>];
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit protocols bgp], [edit protocols bgp group <i>group-name</i>], [edit protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Apply one or more routing policies to routes being imported into the JUNOS routing table from BGP.
Options	<i>policy-names</i> —Name of one or more policies.
Usage Guidelines	See “Configuring BGP Routing Policy” on page 696 and the <i>JUNOS Policy Framework Configuration Guide</i> .
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	export and the <i>JUNOS Policy Framework Configuration Guide</i>


include-mp-next-hop

Syntax	include-mp-next-hop;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols bgp], [edit protocols bgp]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Enable multiprotocol updates to contain next-hop reachability information.
Usage Guidelines	See “Enabling Next-Hop Reachability Information” on page 703.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

ipsec-sa

Syntax	ipsec-sa <i>ipsec-sa</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit protocols bgp], [edit protocols bgp group <i>group-name</i>], [edit protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Apply a security association to BGP peers. You can apply the security association globally for all BGP peers, to a group of peers, or to an individual peer.
Options	<i>ipsec-sa</i> —Security association name.
Usage Guidelines	See “Applying IPsec Security Association” on page 662.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

iso-vpn

Syntax	iso-vpn { unicast { prefix-limit <i>number</i> ; rib-group <i>group-name</i> ; } }
Hierarchy Level	[edit protocols bgp family], [edit protocols bgp group <i>group-name</i> family], [edit protocols bgp group <i>group-name</i> neighbor <i>addressfamily</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp family], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> family], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i> family]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Enable BGP to carry ISO VPN NLRI messages between PE routes connecting a VPN.
<hr/>	
	NOTE: CLNS is supported for the J-series Services Router only.
<hr/>	
Default	Disabled.
Options	The statements are explained separately in this chapter.
Usage Guidelines	See “Enabling BGP to Carry Connectionless Network Services Routes” on page 689 and the <i>J-series Services Router Advanced WAN Access Configuration Guide</i> .
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

keep

Syntax	keep (all none);
Hierarchy Level	<pre> [edit logical-systems <i>logical-system-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit protocols bgp], [edit protocols bgp group <i>group-name</i>], [edit protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>] </pre>
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Specify whether routes learned from a BGP peer are retained in the routing table even if they contain an AS number that was exported from the local AS.
Default	If you do not include this statement, most routes are retained in the routing table.
Options	<p>all—Retain all routes.</p> <p>none—Retain none of the routes. When keep none is configured for the BGP session and the inbound policy changes, the JUNOS software forces readvertisement of the full set of routes advertised by the peer.</p>
Usage Guidelines	See “Configuring How Often BGP Exchanges Routes with the Routing Table” on page 699.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

labeled-unicast

Syntax	<pre> labeled-unicast { aggregate-label { community community-name; } explicit-null { connected-only; } accepted-prefix-limit { maximum <i>number</i>; teardown <percentage> <idle-timeout (forever minutes)>; } prefix-limit { maximum <i>number</i>; teardown <percentage> <idle-timeout (forever minutes)>; } resolve-vpn; rib inet.3; rib-group <i>group-name</i>; } </pre>
Hierarchy Level	<pre> [edit logical-systems <i>logical-system-name</i> protocols bgp family (inet inet6)], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> family (inet inet6)], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i> family (inet inet6)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp family (inet inet6)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> family (inet inet6)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i> family (inet inet6)], [edit protocols bgp family (inet inet6)], [edit protocols bgp group <i>group-name</i> family (inet inet6)], [edit protocols bgp group <i>group-name</i> neighbor <i>address</i> family (inet inet6)], [edit routing-instances <i>routing-instance-name</i> protocols bgp family (inet inet6)], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> family (inet inet6)], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i> family (inet inet6)] </pre>
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure the family type to be labeled-unicast.
Options	The statements are explained separately.
Usage Guidelines	See “Enabling Multiprotocol BGP” on page 682.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

local-address

Syntax	<code>local-address address;</code>
Hierarchy Level	<pre>[edit logical-systems <i>logical-system-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit protocols bgp], [edit protocols bgp group <i>group-name</i>], [edit protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>]</pre>
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Specify the address of the local end of a BGP session. This address is used to accept incoming connections to the peer and to establish connections to the remote peer. When none of the operational interfaces are configured with the specified local address, a session with a BGP peer is placed in the idle state.
Default	If you do not configure a local address, BGP uses the router's source address selection rules to set the local address. For more information, see the <i>JUNOS Network Interfaces Configuration Guide</i> .
Options	<i>address</i> —IPv6 or IPv4 address of the local end of the connection.
Usage Guidelines	See “Assigning a BGP Identifier” on page 645.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	router-id

local-as

Syntax	local-as <i>autonomous-system</i> <private>;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit protocols bgp], [edit protocols bgp group <i>group-name</i>], [edit protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	<p>Set the local AS number.</p> <p>The autonomous system (AS) numeric range in plain-number format has been extended in JUNOS Release 9.1 to provide BGP support for 4-byte AS numbers, as defined in RFC 4893, <i>BGP Support for Four-octet AS Number Space</i>.</p> <p>Beginning with JUNOS Release 9.2, you can also configure a 4-byte AS number using the AS-dot notation format of two integer values joined by a period: < 16-bit high-order value in decimal > . < 16-bit low-order value in decimal > . For example, the 4-byte AS number of 65546 in plain-number format is represented as 1.10 in the AS-dot notation format.</p>
Options	<i>autonomous-system</i> —AS number. Range: 1 through 4,294,967,295 in plain-number format. Range: 0.0 through 65535.65535 in AS-dot notation format. <i>private</i> —(Optional) Hide the local AS in paths learned from this peering.
Usage Guidelines	See “Configuring a Local AS” on page 673.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

local-interface

Syntax	<code>local-interface <i>interface-name</i>;</code>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> neighbor <i>ipv6-link-local-address</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>ipv6-link-local-address</i>], [edit protocols bgp group <i>group-name</i> neighbor <i>ipv6-link-local-address</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>ipv6-link-local-address</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Specify the interface name of the peer for IPv6 peering using link-local addresses. This peer is link-local in scope.
Options	<i>interface-name</i> —Interface name of the EBGp IPv6 peer.
Usage Guidelines	See “Configuring EBGp Peering Using IPv6 Link-Local Address” on page 700.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

local-preference

Syntax	<code>local-preference local-preference;</code>
Hierarchy Level	<p>[edit logical-systems <i>logical-system-name</i> protocols bgp],</p> <p>[edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>],</p> <p>[edit protocols bgp],</p> <p>[edit protocols bgp group <i>group-name</i>],</p> <p>[edit protocols bgp group <i>group-name</i> neighbor <i>address</i>],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols bgp],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>]</p>
Release Information	Statement introduced before JUNOS Release 7.4.
Description	<p>Modify the value of the LOCAL_PREF path attribute, which is a metric used by internal BGP sessions to indicate the degree of preference for an external route. The route with the highest local preference value is preferred.</p> <p>The LOCAL_PREF path attribute always is advertised to internal BGP peers and to neighboring confederations. It is never advertised to external BGP peers.</p>
Default	If you omit this statement, the LOCAL_PREF path attribute, if present, is not modified.
Options	<p><i>local-preference</i>—Preference to assign to routes learned from BGP or from the group or peer.</p> <p>Range: 0 through 4,294,967,295 ($2^{32} - 1$)</p> <p>Default: If the LOCAL_PREF path attribute is present, do not modify its value. If a BGP route is received without a LOCAL_PREF attribute, the route is handled locally (it is stored in the routing table and advertised by BGP) as if it were received with a LOCAL_PREF value of 100. By default, non-BGP routes that are advertised by BGP are advertised with a LOCAL_PREF value of 100.</p>
Usage Guidelines	See “Configuring the BGP Local Preference” on page 669.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>
Related Topics	preference

log-updown

Syntax	log-updown;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit protocols bgp], [edit protocols bgp group <i>group-name</i>], [edit protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Log a message whenever a BGP peer makes a state transition. Messages are logged using the system logging mechanism located at the [edit system syslog] hierarchy level.
Usage Guidelines	See “Configuring BGP to Log System Log Messages” on page 702 and the <i>JUNOS System Basics Configuration Guide</i> .
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	traceoptions

metric-out

Syntax	<code>metric-out (<i>metric</i> minimum-igp <i>offset</i> igp (delay-med-update <i>offset</i>);</code>
Hierarchy Level	<p>[edit logical-systems <i>logical-system-name</i> protocols bgp],</p> <p>[edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>],</p> <p>[edit protocols bgp],</p> <p>[edit protocols bgp group <i>group-name</i>],</p> <p>[edit protocols bgp group <i>group-name</i> neighbor <i>address</i>],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols bgp],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>]</p>
Release Information	<p>Statement introduced before JUNOS Release 7.4.</p> <p><code>delay-med-update</code> option introduced in JUNOS Release 9.0.</p>
Description	<p>Metric for all routes sent using the multiple exit discriminator (MED, or <code>MULTI_EXIT_DISC</code>) path attribute in update messages. This path attribute is used to discriminate among multiple exit points to a neighboring AS. If all other factors are equal, the exit point with the lowest metric is preferred.</p> <p>You can specify a constant metric value by including the <i>metric</i> option. For configurations in which a BGP peer sends third-party next hops that require the local system to perform next-hop resolution—IBGP configurations, configurations within confederation peers, or EBGP configurations that include the <code>multihop</code> command—you can specify a variable metric by including the <code>minimum-igp</code> or <code>igp</code> option.</p> <p>You can increase or decrease the variable metric calculated from the IGP metric (either from the <code>igp</code> or <code>igp-minimum</code> statement) by specifying a value for <i>offset</i>. The metric is increased by specifying a positive value for <i>offset</i>, and decreased by specifying a negative value for <i>offset</i>.</p> <p>Beginning with JUNOS 9.0, you can specify for a BGP group or peer not to advertise updates for the MED path attributes used to calculate IGP costs for BGP next hops unless the MED is lower. You can also configure an interval to delay when MED updates are sent by including the <code>med-igp-update-interval <i>minutes</i></code> at the [edit routing-options] hierarchy level.</p>
Options	<p><code>delay-med-update</code>—Specify for a BGP group or peer configured with the <code>metric-out igp</code> statement not to advertise MED updates when the value worsens, that is, unless the value is lower.</p>



NOTE: You cannot configure `delay-updates` at the global level.

igp—Set the metric to the most recent metric value calculated in the IGP to get to the BGP next hop.

metric—Primary metric on all routes sent to peers.

Range: 0 through 4,294,967,295 ($2^{32} - 1$)

Default: No metric is sent.

minimum-igp—Set the metric to the minimum metric value calculated in the IGP to get to the BGP next hop. If a newly calculated metric is greater than the minimum metric value, the metric value remains unchanged. If a newly calculated metric is lower, the metric value is lowered to that value.

offset—(Optional) Increases or decreases the metric by this value.

Range: -2^{31} through $2^{31} - 1$

Default: No default.

Usage Guidelines See “Configuring the Multiple Exit Discriminator Metric” on page 663.

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

Related Topics med-igp-update-interval

mtu-discovery

Syntax	mtu-discovery;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit protocols bgp], [edit protocols bgp group <i>group-name</i>], [edit protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Configure TCP path MTU discovery. MTU discovery improves convergence times for internal BGP sessions.
Usage Guidelines	See “Configuring MTU Discovery” on page 659.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

multihop

Syntax	<pre>multihop { ttl-value; no-nexthop-change; }</pre>
Hierarchy Level	<pre>[edit logical-systems <i>logical-system-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit protocols bgp], [edit protocols bgp group <i>group-name</i>], [edit protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>]</pre>
Release Information	Statement introduced before JUNOS Release 7.4.
Description	<p>Configure an EBGp multihop session.</p> <p>External confederation peering is a special case that allows unconnected third-party next hops. You do not need to configure multihop sessions explicitly in this particular case; multihop behavior is implied.</p> <p>If you have confederation external BGP peer-to-loopback addresses, you still need the multihop configuration.</p>
Default	If you omit this statement, all EBGp peers are assumed to be directly connected (that is, you are establishing a nonmultihop, or "regular," BGP session), and the default time-to-live (TTL) value is 1.
Options	<p>ttl-value—Configure the maximum TTL value for the TTL in the IP header of BGP packets.</p> <p>Range: 1 through 255</p> <p>Default: 64 (for multihop EBGp sessions, confederations, and internal BGP sessions)</p> <p>no-nexthop-change—Specify not to change the BGP next-hop value; for route advertisements, specify the no-nexthop-self option.</p>
Usage Guidelines	See "Configuring an EBGp Multihop Session" on page 667.
Required Privilege Level	routing—To view this statement in the configuration.

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

multipath

Syntax	multipath { multiple-as; }
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit protocols bgp group <i>group-name</i>], [edit protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Allow load sharing among multiple EBGP paths and multiple IBGP paths.
Options	multiple-as —Disable the default check requiring that paths accepted by BGP multipath must have the same neighboring AS.
Usage Guidelines	See “Configuring BGP to Select Multiple BGP Paths” on page 672.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

neighbor

Syntax `neighbor address {`

```

    advertise-inactive;
    authentication-key key;
    cluster cluster-identifier;
    damping;
    description text-description;
    export [ policy-names ];
    family {
        (inet | inet6 | inet-vpn | inet6-vpn | l2-vpn) {
            (any | multicast | unicast | signaling) {
                prefix-limit {
                    maximum number;
                    teardown <percentage> <idle-timeout (forever | minutes)>;
                }
                rib-group group-name;
            }
        }
        flow {
            no-validate policy-name;
        }
        labeled-unicast {
            explicit-null {
                connected-only;
            }
            prefix-limit {
                maximum number;
                teardown <percentage> <idle-timeout (forever | minutes)>;
            }
            resolve-vpn;
            rib inet.3;
            rib-group group-name;
        }
    }
    route-target {
        advertise-default;
        external-paths number;
        prefix-limit {
            maximum number;
            teardown <percentage> <idle-timeout (forever | minutes)>;
        }
    }
}
hold-time seconds;
import [ policy-names ];
ipsec-sa ipsec-sa;
keep (all | none);
local-address address;
local-as autonomous-system <private>;
local-interface interface-name;
local-preference preference;
log-updown;
metric-out metric;
```

```

    multihop <ttl-value>;
    multipath {
        multiple-as;
    }
    no-aggregator-id;
    no-client-reflect;
    out-delay seconds;
    passive;
    peer-as autonomous-system;
    preference preference;
    tcp-mss segment-size;
    traceoptions {
        file filename <size size> <files number> <(world-readable | no-world-readable)>;
        flag flag <flag-modifier> <disable>;
    }
}

```

Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit protocols bgp group <i>group-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	<p>Explicitly configure a neighbor (peer). To configure multiple BGP peers, include multiple neighbor statements.</p> <p>By default, the peer's options are identical to those of the group. You can override these options by including peer-specific option statements within the neighbor statement.</p> <p>The neighbor statement is one of the statements you can include in the configuration to define a minimal BGP configuration on the router. (You can include an allow all statement in place of a neighbor statement.)</p>
Options	<p>address—IPv6 or IPv4 address of a single peer.</p> <p>The remaining statements are explained separately.</p>
Usage Guidelines	See “Minimum BGP Configuration” on page 643 and “Defining BGP Groups and Peers” on page 647.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

no-advertise-peer-as

See advertise-peer-as

no-aggregator-id

Syntax	no-aggregator-id;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit protocols bgp], [edit protocols bgp group <i>group-name</i>], [edit protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Set the router ID in the BGP aggregator path attribute to zero. (This is one of the path attributes included in BGP update messages.) Doing this prevents different routers within an AS from creating aggregate routes that contain different AS paths.
Default	If you omit this statement, the router ID is included in the BGP aggregator path attribute.
Usage Guidelines	See “Update Messages” on page 639 and “Controlling the Aggregator Path Attribute” on page 667.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

no-client-reflect

Syntax	no-client-reflect;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit protocols bgp], [edit protocols bgp group <i>group-name</i>], [edit protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Disable intracluster route redistribution by the system acting as the route reflector. Include this statement when the client cluster is fully meshed to prevent the sending of redundant route advertisements.
Usage Guidelines	See “Configuring Route Reflection” on page 676.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	cluster

no-validate

Syntax	<code>no-validate <i>policy-name</i>;</code>
Hierarchy Level	[edit protocols bgp group <i>group-name</i> family (inet inet flow)], [edit protocols bgp group <i>group-name</i> neighbor <i>address</i> family (inet inet flow)], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> family (inet inet flow)], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i> family (inet inet flow)]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Allows you to skip the flow route validation procedure after packets are accepted by a policy.
Options	<i>policy-name</i> —Import policy to match NLRI messages.
Usage Guidelines	See “Enabling BGP to Carry Flow-Specification Routes” on page 687.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

out-delay

Syntax	out-delay <i>seconds</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit protocols bgp], [edit protocols bgp group <i>group-name</i>], [edit protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Specify how long a route must be present in the JUNOS routing table before it is exported to BGP. Use this time delay to help bundle routing updates.
Default	If you omit this statement, routes are exported to BGP immediately after they have been added to the routing table.
Options	<i>seconds</i> —Output delay time. Range: 0 through 65,535 seconds Default: 0 seconds
Usage Guidelines	See “Configuring How Often BGP Exchanges Routes with the Routing Table” on page 699.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

outbound-route-filter

Syntax

```
outbound-route-filter {
  <bgp-orf-cisco-mode>;
  prefix-based {
    accept {
      (inet | inet6);
    }
  }
}
```

Hierarchy Level

- [edit protocols bgp],
- [edit logical-systems *logical-system-name* protocols bgp],
- [edit routing-instances *routing-instance-name* protocols bgp],
- [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols bgp],
- [edit protocols bgp group *group-name*],
- [edit logical-systems *logical-system-name* protocols bgp group *group-name*],
- [edit routing-instances *routing-instance-name* protocols bgp group *group-name*],
- [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols bgp group *group-name*],
- [edit protocols bgp group *group-name* neighbor *address*],
- [edit logical-systems *logical-system-name* protocols bgp group *group-name* neighbor *address*],
- [edit routing-instances *routing-instance-name* protocols bgp group *group-name* neighbor *address*],
- [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols bgp group *group-name* neighbor *address*]

Release Information Statement introduced in JUNOS Release 9.2.

Description Configure a BGP peer to accept outbound route filters from a remote peer.

Options

- prefix-based**—Specify that prefix-based filters be accepted.
- accept**—Specify that outbound route filters from a BGP peer be accepted.
- inet**—Specify that IPv4 prefix-based outbound route filters be accepted.
- inet6**—Specify that IPv6 prefix-based outbound route filters be accepted.



NOTE: You can specify that both IPv4 and IPv6 outbound route filters be accepted.

The **bgp-orf-cisco-mode** statement is explained separately.

Usage Guidelines See “Configuring Prefix-Based Outbound Route Filtering” on page 694.


Required Privilege Level

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

passive

Syntax	passive;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit protocols bgp], [edit protocols bgp group <i>group-name</i>], [edit protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Do not send active open messages to the peer. Rather, wait for the peer to issue an open request.
Default	If you omit this statement, all explicitly configured peers are active, and each peer periodically sends open requests until its peer responds.
Usage Guidelines	See “Opening a Peer Connection Passively” on page 663.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

path-selection

Syntax	<pre> path-selection { (cisco-non-deterministic always-compare-med external-router-id); med-plus-igp { igp-multiplier <i>number</i>; med-multiplier <i>number</i>; } } </pre>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp], [edit protocols bgp], [edit routing-instances <i>routing-instance-name</i> protocols bgp]
Release Information	Statement introduced before JUNOS Release 7.4. med-plus-igp option introduced in JUNOS Release 8.1.
Description	Configure BGP path selection.
Default	If the path-selection statement is not included in the configuration, only the MEDs of routes that have the same peer ASs are compared.
Options	<p>cisco-non-deterministic—Configure routing table path selection so that it is performed using the same nondeterministic behavior as the Cisco IOS software. The active path is always first. All inactive, but eligible, paths follow the active path and are maintained in the order in which they were received, with the most recent path first. Ineligible paths remain at the end of the list.</p> <p>always-compare-med—Always compare MEDs whether or not the peer ASs of the compared routes are the same.</p>
<hr/> <div style="display: flex; align-items: center;">  <div> NOTE: We recommend that you configure the always-compare-med option. </div> </div> <hr/>	
	<p>external-router-id—Compare the router ID between external BGP paths to determine the active path.</p> <p>med-plus-igp—Add the IGP cost to the next-hop destination to the MED before comparing MED values for path selection.</p> <p>igp-multiplier <i>number</i>—The multiplier value for the IGP cost to a next-hop address. Range: 1 through 1000 Default: None</p> <p>med-multiplier <i>number</i>—The multiplier value for the MED calculation. Range: 1 through 1000 Default: None</p>
Usage Guidelines	See “Configuring Routing Table Path Selection” on page 671.

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

peer-as

Syntax peer-as *autonomous-system*;

Hierarchy Level [edit logical-systems *logical-system-name* protocols bgp],
 [edit logical-systems *logical-system-name* protocols bgp group *group-name*],
 [edit logical-systems *logical-system-name* protocols bgp group *group-name* neighbor
address],
 [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols
 bgp],
 [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols
 bgp group *group-name*],
 [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols
 bgp group *group-name* neighbor *address*],
 [edit protocols bgp],
 [edit protocols bgp group *group-name*],
 [edit protocols bgp group *group-name* neighbor *address*],
 [edit routing-instances *routing-instance-name* protocols bgp],
 [edit routing-instances *routing-instance-name* protocols bgp group *group-name*],
 [edit routing-instances *routing-instance-name* protocols bgp group *group-name*
 neighbor *address*]

Release Information Statement introduced before JUNOS Release 7.4.

Description Specify the neighbor (peer) AS number.

The autonomous system (AS) numeric range in plain-number format has been extended in JUNOS Release 9.1 to provide BGP support for 4-byte AS numbers, as defined in RFC 4893, *BGP Support for Four-octet AS Number Space*.

Beginning with JUNOS Release 9.2, you can also configure a 4-byte AS number using the AS-dot notation format of two integer values joined by a period: *< 16-bit high-order value in decimal > . < 16-bit low-order value in decimal > .* For example, the 4-byte AS number of 65,546 in plain-number format is represented as 1.10 in the AS-dot notation format.

Options *autonomous-system*—AS number.
Range: 1 through 4,294,967,295 in plain-number format.
Range: 0.0 through 65535.65535 in AS-dot notation format.

Usage Guidelines See “Defining BGP Groups and Peers” on page 647 and “Specifying the Peer’s AS Number” on page 650.

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

preference

Syntax	<code>preference <i>preference</i>;</code>
Hierarchy Level	<p>[edit logical-systems <i>logical-system-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit protocols bgp], [edit protocols bgp group <i>group-name</i>], [edit protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>]</p>
Release Information	Statement introduced before JUNOS Release 7.4.
Description	<p>Specify the preference for routes learned from BGP.</p> <p>At the BGP global level, the preference statement sets the preference for routes learned from BGP. You can override this preference in a BGP group or peer preference statement.</p> <p>At the group or peer level, the preference statement sets the preference for routes learned from the group or peer. Use this statement to override the preference set in the BGP global preference statement when you want to favor routes from one group or peer over those of another.</p>
Options	<p><i>preference</i>—Preference to assign to routes learned from BGP or from the group or peer.</p> <p>Range: 0 through 4,294,967,295 ($2^{32}-1$)</p> <p>Default: 170 for the primary preference</p>
Usage Guidelines	See “Controlling Route Preference” on page 669.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>
Related Topics	local-preference

prefix-limit

Syntax prefix-limit {
 maximum *number*;
 teardown <*percentage*> <idle-timeout (forever | *minutes*)>;
}

Hierarchy Level [edit logical-systems *logical-system-name* protocols bgp family (inet | inet6) (any | flow | labeled-unicast | multicast | unicast)],
 [edit logical-systems *logical-system-name* protocols bgp group *group-name* family (inet | inet6) (any | flow | labeled-unicast | multicast | unicast)],
 [edit logical-systems *logical-system-name* protocols bgp group *group-name* neighbor *address* family (inet | inet6) (any | flow | labeled-unicast | multicast | unicast)],
 [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols bgp family (inet | inet6) (any | flow | labeled-unicast | multicast | unicast)],
 [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols bgp group *group-name* family (inet | inet6) (any | flow | labeled-unicast | multicast | unicast)],
 [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols bgp group *group-name* neighbor *address* family (inet | inet6) (any | flow | labeled-unicast | multicast | unicast)],
 [edit protocols bgp family (inet | inet6) (any | flow | labeled-unicast | multicast | unicast)],
 [edit protocols bgp group *group-name* family (inet | inet6) (any | labeled-unicast | multicast | unicast)],
 [edit protocols bgp group *group-name* neighbor *address* family (inet | inet6) (any | flow | labeled-unicast | multicast | unicast)],
 [edit routing-instances *routing-instance-name* protocols bgp family (inet | inet6) (any | flow | labeled-unicast | multicast | unicast)],
 [edit routing-instances *routing-instance-name* protocols bgp group *group-name* family (inet | inet6) (any | flow | labeled-unicast | multicast | unicast)],
 [edit routing-instances *routing-instance-name* protocols bgp group *group-name* neighbor *address* family (inet | inet6) (any | flow | labeled-unicast | multicast | unicast)]

Release Information Statement introduced before JUNOS Release 7.4.

Description Limit the number of prefixes received on a BGP peering session and a rate-limit logging when injected prefixes exceed a set limit.

Options maximum *number*—When you set the maximum number of prefixes, a message is logged when that number is exceeded.

Range: 1 through 4,294,967,295

teardown <*percentage*>—If you include the **teardown** statement, the session is torn down when the maximum number of prefixes is reached. If you specify a percentage, messages are logged when the number of prefixes exceeds that percentage. After the session is torn down, it will reestablish in a short time unless you include the **idle-timeout** statement. Then the session can be kept down for a specified amount of time, or forever. If you specify **forever**, the session is reestablished only after you issue a **clear bgp neighbor** command.

Range: 1 through 100

idle-timeout (*forever* | *timeout-in-minutes*)—(Optional) If you include the **idle-timeout** statement, the session is torn down for a specified amount of time, or forever. If you specify a period of time, the session is allowed to reestablish after this timeout period. If you specify **forever**, the session is reestablished only after you intervene with a **clear bgp neighbor** command.

Range: 1 through 2400

Usage Guidelines See “Limiting the Number of Prefixes Received on a BGP Peering Session” on page 685.

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

Related Topics accepted-prefix-limit

remove-private

Syntax	remove-private;
Hierarchy Level	<p>[edit logical-systems <i>logical-system-name</i> protocols bgp],</p> <p>[edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>],</p> <p>[edit protocols bgp],</p> <p>[edit protocols bgp group <i>group-name</i>],</p> <p>[edit protocols bgp group <i>group-name</i> neighbor <i>address</i>],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols bgp],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>]</p>
Release Information	Statement introduced before JUNOS Release 7.4.
Description	<p>When advertising AS paths to remote systems, have the local system strip private AS numbers from the AS path. The numbers are stripped from the AS path starting at the left end of the AS path (the end where AS paths have been most recently added). The router stops searching for private ASs when it finds the first nonprivate AS. This operation takes place after any confederation member ASs have already been removed from the AS path, if applicable.</p> <p>The software recognizes the set of AS numbers that is considered private, a range that is defined in the Internet Assigned Numbers Authority (IANA) assigned numbers document.</p> <p>The set of reserved AS numbers is in the range from 64,512 through 65,535.</p>
Usage Guidelines	See “Removing Private AS Numbers from AS Paths” on page 675.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

resolve-vpn

Syntax	resolve-vpn;
Hierarchy Level	<p>[edit logical-systems <i>logical-system-name</i> protocols bgp family inet labeled-unicast],</p> <p>[edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> family inet labeled-unicast],</p> <p>[edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i> family inet labeled-unicast],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp family inet labeled-unicast],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> family inet labeled-unicast],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i> family inet labeled-unicast],</p> <p>[edit protocols bgp family inet labeled-unicast],</p> <p>[edit protocols bgp group <i>group-name</i> family inet labeled-unicast],</p> <p>[edit protocols bgp group <i>group-name</i> neighbor <i>address</i> family inet labeled-unicast],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols bgp family inet labeled-unicast],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> family inet labeled-unicast],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i> family inet labeled-unicast]</p>
Release Information	Statement introduced before JUNOS Release 7.4.
Description	<p>Allow labeled routes to be placed in the inet.3 routing table for route resolution. These routes are then resolved for PE router connections where the remote PE is located across another AS. For a PE router to install a route in the VRF, the next hop must resolve to a route stored within the inet.3 table.</p>
Usage Guidelines	See “Enabling Multiprotocol BGP” on page 682.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

rib

Syntax	rib inet.3;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols bgp family inet labeled-unicast], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> family inet labeled-unicast], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i> family inet labeled-unicast], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp family inet labeled-unicast], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> family inet labeled-unicast], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i> family inet labeled-unicast], [edit protocols bgp family inet labeled-unicast], [edit protocols bgp group <i>group-name</i> family inet labeled-unicast], [edit protocols bgp group <i>group-name</i> neighbor <i>address</i> family inet labeled-unicast], [edit routing-instances <i>routing-instance-name</i> protocols bgp family inet labeled-unicast], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> family inet labeled-unicast], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i> inet labeled-unicast]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	You can allow both labeled and unlabeled routes to be exchanged in a single session. The labeled routes are placed in the inet.3 routing table, and both labeled and unlabeled unicast routes can be sent or received by the router.
Options	inet.3—Name of the routing table.
Usage Guidelines	See “Enabling Multiprotocol BGP” on page 682.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

rib-group

Syntax	<code>rib-group group-name;</code>
Hierarchy Level	<pre>[edit logical-systems <i>logical-system-name</i> protocols bgp family inet (any labeled-unicast unicast multicast)], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> family inet (any labeled-unicast unicast multicast)], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> neighbor address family inet (any labeled-unicast unicast multicast)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp family inet (any labeled-unicast unicast multicast)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> family inet (any labeled-unicast unicast multicast)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor address family inet (any labeled-unicast unicast multicast)], [edit protocols bgp family inet (any labeled-unicast unicast multicast)], [edit protocols bgp group <i>group-name</i> family inet (any labeled-unicast unicast multicast)], [edit protocols bgp group <i>group-name</i> neighbor address family inet (any labeled-unicast unicast multicast)], [edit routing-instances <i>routing-instance-name</i> protocols bgp family inet (any labeled-unicast unicast multicast)], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> family inet (any labeled-unicast unicast multicast)], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor address family inet (any labeled-unicast unicast multicast)]</pre>
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Add unicast prefixes to unicast and multicast tables.
Options	<i>group-name</i> —Name of the routing table group. The name must start with a letter and can include letters, numbers, and hyphens. You generally specify only one routing table group.
Usage Guidelines	See “Creating Routing Table Groups” on page 104, “Configuring How Interface Routes Are Imported into Routing Tables” on page 106, and “Configuring BGP Routing Table Groups” on page 686.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	interface-routes, rib-group

route-target

Syntax	<pre> route-target { advertise-default; external-paths <i>number</i>; accepted-prefix-limit { maximum <i>number</i>; teardown <percentage> <idle-timeout (forever time-in-minutes)>; } prefix-limit { maximum <i>number</i>; teardown <percentage> <idle-timeout (forever time-in-minutes)>; } } </pre>
Hierarchy Level	<p>[edit logical-systems <i>logical-system-name</i> protocols bgp family], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> family], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i> family], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> family], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i> family], [edit protocols bgp family], [edit protocols bgp group <i>group-name</i> family], [edit protocols bgp group <i>group-name</i> neighbor <i>address</i> family], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> family], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i> family]</p>
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Limit the number of prefixes advertised on BGP peerings specifically to the peers that need the updates.
Options	<p>advertise-default—Advertise default routes and suppress more specific routes.</p> <p>external-paths <i>number</i>—Number of external paths accepted for route filtering. Range: 1 through 16 paths Default: 1 path</p> <p>The remaining statements are explained separately.</p>
Usage Guidelines	See “Enabling Route Target Filtering” on page 693.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

tcp-mss

Syntax	<code>tcp-mss <i>segment-size</i>;</code>
Hierarchy Level	<pre> [edit logical-systems <i>logical-system-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit protocols bgp], [edit protocol bgp group <i>group-name</i>], [edit protocols bgp group <i>group-name</i> neighbor <i>neighbor-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor <i>neighbor-name</i>] </pre>
Release Information	Statement introduced in JUNOS Release 8.1.
Description	Configure the maximum segment size (MSS) for the TCP connection for BGP neighbors.
Usage Guidelines	See “Configuring the Segment Size for TCP” on page 706.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

traceoptions

Syntax	<pre> traceoptions { file <i>name</i> <size <i>size</i>> <files <i>number</i>> <(world-readable no-world-readable)>; flag <i>flag</i> <flag-modifier> <disable>; } </pre>
Hierarchy Level	<pre> [edit logical-systems <i>logical-system-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> neighbor address], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor address], [edit protocols bgp], [edit protocols bgp group <i>group-name</i>], [edit protocols bgp group <i>group-name</i> neighbor address], [edit routing-instances <i>routing-instance-name</i> protocols bgp], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i> neighbor address] </pre>
Release Information	<p>Statement introduced before JUNOS Release 7.4.</p> <p>4byte-as statement introduced in JUNOS Release 9.2.</p>
Description	<p>Configure BGP protocol-level tracing options.</p> <p>To specify more than one tracing operation, include multiple flag statements.</p>
Default	<p>The default BGP protocol-level tracing options are inherited from the routing protocols traceoptions statement included at the [edit routing-options] hierarchy level. The default group-level trace options are inherited from the BGP protocol-level traceoptions statement. The default peer-level trace options are inherited from the group-level traceoptions statement.</p>
Options	<p>disable—(Optional) Disable the tracing operation. You can use this option is to disable a single operation when you have defined a broad group of tracing operations, such as all.</p> <p>file <i>name</i>—Name of the file to receive the output of the tracing operation. Enclose the name within quotation marks. All files are placed in the directory <code>/var/log</code>. We recommend that you place BGP tracing output in the file bgp-log.</p> <p>files <i>number</i>—(Optional) Maximum number of trace files. When a trace file named <i>trace-file</i> reaches its maximum size, it is renamed <i>trace-file.0</i>, then <i>trace-file.1</i>, and so on, until the maximum number of trace files is reached. Then, the oldest trace file is overwritten.</p>



NOTE: If you specify a maximum number of files, you must also specify a maximum file size with the **size** option.

Range: 2 through 1000 files

Default: 10 files

flag—Tracing operation to perform. To specify more than one tracing operation, include multiple **flag** statements.

BGP Tracing Flags

- **4byte-as**—4-byte AS events
- **as-path**—AS path regular expression operations.
- **damping**—Damping operations.
- **keepalive**—BGP keepalive messages.
- **open**—Open packets. These packets are sent between peers when they are establishing a connection.
- **packets**—All BGP protocol packets.
- **update**—Update packets. These packets provide routing updates to BGP systems.

Global Tracing Flags

- **all**—All tracing operations.
- **general**—A combination of the **normal** and **route** trace operations.
- **normal**—All normal operations.
Default: If you do not specify this option, only unusual or abnormal operations are traced.
- **policy**—Policy operations and actions.
- **route**—Routing table changes.
- **state**—State transitions.
- **task**—Interface transactions and processing.
- **timer**—Timer usage.

flag-modifier—(Optional) Modifier for the tracing flag. You can specify one or more of these modifiers:

- **detail**—Provide detailed trace information.
- **filter**—Filter trace information. Applies only for **route** and **damping** tracing flags.
- **receive**—Packets being received.
- **send**—Packets being transmitted.

no-world-readable—(Optional) Prevent any user from reading the log file.

size size—(Optional) Maximum size of each trace file, in kilobytes (KB), megabytes (MB), or gigabytes (GB). When a trace file named *trace-file* reaches this size, it is renamed *trace-file.0*. When the *trace-file* again reaches its maximum size, *trace-file.0* is renamed *trace-file.1* and *trace-file* is renamed *trace-file.0*. This renaming scheme continues until the maximum number of trace files is reached. Then, the oldest trace file is overwritten.

If you specify a maximum file size, you also must specify a maximum number of trace files with the **files** option.

Syntax: *xk* to specify KB, *xm* to specify MB, or *xg* to specify GB

Range: 10 KB through the maximum file size supported on your system

Default: 128 KB

world-readable—(Optional) Allow any user to read the log file.

Usage Guidelines See “Tracing BGP Protocol Traffic” on page 706.

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

Related Topics log-updown

type

Syntax	<code>type type;</code>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>], [edit protocols bgp group <i>group-</i>], [edit routing-instances <i>routing-instance-name</i> protocols bgp group <i>group-name</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Specify the type of BGP peer group.
Options	<i>type</i> —Type of group: <ul style="list-style-type: none"> ■ <i>internal</i>—Internal group ■ <i>external</i>—External group
Usage Guidelines	See “Defining BGP Groups and Peers” on page 647.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

vpn-apply-export

Syntax	<code>vpn-apply-export;</code>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols bgp], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i>], [edit logical-systems <i>logical-system-name</i> protocols bgp group <i>group-name</i> neighbor <i>address</i>], [edit protocols bgp], [edit protocols bgp group <i>group-name</i>], [edit protocols bgp group <i>group-name</i> neighbor <i>address</i>]
Release Information	Statement introduced before JUNOS Release 7.4.
Description	Apply a BGP export policy in addition to a VPN routing and forwarding (VRF) export policy to routes.
Default	The default action is to accept.
Usage Guidelines	See “Applying BGP Export Policy to VRF Routes” on page 703.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

Part 7

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