



JUNOS[™]e Software for E-series[™] Routing Platforms

System Basics Configuration Guide

Release 9.3.x

Juniper Networks, Inc.

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JUNOSe™ Software for E-series™ Routing Platforms System Basics Configuration Guide

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Part 1

Chapters

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E-series and JUNOS^e Documentation and Release Notes

For a list of related E-series and JUNOS^e documentation, see
<http://www.juniper.net/techpubs/index.html>.

If the information in the latest *JUNOS^e Release Notes* differs from the information in the documentation, follow the *JUNOS^e Release Notes*.

To obtain the most current version of all Juniper Networks technical documentation, see the products documentation page on the Juniper Networks Web site at <http://www.juniper.net/>.

Audience

This guide is intended for experienced system and network specialists working with E-series routers in an Internet access environment.

E-series and JUNOS^e Text and Syntax Conventions

Table 1 on page xxx defines notice icons used in this documentation.

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 xxx defines text and syntax conventions that we use throughout the E-series and JUNOS documentation.

Table 2: Text and Syntax Conventions

Convention	Description	Examples
Bold text like this	Represents commands and keywords in text.	<ul style="list-style-type: none"> ■ Issue the clock source command. ■ Specify the keyword exp-msg.
Bold text like this	Represents text that the user must type.	host1(config)# traffic class low-loss1
Fixed-width text like this	Represents information as displayed on your terminal's screen.	host1#show ip ospf 2 Routing Process OSPF 2 with Router ID 5.5.0.250 Router is an Area Border Router (ABR)
<i>Italic text like this</i>	<ul style="list-style-type: none"> ■ Emphasizes words. ■ Identifies variables. ■ Identifies chapter, appendix, and book names. 	<ul style="list-style-type: none"> ■ There are two levels of access: <i>user</i> and <i>privileged</i>. ■ <i>clusterId</i>, <i>ipAddress</i>. ■ <i>Appendix A, System Specifications</i>
Plus sign (+) linking key names	Indicates that you must press two or more keys simultaneously.	Press Ctrl + b.
Syntax Conventions in the Command Reference Guide		
Plain text like this	Represents keywords.	terminal length
<i>Italic text like this</i>	Represents variables.	<i>mask</i> , <i>accessListName</i>
(pipe symbol)	Represents a choice to select one keyword or variable to the left or to the right of this symbol. (The keyword or variable can be either optional or required.)	diagnostic line

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

Convention	Description	Examples
[] (brackets)	Represent optional keywords or variables.	[internal external]
[]* (brackets and asterisk)	Represent optional keywords or variables that can be entered more than once.	[level1 level2 l1]*
{ } (braces)	Represent required keywords or variables.	{ permit deny } { in out } { <i>clusterId</i> <i>ipAddress</i> }

Related E-series and JUNOS^e Documentation

Table 3 on page xxxi lists and describes the E-series and JUNOS^e document set.

Table 3: Juniper Networks E-series and JUNOS^e Technical Publications

Document	Description
E-series Hardware Documentation	
<i>E120 and E320 Quick Start Guide</i>	Shipped in the box with all new E120 and E320 routers. Provides the basic procedures to help you get the routers up and running quickly.
<i>E120 and E320 Hardware Guide</i>	<p>Provides the necessary procedures for getting the E120 routers and E320 routers operational, including information about:</p> <ul style="list-style-type: none"> ■ Installing the chassis and modules ■ Connecting cables ■ Powering up the routers ■ Configuring the routers for management access ■ Troubleshooting common issues <p>Describes switch router processor (SRP) modules, line modules, and I/O adapters (IOAs) available for the E120 and E320 routers.</p>
<i>E120 and E320 Module Guide</i>	<p>Provides detailed specifications for line modules and IOAs in E120 and E320 routers, and information about the compatibility of these modules with JUNOS^e software releases.</p> <p>Lists the layer 2 protocols, layer 3 protocols, and applications that line modules and their corresponding IOAs modules support.</p> <p>Provides module LED information.</p>
<i>E-series Installation Quick Start poster or ERX Quick Start Guide</i>	Shipped in the box with all new ERX routers. Provides the basic procedures to help you get an ERX router up and running quickly.

Table 3: Juniper Networks E-series and JUNOS Technical Publications *(continued)*

Document	Description
<i>ERX Hardware Guide</i>	<p>Provides the necessary procedures for getting ERX-14xx models, ERX-7xx models, and ERX-310 routers operational, including information about:</p> <ul style="list-style-type: none"> ■ Installing the chassis and modules ■ Connecting cables ■ Powering up the routers ■ Configuring the routers for management access ■ Troubleshooting common issues <p>Describes switch router processor (SRP) modules, line modules, and I/O modules available for the ERX routers.</p>
<i>ERX Module Guide</i>	<p>Provides detailed specifications for line modules and I/O modules in ERX-14xx models, ERX-7xx models, and ERX-310 routers, and information about the compatibility of these modules with JUNOS software releases.</p> <p>Lists the layer 2 protocols, layer 3 protocols, and applications that line modules and their corresponding I/O modules support.</p> <p>Provides module LED information.</p>
<i>ERX End-of-Life Module Guide</i>	<p>Provides an overview and description of ERX modules that are end-of-life (EOL) and can no longer be ordered for the following routers:</p> <ul style="list-style-type: none"> ■ ERX-7xx models ■ ERX-14xx models ■ ERX-310 router
JUNOS Software Guides	
<i>JUNOS System Basics Configuration Guide</i>	<p>Provides information about:</p> <ul style="list-style-type: none"> ■ Planning and configuring your network ■ Using the command-line interface (CLI) ■ Installing JUNOS software ■ Configuring the Simple Network Management Protocol (SNMP) ■ Managing the router and its modules, including the use of high availability (HA) for SRP redundancy ■ Configuring and running a unified in-service software upgrade (ISSU) ■ Configuring passwords and security ■ Configuring the router clock ■ Configuring virtual routers
<i>JUNOS Physical Layer Configuration Guide</i>	Explains how to configure, test, and monitor physical layer interfaces.
<i>JUNOS Link Layer Configuration Guide</i>	Explains how to configure and monitor static and dynamic link layer interfaces.
<i>JUNOS IP, IPv6, and IGP Configuration Guide</i>	Explains how to configure and monitor IP, IPv6 and Neighbor Discovery, and interior gateway protocols (RIP, OSPF, and IS-IS).

Table 3: Juniper Networks E-series and JUNOS Technical Publications *(continued)*

Document	Description
<i>JUNOS IP Services Configuration Guide</i>	<p>Explains how to configure and monitor IP routing services. Topics include:</p> <ul style="list-style-type: none"> ■ Routing policies ■ Firewalls ■ Network Address Translation (NAT) ■ J-Flow statistics ■ Bidirectional forwarding detection (BFD) ■ Internet Protocol Security (IPSec) ■ Access Node Control Protocol (ANCP), also known as Layer 2 Control (L2C) ■ Digital certificates ■ IP tunnels ■ Virtual Router Redundancy Protocol (VRRP) ■ Mobile IP home agent
<i>JUNOS Multicast Routing Configuration Guide</i>	<p>Explains how to configure and monitor IP multicast routing and IPv6 multicast routing. Topics include:</p> <ul style="list-style-type: none"> ■ Internet Group Management Protocol (IGMP) ■ Protocol Independent Multicast (PIM) ■ Distance Vector Multicast Routing Protocol (DVMRP) ■ Multicast Listener Discovery (MLD)
<i>JUNOS BGP and MPLS Configuration Guide</i>	<p>Explains how to configure and monitor:</p> <ul style="list-style-type: none"> ■ Border Gateway Protocol (BGP) routing ■ Multiprotocol Label Switching (MPLS) and related applications ■ Layer 2 services over MPLS ■ Virtual private LAN service (VPLS) ■ Layer 2 virtual private networks (L2VPNs)
<i>JUNOS Policy Management Configuration Guide</i>	<p>Explains how to configure, manage, and monitor customized policy rules for packet classification, forwarding, filtering, and flow rates. Also describes the packet-mirroring feature, which uses secure policies.</p>
<i>JUNOS Quality of Service Configuration Guide</i>	<p>Explains how to configure quality of service (QoS) features to queue, schedule, and monitor traffic flow. These features include:</p> <ul style="list-style-type: none"> ■ Traffic classes and traffic-class groups ■ Drop, queue, QoS, and scheduler profiles ■ QoS parameters ■ Statistics

Table 3: Juniper Networks E-series and JUNOS Technical Publications *(continued)*

Document	Description
<i>JUNOS Broadband Access Configuration Guide</i>	Explains how to configure and monitor a remote access environment, which can include the following features: <ul style="list-style-type: none"> ■ Authentication, authorization, and accounting (AAA) ■ Dynamic Host Configuration Protocol (DHCP) ■ Remote Authentication Dial-In User Service (RADIUS) ■ Terminal Access Controller Access Control System (TACACS +) ■ Layer 2 Tunneling Protocol (L2TP) ■ Subscriber management
<i>JUNOS System Event Logging Reference Guide</i>	Describes the JUNOS system logging feature and describes how to use the CLI to monitor your system's log configuration and system events.
<i>JUNOS Command Reference Guide A to M</i>	Together constitute the <i>JUNOS Command Reference Guide</i> . Contain important information about commands implemented in the system software. Use to look up: <ul style="list-style-type: none"> ■ Descriptions of commands and command parameters ■ Command syntax ■ A command's related mode ■ Starting with JUNOS Release 7.1.0, a history of when a command, its keywords, and its variables were introduced or added <p>Use with the JUNOS configuration guides.</p>
<i>JUNOS Command Reference Guide N to Z</i>	
<i>JUNOS Glossary</i>	Provides definitions for terms used in JUNOS technical documentation.
Release Notes	
<i>JUNOS Release Notes</i>	Provide the latest information about features, changes, known problems, resolved problems, and system maximum values. If the information in the <i>Release Notes</i> differs from the information found in the documentation set, follow the <i>Release Notes</i> . <p>Release notes are included on the corresponding software CD and are available on the Web.</p>

Obtaining Documentation

To obtain the most current version of all Juniper Networks technical documentation, see the products documentation page on the Juniper Networks Web site at <http://www.juniper.net/>.

To order a documentation CD, which contains this guide, contact your sales representative.

Copies of the Management Information Bases (MIBs) available in a software release are included on the software CDs and at <http://www.juniper.net/>.

Documentation Feedback

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

- Document or topic name
- URL or page number
- Software release version

Requesting Technical Support

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

- JTAC policies—For a complete understanding of our JTAC procedures and policies, review the JTAC User Guide located at <http://www.juniper.net/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, see <http://www.juniper.net/support/requesting support.html>

Part 1

Chapters

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- Managing the System on page 235
- Managing Modules on page 335
- Managing High Availability on page 413
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Chapter 1

Planning Your Network

This chapter describes planning steps that will make it easier to configure the physical interfaces, logical interfaces, and routing protocols for the E-series routers in:

- A new network that you are creating and implementing
- An existing network that you are expanding

This chapter contains the following sections:

- Platform Considerations on page 3
- Edge Applications Overview on page 4
- Layered Approach on page 6
- Line Modules, I/O Modules, and IOAs on page 7
- Interfaces on page 8
- General Configuration Tasks on page 9
- Configuring Virtual Routers on page 10
- Configuring IPSec on page 10
- Configuring Physical Layer Interfaces on page 10
- Configuring Data Link-Layer Interfaces on page 17
- Configuring IP Tunnels, Shared IP Interfaces, and Subscriber Interfaces on page 23
- Configuring Routing Protocols on page 24
- Configuring VRRP on page 25
- Configuring Routing Policy on page 25
- Configuring QoS on page 25
- Configuring Policy Management on page 26
- Configuring Remote Access on page 26

Platform Considerations

For information about the modules supported on E-series routers:

- See the *ERX Module Guide* for modules supported on ERX-7xx models, ERX-14xx models, and the ERX-310 router.

- See the *E120 and E320 Module Guide* for modules supported on the E120 router and the E320 router.

Interface Specifiers

The configuration task examples in this chapter use the *slot/port* format to specify an interface. However, the interface specifier format that you use depends on the router that you are using.

For ERX-7xx models, ERX-14xx models, and ERX-310 routers, use the *slot/port* format. For example, the following command specifies an ATM interface on slot 0, port 1 of an ERX-7xx model, ERX-14xx model, or ERX-310 router.

```
host1(config)#interface atm 0/1
```

For E120 and E320 routers, use the *slot/adapter/port* format, which includes an identifier for the bay in which the I/O adapter (IOA) resides. In the software, adapter 0 identifies the right IOA bay (E120 router) and the upper IOA bay (E320 router); adapter 1 identifies the left IOA bay (E120 router) and the lower IOA bay (E320 router). For example, the following command specifies an ATM interface on slot 5, adapter 0, port 0 of an E320 router.

```
host1(config)#interface atm 5/0/0
```

For more information about supported interface types and specifiers on E-series routers, see *Interface Types and Specifiers*.

Edge Applications Overview

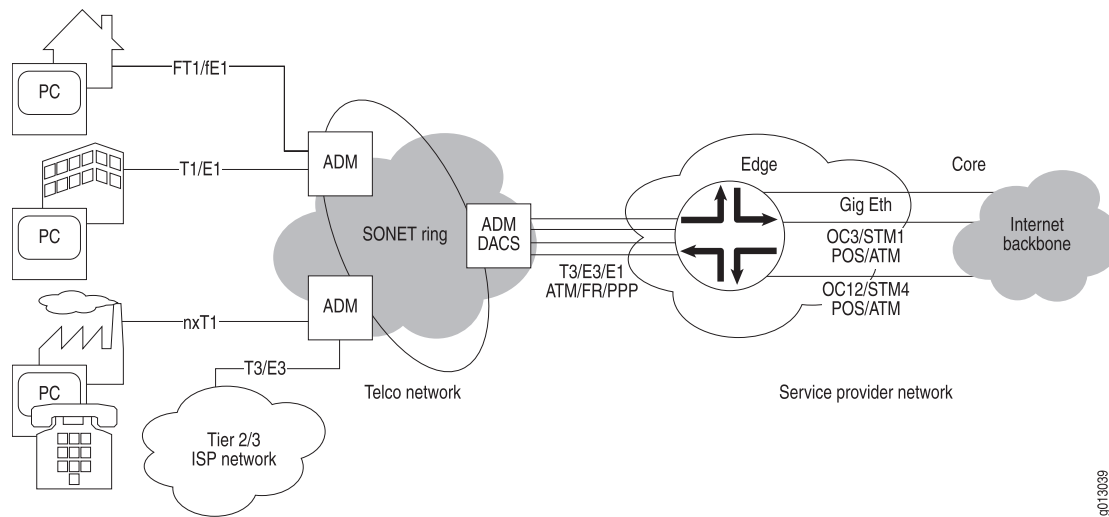
The E-series router can be used for a number of edge aggregation applications. Two of the most common are:

- Private line aggregation
- xDSL session termination

Private Line Aggregation

A major application of the E-series router is for private line aggregation—the consolidation of multiple high-speed access lines into one access point. See Figure 1 on page 5.

In this application, the service provider can use a single router to offer high-speed access (FT1/FE1 through T3/E3) to thousands of subscribers. The individual subscriber lines can be multiplexed into T3 lines by the service provider and fed into the router. (The router can also accept unchannelized T3 or E3 connections from high-speed users and channelized E1 connections directly into the unit.) Once the traffic is received, the router then handles all IP packet processing, including the assignment of QoS and routing policies. The packets are then routed into the backbone network.

Figure 1: Private Line Aggregation with the E-series Router

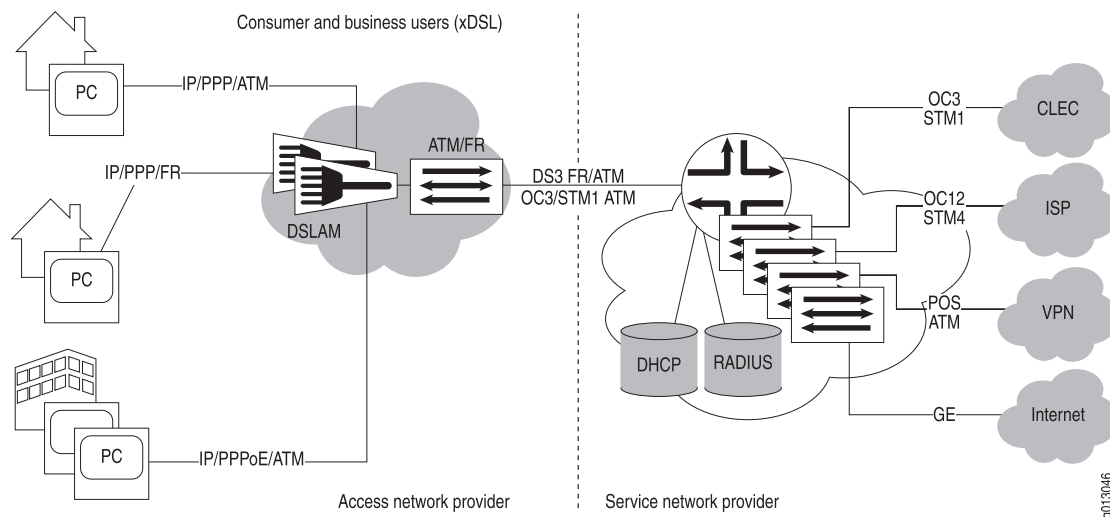
The router supports a number of access and uplink methods; the most common pairings are listed in Table 4 on page 5.

Table 4: Common Access/Uplink Pairings

Access	Uplink
PPP	ATM, Fast Ethernet, Gigabit Ethernet, or POS
Frame Relay	
ATM	

xDSL Session Termination

The router supports Broadband Remote Access Server (B-RAS) applications, as shown in Figure 2 on page 6. In this application, the router handles the aggregated output from the digital subscriber line access multiplexers (DSLAMs). Directly connected to the subscriber premises, the DSLAMs handle the copper termination and aggregate the traffic into a higher-speed uplink. The output from the DSLAM is fed into the router through a DS3 or OC3 link.

Figure 2: B-RAS Application

The router then performs several functions:

- PPP session termination and authentication checking through PAP or CHAP
- Coordination with DHCP servers and local IP pools to assign IP addresses
- Connection to RADIUS servers or use of domain names to associate subscribers with user profile information
- Support for RADIUS accounting to gather detailed billing information
- Application of the user profile to the user traffic flow, which could include QoS, VPN, and routing profiles

The output of the router is typically a high-speed link, such as OC3/STM1 to feed a core backbone router. Virtual routers can also be used to keep the traffic logically separate and to direct packets to different destinations. As shown in Figure 2 on page 6, the packets can be directed to a CLEC, ISP, corporate VPN, or the Internet.

A large number of xDSL protocols are supported, including:

- IP/PPP/ATM
- IP/PPP/Ethernet/ATM
- IP/bridged Ethernet/ATM

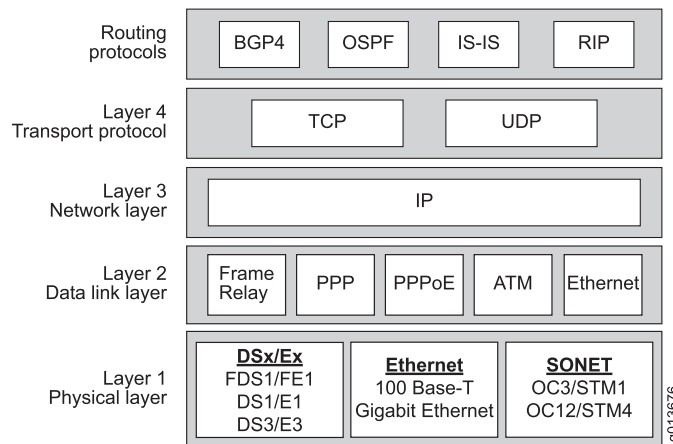
See *JUNOS Broadband Access Configuration Guide*, for information about configuring B-RAS.

Layered Approach

The JUNOS CLI enables you to configure your network based on the hierarchy of the OSI model. Therefore, the JUNOS configuration guides use a bottom-up approach to describe the configuration process. Figure 3 on page 7 shows the relationship of

layers, protocols, and interfaces to the configuration process. Software functions are layered on top of physical (copper or optical) interfaces. The router supports a number of access protocols (PPP/POS, Frame Relay, ATM) that allow service providers to offer a number of access methods and line speeds to their subscribers. The router is optimized to handle IP connections regardless of the access protocol used. The router also supports a number of protocols that are specific to the B-RAS application. These are shown in Figure 3 on page 7, and include IP/PPP/ATM and IP/PPP/Ethernet/ATM.

Figure 3: Network Configuration Using a Bottom-Up Approach



Layer 2 (data link) defines how the data is packaged and sent to an IP data connection point in layer 3 (IP interfaces). In layer 3, you define the global attributes for IP services that serve as a platform from which you add routing information.

Line Modules, I/O Modules, and IOAs

A range of line modules, I/O modules, and I/O adapters (IOAs) are available for the router. On the ERX-14xx models, ERX-7xx models, and the ERX-310 router, most line modules pair with a corresponding I/O module. On the E120 router and the E320 router, a single line module pairs with all available IOAs.

I/O modules and IOAs provide the input and output connections from the network to the router. Line modules connect to their corresponding I/O modules or IOAs through a passive midplane. A line module receives packets through its I/O module or IOA and processes those packets. The router then routes the packets out to the network through the designated I/O module or IOA.

Each line module, I/O module, and IOA has a label on its faceplate. In this documentation, these modules are identified by that label. For example, the high-density Gigabit Ethernet line module has two ports, and is called the GE-HDE line module. Its corresponding I/O modules are the GE-HDE I/O module and the GE-2 SFP I/O module.

When we refer to a related set of line modules, I/O modules, or IOAs, the generic information from the module labels is used in this documentation. For example, the term “OCx/STMx line modules” refers to both the OCx/STMx ATM and the OCx/STMx

POS line modules. Similarly, the term “GE I/O modules” refers to both the GE Multimode I/O module and the GE Single Mode I/O module.

For a complete list of the line modules and I/O modules available for ERX-14xx models, ERX-7xx models, and the ERX-310 router, see *ERX Module Guide, Table 1, Module Combinations*. For more information about line modules and IOAs available with the E120 and E320 routers, see *E120 and E320 Module Guide, Table 1, Modules and IOAs*.

For more information about managing these modules, see “Managing Modules” on page 335.

Interfaces

The term *interfaces* is used in a very specific way in the JUNOS CLI and this documentation. Interfaces are both physical and logical channels on the router that define how data is transmitted to and received from lower layers in the protocol stack. Conceptually, you configure an interface as part of the physical layer, layer 1.

For example, you can configure the physical and logical characteristics of T3 and T1 lines coming directly from the customer premises or from a central office switch and OC3 lines going out to the core of your network infrastructure. These physical and logical characteristics define an interface.

Interface layering must always be configured in order from the lowest layer to the highest layer. For example, if you have already configured IP to run over ATM and you want to reconfigure the interface to run IP over PPP over ATM, you must first remove the IP interface, apply PPP, and then reapply IP.

Subinterfaces

A subinterface is a mechanism that allows a single physical interface to support multiple logical interfaces or networks. Several logical interfaces or networks can be associated with a single physical interface. Configuring multiple virtual interfaces, or subinterfaces, on a single physical interface allows greater flexibility and connectivity on the network.

Protocols such as Frame Relay and ATM require that you create one or more virtual circuits over which your data traffic is transmitted to higher layers in the protocol stack. The router requires that you define a subinterface on top of a physical interface as a platform for a virtual circuit, such as a permanent virtual circuit (PVC).

Once you have defined the underlying characteristics of an interface, use the interface command to:

1. Assign an *interface type*, such as POS or ATM.
2. Assign the associated *interface specifier* to the interface, such as the *slot/port* or *slot/adaptor/port* and *channel/subchannel*.
3. Assign one or more subinterfaces.

Interface Command

The **interface** command has the following format:

interface *interfaceType interfaceSpecifier*

Each interface type has an interface specifier associated with it. The interface specifier identifies the physical location of the interface on the router, such as the chassis slot and port number, and logical interface information, such as a T1 channel on a channelized T3 interface.

For detailed information about interface types and specifiers and for specific syntax for the **interface** command, see the Interface Types and Specifiers.

General Configuration Tasks

The configuration process for E-series routers involves the following general tasks:

1. Determine IP-addressing information and information about the physical and logical characteristics of the various interfaces that you want to configure.
2. Determine information about the link-layer protocols.
3. Determine how to organize virtual routers on the router.
4. Determine how IPSec will be used to provide security.
5. Determine routing information that defines all or part of the network.
6. Create the virtual routers.
7. Configure the interfaces and subinterfaces (such as channelized T3, OCx/STMx, and HDLC data channels) over which the higher-layer protocols run.
8. Configure the data link-layer protocols, such as Frame Relay, PPP, and ATM, that run over these physical interfaces.
9. Configure the general IP information from which the other routing protocols will operate.
10. Configure IP tunnels, shared interfaces, and subscriber interfaces.
11. Configure IPSec.
12. Configure the routing protocols that will run on the router, such as IP multicasting protocols, OSPF, IS-IS, RIP, BGP-4, and MPLS.
13. Configure the Virtual Router Redundancy Protocol (VRRP) on IP/Ethernet interfaces.
14. Configure QoS and policy management.
15. Configure the router for remote access.
16. Use the appropriate show commands to display network activity on each of the interfaces that you have configured. Do this to verify that they are operating as you expect and to help improve the management of your network.

Configuring Virtual Routers

Multiple distinct virtual routers are supported within a single router, which allows service providers to configure multiple, separate, secure routers within a single chassis. These routers are identified as *virtual routers (VRs)*. Applications for this function include the creation of individual routers dedicated to wholesale customers, corporate virtual private network (VPN) users, or a specific traffic type.

The router implements the virtual routers by maintaining a separate instance of each data structure for each virtual router and allowing each protocol to be enabled on a case-by-case basis. Virtual routers provide full support for all supported routing protocols (unicast, multicast, and MPLS).

For information about configuring virtual routers, see “Configuring Virtual Routers” on page 609.

Configuring IPSec

IPSec provides security to IP flows through the use of authentication and encryption.

- Authentication verifies that data is not altered during transmission and ensures that users are communicating with the individual or organization that they believe they are communicating with.
- Encryption makes data confidential by making it unreadable to everyone except the sender and intended recipient.

IPSec comprises two encapsulating protocols:

- Encapsulating Security Payload (ESP) provides confidentiality and authentication functions to every data packet.
- Authentication header (AH) provides authentication to every data packet.

For information about configuring IPSec, see *JUNOS IP Services Configuration Guide*.

Configuring Physical Layer Interfaces

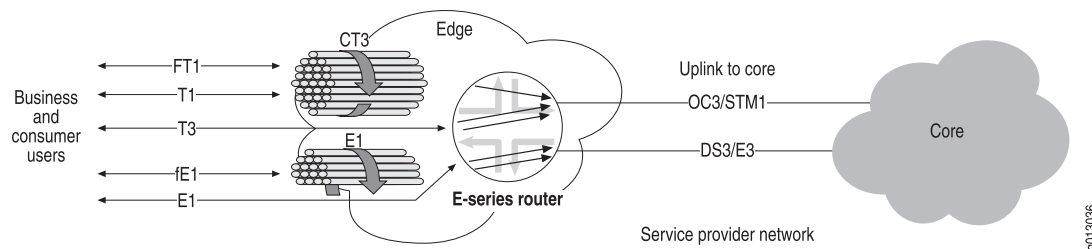
The router supports a number of line rates; some of these are listed per line module below.

- COCX-F3 line module supports unchannelized E3.
- Channelized OCx/STMx (cOCx/STMx) line module supports DS3 channelized to DS1, fractional DS1, or the DS0 level; unchannelized DS3; E1/T1 channelized to fractional DS1; unframed E1.
- CT3 12-F0 line modules support DS3 channelized to DS1, fractional DS1, or the DS0 level. CT3 12-F0 line modules also support unchannelized T3.
- IPSec Service module provides tunnel service for secure tunnels.
- GE/FE line module supports Gigabit Ethernet and Fast Ethernet.
- GE-2 line module and GE-HDE line module support Gigabit Ethernet.

- OCx/STMx ATM line module supports OC3/STM1 ATM, OC12/STM4 ATM, and unchannelized T3.
- OCx/STMx POS line module supports OC3/STM1 POS and OC12/STM4 POS.
- OC48 line module supports OC48/STM16 POS.
- OC3/STM1 GE/FE line module supports OC3/STM1 ATM and Gigabit Ethernet.
- ES2 4G line module (LM) supports OC48/STM16 POS, OC12/STM1 POS, OC3/STM1 ATM, OC12/STM1 ATM, Gigabit Ethernet, 10-Gigabit Ethernet, and tunnel-service interfaces.
- ES2 10G Uplink LM and ES2 10G LM supports 10-Gigabit Ethernet interfaces.
- COCX-F3 line module supports unchannelized T3.
- Service Module (SM) provides tunnel service for IP tunnels and LNS termination.

A variety of protocols are supported over these interfaces, including IP/Frame Relay, IP/ATM, IP/PPP, as well as the protocols to enable B-RAS services. The router's DSx and E1/E3 implementations support termination, statistics gathering, alarm surveillance, and performance monitoring. These links can be used for either network ingress or network egress.

Figure 4: E-series Router Support for Fractional T1/E1 Through T3/E3 Interfaces



As shown in Figure 4 on page 11, the router can support fractional, full, and channelized interfaces.



NOTE: See *ERX Hardware Guide, Chapter 4, Installing Modules* and *E120 and E320 Hardware Guide, Chapter 4, Installing Modules*, for a discussion of slot groups and modules. See the *ERX Module Guide* and the *E120 and E320 Module Guide*, for a discussion of the combination of line modules allowed in E-series routers.

Line Module Features

The following features are supported by the system line modules:

- Three different clocking options: internal timing, loop timing, and chassis timing
- DS3 framing type—Both M23 framing and C-bit parity
- DS1 framing type—Both D4 framing mode and ESF framing mode
- DS3 loopback—For line, payload, diagnostic, and DS1 loopbacks

- DS1 loopback—For line, payload, and diagnostic loopbacks
- DS3/DS1 line status/alarm monitoring
- DS1 line coding type—Both AMI line encoding and B8ZS line encoding
- Unique IP interface support—For each PPP or Frame Relay PVC interface

Configurable HDLC Parameters

The following HDLC parameters are configurable:

- Mapping of DS0 timeslots for T1/FT1 DS0 mapping
- Setting the speed of the DS0 to Nx56 or Nx64
- HDLC CRC checking (enable/disable)
- HDLC CRC algorithm (CRC16 or CRC32)
- Channel data inversion (enable/disable)
- Maximum receive unit (MRU)
- Maximum transmit unit (MTU)

Statistics are also gathered per line module.

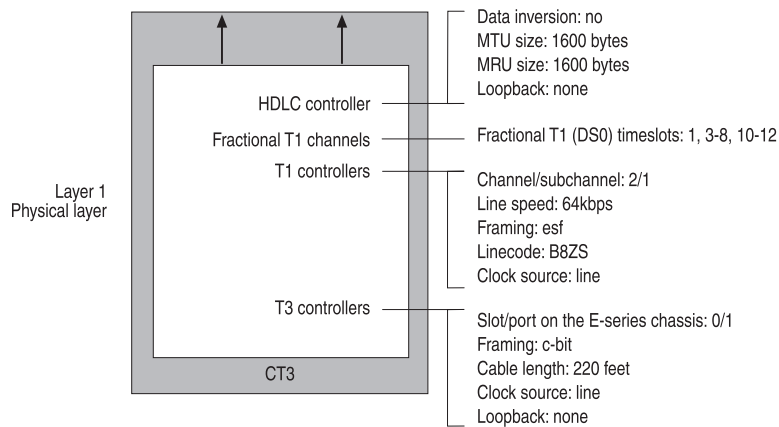
Configuring Channelized T3 Interfaces

There are 12 T3 controllers available on each CT3 12-F0 line module. When you configure these T3 controllers, you are actually configuring T3 (DS3) lines. Each T3 controller has, by definition, 28 T1 controllers representing T1 (DS1) lines.

Use the T3 and T1 commands described in *JUNOS Physical Layer Configuration Guide*, to:

- Specify the line characteristics, such as framing format and clock source, for T3s and associated T1s.
- Assign full and fractional T1 channels (DS0) to a virtual channel.

Figure 5 on page 13 shows sample parameters for a channelized T3 interface configuration.

Figure 5: Channelized T3 Interface Configuration Parameters

The following sample command sequence configures a serial interface for a CT3 12-F0 module. See *JUNOS Physical Layer Configuration Guide*, for details.

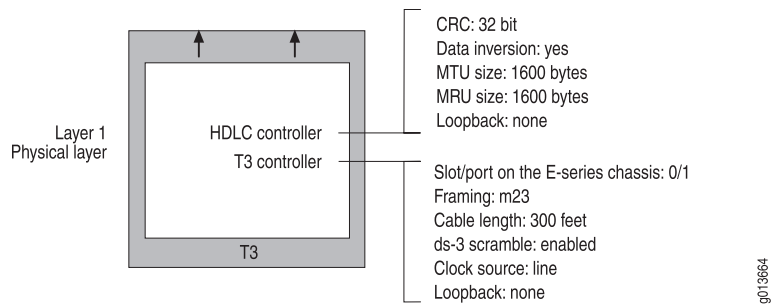
```
host1(config)#controller t3 0/1
host1(config-controll)#framing c-bit
host1(config-controll)#clock source line
host1(config-controll)#cablelength 220
host1(config-controll)#t1 2/1
host1(config-controll)#t1 2 framing esf
host1(config-controll)#t1 2 lineCoding b8zs
host1(config-controll)#t1 2/1 timeslots 2/1 1,3-8,10-12
host1(config-controll)#interface serial 0/1:2/1
```

Configuring T3 and E3 Interfaces

The COCX-F3 line module supports the following wide area network (WAN) protocol encapsulations:

- IP over PPP
- IP over ATM
- IP over PPP over ATM
- IP over PPP over PPPoE over ATM
- IP over Frame Relay

Figure 6 on page 14 shows sample configuration parameters for a T3 interface configuration.

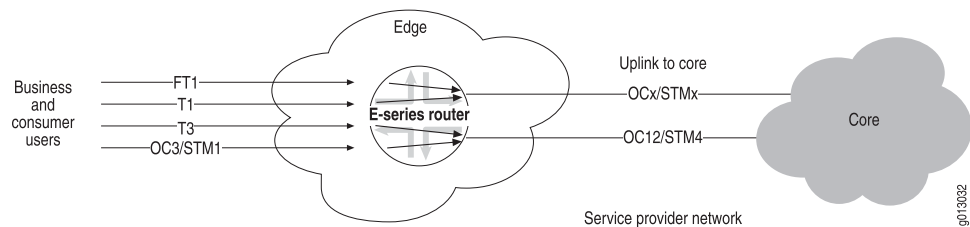
Figure 6: T3 Interface Configuration Parameters

The following sample command sequence configures a serial interface for a T3 module. See *JUNOS Physical Layer Configuration Guide*, for details.

```
host1(config)#controller t3 0/1
host1(config-controll)#framing m23
host1(config-controll)#cablelength 300
host1(config-controll)#ds3-scramble
host1(config-controll)#exit
host1(config)#interface serial 0/1
host1(config-if)#invert data
host1(config-if)#mtu 1600
host1(config-if)#mru 1600
```

Configuring OCx/STMx and OC48 Interfaces

The router supports IP/ATM, IP/Frame Relay, and IP/PPP over SONET on the OCx/STMx interfaces. OC48 interfaces support IP/Frame Relay and IP/PPP over SONET, but do not support ATM operation. This interface support allows service providers to accept incoming optical connections or connect the router to the backbone network through optical connections. The router's SONET implementation supports termination, statistic gathering, and alarm surveillance at the section, line, and path layers of a SONET interface.

Figure 7: SONET Interfaces

The following sample command sequence configures POS for an OC3 interface. See *JUNOS Link Layer Configuration Guide*, for details.

```
host1(config)#interface pos 0/1
host1(config-if)#encapsulation ppp
host1(config-if)#clock source internal module
host1(config-if)#loopback line
```

```

host1(config-if)#pos framing sdh
host1(config-if)#mtu 1600
host1(config-if)#mru 1600
host1(config-if)#pos scramble-atm

```

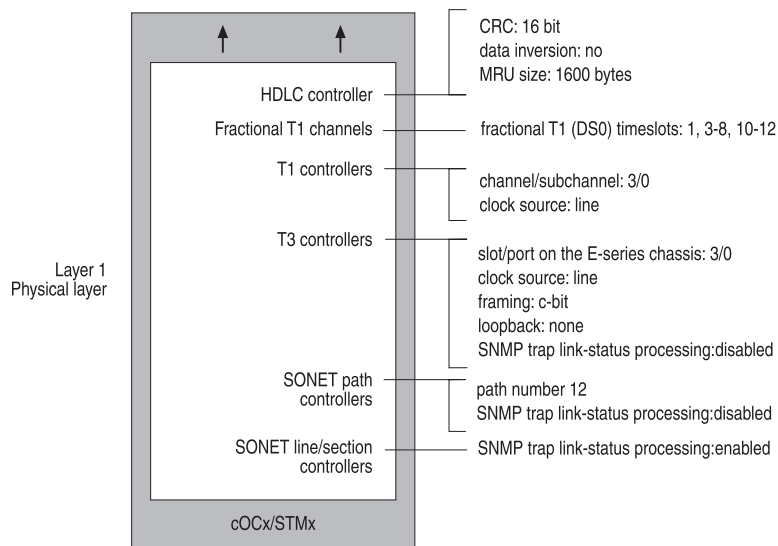
Configuring Channelized OCx/STMx Line Interfaces

The cOCx/STMx modules are generally used for circuit aggregation on the router. These line modules support the following controllers over OC3/STM1 or OC12/STM4, depending on the I/O module used with the line module:

- Fractional T1/E1 over SONET/SDH virtual tributaries or T3
- Unframed E1
- Unchannelized DS3

Figure 8 on page 15 shows the configuration parameters for a sample T1 over DS3 interface configuration.

Figure 8: Parameters for T1 over DS3 Interface Configuration



The following sample command sequence configures T1 over DS3 on a channelized SONET interface as described in Figure 8 on page 15. See *JUNOS Physical Layer Configuration Guide*, for details.

```

host1(config)#controller sonet 3/0
host1(config-controller)#path 12 oc1 4/1
host1(config-controller)#path 12 ds3 1 channelized
host1(config-controller)#path 12 ds3 1 t1 4
host1(config-controller)#path 12 ds3 1 t1 4/2 timeslots 1, 3-8, 10-12
host1(config)#interface serial 3/0:12/1/4/2

```

Configuring Ethernet Interfaces

Ethernet interfaces support IP, PPPoE, multinetting (multiple IP addresses), and VLANs (subinterfaces). Ethernet modules use the Address Resolution Protocol (ARP) to obtain MAC addresses for outgoing Ethernet frames and support quality of service (QoS) classification. See *JUNOS Physical Layer Configuration Guide*, for a description of limitations of individual modules.

Use the Fast Ethernet, Gigabit Ethernet, and 10-Gigabit Ethernet commands described in *JUNOS Physical Layer Configuration Guide* to:

- Configure with IP only, with PPPoE only, with both IP and PPPoE, and with or without VLANs.
- Specify the line speed and duplex mode.
- Specify the MTU.

The following sample command sequence configures an IP interface on a VLAN on an Ethernet interface:

```
host1(config)#interface fastEthernet 2/0
host1(config-if)#encapsulation vlan
host1(config-if)#interface fastEthernet 2/0.1
host1(config-if)#vlan id 201
host1(config-if)#ip address 192.168.129.5 255.255.255.0
```

The following sample command sequence adds an IP interface over PPPoE to the same VLAN:

```
host1(config)#interface fastEthernet 2/0.1.2
host1(config-if)#encapsulation pppoe
host1(config-if)#interface fastEthernet 2/0.1.2.1
host1(config-if)#encapsulation ppp
host1(config-if)#ip address 192.2.2.1 255.255.255.0
```

Configuring IPSec-Service Interfaces

IPSec Service modules support interfaces associated with secure IP tunnels. You configure and delete these interfaces statically; however, the router assigns tunnels to the interfaces dynamically. This mechanism means that you must manage the interfaces for tunnels manually; however, the router will add and remove tunnels when required.

For information about configuring secure IP interfaces, see *JUNOS IP Services Configuration Guide*. For information about managing IPSec service interfaces, see *JUNOS Physical Layer Configuration Guide*.

Configuring Tunnel Service Interfaces

You can configure both dynamic tunnels associated with L2TP and static IP tunnels on your E-series router; however, you must first install a Service Module (SM). Dynamic tunnels, which are not associated with a particular interface, are described in *JUNOS Broadband Access Configuration Guide*. Static tunnels, in which the tunnel

is assigned to a particular interface and specified in slot/port format, are described in *JUNOS IP Services Configuration Guide*.

For information about managing these types of tunnels on the router, see *JUNOS Physical Layer Configuration Guide*.

Configuring Data Link-Layer Interfaces

You can configure the following data link-layer interfaces:

- IP/Frame Relay or multilink Frame Relay
- IP/ATM
- IP/PPP or multilink PPP
- IP/Cisco HDLC
- IP/Ethernet

Configuring IP/Frame Relay

The router supports IP over Frame Relay PVCs on the CT3 12-F0 and OCx/STMx POS modules. The interface presented to the incoming traffic is an IP/Frame Relay router. In addition, IP/PPP/Frame Relay is supported on the T3 and E3 modules. With this interface, the service provider can:

- Receive traffic from subscribers that have CPE equipment, such as routers with Frame Relay interfaces
- Take in traffic from other network devices that use Frame Relay, such as DSLAMs and Frame Relay switches
- Use Frame Relay as an uplink technology on an unchannelized T3 or E3 link

Figure 9 on page 17 shows the structure of the Frame Relay interface. Each Frame Relay major interface sits on top of an HDLC interface. The Frame Relay implementation is divided into two levels: a major interface and one or more subinterfaces. This division allows a single physical interface to support multiple logical interfaces. Multiple IP interfaces can also be assigned to each Frame Relay major interface through the subinterfaces.

Figure 9: Frame Relay Interface Design

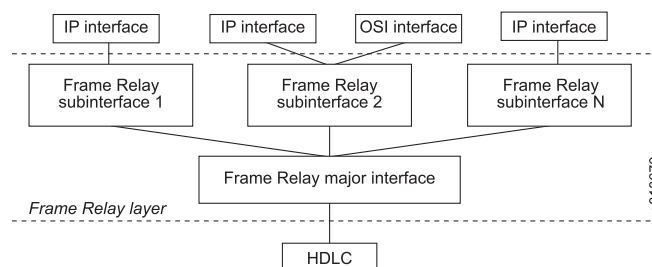
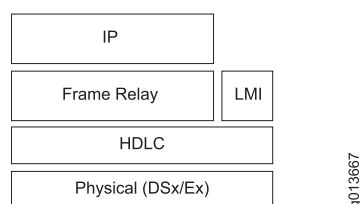


Figure 10 on page 18 shows the structure of the Frame Relay protocols with the physical layer as the foundation. For Frame Relay, the physical layer can be channelized E1, E3, channelized T1, T3, or a fractional service, as supported by the different line module ports. The HDLC layer is on top of the physical layer and can support flexible assignment of physical resources.

For example, an HDLC channel can support one DS0, a fractional T1, or an entire T1. The major Frame Relay interface sits on top of the HDLC resource, and the subinterfaces sit on top of the major interface. The Frame Relay subinterfaces connect to the IP interface layer.

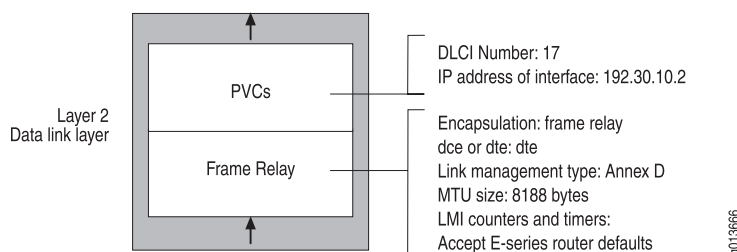
Figure 10: Structure of Frame Relay Protocols



The router supports Frame Relay LMI (local management interface) to provide the operator with configuration and status information relating to the Frame Relay VCs in operation. LMI specifies a polling mechanism to receive incremental and full-status updates from the network. The router can represent either side of the User-to-Network Interface (UNI) and supports unidirectional LMI. Bidirectional support for the Network-to-Network Interface (NNI) is also supported.

Figure 11 on page 18 shows sample configuration parameters for Frame Relay on a serial interface.

Figure 11: Serial Interface Configuration Parameters for a Frame Relay Connection



The following sample command sequence configures a serial interface for Frame Relay. See *JUNOS Link Layer Configuration Guide*, for information.

```

host1(config)#interface serial 0/1:1/5
host1(config-if)#encapsulation frame-relay ietf
host1(config-if)#frame-relay intf-type dte
host1(config-if)#frame-relay lmi-type ansi
host1(config-if)#interface serial 0/1:1/5.1
host1(config-subif)#frame-relay interface-dlci 17 ietf
host1(config-subif)#ip address 192.32.10.2 255.255.255.0
  
```

Configuring IP/ATM

The router supports IP over ATM PVCs on ATM line modules. This support allows service providers to receive traffic from subscribers who have CPE equipment, such as routers with ATM interfaces, to take in traffic from other network devices that use ATM, such as DSLAMs, and to connect to service providers with ATM backbone structures.

Figure 12 on page 19 shows an IP/ATM access connection.

Figure 12: E-series Router IP/ATM Access Connection

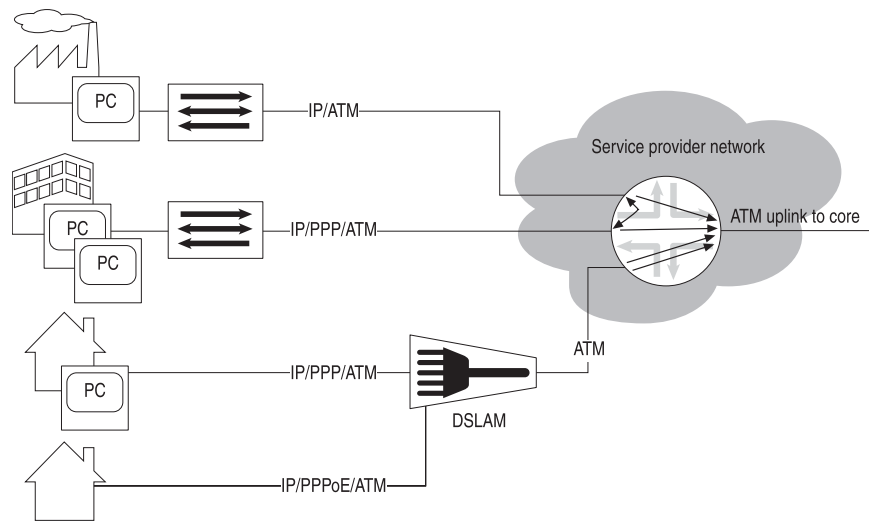


Figure 13 on page 19 shows the structure of the ATM interface. For ATM, this can be SONET, DS3, or E3 as supported by the different line modules. The major ATM interface sits on top of the SONET/DS3/E3 resource, and the subinterfaces sit on top of the major interface. The ATM subinterfaces connect to the IP interface layer.

Figure 13: Structure of the ATM Interface Design

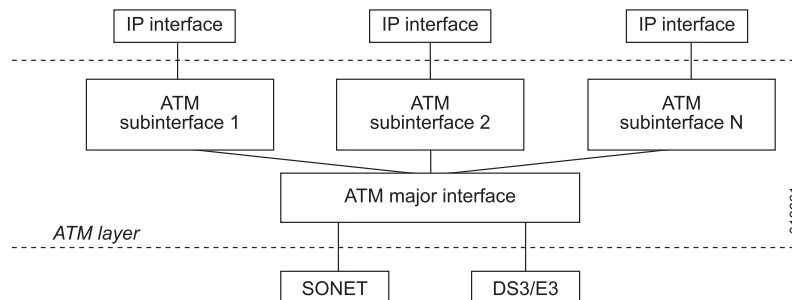


Figure 14 on page 20 shows the structure of the ATM protocols. The physical layer (SONET and/or DSx/Ex) is the foundation and provider of layer 1 framing service. The ATM layer is on top and provides cell, circuit, and OAM services. The AAL5 layer provides a frame-oriented interface to the ATM layer. The integrated local management interface (ILMI) provides local management across the UNI.

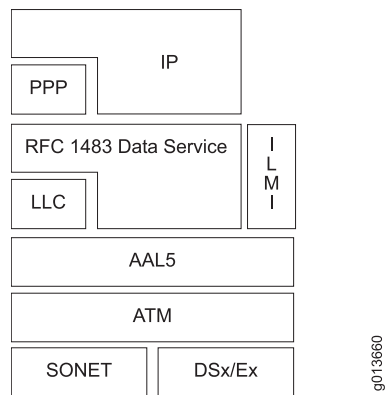
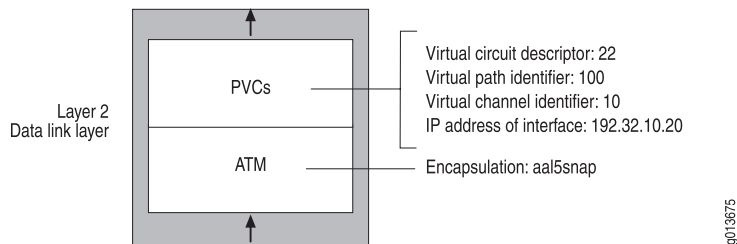
Figure 14: Structure of ATM Protocol

Figure 15 on page 20 shows sample configuration parameters for a typical ATM interface configuration.

Figure 15: ATM Interface Configuration Parameters

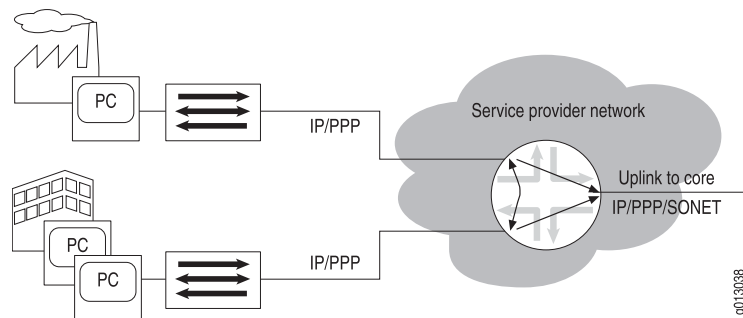
The following sample command sequence configures an ATM interface on port 0 of the line module in slot 1. See *JUNOS Link Layer Configuration Guide*, for information about how to configure an ATM interface.

```
host1(config)#interface atm 0/1
host1(config-if)#interface atm 0/1.22
host1(config-if)#atm pvc 22 100 10 aal5snap
host1(config-subif)#ip address 192.32.10.20 255.255.255.0
```

Configuring IP/PPP

The router supports IP/PPP on the channelized T3, E1, and T3/E3 interfaces and IP/PPP/SONET on the OC3/STM1 and OC12/STM4 interfaces. This support allows service providers to accept traffic from subscribers who have CPE equipment, such as routers with PPP interfaces, and to transmit traffic in PPP format to other network devices.

Figure 16 on page 21 shows that the router supports the incoming IP/PPP traffic from the CPE. This traffic can then be routed to the uplink(s) attached to the router or to other CPEs that are attached to the router.

Figure 16: IP/PPP Connections from the CPE on an E-series Router

As shown in Figure 17 on page 21, the PPP protocol can exist directly on top of the HDLC layer or on top of a layer 2 Frame Relay or ATM interface. In either case, IP rides on top of PPP, providing support for IP/PPP/ATM, IP/PPP/HDLC, and IP/PPP/Frame Relay. Both SONET and DSx/Ex interfaces are supported at the physical layer.

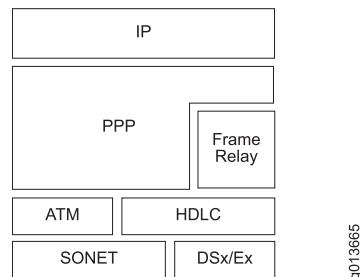
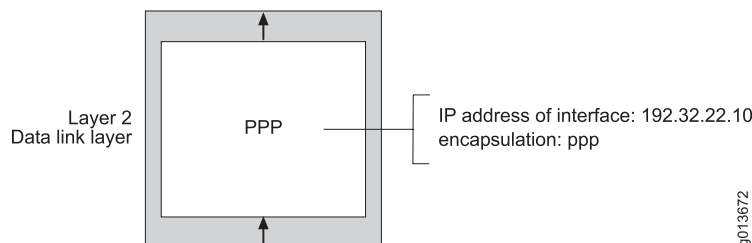
Figure 17: Structure of PPP

Figure 18 on page 21 shows sample configuration parameters for PPP on a serial interface.

Figure 18: PPP Interface Configuration Parameters

The following sample command sequence configures PPP on a serial interface. See *JUNOS Link Layer Configuration Guide*, for details.

```
host1(config)#interface serial 3/0:2/5
host1(config-if)#encapsulation ppp
host1(config-if)#ip address 192.32.22.10 255.255.255.0
```

Configuring IP/HDLC

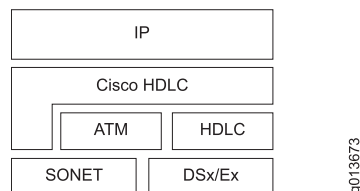
The E-series router supports IP over Cisco HDLC on many types of serial interfaces. Cisco HDLC monitors line status on a serial interface by exchanging keepalive request messages with peer network devices. It also allows routers to discover IP addresses of neighbors by exchanging Serial Link Address Resolution Protocol (SLARP) address request and address response messages with peer network devices.

The E-series router Cisco HDLC is compatible with the Cisco Systems Cisco-HDLC protocol, the default protocol for all Cisco serial interfaces.

The router supports the following framing features:

- HDLC for data-link framing
- 18,000-byte information field size

Figure 19: Structure of Cisco HDLC Protocol



As shown in Figure 19 on page 22, the Cisco HDLC protocol can exist directly on top of the HDLC layer or ATM or SONET interface. Both SONET and DSx/Ex interfaces are supported at the physical layer.

The following example configures HDLC on a serial interface. See *JUNOS Link Layer Configuration Guide*, for details.

```

host1(config)#interface serial 3/1:2/1
host1(config-if)#encapsulation hdlc
host1(config-if)#ip address 192.32.10.2 255.255.255.0
  
```

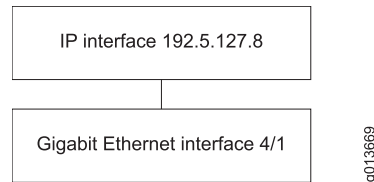
Configuring IP/Ethernet

The E-series router supports IP/Ethernet. When you select an Ethernet interface, you can assign an IP address to it, as the following example shows:

```

host1(config)#interface fastethernet 4/1
host1(config-if)#ip address 192.5.127.8 255.255.255.0
  
```

Figure 20 on page 23 shows an IP/Ethernet interface stack.

Figure 20: Example of IP over Ethernet Stacking Configuration Steps

Configuring IP Tunnels, Shared IP Interfaces, and Subscriber Interfaces

The E-series router supports IP tunnels, shared IP interfaces, and subscriber interfaces.

Configuring IP Tunnels

IP tunnels provide a way of transporting datagrams between routers separated by networks that do not support all the protocols that those routers support. To configure an IP tunnel, you must first configure a tunnel-service interface. (See “Configuring Tunnel Service Interfaces” on page 16.)

When you have configured a tunnel-service interface, treat it in the same way as any IP interface on the router. For example, you can configure static IP routes or enable routing protocols on the tunnel interface. The IP configurations that you apply to the tunnels control how traffic travels through the network.

Configuring Shared Interfaces and Subscriber Interfaces

A shared IP interface is one of a group of IP interfaces that use the same layer 2 interface. Shared IP interfaces are unidirectional—they can transmit but not receive traffic. A subscriber interface is an extension of a shared IP interface. Subscriber interfaces are bidirectional—they can both receive and transmit traffic.

You can create multiple shared IP interfaces over the same layer 2 logical interface—for example, atm 5/3.101—enabling more than one IP interface to share the same logical resources. This capability is useful, for example, when data received in one VRF needs to be forwarded out an interface in another VRF, such as for BGP/MPLS VPNs (see *JUNOS BGP and MPLS Configuration Guide*, for more information). You can configure one or more shared IP interfaces. Data sent over shared interfaces uses the same layer 2 interface. You can configure shared interfaces as you would other IP interfaces. Each shared interface has its own statistics.

The E-series router supports subscriber interfaces on a particular type of layer 2 interface, Ethernet. In the absence of VLANs, Ethernet does not have a demultiplexing layer. A subscriber interface adds a demultiplexing layer for an Ethernet interface that is configured without VLANs. Using subscriber interfaces, the router can demultiplex or separate the traffic associated with different subscribers. You can use subscriber interfaces to separate traffic for cable modem subscribers with different levels of service and to separate traffic for VPNs.

For information about configuring shared interfaces and subscriber interfaces, see *JUNOS IP, IPv6, and IGP Configuration Guide*.

Configuring Routing Protocols

After you have set up the interfaces on which IP traffic flows, you can configure the following routing protocols:

- IP multicast protocols—IP multicasting allows a device to send packets to a group of hosts, rather than to a list of individual hosts. Routers use multicast routing algorithms to determine the best route and transmit datagrams throughout the network. See *JUNOS Multicast Routing Configuration Guide*, for information about how to configure IP multicast.
- Open Shortest Path First (OSPF)—This interior gateway protocol (IGP) advertises the states of network links within an autonomous system. An autonomous system is a set of routers having a single routing policy running under a single technical administration. See *JUNOS IP, IPv6, and IGP Configuration Guide*, for information about how to configure OSPF.
- Integrated Intermediate System-to-Intermediate System (integrated IS-IS)—The integrated IS-IS protocol provides routing for IP networks and is an extension of the original IS-IS protocol, which provides routing for pure Open Systems Interconnection (OSI) environments. This link-state protocol builds a complete and consistent picture of a network's topology by sharing link-state information across network devices in a routing domain. A routing domain is a collection of contiguous networks that provide full connectivity to all end systems located within them. See *JUNOS IP, IPv6, and IGP Configuration Guide*, for information about how to configure IS-IS.
- Border Gateway Protocol (BGP)—BGP, an external gateway protocol (EGP), provides loop-free interdomain routing between autonomous systems. See *JUNOS BGP and MPLS Configuration Guide*, for information about how to configure BGP.
- Routing Information Protocol (RIP)—RIP is an IGP created for use in small, homogeneous networks. RIP uses distance-vector routing to route information through IP networks. See *JUNOS IP, IPv6, and IGP Configuration Guide*, for information about how to configure RIP.
- Multiprotocol Label Switching (MPLS)—MPLS is a hybrid protocol that integrates network layer routing with label switching to provide a layer 3 network with traffic management capability. Traffic engineering enables more effective use of network resources while maintaining high bandwidth and stability. MPLS enables service providers to offer their customers the best service available given the provider's resources. There are two fundamental aspects to MPLS:
 - Label distribution—The set of actions MPLS performs to establish and maintain a label-switched path (LSP), also known as an MPLS tunnel.
 - Data mapping—The process of getting data packets onto an established LSP.

See *JUNOS BGP and MPLS Configuration Guide*, for information about configuring MPLS.

In addition, if you want to make configuration adjustments to IP, see *JUNOS IP, IPv6, and IGP Configuration Guide*, for details.

Configuring VRRP

The Virtual Router Redundancy Protocol (VRRP) can prevent loss of network connectivity to end hosts if the static default IP gateway fails. By implementing VRRP, you can designate a number of routers as “ backup” routers in case the default “ master” router fails. You can configure VRRP on IP/Ethernet interfaces.

For information about configuring VRRP, see *JUNOS IP Services Configuration Guide*.

Configuring Routing Policy

The router supports a number of features that allow the service provider to control the exchange of routing information between virtual routers in the router, between routers in the network, and between protocols within a router:

- Access lists—Provide filters that can be applied to route maps or distribution lists. They allow policies to be created, such as a policy to prevent forwarding of specified routes between the BGP-4 and IS-IS routing tables.
- Route maps—Modify the characteristics of a route (generally to set its metric or to specify additional attributes) as it is transmitted or accepted by a router. Route maps can use access lists to identify the set of routes to modify.
- Distribution lists—Control the routing information that is accepted or transmitted to peer routers. Distribution lists always use access lists to identify routes for distribution. For example, distribution lists could use access lists to specify routes to advertise.
- Redistribute routes—Allow routes to be shared between routing protocols and routing domains. For example, a subset of BGP-4 routes could be leaked into the IS-IS routing tables.

See *JUNOS IP Services Configuration Guide* , for details.

Configuring QoS

QoS is a suite of features that configure queuing and scheduling on the forwarding path of your E-series router. QoS provides a level of predictability and control beyond the best-effort service that is the E-series router’s default data delivery service. Packets not assigned to a specific traffic class are carried in the best-effort traffic class. Best-effort service provides packet transmission with no guarantee of results.

The major QoS features that the E-series router provides are:

- Multiple traffic classes
- Configurable scheduling
- Configurable buffer management

For information about configuring QoS, see *JUNOS Quality of Service Configuration Guide*.

Configuring Policy Management

Policy management allows network service providers to implement packet forwarding and routing specifically tailored to their customer's requirements. Using policy management, customers can implement policies that selectively cause packets to take different paths. Policy management provides several types of services:

- Policy routing—Predefines packet flow to a destination port or IP address
- QoS classification and marking—Marks packets of a packet flow.
- Packet forwarding—Allows forwarding of a packet flow.
- Packet filtering—Drops packets of a packet flow.
- Packet logging—Logs packets of a packet flow.
- Rate limiting—Enforces line rates below the physical line rate of the port and sets limits on packet flows.
- RADIUS policy support—Allows you to attach a preconfigured policy to an interface through RADIUS.

See *JUNOS Policy Management Configuration Guide*, for details about configuring policy management.

Configuring Remote Access

The E-series router supports the following remote access functionality:

- Broadband Remote Access Server (B-RAS)—This application runs on the router and is responsible for:
 - Aggregating the output from DSLAMs
 - Providing user PPP sessions and PPP session termination
 - Enforcing QoS policies
 - Routing traffic into an ISP's backbone network

See *JUNOS Broadband Access Configuration Guide*.

- Layer 2 Tunneling Protocol (L2TP)—A method of encapsulating layer 2 packets, such as PPP, for transmission across a network. In an L2TP relationship, an L2TP access concentrator (LAC) forms a client-server relationship with a destination, known as an L2TP network server (LNS), on a remote network.

You can configure the router to act as an LAC in PPP pass-through mode. The router creates tunnels dynamically by using AAA authentication parameters and transmits L2TP packets to the LNS through IP/UDP. See *JUNOS Broadband Access Configuration Guide*.

- Non-PPP equal access—A method of allowing remote access in which the router provides IP addresses to subscribers' computers through Dynamic Host Configuration Protocol (DHCP). This method is particularly convenient for broadband (cable and DSL) environments or environments that use bridged Ethernet over ATM, because network operators can support one central system

rather than an individual PPPoE client on each subscriber's computer. See *JUNOS Broadband Access Configuration Guide*.

Chapter 2

Command-Line Interface

This chapter provides information about the E-series router command-line interface (CLI).

This chapter contains the following sections:

- Overview on page 29
- Platform Considerations on page 48
- Accessing the CLI on page 48
- CLI Command Privileges on page 52
- Using Help on page 64
- Using Command-Line Editing on page 67
- Accessing Command Modes on page 69

Overview

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

Managing your router using the CLI gives you access to thousands of commands. The router's CLI uses an industry *de facto* standard look and feel, which might be familiar to you. If you are new to this CLI, it is helpful to read this entire chapter, where you can learn about CLI shortcuts and other helpful information.

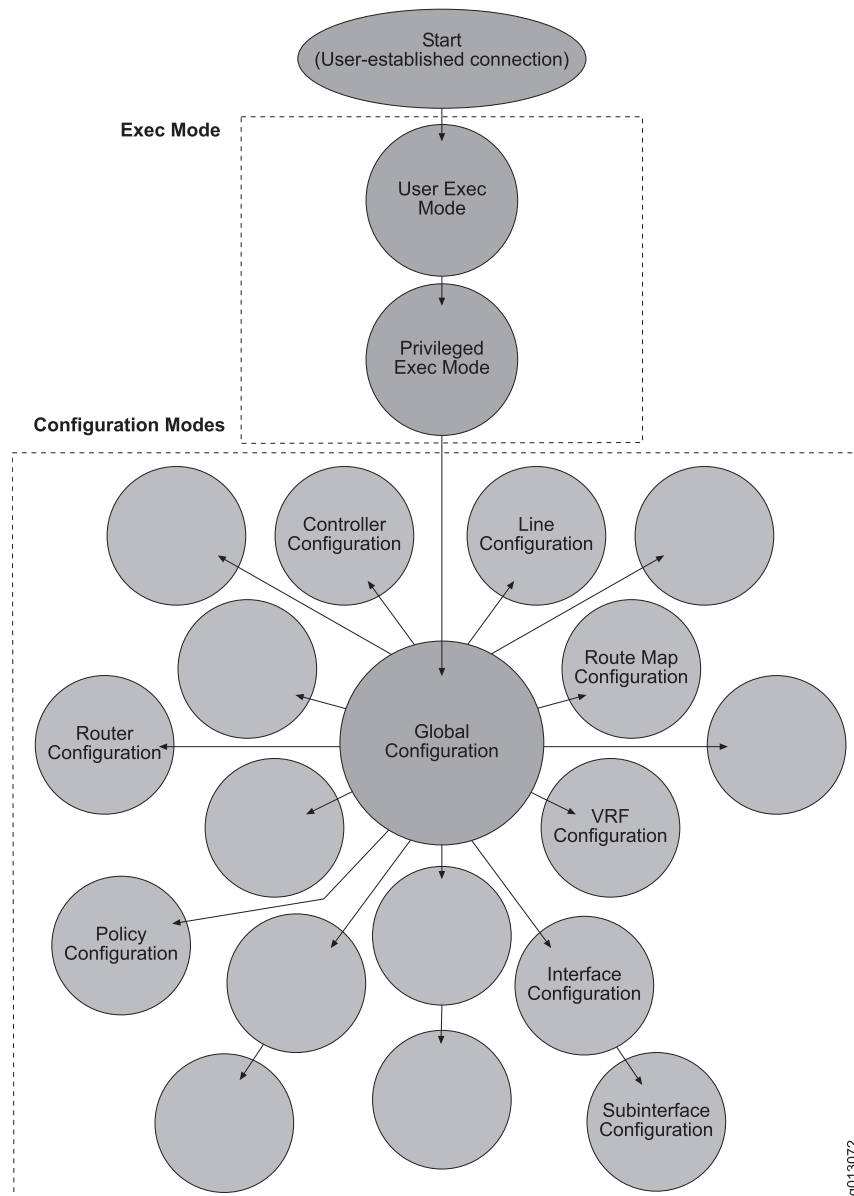
Command Modes

Command modes set a context for the CLI. Each command in the CLI is available from one or more command modes. From some command modes you can only view router information; from others you can perform configuration tasks. For example, you can access User Exec mode to display information and then access Global Configuration mode to set parameters or enable a particular feature. By recognizing the command-line prompt, you can identify where you are in the CLI at any given point. When you can easily identify where you are, it is easy to get to where you want to be.

Figure 21 on page 30 illustrates the command mode architecture. Only some of the many configuration modes are shown.

Command modes are discussed in greater detail in the section “Accessing Command Modes” on page 69 . See the JUNOS Command Reference Guide to find related command modes for any command.

Figure 21: Command Mode Architecture



Parameters

Parameters are often required elements of a command; however, for some commands, parameters are not required. A parameter is most often a value that you specify after the keyword. There are different types of parameters, such as strings, integers, or IP addresses.

The CLI indicates the type of parameter that you must enter. When you see a range of numbers or uppercase letters, it indicates that you must specify a value. For example:

CLI Parameter Placeholder or Range	Sample Parameter User Input
ROUTER[:VRF]	charlie:1234
INTERFACE	3/2:20/15
WORD	windtunnel
<0-4294967295>	5600
A.B.C.D	192.56.32.2

Keywords and Parameters Together

By combining keywords and parameters in the correct sequence, you can begin using the CLI to configure and monitor your router. For example, you could specify the command **hostname** to change the name of your router by entering a keyword and a parameter. You need to type only the portion of the keyword that makes it unambiguous, such as **hostn**. Here, the value of the parameter, which is the name you assign to the host, is a string of up to 64 characters.

```

      command
      /    \
command-line prompt  keyword  parameter
  _____|_____
host1(config)#hostn washington
  
```

When you enter this command, the new hostname appears in the prompt.

```

washington(config)#
  _____|_____
new command-line prompt
  
```

Another example is a command that requires you to enter a number from within a given range. The command **ip http port** requires that a value be entered for the *portNumber* parameter. The value of this parameter is a number in the range of 0-65535. For example, you could enter:

```
juniper(config)#ip http port 56789
```




NOTE: You can find detailed information about command syntax, with parameter values defined, in the *JUNOS Command Reference Guide*.

Using CLI Commands

This section introduces some useful shortcuts and command-related highlights. These include:

- Abbreviated Commands on page 33
- The ? Key on page 33
- Backspace or Delete on page 34
- Enter on page 34
- Tab on page 34
- Arrow Keys on page 34
- The no Version on page 35
- run and do Commands on page 35
- show Commands on page 37
- Redirection of show Command Output on page 40
- Regular Expressions on page 41
- The - More- - Prompt on page 43
- Responding to Prompts on page 46

Abbreviated Commands

Remember, you can abbreviate keywords to save time if you enter at least enough leading characters to uniquely identify the desired keyword. For example:

```
host1(config-if)#ip re
```

This abbreviation is for the command **ip redirects**. The string **ip re** is enough information for the CLI to identify the command you are using. See the section “Using Help” on page 64 for additional information.

The ? Key

Use the ? key at any time to see all the choices you can enter next. For example:

```
host1(config)#router ?
bgpConfigure the Border-Gateway Protocol (BGP)
isisConfigure ISO IS-IS
ospfConfigure the Open Shortest Path First protocol (OSPF)
ripConfigure the Routing Information Protocol
host1(config)#router
```

When you enter the ? character, all available choices are displayed. The router again displays the command you typed. You then have to type in only the choice you want and press Enter.

A <cr> in the list of choices means that you can press Enter to execute the command. For example:

```
host1(config-if)#isis metric 40 level-2 ?
<cr>
```

```
host1(config-if)#isis metric 40 level-2
```



NOTE: If the list of options extends beyond one screen, the last line on your screen displays the --More-- prompt. If you want to use the ? character as part of a string, such as a hostname or a regular expression, you must enter the following key sequence: Ctrl + v + ?. Otherwise, the CLI considers the ? to be a request for assistance in completing the command.

Backspace or Delete

Use either key to delete the character immediately preceding the cursor.

Enter

Always use this key to execute the command you entered.

Tab

Use this key to complete the current keyword. For example, if you entered a portion of a lengthy command, such as

```
host1(config)#class
```

and press Tab, the full name of the command appears:

```
host1(config)#classifier-list
```

Arrow Keys

Some terminals have arrow (or cursor) keys on their keyboards. These arrow keys are very useful; however, to use them you must have an ANSI/VT100 emulating terminal.

The Up Arrow and Down Arrow keys display command history. The Up Arrow key displays the previous command; you can also use Ctrl + p. The Down Arrow key displays the next command; you can also use Ctrl + n.

The Left Arrow and Right Arrow keys allow the user to move the cursor back and forth in the command line.

The no Version

With very few exceptions, every system configuration command has a **no** version, which you can use to negate a command (or a portion of it as specified by an optional keyword) or to restore its default setting. When you use a command *without* the keyword **no**, you can reenable a disabled feature or override a default setting.

You have the option of using the **default** keyword whenever the **no** keyword is also a choice; simply enter the keyword **default** instead of **no**.

In most cases, when you execute the **default** version of a command, it produces the exact results as the **no** version. There are some commands for which the **default** version yields a different result from the **no** version.

Commands for which the **default** behavior differs from the **no** behavior are clearly identified in the JUNOS Command Reference Guide. Unless otherwise specified, therefore, the **default** command is identical to the **no** command and is neither documented nor discussed.

The syntax for each **no** command is described in the *JUNOS Command Reference Guide*. The few system configuration commands that do not have a **no** version are indicated in the individual command description.

Because **show** commands are for the purpose of monitoring your configurations, they do not have **no** versions. Most User Exec and Privileged Exec mode commands do not have **no** versions.

The CLI can act on **no** versions of commands when you have entered sufficient information to distinguish the command syntactically; the CLI ignores all subsequent input on that line.

To be compatible with some non-Juniper Networks implementations, the **no** versions of commands will accept the same options as the affirmative version of the commands. The CLI ignores the optional input if it has no effect on the command behavior. If using the option changes the behavior of the **no** version, the individual command entry in this guide describes the difference in behavior.

run and do Commands

You can run Exec mode commands while in any configuration mode by preceding the command with the keyword **run** or **do**. For example:

```
host1(config)#run show users
```



NOTE: The **run** and **do** commands are interchangeable.

By using the **run** or **do** command in this way, you can obtain **show** command information without leaving configuration mode.

The only commands that cannot be preceded by **run** or **do** are the **configure** command and those commands that are already available in all modes, such as **sleep** or **exit**.

Example 1 host1(config)#run show config | begin interface

```
interface null 0
!
interface fastEthernet 0/0
  ip address 10.6.129.41 255.255.128.0
!
interface gigabitEthernet 5/0
!
interface atm 6/0
  interface atm 6/0.1 point-to-point
    encapsulation pppoe
!
  interface atm 6/0.1.7
!
  interface atm 6/0.1.5
!
  interface atm 6/0.1.2
!
  interface atm 6/0.1.9
!
  interface atm 6/0.1.11
!
  interface atm 6/0.1.15
!
  interface atm 6/0.1.18
!
ip route 0.0.0.0 0.0.0.0 10.6.128.1
ip route 10.10.121.72 255.255.255.255 10.6.128.1
!
!
route-map adsf permit 10
router dvmrp
!
router igmp
!
snmp-server community private view everything rw
snmp-server contact Mary
snmp-server
!
! End of generated configuration script.
host 1(config)#int fa 0/0
```

Example 2 host1(config-if)#do dir

Please wait...

file	size	unshared size	date (UTC)	in use
-----	-----	-----	-----	---
reboot.hty	31040	31040	10/30/2001 15:31:10	
system.log	20481	20481	10/26/2001 17:24:16	
soft_clear_in.mac	8578	8578	10/24/2001 14:39:02	
erx_3-3-1.rel	71082105	71082105	10/25/2001 13:02:50	!
erx_3-3-1.rel	70502991	70502991	10/24/2001 19:58:08	
autocfg.scr	355	355	09/28/2001 13:33:04	
Capacity = 224133120, Bytes Free = 44986177, Reserved = 36700160				

host1(config-if)#

show Commands

You have access to a variety of **show** commands that display router and protocol information. You can filter the output of a **show** command by specifying `|` (the UNIX pipe symbol), one of the following keywords, and either a case-sensitive text string or a regular expression.

- **begin**—Displays output beginning with the first line that contains the text string or regular expression
- **include**—Displays output lines that contain the text string or regular expression and excludes lines that do not contain the text string or regular expression
- **exclude**—Displays output lines that do not contain the text string or regular expression and excludes lines that do contain the text string or regular expression

For a list of regular expressions, see “Regular Expressions” on page 41. You can press `Ctrl + c` to interrupt the **show** command output.



NOTE: The system does not recognize beginning spaces of the text string. For example, if you enter **include IP** as the text string on which to filter, the system ignores the space and displays lines that include words such as RIP.

Example 1 In the following example, the output display starts with the first line that contains the string *inter*. The system omits all the preceding lines of the output from the display because none of them contains the string *inter*.

```
host1#show config include-defaults | begin inter
Please wait...log verbosity low internalNetwork
log verbosity low ipEngine
log verbosity low ipProfileMgr
log verbosity low ipProfileMgrEngineering
no log engineering
log fields timestamp instance no-calling-task
!
timing select primary
timing source primary internal
timing source secondary internal
timing source tertiary internal
!
no disable-autosync
no disable-switch-on-error
no redundancy lockout 0
!
virtual-router default
ip domain-lookup
ip name-server 10.2.0.3
ip domain-name 789df
!
host f 10.10.133.11 ftp anonymous null
interface null 0
interface ip 0/0
  arp timeout 21600
!
interface ip 2/0
  arp timeout 21600
```

```

!
interface ip s10
  arp timeout 21600
!
interface atm 2/0
  no shutdown
  atm sonet stm-1
  loopback line
  atm uni-version 3.0
  atm oam loopback-location 0xFFFFFFFF
  atm vc-per-vp 32768
  atm vp-tunnel 1 10
  load-interval 300
  no atm snmp trap link-status
  no atm shutdown
!
no atm aal5 snmp trap link-status
no atm aal5 shutdown
!
interface atm 2/0.1 point-to-point
  no shutdown
  no atm atm1483 shutdown
  no atm atm1483 snmp trap link-status
!
ip route 0.0.0.0 0.0.0.0 10.13.5.1
ip debounce-time 0
ip source-route
!
router ospf 5
  no ospf shutdown
  ip route-type both
  timers spf 3
  maximum-paths 4
  ospf auto-cost reference-bandwidth 100
  distance ospf intra-area 110
  distance ospf inter-area 112
  distance ospf external 114
! Area 0.0.0.0
!
! Trap Source: <not configured>
! Note: SNMP server not running.
!
host1#

```

Example 2 In the following example, the output display consists only of lines that contain the string *ip*. The system omits all other lines of the output from the display because none of them contains the string *ip*.

```

host1#show config include-defaults | include ip
! Configuration script generated on WED JUN 06 2001 02:17:00 UTC
strip-domain disable
Please wait...log verbosity low ipEngine
log verbosity low ipEngineering
log verbosity low ipGeneral
log verbosity low ipInterface
log verbosity low ipNhopTrackerEngineering
log verbosity low ipNhopTrackerGeneral
log verbosity low ipProfileMgr
log verbosity low ipProfileMgrEngineering
!

```

```

bandwidth oversubscription
ip domain-lookup
ip name-server 10.2.0.3
ip domain-name 789df
interface ip 0/0
interface ip 2/0
interface ip s10
  ip address 10.13.5.61 255.255.255.0
  no ip proxy-arp
  no ip directed-broadcast
  ip redirects
ip route 0.0.0.0 0.0.0.0 10.13.5.1
ip debounce-time 0
ip source-route
no ip ftp source-address
  type echo protocol ipIcmpEcho 10.5.0.200 source fastEthernet0/0
  type pathEcho protocol ipIcmpEcho 10.2.0.3
  type echo protocol ipIcmpEcho 10.5.0.11 source-ipaddr 10.13.5.61
!
controller t1 6/0
  framing esf
  lineCoding b8zs
  clock source line
  cablelength short 0
  no remote-loopback
!
log engineering
log verbosity low
no log severity
log verbosity low NameResolverLog
log verbosity low atm
log verbosity low atm1483
log verbosity low atmAa15
log verbosity low bgpConnections
log verbosity low bgpDampening
!
host1#

```

Example 3 In the following example, the output display consists only of lines that do not contain the string `!`. The system omits all other lines of the output from the display because each line contains the string `!`.

```

host1#show config include-defaults | exclude !
boot config running-configuration
boot system 3-3-1.rel
no boot backup
no boot subsystem
no boot backup subsystem
boot revert-tolerance 3 1800
no boot force-backup
aaa domain-map jacksonville
  virtual-router miami
  strip-domain disable
aaa domain-map jak
  virtual-router default
  strip-domain disable
aaa domain-map northeast
  virtual-router default
  strip-domain disable
aaa delimiter realmName "/"

```

```

hostname host1
no aaa new-model
no service ctrl-x-reboot
no service password-encryption
no baseline show-delta-counts
clock timezone UTC 0 0
no exception dump
exception protocol ftp anonymous null
controller sonet 2/0
  sdh
  loopback network
  clock source line
  no shutdown
  path 0 overhead j1 msg hello
  path 0 overhead j1 exp-msg
ftp-server enable
no login
log engineering
log verbosity low
no log severity
log verbosity low NameResolverLog
log verbosity low aaaAtm1483Cfg
log verbosity low atm1483
log verbosity low atmAa15
log verbosity low bgpConnections
log verbosity low bgpDampening
log verbosity low bgpEng1
log verbosity low bgpEngineering
log verbosity low bgpEvents
log verbosity low bgpKeepAlives
no log engineering
log fields timestamp instance no-calling-task
timing select primary
timing source primary internal
timing source secondary internal
timing source tertiary internal
no atm aa15 snmp trap link-status
no atm aa15 shutdown
interface atm 2/0.1 point-to-point
  no shutdown
  no atm atm1483 shutdown
  no atm atm1483 snmp trap link-status
ip route 0.0.0.0 0.0.0.0 10.13.5.1
ip debounce-time 0
ip source-route

```

Redirection of show Command Output

You can redirect the output of **show** commands to network files or local files (in NVS memory) using the redirection operators described in Table 5 on page 40 .

Table 5: Redirect Operators

Redirect Operator	Use
>	Redirects output to the specified file, overwriting the file if it already exists, creating the file if it does not.

Table 5: Redirect Operators *(continued)*

Redirect Operator	Use
> >	Appends output to the end of the specified file, creating the file if it does not exist.
&>	Redirects output to the specified file, overwriting the file if it already exists, and displays the output on the screen. The redirection is synchronized with the screen display; for example, if a <code>--More--</code> prompt appears, the redirection halts until you take further action.
&> >	Appends output to the end of the specified file and displays the output to the screen. The redirection is synchronized with the screen display; for example, if a <code>--More--</code> prompt appears, the redirection halts until you take further action.

For example, you can redirect the output of the **show config** command to a script file and later run that script:

```
host1#show config > showconfig.scr
```

The following command *writes* the output to a text file, `version.txt`, on a remote router:

```
host1#show hardware > pc:/erxfiles/version.txt
```

The following command *appends* the output to `version.txt`:

```
host1#show hardware >> version.txt
```

Only one instance of a file can be open for file redirection. An error message is generated if you attempt to redirect output to a file that is already open. You cannot redirect output to a file that includes a local path in the filename.

You can use redirection with output filtering. The general syntax is:

```
show options [ { > | >> | &> | &>> } filename ]
[ [ { begin | include | exclude } filterstring ]
```

The filtering is performed before redirection. In the following example, the `cnfgfltr.txt` file will contain the output of **show config include-defaults** beginning with the first occurrence of the string *inter*.

```
host1#show config include-defaults &> cnfgfltr.txt | begin inter
```

Regular Expressions

A regular expression uses special characters—often referred to as metacharacters—to define a pattern that is compared with an input string. You can use regular expressions to filter the output of **show** commands and to define AS-path access lists and community lists to more easily filter routes.

For examples of using regular expressions with AS-path access lists and community lists, see *JUNOS IP Services Configuration Guide*.

Metacharacters

Table 6 on page 42 describes the metacharacters supported for regular expression pattern-matching.

Table 6: Supported Regular Expression Metacharacters

Metacharacter	Description
^	Matches the beginning of the input string. Alternatively, when used as the first character within brackets— <code>[^]</code> —matches any number except the ones specified within the brackets.
\$	Matches the end of the input string.
.	Matches any single character, including white space.
*	Matches 0 or more sequences of the immediately previous character or pattern.
+	Matches 1 or more sequences of the immediately previous character or pattern.
?	Matches 0 or 1 sequence of the immediately previous character or pattern.
()	Specifies patterns for multiple use when followed by one of the multiplier metacharacters: asterisk *, plus sign +, or question mark ?
[]	Matches any enclosed character; specifies a range of single characters.
– (hyphen)	Used within brackets to specify a range of AS or community numbers.
_ (underscore)	Matches a ^, a \$, a comma, a space, a {, or a }. Placed on either side of a string to specify a literal and disallow substring matching. Numerals enclosed by underscores can be preceded or followed by any of the characters listed above.
	Matches characters on either side of the metacharacter; logical OR.

Using Metacharacters as Literal Tokens

You can remove the special meaning of a metacharacter by preceding it with a backslash (\). Such a construction denotes that the metacharacter is *not* treated as a metacharacter for that regular expression. It is simply a character or token with no special meaning, just as a numeral has no special meaning. The backslash applies only to the character immediately following it in the regular expression.

On the E-series router, you are likely to do this only for the parentheses characters, (or). BGP indicates a segment of an AS path that is of type AS-confed-set or AS-confed-seq by enclosing that segment within parentheses.

The --More-- Prompt

When command output continues beyond the available space on your monitor screen, the system displays the --More-- prompt. If you press Enter, the system displays the next line of output. If you press the Spacebar, the system displays the next screen of output.

You can begin filtering the output from the --More-- prompt, or change a filter that is already in effect, by entering one of the following characters and a text string:

+ (plus)	Displays all output lines that contain the text string
- (minus)	Displays all output lines that do not contain the text string
/ (forward slash)	Displays all output lines starting at the first line that contains the text string

Initial spaces are not ignored when you filter at the --More-- prompt.

Example 1 In the following example, the output is displayed until the screen is filled and the --More-- prompt appears. By entering the filter **/interf**, the user forces the system to filter out all output lines until the first occurrence of the string *interf*. The system displays that line and all following lines of the output.

```

host1#show config include-defaults
! Configuration script being generated on FRI AUG 04 2006 12:48:48 UTC
! Juniper Edge Routing Switch ERX-700
! Version: 7.3.0 beta-1.6 [BuildId 5672] (July 11, 2006 11:58)
! Copyright (c) 1999-2006 Juniper Networks, Inc. All rights reserved.
!
boot config running-configuration
boot system erx_7-3-0.rel
no boot backup
no boot subsystem
no boot backup subsystem
boot revert-tolerance 3 1800
no boot force-backup
!
aaa domain-map jacksonville
    virtual-router miami
    strip-domain disable
!
aaa domain-map jak
    virtual-router default
    strip-domain disable
!
aaa domain-map northeast
    virtual-router default

/interf
(Suppressing output until 'interf' is found, press ^C to end...)
interface null 0
interface ip 0/0
    arp timeout 21600
!
```

```

interface ip 2/0
  arp timeout 21600
!
interface ip s10
  arp timeout 21600
!
interface atm 2/0
  no shutdown
  atm sonet stm-1
  loopback line
  atm uni-version 3.0
  atm oam loopback-location 0xFFFFFFFF
--More--

```

Example 2 In the following example, the output is displayed until the screen is filled and the --More-- prompt appears. By entering the filter **+ip**, the user forces the system to filter out all lines from the remainder of the output that do not contain the string *ip*. The system displays only lines that contain the string *ip*.

```

host1#show config include-defaults
! Configuration script being generated on FRI AUG 04 2006 12:48:48 UTC
! Juniper Edge Routing Switch ERX-700
! Version: 7.3.0 beta-1.6 [BuildId 5672] (July 11, 2006 11:58)
! Copyright (c) 1999-2006 Juniper Networks, Inc. All rights reserved.
!
boot config running-configuration
boot system erx_7-3-0.rel
boot config running-configuration
boot system 3-3.1.rel
no boot backup
no boot subsystem
no boot backup subsystem
boot revert-tolerance 3 1800
no boot force-backup
!
aaa domain-map jacksonville
  virtual-router miami
  strip-domain disable
!
aaa domain-map jak
  virtual-router default
  strip-domain disable
!
aaa domain-map northeast
  virtual-router default
--More--
+ip
(Displaying only lines that include 'ip', press ^C to end...)
  strip-domain disable
log verbosity low ipEngine
log verbosity low ipEngineering
log verbosity low ipGeneral
log verbosity low ipInterface
log verbosity low ipNhopTrackerEngineering
log verbosity low ipNhopTrackerGeneral
log verbosity low ipProfileMgr
log verbosity low ipProfileMgrEngineering
log verbosity low ipRoutePolicy
log verbosity low ipRoute
log verbosity low ipTraffic

```

```

log verbosity low ipTunnel
log verbosity low ripEngineering
log verbosity low ripGeneral
log verbosity low ripRoute
log verbosity low ripRtTable
bandwidth oversubscription
ip domain-lookup
ip name-server 10.2.0.3
ip domain-name 789df
ip explicit-path name xyz disable
interface ip 0/0
interface ip 2/0
--More--

```

Example 3 In the following example, the output is displayed until the screen is filled and the --More-- prompt appears. By entering the filter -!, the user forces the system to filter out all comments from the remainder of the output; that is, output lines that contain the string !. The system displays only lines that do not contain the string !.

```

host1#show config include-defaults
! Configuration script being generated on FRI AUG 04 2006 12:48:48 UTC
! Juniper Edge Routing Switch ERX-700
! Version: 7.3.0 beta-1.6 [BuildId 5672] (July 11, 2006 11:58)
! Copyright (c) 1999-2006 Juniper Networks, Inc. All rights reserved.
!
boot config running-configuration
boot system erx_7-3-0.rel
boot config running-configuration
boot system 3-3.1.rel
no boot backup
no boot subsystem
no boot backup subsystem
boot revert-tolerance 3 1800
no boot force-backup
!
aaa domain-map jacksonville
    virtual-router miami
    strip-domain disable
!
aaa domain-map jak
    virtual-router default
    strip-domain disable
!
aaa domain-map northeast
    virtual-router default
--More--
-!
(Displaying only lines that exclude '!'. press ^C to end...)
    strip-domain disable
aaa delimiter realmName "/"
hostname host1
no aaa new-model
no service ctrl-x-reboot
no service password-encryption
no baseline show-delta-counts
clock timezone UTC 0 0
no exception dump
exception protocol ftp anonymous null
line vty 4
    exec-timeout 0 0

```

```

exec-banner
motd-banner
timeout login response 30
data-character-bits 8
no login
log engineering
log verbosity low
no log severity
log verbosity low NameResolverLog
log verbosity low aaaAtm1483Cfg
log verbosity low aaaEngineGeneral
log verbosity low aaaServerGeneral
log verbosity low aaaUserAccess
log verbosity low addressServerGeneral
log verbosity low atm
log verbosity low atm1483
log verbosity low atmAa15
log verbosity low bgpConnections
log verbosity low bgpDampening
log verbosity low bgpEng1
--More--

```

Responding to Prompts

For some actions, the system prompts you for a response. The acceptable default responses are the following:

- You can press **y** or Enter to agree with the prompt and continue.
- You can press any other key to disagree with the prompt and cancel the action.

You can use the **confirmations explicit** command to require a more explicit response to CLI prompts.

confirmations explicit

- Use to require an explicit response to a CLI prompt, as follows:
 - To agree with the prompt and continue, you must type **y** and press Enter, type **ye** and press Enter, or type **yes** and press Enter.
 - To disagree with the prompt and cancel the action, you must type **n** and press Enter or type **no** and press Enter.
 - Pressing Enter alone, or entering any other characters, is not an acceptable response, and the CLI will repeat the prompt.
 - Acceptable responses to a prompt are not case sensitive.
 - Use the **no** version to restore the default state, where pressing **y** or Enter alone responds in the affirmative, and any other entry is accepted as a negative response.



NOTE: The system's CLI supports a powerful command-line editor, enabling you to easily correct, edit, and recall previously entered commands. For more information, see "Using Command-Line Editing" on page 67.

For a description of the commands that you use to get around the CLI, see "Managing the System" on page 235.

- See confirmations explicit.

CLI Status Indicators

The E-series software includes two types of indicators to inform you of the status of your CLI operation.

- The **dot service** indicator is used when your operation does not finish within 2 seconds. The service displays the Please wait message and a dot every 5 seconds until the operation is completed. The dot service is used for all CLI operations, except those that use the more descriptive progress indicator.
- The **progress indicator** is an animated representation of how much progress has been made on a CLI operation that does not finish within the expected completion time. This type of status indicator is supported for the file system synchronization application and the file copy application.

The progress indicator displays a series of dots that represents the time required to complete the operation. The dots are followed by the actual percentage of the total that has been completed and by an oscillating asterisk that indicates ongoing activity.

As the application progresses, the dots are replaced with asterisks, starting at the left, to represent how much of the operation is finished. The actual percentage is also adjusted accordingly. When the operation is complete, all dots are replaced by asterisks, and the message DONE replaces the numerical percentage.

The number of dots that appears and the percentage of completion represented by each dot or asterisk are based on the terminal width. For example, if the terminal is set to 80 characters, each of the 50 dots indicates 2 percent of the total time (2 percent x 50 characters = 100 percent). See "Managing the System" on page 235 for information about setting the terminal width.

The following examples show progress indicator output for a 50-character-wide display.

```

****..... (10%) *

*****..... (90%) *

***** (DONE)

```

Levels of Access

The CLI has two levels of access: *user* and *privileged*.

User Level

User level allows you only to view a router's status. This level restricts you to User Exec mode.

Privileged Level

Privileged level allows you to view a router configuration, change a configuration, and run debugging commands. You need a password to access this level. This level gives you full CLI privileges. Passwords are covered in more detail in "Managing the System" on page 235.

Initialization Sequence

Each line module in a router is initialized independently. As a result, the CLI on the SRP module can become available before the line modules have completed initialization. Commands relating to a line module can fail if the module has not completed initialization. The **show version** command can be used to display line module status. Do not enter commands for a line module until its state is online.

Platform Considerations

The CLI is supported on all E-series routers.

For information about the modules supported on E-series routers:

- See the *ERX Module Guide* for modules supported on ERX-7xx models, ERX-14xx models, and the ERX-310 router.
- See the *E120 and E320 Module Guide* for modules supported on the E120 router and the E320 router.

Accessing the CLI

This section describes logging in to and exiting from the router.

Logging In

The system supports a local console session and up to 30 virtual terminal (vty) sessions simultaneously. A virtual terminal session can be a Telnet session, Secure Shell Server (SSH) protocol session, or File Transfer Protocol (FTP) server session.



NOTE: The vty session factory default is 5. Use the **line** command to configure up to a maximum of 30 vtys. The configured vtys are shared among all types of connections; for example, if you configure 7 vtys, then no more than a total of 7 SSH plus FTP plus Telnet sessions can simultaneously exist on the router.

To access the system through a local console, attach a terminal to the system console port. To access the system through Telnet, Telnet client software must be installed on your host system. To access the system through SSH, SSH version 2.0 client software must be installed on your host system. To access the system through FTP, FTP client software must be installed on your host system.

You can configure Telnet to validate login requests. See “Vty Line Authentication and Authorization” on page 495 in “Managing the System” on page 235 , for more information. Once Telnet is running on your host system, type in the E-series router name or its IP address and press Enter. To use a name, your network must have a name server.

For example, for Microsoft Windows NT enter:

```
telnet 192.168.1.13
```

or

```
telnet westford2
```

You are connected to your E-series router when the following prompt appears:

```
Logging in.  
host1>
```



NOTE: At this point, you have access only to User Exec commands.

To connect through SSH, refer to your SSH client documentation.

Privileged-Level Access

You access the CLI Privileged Exec commands using the **enable** command.

Defining CLI Levels of Privilege

The CLI has the ability to map any command to one of 16 levels of command privilege (0 to 15). When you access the Privileged Exec mode, you have access to those commands that map to your access level or below. In other words, if you access the Privileged Exec mode at access level 10 (the default), you have access to all commands with an access level setting of 10 or lower.

In general, command privileges fall within one of the following levels:

- 0—Allows you to execute the **help**, **enable**, **disable**, and **exit** commands
- 1—Allows you to execute commands in User Exec mode plus commands at level 0
- 5—Allows you to execute Privileged Exec **show** commands plus the commands at levels 1 and 0
- 10—Allows you to execute all commands except support commands, which may be provided by Juniper Networks Customer Service, or the **privilege** command to assign privileges to commands
- 15—Allows you to execute support commands and assign privileges to commands

For information about how to set individual command levels, see “CLI Command Privileges” on page 52.

Accessing the Privileged Exec Level

You can access the Privileged Exec commands using one of 16 levels of command privilege. If you do not enter a privilege level and you are not accessing the router through a RADIUS authentication account, the default CLI access level is 10.

To access the default Privileged Exec mode:

1. At the prompt, type **enable** and press Enter.

```
host1>enable
Password:
```



NOTE: You will be prompted for a password only if your system has been configured with one. Refer to the **enable secret** and **enable password** Global Configuration commands described in “Managing the System” on page 235.

2. Type your password and press Enter.

```
Password:*****<Enter>
host1#
```

You can tell that you have access to Privileged Exec mode when the command prompt changes from a > character to a # character.

enable

- Use to move from User Exec to Privileged Exec mode.
- Privileged Exec mode allows you to access all other user interface modes. From here you can configure, monitor, and manage all aspects of the router.
- You can access the Privileged Exec commands using one of 16 levels of command privilege. If you do not enter a privilege level and you are not accessing the router through a RADIUS authentication account, the default CLI access level is 10.

- Set a password for this mode by using either the **enable password** or the **enable secret** command in Global Configuration mode. This protects the system from any unauthorized use.
- Once a password is set, anyone trying to use Privileged Exec mode will be asked to provide the password.
- Example 1 (accessing Privileged Exec mode at the default level [10])

```
host1>enable
password:*****
host1#
```

- Example 2 (accessing Privileged Exec mode at the highest level [15]; a password is not set for this example)

```
host1>enable 15
host1#
```

- There is no **no** version.
- See **enable**.

Moving from Privileged Exec to User Exec Mode

To move from the Privileged Exec mode to the User Exec mode, enter the **disable** command. For example:

```
host1#disable
host1>
```



NOTE: Using the **exit** command from either the Privileged Exec or User Exec mode logs out of the CLI.

To move to a lower Privileged Exec mode, follow the **disable** command with an access level value. For example:

```
host1#show privilege
Privilege level is 10
host1#disable 5
host1#show privilege
Privilege level is 5
```

disable

- Use to exit Privileged Exec mode and return to User Exec mode.
 - Use to shift to a lower Privilege Exec mode level without returning to User Exec mode. Specifying a privilege level after the **disable** command changes the Privileged Exec mode to the lower level that you specify; you do not return to User Exec mode.
 - Example 1

```
host1#disable
host1>
```

- Example 2

```
host1#show privilege
Privilege level is 10
host1#disable 5
host1#show privilege
Privilege level is 5
```

- There is no **no** version.

- See **disable**.

Logging Out

You can log out of the CLI from either the User Exec and Privileged Exec modes by entering the **exit** command. For example:

```
host1>exit
logging out.
```

or

```
host1#exit
logging out.
```

CLI Command Privileges

You can change the privilege level of most commands by using the **privilege** command that is available in Global Configuration mode. To use this command, you must enable your CLI session to privilege level 15.

CLI Privilege Groups

You can change privilege group accessibility. Privilege groups are no longer required to be hierarchical. You can modify the privilege group membership and define which privilege group is a member of another privilege group.

A privilege group can contain commands and other privilege groups as members. A group always has access to commands in its own privilege group and in privilege group 0. By default, all groups have one member and a specific privilege group has access to all commands in all privilege groups with a lower number than the specific group.

A privilege group is reachable from another privilege group when it is a member of that privilege group, or a member of a group that is a member of that privilege group until a search of all member groups is exhausted. This can go through several recursions as long as there are no circular dependencies.

Privilege group 0 is not a member of any group and you cannot assign member groups to it, but it is reachable from every privilege group.

Numbers in the range 0—15 identify the 16 privilege groups. Each of the 16 groups can have a name or an alias. The default internal name is the privilege group number. By default, the groups are hierarchical and each group, with the exception of groups 1 and 0, contains one group. When a group contains a group, the contained group is a member of the original group: privilege group *p* has one member, privilege group *p-1*. For example, privilege group 15 has member 14, privilege group 14 has member 13, and privilege group 2 has member 1.

For hierarchical groups, groups 0 through 14 are reachable from privilege group 15, groups 0 through 13 are reachable from privilege group 14, groups 0 to 4 are reachable from 5, and so forth. Hierarchical groups can also contain other privilege groups. For example, group A is reachable from group B if group A is a member of group B or is a member of a group that is a member of group B. If group X has member Y and Y has member Z then Z is reachable from X.

You cannot configure circular dependencies. For example, you cannot configure a circular dependency where group X has member Y, Y has member Z, Z has member P, and X can reach Z and P. Group X cannot have member Z or P because Z and P are reachable through Y.

Examples Using Privilege Group Membership

In each of the following examples, privilege groups are at the default setting, where privilege group 0 is reachable from every privilege group, 15 contains 14, 14 contains 13, 13 contains 12, and so forth. The commands in each example change the privilege group settings from the default.

Example 1 `host1(config)#privilege-group membership clear 11`
 `host1(config)#privilege-group membership 15 add 10`

In Example 1:

- Privilege group 11 does not contain any privilege groups
- Privilege group 15 contains group 10. Therefore, privilege group 10 and all groups contained or reachable from privilege group 10 are now reachable from privilege group 15.
- Because privilege group 15 already contains privilege group 14, all groups with the exception of privilege group 11 are reachable from privilege group 15.
- A command that is in privilege group 11 can only be executed by a user at privilege 11. A user at any other privilege does not have access to privilege group 11 commands.

Example 2 `host1(config)#privilege-group membership 14 remove 13`

In Example 2:

- Privilege group 14 does not contain any privilege groups.
- Privilege group 15 contains two groups: 14 and 10. The privilege groups 0, 1, 2, 4, 5, 6, 7, 8, 9, 10, and 14 are reachable from privilege group 15.

- A user at privilege 15 does not have access to commands in privilege groups 11, 12, or 13.

Example 3 `host1(config)#privilege-group membership clear 13`
`host1(config)#privilege-group membership 13 add 10`

In Example 3:

- Commands are executed in the following sequence: 15 contains 14, 14 contains 13, 13 contains 12, and so forth,
- Privilege group 13 contains one privilege group: privilege group 10.
- The privilege groups 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10 are reachable from privilege group 13.

Example 4 `host1(config)#privilege-group membership 12 remove 11`
`host1(config)#privilege-group membership 12 add 5`
`host1(config)#privilege-group membership 11 add 5`

In Example 4:

- Commands are executed in the following sequence: 15 contains 14, 14 contains 13, 13 contains 12, and so forth.
- Privilege group 12 contains one privilege group: the privilege group 5.
- Privilege group 11 contains one privilege group: the privilege group 5.
- Privilege groups 0, 1, 2, 3, 4, 5 are reachable from privilege groups 12 and 11.

Example 5 `host1(config)#privilege-group membership clear 9 8 7`
`host1(config)#privilege-group membership 7 add 1`
`host1(config)#privilege-group membership 8 add 14`

In Example 5:

- Privilege group 9 contains no privilege groups.
- Privilege group 8 contains group 14.
- Privilege group 7 contains group 1.

Example 6 `host1(config)#privilege-group alias 13 LI`
`host1(config)#privilege-group alias 10 dailyAdmin`
`host1(config)#privilege-group alias 7 weekendAdmin`
`host1(config)#privilege-group alias 6 dailyTroll`
`host1(config)#privilege-group alias 5 basicUser`
`host1(config)#privilege-group alias 0 minUser`
`host1(config)#privilege-group alias 15 superUser`

In Example 6, a number or name can specify the seven privilege groups 0, 5, 6, 7, 10, 13, and 15.

Example 7 `host1(config)#privilege-group membership clear dailyAdmin`
`host1(config)#privilege-group membership dailyAdmin add dailyTroll`

In Example 7, privilege group 10 alias dailyAdmin has one member: privilege group 6 alias dailyTroll.

Example 8 `host1(config)#no privilege-group membership 9`

Example 8 reverts one privilege group membership to its default setting. Prior to the execution of this command, the following group memberships were in place:

group	member	reachable
8	12	12,0
9	--	0
10	9	9,0
11	10	10,9,0
12	11	11,10,9,0

Reverting privilege group 9 to its default gives it one member: privilege group 8. This creates the circular dependency: 8 contains 12, 12 contains 11, 11 contains 10, 10 contains 9, and 9 contains 8.

Example 9 `host1(config)#no privilege-group membership`

In Example 9, privilege group membership reverts to the default setting. All privilege groups revert to hierarchical settings: 15 contains 14, 14 contains 13, 13 contains 12, and so forth. Privilege group 0 is reachable from every privilege group.

Example 10 `host1(config)#no privilege-group membership 7`

In this example, one privilege group membership reverts to its default setting. Privilege group 7 contains group 6.

Example 11 `host1(config)#no privilege-group alias`

In Example 11, all alias settings are removed.

Example 12 `host1#show privilege group`

privilege group	privilege group alias	directly reachable groups	all reachable groups *
0	minUser	--	--
1	--	--	0
2	--	1	0 1
3	--	2	0 1 2
4	--	3	0 1 2 3
5	basicUser	4	0 1 2 3 4
6	dailyTroll	5	0 1 2 3 4 5
7	weekendAdmin	1	0 1
8	--	14	0 14

```

9          --          --          0
10         dailyAdmin    6          0 1 2 3 4 5 6
11         --          5          0 1 2 3 4 5
12         --          5          0 1 2 3 4 5
13         LI           10         0 1 2 3 4 5 6 10
14         --          --          0
15         superUser     10 14     0 1 2 3 4 5 6 10 14 15
*Privilege Group can reach itself

```

Example 12 shows privilege group overrides in effect.

Example 13 `host1#show privilege group 15 superUser`
The following groups are directly reachable:
14
dailyAdmin
The following groups are reachable:
1
14
2
3
4
basicUser
dailyAdmin
dailyTroll
minUser

In Example 13, groups 14 and dailyAdmin are directly reachable and groups 1, 14, 2, 3, 4, basicUser, dailyAdmin, dailyTroll, and minUser are reachable.

privilege

- Use to change the privilege level of any command within a specified mode.
- Example 1

```
host1(config)#privilege exec level 12 terminal width
```
- Example 2

```
host1(config)#privilege exec all level 5 terminal
```
- Use the **all** keyword to change the privilege level of groups of commands. For more information, see “Setting Privilege Levels for Multiple Commands” on page 59.
- Use the **reset** version to restore the default privilege level for the command; issuing this command results in the **show configuration** command not showing the default privilege setting for the command.
- Use the **no** version to restore the default privilege level for the command; issuing this command results in the **show configuration** command showing the default privilege level of the command in its output.



NOTE: You must access the CLI at privilege level 15 to view or use this command.

- `privilege`

privilege-group alias

- Use to give the privilege group name alias to the privilege group.
- Example

`host1(config-if)#privilege-group alias`

- Use the **no** version to remove the privilege group alias.
- See `privilege-group alias`.

privilege-group membership

- Use to add the member group to or remove the member group from the privilege group.
- Example

`host1(config-if)#privilege-group membership`

- Use the **no** version to restore one or all privilege groups to the default settings. When all privilege groups are reset to the default settings, the privilege group membership is hierarchical.
- See `privilege-group membership`.

privilege-group membership clear

- Use to clear a privilege group or all members from a privilege group.
- Example

`host1(config-if)#privilege-group membership clear`

- There is no **no** version.
- See `privilege-group membership clear`.

CLI Command Exceptions

Changing command privilege levels can be a powerful security tool. However, changing the command privilege for some commands could render the CLI unusable and require you to reboot the router. To eliminate this possibility, the CLI does not allow you to remap the following commands:

- `disable`
- `enable`
- `exit`

- **help**
- **privilege**
- **support**

CLI Keyword Mapping

You cannot change the privilege level of keywords that are separated from the command string by a parameter in the command sequence. In other words, once the privilege algorithm reaches a parameter, the privilege algorithm that maps the commands to the desired privilege level stops and allows any keyword options that may follow in the command sequence. The algorithm then waits for a carriage return before looking at the next command sequence.

For example, you can change the command privilege level for the **telnet** command. However, because the **telnet** command is immediately followed by a variable (that is, a hostname or IP address) and not a keyword, you cannot change the privilege level for any keywords that follow the command.

```
host1#telnet ?
HOSTNAME or A.B.C.D The ip address of the remote system
```

```
host1#telnet router2 ?
<0 - 65535> The port on which to send the request
bgp Border Gateway Protocol (179)
chargen Character generator (19)
cmd Remote commands (rcmd, 514)
```

Setting Privileges for Ambiguous Commands

The **privilege** command allows you to set command privilege levels for parts of commands that the CLI would normally consider ambiguous. In other words, you can set privilege levels by specifying letters that represent only the beginning part of a command or group of commands (even the first letter of a command or group of commands).

The following example sets the privilege level to 12 for any Exec mode (user or privileged) command that start with the letter “t” :

```
host1(config)#privilege exec level 12 t
```

The list of affected commands includes **telnet**, **terminal**, **test**, and **traceroute**.

The following example changes all the above commands, with the exception of the **traceroute** command, to level 15:

```
host1(config)#privilege exec level 15 te
```

The following example changes all commands that start with the letters “te” (for example, **telnet**, **terminal**, and **test**) and any second keyword that starts with the letter “i” and follows a command that starts with the letters “te” (for example, the keyword “ip” in the command **test ip**) to level 1:

```
host1(config)#privilege exec level 1 te i
```

When you enter an ambiguous command and an exact match of the command is found, partial matches are ignored and are not modified.

For example, the **traffic-class** and **traffic-class-group** commands are available in Global Configuration mode. If you issue the **privilege configure level 5 traffic-class** command, an exact match is made to **traffic-class**, and **traffic-class-group** is not modified.

If you want to set the privilege level for both **traffic-class** and **traffic-class-group** and you do not want the exact match to be made to **traffic-class**, issue a partial command such as **traffic-c**. The privilege level of all commands that begin with **traffic-c** is modified.

Setting Privilege Levels for no or default Versions

The **privilege** command allows you to set command privilege levels for **no** and **default** versions of commands. However, setting the privilege level for either the **no** or **default** versions of a command does *not* set the privilege level of the affirmative version of the command. This means that you can have the **no** or **default** version of a command at a different privilege level than its affirmative version



NOTE: You can set the **no** or **default** command to a separate privilege level without specifying any other command to follow. This would force all commands that have a **no** or **default** version to function only for that privilege level and higher.

For example, if you issue the **privilege exec level 10 no** command, all **no** versions in the Privileged Exec mode are available to users at level 10 and higher.

Setting Privilege Levels for Multiple Commands

The **all** keyword is a wildcard parameter that enables you to set privilege levels for multiple commands rather than setting them individually.

Setting Privilege Levels for All Commands in a Mode

You can set the privilege level for all commands within a specified mode. This setting includes all commands in modes that you can access from a specified mode.

If the command specified in the **privilege** command changes the configuration mode, all commands in the configuration will also be set to the specified privilege level. For more information about accessing modes, see “Accessing Command Modes” on page 69.

For example, issuing the **configure** command in Privileged Exec mode changes the configuration mode to Global Configuration. If you issue the **privilege exec all level**

5 configure command, all commands in Global Configuration mode become accessible to users who have CLI privileges at level 5 and higher. For more information about user privilege levels, see “Privileged-Level Access” on page 49.

Setting Privilege Levels for a Group of Commands

You can set the privilege level for a group of commands by using the **beginning** keyword in a command.

For example, if you issue the **privilege configure all level 5 snmp** command, all commands in Global Configuration mode that begin with **snmp** become accessible to users who have CLI privileges at level 5 and higher.

Using the Order of Precedence

The effectiveness of a privilege level that is set with the **all** keyword depends on its precedence level in the CLI. A privilege level is considered to be in effect only if a privilege level that is configured at a higher precedence level does not override it.

The CLI uses the following order of precedence:

1. Privilege level set for all commands within a mode, including modes that are accessed from another mode; for example, Global Configuration mode
2. Privilege level set for all commands that begin with the same keyword; for example, **snmp** commands
3. Privilege level set for individual commands; for example, **snmp-server community**



NOTE: This order of precedence does not apply to privilege levels that are set without the **all** keyword.

In the following example, the privilege level of the **snmp-server community** command is set to level 11, the privilege level for all commands that begin with **snmp** is set to level 10, and the privilege level for all commands in Global Configuration mode is set to level 5.

```
host1(config)#privilege configure level 11 snmp-server community
host1(config)#privilege configure all level 10 snmp
host1(config)#privilege exec all level 5 configure
```

The following **show configuration** output displays the privilege levels set above. The privilege levels for the **snmp-server community** command and the **snmp-server** group of commands are still present in the output. However, the privilege level of Global Configuration mode takes precedence, and the privilege levels of the other commands are rendered ineffective. Users can access all **snmp** commands at level 5 or higher.

```
host1#show config category management cli command-privileges
privilege configure level 11 snmp-server community
```

```
privilege configure all level 10 snmp-server
privilege exec all level 5 configure
```

Superseding Privilege Levels with the all Keyword

Issuing the **all** keyword supersedes privilege levels that were previously set without the **all** keyword.

In the following example, the **snmp-server-community** command is set to level 7, and the **snmp** keyword is set to level 6. The privilege level of the **snmp** keyword does not override the **snmp-server community** setting, because both of these commands are set without the **all** keyword.

```
host1(config)#privilege configure level 7 snmp-server community
host1(config)#privilege configure level 6 snmp
```

All **snmp** commands are then changed to level 5 with the **all** keyword.

```
host1(config)#privilege configure all level 5 snmp
```

The **show configuration** output displays all **snmp** commands at level 5, superseding the existing level 6 setting. The **snmp-server community** command is still present in the show configuration output, but it is ineffective.

```
host1#show config category management cli command-privileges
privilege configure level 7 snmp-server community
privilege configure all level 5 snmp-server
```

Removing the all Keyword

Using the **no** version or **reset** version removes the **all** keyword and restores default privilege levels.

If the privilege setting of the mode or command for which you are restoring default privilege levels takes precedence over any ineffective privilege settings, those settings will automatically take effect according to the order of precedence (see “Using the Order of Precedence” on page 60).

The difference between the **no** version and the **reset** version is that the **reset** version removes the configuration from the **show configuration** output. This is useful when you want to remove a configuration that has been overridden and rendered ineffective by a privilege level that takes precedence.

Setting Default Line Privilege

The factory default privilege level for the console line and all vty lines is 1. However, you can use the **privilege level** command in Line Configuration mode to set the default login privilege for the console line or any number of vty lines.

To change the default privilege level:

1. Access line configuration mode on the router for the console.

```
host1(config)#line console 0
host1(config-line)#
```

or on one or more vty lines

```
host1(config)#line vty 0 12
host1(config-line)#
```



NOTE: The latter command configures vty lines 0 to 12.

2. Specify a starting privilege level for the line or lines.

```
host1(config-line)#privilege level 5
```

The default privilege level for the specified line (or lines) changes. The new values take effect immediately for any new users. If using the console line, you must exit out of the CLI and reestablish a connection before the default takes effect.

If you are validating through RADIUS or TACACS+ and the server specifies an enable level, that enable level takes precedence over the line privilege level.

privilege level

- Use to change the default privilege level of the console line or one or more vty lines.
- Example

```
host1(config-line)#privilege level 5
```

- Use the **no** or **default** version to restore the default privilege level for the command.



NOTE: You must access the CLI at privilege level 15 to view or use this command.

- See privilege level.

Viewing CLI Privilege Information

You can view CLI privilege information for yourself (the current user), all connected users on the router, or for any modified CLI commands.

Viewing the Current User Privilege Level

Use the **show privilege** command to view your current privilege level.

show privilege

- Use to view your current privilege level.
- Example

```
host1#show privilege
Privilege level is 10
```

- There is no **no** version.
- See show privilege.

Viewing Privilege Levels for All Connected Users

Use the **show users detail** command to view the privilege levels for all users currently connected to the router. See “Monitoring the FTP Server” on page 292 for information about the **show users detail** command.

Viewing Privilege Levels for Changed CLI Commands

Use the **show configuration** command to view the changed privilege levels for any modified CLI commands. See “Saving the Current Configuration” on page 257 for information about the **show configuration** command.



NOTE: The **show configuration** command output displays output specific to the session access level. For example, if the session is enabled at level 5, issuing the **show configuration** command displays only output for commands at level 5 and below.

show privilege group

- Use to view the privilege groups.
- Example

```
host1(config-if)#show privilege group superUser
The following groups are directly reachable:
14
dailyAdmin

The following groups are reachable:
1
14
2
3
4
basicUser
dailyAdmin
dailyTroll
minUser
```

- There is no **no** version.
- See show privilege group.

Using Help

The system CLI provides a variety of useful context-sensitive help features. An important thing to remember about using the help features is that the use of a space or the lack of a space before the ? gives different results. Table 7 on page 64 describes the help system.

Table 7: Help Commands

Command	Description
?	Lists all keywords applicable to the current command mode
help	Displays a brief description of the help system (available in all command modes)
partial-keyword?	Lists the keywords that begin with a certain character string
partial-keyword < Tab >	Completes the partial keyword you entered, if you have provided an unambiguous abbreviation
command < Space > ?	Lists the set of all valid next available choices

Commands listed in the left column of Table 7 on page 64 are further described with examples in the following sections.

? (Question Mark Key)

You can use the question mark (?) key whenever you need additional information. When you enter ?, all available choices are displayed. The CLI then redisplay the command you typed. The following examples show different ways you can use the ? key.

When you use ? on a line by itself or when it is preceded by one or more spaces, a list of all next available choices is displayed.

Example 1	host1(config)#?	
	aaa	Configure authentication, authorization, and accounting characteristics
	access-list	Configure an access list entry
	arp	Configure a static ARP entry
	bandwidth	Configure slot-group bandwidth control
	banner	Define a banner line
	baseline	Configure baseline operations
	boot	Configure boot time behavior
	bulkstats	Configure bulkstats parameters
	classifier-list	Configure a classifier list entry
	clns	Configure CLNS characteristics
	clock	Set the system's clock
	confirmations	Configure confirmation mode
	controller	Configure controller parameters
	crypto	Configure cryptographic parameters
	default	Set a command to its default(s)
	disable-autosync	Disable automatic synchronization of redundant

	system controller file system
disable-switch-on-error	Disable automatic switch to redundant system controller upon software/hardware error
do	Run an exec mode command (alias command run)
enable	Configure security related options
end	Exit Global Configuration mode
exception	Configure core dump
exclude-subsystem	Exclude copying a subsystem from the release
exit	Exit from the current command mode
ftp-server	Configure FTP Server characteristics
help	Describe the interactive help system
host	Add/modify an entry to the host table
hostname	Set the host (system) name
interface	Enter Interface Configuration mode
ip	Configure IP characteristics
l2tp	Configure L2TP parameters
license	Configure licenses
line	Enter Line Configuration mode
log	Configure logging settings
macro	Run a CLI macro
map-list	Create an NBMA static map
memory	Configure and administer memory operations
mpls	Configure MPLS global parameters
no	Negate a command or set its default(s)
ntp	Configure the Network Time Protocol
policy-list	Enter Policy Configuration mode
pppoe	Configure PPPoE
profile	Specify a profile
radius	Configure RADIUS server
rate-limit-profile	Enter rate limit profile configuration mode
redundancy	Perform a redundancy configuration
route-map	Configure a route map
router	Configure a routing protocol
rtr	Configure rtr parameters
run	Run an exec mode command (alias command do)
service	Configure system-level services
set	Configure
sleep	Make the Command Interface pause for a specified duration
slot	Configure and administer slot operation
snmp-server	Configure SNMP parameters
sscc	The SSC Client telnet
telnet	telnet daemon configuration
timing	Configure network timing
traffic-shape-profile	Enter traffic shape profile configuration mode
virtual-router	Specify a virtual router

Example 2 host1(config)#ip ?
address-pool

address-pool	Configure address pool for PPP Broadband RAS clients
as-path	Configure a path filter for AS-Paths in BGP
bgp-community	Format for BGP community
community-list	Configure an entry in a community list
debounce-time	Specify the minimum amount of time that an event needs to be in same state before being reported
dhcp-local	The DHCP Local Server protocol
dhcp-server	DHCP Server for Proxy Client
domain-lookup	Enable DNS lookup
domain-name	Specify local Domain name
dvmrp	configure dvmrp parameters

dynamic-interface-prefix	Specify name prefix for dynamic Ip shared interfaces
explicit-path	Configure an explicit path
extcommunity-list	The extended community list
ftp	Configure FTP characteristics
http	Configure http server
local	Local IP address assignment
multicast-routing	Enable IP multicast forwarding
name-server	Configure DNS server
pim	Configure PIM Protocol
prefix-list	Configure a prefix list entry
prefix-tree	Configure a prefix tree entry
route	Define a static IP route
router-id	Configure the router-id to be used
rpf-route	Define a static IP route for mcast RPF check
source-route	Configure source-routing capabilities
ssh	Configure SSH characteristics
ttl	Configure the default value to be used by IP for Time-To-Live
tunnel	Configure tunnel parameter
vpn-id	Configure the VPN ID associated with this router
vrf	Specify a VRF

host1(config)#ip

Example 3 host1(config)#ip community-list ?
<1 - 99> The community list

host1(config)#ip community-list

When you want to see a list of commands that begin with a particular set of characters, type a question mark (?) immediately after the last letter. Do not use a space between the partial keyword and the ? key. For example:

```
host1#sh?
show shutdown
host1#sh
```



NOTE: If you want to use the ? character as part of a string, such as a hostname or a regular expression, you must enter the following key sequence: Ctrl + v + ?. Otherwise, the CLI considers the ? to be a request for assistance in completing the command.

help Command

Use the **help** command when you want to see a brief description of the context-sensitive help system.

```
host1>help
Use the help options as follows:
```

?, or command<Space>? - Lists the set of all valid next keywords or arguments
partial-keyword? - Lists the keywords that begin with a certain character string

partial-keyword<Tab> - Completes the partial keyword
host1>

Partial-keyword <Tab>

When you cannot recall a complete command name or keyword, type in the first few letters, press Tab, and the system completes your partial entry. You must type enough characters to provide a unique abbreviation. If you type a few letters, press Tab, and your terminal beeps, then you have not typed enough characters to be unambiguous.

```
host1(config)#int<Tab>
host1(config)#interface
```

Using Command-Line Editing

This section provides information about the command-line editor.

Basic Editing

Here are a few basic command-line editing notes:

- Case—Keywords are not case sensitive; that is, they can be entered in uppercase, lowercase, or a mix of both. Filenames may be case sensitive. Local filenames are case sensitive; remote filenames are case sensitive if the host system treats filenames as case sensitive. Passwords are case sensitive.
- Abbreviating keywords—You may abbreviate keywords using as few characters as you want, as long as the characters provide a unique abbreviation.
- Executing a command—Always use the Enter key.

Command-Line Editing Keys

You can use several keys to edit the command line. Table 8 on page 67 defines the keys for editing the command line. Arrow keys function only on ANSI-compatible terminals, such as VT100s.

Table 8: Command-Line Editing Keys

Key(s)	Function
Delete or Backspace	Removes characters to left of cursor
Left Arrow	Moves cursor one character to left
Right Arrow	Moves cursor one character to right
Ctrl + a	Moves cursor to beginning of command line
Ctrl + b	Moves cursor back one character
Ctrl + d	Deletes character at cursor

Table 8: Command-Line Editing Keys *(continued)*

Key(s)	Function
Ctrl + e	Moves cursor to end of command line
Ctrl + f	Moves cursor forward one character
Ctrl + h	Deletes character to left of cursor
Ctrl + k	Deletes all characters from cursor to end of command line
Ctrl + l	Redisplays system prompt and command line
Ctrl + o	Toggles overwrite/insert mode
Ctrl + t	Transposes character to left of cursor with character located at cursor
Ctrl + u	Deletes entire command line
Ctrl + v	Allows the “ ? ” character to be used as a character instead of as a request for help
Ctrl + w	Deletes the previous word
Ctrl + x	<p>In all modes, reboots the system. This feature is useful if a command is taking a prolonged time to complete and hangs the console. The command has no effect if you access the system through Telnet.</p> <p>Set the boot option flag by using the <code>service ctrl-x-reboot</code> command from Global Configuration mode.</p>
Ctrl + y	Recalls most recent entry from delete buffer; recalled characters overwrite or are inserted in current line depending on overwrite/insert toggle
Ctrl + z	In all modes except User Exec mode, executes any command typed immediately before the command sequence and then changes the mode to Privileged Exec mode. In User Exec mode, only executes any command typed immediately before the command sequence.
Esc + b	Moves cursor back one word
Esc + Backspace	Deletes previous word
Esc + d	Deletes current or next word

Command History Keys

The CLI maintains two separate command histories. The first command history maintains only Exec mode commands. The second history maintains all commands entered in any of the configuration modes. The appropriate history will automatically be restored as you transition between Global Configuration mode and Exec mode.

Table 9 on page 69 defines the keys related to command history. Arrow keys functions only on ANSI-compatible terminals, such as VT100s.

Table 9: Command History Keys

Key	Function
Up Arrow <i>or</i> Ctrl + p	Recalls commands in history buffer, starting with most recent command. Repeat key sequence to recall successively older commands.
Down Arrow <i>or</i> Ctrl + n	Returns to more recent commands in history buffer after recalling commands with Up Arrow or Ctrl + p. Repeat key sequence to recall successively more recent commands.
Ctrl + r	Begin a <i>reverse search</i> for a previously entered string in the history buffer by providing a character string when prompted. Enter Ctrl + r to continue searching. Ctrl + h or Del deletes the last character in the string and starts a search on the new string.

Pagination Keys

If the system needs to display more text than you can fit on the screen, the output pauses and the `--More--` prompt appears. Table 10 on page 69 defines the pagination keys that you can use when the `--More--` prompt appears. For more information, see “The `--More--` Prompt” on page 43.

Table 10: Pagination Keys

Key	Function
Enter	Scrolls down one more line
Spacebar	Displays one more screen
+	Displays all output lines that contain the text string
-	Displays all output lines that do not contain the text string
/	Displays all output lines starting at the first line that contains the text string
Any other key	Aborts output and returns you to command prompt

Accessing Command Modes

Table 11 on page 70 describes the command modes available in the CLI.

Table 11: Command Mode Overview

Mode Name	Use of Mode	Access to Mode	Exit from Mode
AAA Profile Configuration	<ul style="list-style-type: none"> ■ Configure new AAA profiles. 	<ul style="list-style-type: none"> ■ From Global Configuration mode, use aaa-profile command. ■ Prompt: host1(config-aaa-profile)# 	<ul style="list-style-type: none"> ■ Use the exit command to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec mode.
Address Family Configuration	<ul style="list-style-type: none"> ■ Configure BGP or RIP address family parameters. 	<ul style="list-style-type: none"> ■ From Global Configuration mode, use router bgp or router rip to enter Router Configuration mode. From Router Configuration, use the address-family command. ■ Prompt: host1(config-router-af)# 	<ul style="list-style-type: none"> ■ Use the exit command twice to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec mode.
ATM VC Class Configuration	<ul style="list-style-type: none"> ■ Configure a class of attributes for an ATM data PVC. 	<ul style="list-style-type: none"> ■ From Global Configuration mode, use the vc-class atm command, and specify the name of the VC class. ■ Prompt: host1(config-vc-class)# 	<ul style="list-style-type: none"> ■ Use the exit command to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec mode.
ATM VC Configuration	<ul style="list-style-type: none"> ■ Configure individual attributes for an ATM data PVC. 	<ul style="list-style-type: none"> ■ From Global Configuration mode, use the interface command to enter Subinterface Configuration mode. From Subinterface Configuration mode, use the pvc command. ■ Prompt: host1(config-subif-atm-vc)# 	<ul style="list-style-type: none"> ■ Use the exit command twice to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec mode.

Table 11: Command Mode Overview *(continued)*

Mode Name	Use of Mode	Access to Mode	Exit from Mode
Classifier Group Configuration	<ul style="list-style-type: none"> ■ Configure classifier groups with policy rules used for policy lists. 	<ul style="list-style-type: none"> ■ To create a classifier group, from Policy List Configuration mode use the classifier-group command and identify the CLACL and precedence. ■ Prompt: host1(config-policy-list-classifier-group)# 	<ul style="list-style-type: none"> ■ Use the exit command twice to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec mode.
Color Mark Profile Configuration	<ul style="list-style-type: none"> ■ Configure packet color after exit from rate-limit hierarchy. 	<ul style="list-style-type: none"> ■ From Rate Limit Profile Configuration Mode, use the color-mark-profile command and identify the interface type (IP, IPv6, MPLS). ■ Prompt: host1(config-color-mark-profile)# 	<ul style="list-style-type: none"> ■ Use the exit command once to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec mode.
Control Plane Configuration	<ul style="list-style-type: none"> ■ Configure SRP module policing. 	<ul style="list-style-type: none"> ■ From Global Configuration Mode, use the control-plane command. ■ Prompt: host1(config-control-plane)# 	<ul style="list-style-type: none"> ■ Use the exit command once to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec mode.
Controller Configuration	<ul style="list-style-type: none"> ■ Configure physical interfaces (for example, T3). 	<ul style="list-style-type: none"> ■ From Global Configuration mode, use the controller command. ■ Prompt: host1(config-controller)# 	<ul style="list-style-type: none"> ■ Use the exit command once to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec mode.
DHCP Local Pool Configuration	<ul style="list-style-type: none"> ■ Configure DHCP local pools. 	<ul style="list-style-type: none"> ■ From Global Configuration mode, use the ip dhcp-local pool command. ■ Prompt: host1(config-dhcp-local)# 	<ul style="list-style-type: none"> ■ Use the exit command once to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec mode.

Table 11: Command Mode Overview *(continued)*

Mode Name	Use of Mode	Access to Mode	Exit from Mode
Domain Map Configuration	<ul style="list-style-type: none"> ■ Configure domain maps. 	<ul style="list-style-type: none"> ■ From Global Configuration mode, use the aaa domain-map command. ■ Prompt: host1(config-domain-map)# 	<ul style="list-style-type: none"> ■ Use the exit command once to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec mode.
Domain Map Tunnel Configuration	<ul style="list-style-type: none"> ■ Configure tunnel parameters. 	<ul style="list-style-type: none"> ■ From Domain-Map Configuration mode, use the tunnel command. ■ Prompt: host1(config-domain-map-tunnel)# 	<ul style="list-style-type: none"> ■ Use the exit command twice to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec mode.
DoS Protection Group Configuration	<ul style="list-style-type: none"> ■ Configure parameters for DoS protection groups. 	<ul style="list-style-type: none"> ■ From Global Configuration Mode, use the dos-protection-group command. ■ Prompt: host1(config-dos-group)# 	<ul style="list-style-type: none"> ■ Use the exit command once to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec mode.
Drop Profile Configuration	<ul style="list-style-type: none"> ■ Configure drop profiles. 	<ul style="list-style-type: none"> ■ From Global Configuration mode, use the drop-profile command. ■ Prompt: host1(config-drop-profile)# 	<ul style="list-style-type: none"> ■ Use the exit command once to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec mode.
Explicit Path Configuration	<ul style="list-style-type: none"> ■ Configure MPLS explicit path parameters. 	<ul style="list-style-type: none"> ■ From Global Configuration mode, specify the mpls explicit-path name command. ■ Prompt: host1(config-exp1-path)# 	<ul style="list-style-type: none"> ■ Use the exit command to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec mode.

Table 11: Command Mode Overview *(continued)*

Mode Name	Use of Mode	Access to Mode	Exit from Mode
Flow Cache Configuration	<ul style="list-style-type: none"> ■ Configure parameters for the aggregation cache. 	<ul style="list-style-type: none"> ■ From Global Configuration Mode, use the ip flow-aggregation cache command. ■ Prompt: host1(config-flow-cache)# 	<ul style="list-style-type: none"> ■ Use the exit command once to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec mode.
Global Configuration	<ul style="list-style-type: none"> ■ Enable a feature or function. ■ Disable a feature or function. ■ Configure a feature or function. 	<ul style="list-style-type: none"> ■ From Privileged Exec mode, use the configure command. ■ Prompt: host1(config)# 	<ul style="list-style-type: none"> ■ Use the exit command, or press Ctrl + z to return to Exec mode. ■ Use the interface command to enter Interface Configuration mode.
Interface Configuration	<ul style="list-style-type: none"> ■ Create an interface. ■ Modify the operation of an interface, such as bandwidth or clock rate. 	<ul style="list-style-type: none"> ■ From Global Configuration mode, use the interface command and identify the interface by slot/port. ■ Prompt: host1(config-if)# 	<ul style="list-style-type: none"> ■ Use the exit command once to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec mode.
IP NAT Pool Configuration	<ul style="list-style-type: none"> ■ Create a NAT pool with a multiple, discontinuous range. 	<ul style="list-style-type: none"> ■ From Global Configuration mode, use the ip nat pool command and specify only a prefix length value. ■ Prompt: host1(config-ipnat-pool)# 	<ul style="list-style-type: none"> ■ Use the exit command once to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec mode.
IP PIM Data MDT Configuration	<ul style="list-style-type: none"> ■ Create and activate data multicast distribution trees (MDTs) 	<ul style="list-style-type: none"> ■ From Global Configuration mode, use the ip pim data-mdt command and specify a name. ■ Prompt: host1(config-ip-pim-data-mdt)# 	<ul style="list-style-type: none"> ■ Use the exit command once to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec mode.

Table 11: Command Mode Overview *(continued)*

Mode Name	Use of Mode	Access to Mode	Exit from Mode
IP Service Profile Configuration	<ul style="list-style-type: none"> Create a service profile to use in route maps for subscriber management and to authenticate subscribers with RADIUS. 	<ul style="list-style-type: none"> From Global Configuration mode, use the ip service-profile command and specify a service profile name with up to 32 ASCII characters. Prompt: host1(config-service-profile)# 	<ul style="list-style-type: none"> Use the exit command once to return to Global Configuration mode. Press Ctrl + z to return to Exec mode.
IPSec CA Identity Configuration	<ul style="list-style-type: none"> Create an IPSec identity used in online certificate requests and during negotiations with IKE peers. 	<ul style="list-style-type: none"> From the Global Configuration mode, use the ipsec ca identity command. Prompt: host1(config-ca-identity)# 	<ul style="list-style-type: none"> Use the exit command once to return to Global Configuration mode. Press Ctrl + z to return to Exec mode.
IPSec Identity Configuration	<ul style="list-style-type: none"> Create an IPSec identity used in offline certificate requests and during negotiations with IKE peers. 	<ul style="list-style-type: none"> From the Global Configuration mode, use the ipsec identity command. Prompt: host1(config-ipsec-identity)# 	<ul style="list-style-type: none"> Use the exit command once to return to Global Configuration mode. Press Ctrl + z to return to Exec mode.
IPSec IKE Policy Configuration	<ul style="list-style-type: none"> Define an IKE policy. 	<ul style="list-style-type: none"> From the Global Configuration mode, use the ipsec ike-policy-rule command. Prompt: host1(config-ike-policy)# 	<ul style="list-style-type: none"> Use the exit command once to return to Global Configuration mode. Press Ctrl + z to return to Exec mode.
IPSec Manual Key Configuration	<ul style="list-style-type: none"> Enter manual keys. 	<ul style="list-style-type: none"> From Global Configuration mode, use the ipsec key manual pre-share command. Prompt: host1(config-manual-key)# 	<ul style="list-style-type: none"> Use the exit command once to return to Global Configuration mode. Press Ctrl + z to return to Exec mode.

Table 11: Command Mode Overview *(continued)*

Mode Name	Use of Mode	Access to Mode	Exit from Mode
IPSec Peer Public Key Configuration	<ul style="list-style-type: none"> Enter an ISAKMP/IKE public key that a remote peer uses for RSA authentication without the need for a digital certificate. 	<ul style="list-style-type: none"> From Global Configuration mode, use the ipsec key pubkey-chain rsa command. Prompt: host1(config-peer-public-key)# 	<ul style="list-style-type: none"> Use the exit command once to return to Global Configuration mode. Press Ctrl + z to return to Exec mode.
IPSec Transport Profile Configuration	<ul style="list-style-type: none"> Configure a profile for L2TP over IPSec. 	<ul style="list-style-type: none"> From Global Configuration mode, use the ipsec transport profile command. Prompt: host1(config-ipsec-transport-profile)# 	<ul style="list-style-type: none"> Use the exit command once to return to Global Configuration mode. Press Ctrl + z to return to Exec mode.
IPSec Tunnel Profile Configuration	<ul style="list-style-type: none"> Configure a profile for IPSec tunnels. 	<ul style="list-style-type: none"> From Global Configuration mode, use the ipsec tunnel profile command. Prompt: host1(config-ipsec-tunnel-profile)# 	<ul style="list-style-type: none"> Use the exit command once to return to Global Configuration mode. Press Ctrl + z to return to Exec mode.
IP Tunnel Destination Profile Configuration	<ul style="list-style-type: none"> Create a profile for dynamic GRE or DVMRP tunnels 	<ul style="list-style-type: none"> From Global Configuration mode, use the gre destination profile command or the dvmrp destination profile command and specify a destination profile name. Prompt: host1(config-dest-profile)# 	<ul style="list-style-type: none"> Use the exit command once to return to Global Configuration mode. Press Ctrl + z to return to Exec mode.

Table 11: Command Mode Overview (continued)

Mode Name	Use of Mode	Access to Mode	Exit from Mode
L2 Transport Load-Balancing-Circuit Configuration	<ul style="list-style-type: none"> Configure Martini layer 2 transport circuit associated with load-balancing group. 	<ul style="list-style-type: none"> From Global Configuration mode, specify the mpls l2transport load-balancing-group command. Prompt: host1(config-l2transport-load-balancing-circuit)# 	<ul style="list-style-type: none"> Use the exit command once to return to Global Configuration mode. Press Ctrl + z to return to Exec mode.
L2TP Destination Profile Configuration	<ul style="list-style-type: none"> Define the location of an LAC. 	<ul style="list-style-type: none"> From Global Configuration mode, use the l2tp destination profile command. Prompt: host1(config-l2tp-dest-profile)# 	<ul style="list-style-type: none"> Use the exit command once to return to Global Configuration mode. Press Ctrl + z to return to Exec mode.
L2TP Destination Profile Host Configuration	<ul style="list-style-type: none"> Configure host profile attributes. 	<ul style="list-style-type: none"> From L2TP Destination Profile Configuration mode, use the remote host command. Prompt: host1(config-l2tp-dest-profile-host)# 	<ul style="list-style-type: none"> Use the exit command twice to return to Global Configuration mode. Press Ctrl + z to return to Exec mode.
L2TP Tunnel Switch Profile Configuration	<ul style="list-style-type: none"> Configure the L2TP tunnel switching behavior for interfaces to which this profile is assigned. 	<ul style="list-style-type: none"> From Global Configuration mode, use the l2tp switch-profile command, and specify the name of the L2TP tunnel switch profile. Prompt: host1(config-l2tp-tunnel-switch-profile)# 	<ul style="list-style-type: none"> Use the exit command once to return to Global Configuration mode. Press Ctrl + z to return to Exec mode.
Layer 2 Control Configuration	<ul style="list-style-type: none"> Configure ANCP (L2C) parameters. 	<ul style="list-style-type: none"> From Global Configuration mode, use the l2c command. Prompt: host1(config-l2c)# 	<ul style="list-style-type: none"> Use the exit command once to return to Global Configuration mode. Press Ctrl + z to return to Exec mode.

Table 11: Command Mode Overview *(continued)*

Mode Name	Use of Mode	Access to Mode	Exit from Mode
Layer 2 Control Neighbor Configuration	<ul style="list-style-type: none"> ■ Configure ANCP (L2C) neighbor parameters. 	<ul style="list-style-type: none"> ■ From Layer 2 Configuration mode, use the neighbor command. ■ Prompt: host1(config-l2c-neighbor)# 	<ul style="list-style-type: none"> ■ Use the exit command twice to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec mode.
LDP Configuration	<ul style="list-style-type: none"> ■ Configure MPLS LDP profile parameters. 	<ul style="list-style-type: none"> ■ From Global Configuration mode, specify the mpls ldp profile command. ■ Prompt: host1(config-ldp)# 	<ul style="list-style-type: none"> ■ Use the exit command once to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec mode.
Line Configuration	<ul style="list-style-type: none"> ■ Modify a virtual terminal line. 	<ul style="list-style-type: none"> ■ From Global Configuration mode, use the line command. ■ Prompt: host1(config-line)# 	<ul style="list-style-type: none"> ■ Use the exit command once to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec mode.
Local IPSec Transport Profile Configuration	<ul style="list-style-type: none"> ■ Configure preshared IKE keys for L2TP over IPSec profiles. 	<ul style="list-style-type: none"> ■ From the IPSec Transport Profile Configuration mode, use the local ip address command. ■ Prompt: host1(config-ipsec-transport-profile-local)# 	<ul style="list-style-type: none"> ■ Use the exit command twice to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec mode.
Local User Configuration	<ul style="list-style-type: none"> ■ Configure user parameters in local user databases. 	<ul style="list-style-type: none"> ■ From Global Configuration mode, specify the aaa local username or the aaa local database command. ■ Prompt: host1(config-local-user)# 	<ul style="list-style-type: none"> ■ Use the exit command to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec mode.

Table 11: Command Mode Overview *(continued)*

Mode Name	Use of Mode	Access to Mode	Exit from Mode
Map Class Configuration	<ul style="list-style-type: none"> Specify fragmentation for a map class. 	<ul style="list-style-type: none"> From Global Configuration mode, specify the map-class frame-relay command. Prompt: host1(config-map-class)# 	<ul style="list-style-type: none"> Use the exit command once to return to Global Configuration mode. Press Ctrl + z to return to Exec mode.
Map List Configuration	<ul style="list-style-type: none"> Configure map list parameters. 	<ul style="list-style-type: none"> From Global Configuration mode, use the map-list command. Prompt: host1(config-map-list)# 	<ul style="list-style-type: none"> Use the exit command once to return to Global Configuration mode. Press Ctrl + z to return to Exec mode.
Parent Group Configuration	<ul style="list-style-type: none"> Configure an external parent group. 	<ul style="list-style-type: none"> From Global Configuration mode, use the parent-group command. Prompt: host1(config-parent-group)# 	<ul style="list-style-type: none"> Use the exit command once to return to Global Configuration mode. Press Ctrl + z to return to Exec mode.
Policy List Configuration	<ul style="list-style-type: none"> Configure policy lists. 	<ul style="list-style-type: none"> To create a policy list, from Global Configuration mode use the policy-list command and identify the type of policy list. Prompt: host1(config-policy-list)# 	<ul style="list-style-type: none"> Use the exit command once to return to Global Configuration mode. Press Ctrl + z to return to Exec mode.
Policy List Parent Group Configuration	<ul style="list-style-type: none"> Configure an internal parent group in a hierarchy. 	<ul style="list-style-type: none"> From Global Configuration Mode, use the policy-list command to create or access a policy list. From Policy List Configuration Mode, use the parent-group command. Prompt: host1(config-policy-list-parent-group)# 	<ul style="list-style-type: none"> Use the exit command twice to return to Global Configuration mode. Press Ctrl + z to return to Exec mode.

Table 11: Command Mode Overview *(continued)*

Mode Name	Use of Mode	Access to Mode	Exit from Mode
Policy Parameter Configuration	<ul style="list-style-type: none"> ■ Configure a policy parameter. 	<ul style="list-style-type: none"> ■ From Global Configuration mode, use the policy-parameter command. ■ Prompt: host1(config-policy-parameter)# 	<ul style="list-style-type: none"> ■ Use the exit command once to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec mode.
PPPoE Service Name Table Configuration	<ul style="list-style-type: none"> ■ Configure services for a PPPoE service name table. 	<ul style="list-style-type: none"> ■ From Global Configuration mode, use the pppoe-service-name-table command, and specify the alphanumeric name of the PPPoE service name table. ■ Prompt: host1(config-pppoe-service-name-table)# 	<ul style="list-style-type: none"> ■ Use the exit command once to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec mode.
Privileged Exec	<ul style="list-style-type: none"> ■ Show system information. ■ Set operating parameters. ■ Access Global Configuration mode. 	<ul style="list-style-type: none"> ■ From User Exec mode, use the enable command. ■ Prompt: host1# 	<ul style="list-style-type: none"> ■ Use the disable command to return to User Exec mode. ■ Use the exit command to log out of the CLI. ■ Use the configure command to enter Global Configuration mode.
Profile Configuration	<ul style="list-style-type: none"> ■ Configure profiles. 	<ul style="list-style-type: none"> ■ From Global Configuration mode, use the profile command. ■ Prompt: host1(config-profile)# 	<ul style="list-style-type: none"> ■ Use the exit command once to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec mode.
QoS Interface Set Configuration	<ul style="list-style-type: none"> ■ Configure QoS interface sets. 	<ul style="list-style-type: none"> ■ From Global Configuration mode, use the qos-interface-set command. ■ Prompt: host1(config-qos-interface-set)# 	<ul style="list-style-type: none"> ■ Use the exit command once to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec mode.

Table 11: Command Mode Overview *(continued)*

Mode Name	Use of Mode	Access to Mode	Exit from Mode
QoS Interface Superet Configuration	<ul style="list-style-type: none"> ■ Configure QoS interface supersets. 	<ul style="list-style-type: none"> ■ From Global Configuration mode, use the qos-interface-superset command. ■ Prompt: host1(config-qos-interface-superset)# 	<ul style="list-style-type: none"> ■ Use the exit command once to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec mode.
QoS Parameter Definition Configuration	<ul style="list-style-type: none"> ■ Configure QoS parameter definitions. 	<ul style="list-style-type: none"> ■ From Global Configuration mode, use the qos-parameter-define command. ■ Prompt: host1(config-qos-parameter-define)# 	<ul style="list-style-type: none"> ■ Use the exit command once to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec mode.
QoS Profile Configuration	<ul style="list-style-type: none"> ■ Configure QoS profiles. 	<ul style="list-style-type: none"> ■ From Global Configuration mode, use the qos-profile command. ■ Prompt: host1(config-qos-profile)# 	<ul style="list-style-type: none"> ■ Use the exit command once to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec mode.
QoS Shared Shaper Control Configuration	<ul style="list-style-type: none"> ■ Configure variables within the simple shared shaper algorithm. 	<ul style="list-style-type: none"> ■ From Global Configuration mode, use the qos-shared-shaper-control command. ■ Prompt: host1(config-qos-shared-shaper-control)# 	<ul style="list-style-type: none"> ■ Use the exit command once to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec mode.
Queue Profile Configuration	<ul style="list-style-type: none"> ■ Configure queue profiles. 	<ul style="list-style-type: none"> ■ From Global Configuration mode, use the queue-profile command. ■ Prompt: host1(config-queue)# 	<ul style="list-style-type: none"> ■ Use the exit command once to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec mode.

Table 11: Command Mode Overview *(continued)*

Mode Name	Use of Mode	Access to Mode	Exit from Mode
RADIUS Configuration	<ul style="list-style-type: none"> ■ Configure Broadband Remote Access Server (B-RAS) parameters. 	<ul style="list-style-type: none"> ■ From Global Configuration mode, use the radius server command. ■ Prompt: host1(config-radius)# 	<ul style="list-style-type: none"> ■ Use the exit command once to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec mode.
RADIUS Relay Configuration	<ul style="list-style-type: none"> ■ Configure RADIUS relay server parameters. 	<ul style="list-style-type: none"> ■ From Global Configuration mode, use the radius relay server command. ■ Prompt: host1(config-radius-relay)# 	<ul style="list-style-type: none"> ■ Use the exit command once to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec mode.
Rate Limit Profile Configuration	<ul style="list-style-type: none"> ■ Configure an IP or L2TP rate limit parameters. 	<ul style="list-style-type: none"> ■ To create an IP rate limit profile, from Global Configuration mode use the ip rate-limit-profile command. ■ To create an L2TP rate limit profile, from Global Configuration mode use the l2tp rate-limit-profile command. ■ Prompt: host1(config-rate-limit-profile)# 	<ul style="list-style-type: none"> ■ Use the exit command once to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec mode.
Redundancy Configuration	<ul style="list-style-type: none"> ■ Configure high availability (stateful SRP switchover). 	<ul style="list-style-type: none"> ■ From Global Configuration mode, use the redundancy command. ■ Prompt: host1(config-redundancy)# 	<ul style="list-style-type: none"> ■ Use the exit command once to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec mode.

Table 11: Command Mode Overview *(continued)*

Mode Name	Use of Mode	Access to Mode	Exit from Mode
Remote Neighbor Configuration	<ul style="list-style-type: none"> Configure remote neighbor parameters for OSPF, PIM, or RIP. 	<ul style="list-style-type: none"> From Router Configuration mode, use the remote-neighbor command. Prompt: host1(config-router-rn)# 	<ul style="list-style-type: none"> Use the exit command twice to return to Global Configuration mode. Press Ctrl + z to return to Exec mode.
Route Map Configuration	<ul style="list-style-type: none"> Configure routing tables and source and destination information. 	<ul style="list-style-type: none"> From Global Configuration mode, use the route-map command. Prompt: host1(config-route-map)# 	<ul style="list-style-type: none"> Use the exit command once to return to Global Configuration mode. Press Ctrl + z to return to Exec mode.
Router Configuration	<ul style="list-style-type: none"> Configure a routing protocol. 	<ul style="list-style-type: none"> From Global Configuration mode, specify a routing protocol with the router command. Prompt: host1(config-router)# 	<ul style="list-style-type: none"> Use the exit command once to return to Global Configuration mode. Press Ctrl + z to return to Exec mode.
RSVP Configuration	<ul style="list-style-type: none"> Configure an RSVP profile. 	<ul style="list-style-type: none"> From Global Configuration mode, use the mpls rsvp profile command. Prompt: host1(config-rsvp)# 	<ul style="list-style-type: none"> Use the exit command once to return to Global Configuration mode. Press Ctrl + z to return to Exec mode.
RTR Configuration	<ul style="list-style-type: none"> Configure RTR parameters. 	<ul style="list-style-type: none"> From Global Configuration mode, use the rtr command. Prompt: host1(config-rtr)# 	<ul style="list-style-type: none"> Use the exit command once to return to Global Configuration mode. Press Ctrl + z to return to Exec mode.

Table 11: Command Mode Overview (continued)

Mode Name	Use of Mode	Access to Mode	Exit from Mode
Scheduler Profile Configuration	<ul style="list-style-type: none"> ■ Configure shaping parameters. ■ Configure scheduler profiles. 	<ul style="list-style-type: none"> ■ From Global Configuration mode, use the scheduler-profile command. ■ Prompt: host1(config-scheduler-profile)# 	<ul style="list-style-type: none"> ■ Use the exit command once to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec menu.
Service Session Profile Configuration	<ul style="list-style-type: none"> ■ Configure attributes for Service Manager service session profiles. 	<ul style="list-style-type: none"> ■ From Global Configuration mode, use the service-management service-session-profile command. ■ Prompt: host1(config-service-session-profile)# 	<ul style="list-style-type: none"> ■ Use the exit command twice to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec mode.
SNMP Event Manager Configuration	<ul style="list-style-type: none"> ■ Configure SNMP events. 	<ul style="list-style-type: none"> ■ From Global Configuration mode, use the snmp-server management-event command. ■ Prompt: host1(config-mgmtevent)# 	<ul style="list-style-type: none"> ■ Use the exit command once to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec menu.
Statistics Profile Configuration	<ul style="list-style-type: none"> ■ Configure statistics profiles. 	<ul style="list-style-type: none"> ■ From Global Configuration mode, use the statistics-profile command. ■ Prompt: host1(config-statistics-profile)# 	<ul style="list-style-type: none"> ■ Use the exit command once to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec menu.
Subinterface Configuration	<ul style="list-style-type: none"> ■ Configure multiple virtual interfaces on a single physical interface. 	<ul style="list-style-type: none"> ■ From Global Configuration mode, use the interface command and identify the interface (slot/port.subinterface). ■ Prompt: host1(config-subif)# 	<ul style="list-style-type: none"> ■ Use the exit command once to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec mode.

Table 11: Command Mode Overview *(continued)*

Mode Name	Use of Mode	Access to Mode	Exit from Mode
Subscriber Policy Configuration	<ul style="list-style-type: none"> Configure a nondefault subscriber policy for a subscriber (client) bridge group interface. 	<ul style="list-style-type: none"> From Global Configuration mode, use the subscriber-policy command and specify the alphanumeric name of the subscriber policy. Prompt: host1(config-policy)# 	<ul style="list-style-type: none"> Use the exit command once to return to Global Configuration mode. Press Ctrl + z to return to Exec mode.
Traffic Class Configuration	<ul style="list-style-type: none"> Configure a traffic class. 	<ul style="list-style-type: none"> From Global Configuration mode, use the traffic-class command. Prompt: host1(config-traffic-class)# 	<ul style="list-style-type: none"> Use the exit command once to return to Global Configuration mode. Press Ctrl + z to return to Exec mode.
Traffic Class Group Configuration	<ul style="list-style-type: none"> Configure a traffic class group. 	<ul style="list-style-type: none"> From Global Configuration mode, use the traffic-class-group command. Prompt: host1(config-traffic-class-group) 	<ul style="list-style-type: none"> Use the exit command once to return to Global Configuration mode. Press Ctrl + z to return to Exec mode.
Tunnel Group Configuration	<ul style="list-style-type: none"> Add up to 31 tunnel definitions to a tunnel group. 	<ul style="list-style-type: none"> From Global Configuration mode, use the aaa tunnel-group command and specify the name of the tunnel. Prompt: host1(config-tunnel-group)# 	<ul style="list-style-type: none"> Use the exit command once to return to Global Configuration mode. Press Ctrl + z to return to Exec mode.

Table 11: Command Mode Overview (continued)

Mode Name	Use of Mode	Access to Mode	Exit from Mode
Tunnel Group Tunnel Configuration	<ul style="list-style-type: none"> ■ Configure attributes for a tunnel group tunnel. 	<ul style="list-style-type: none"> ■ From Tunnel Group Configuration mode, use the tunnel command and specify the tag value (1-31) of the tunnel. ■ Prompt: host1(config-tunnel-group-tunnel)# 	<ul style="list-style-type: none"> ■ Use the exit command twice to return to Global Configuration Mode. ■ Press Ctrl + z to return to Exec mode.
Tunnel Profile Configuration	<ul style="list-style-type: none"> ■ Configure tunnel profile parameters. 	<ul style="list-style-type: none"> ■ From Global Configuration mode, specify the mpls tunnels profile command. ■ Prompt: host1(config-tunnelprofile)# 	<ul style="list-style-type: none"> ■ Use the exit command once to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec mode.
Tunnel Server Configuration	<ul style="list-style-type: none"> ■ Configure the maximum number of tunnel-service interfaces for a dynamic tunnel-server port. 	<ul style="list-style-type: none"> ■ From Global Configuration mode, use the tunnel-server command and identify the slot/port location of the dynamic tunnel-server port. ■ Prompt: host1(config-tunnel-server)# 	<ul style="list-style-type: none"> ■ Use the exit command once to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec mode.
User Exec	<ul style="list-style-type: none"> ■ Change terminal settings on a temporary basis. ■ Show system information. ■ Access Privileged Exec mode. 	<ul style="list-style-type: none"> ■ Log into system. ■ Prompt: host1> 	<ul style="list-style-type: none"> ■ Use the enable command to enter Privileged Exec mode. ■ Use the exit command to log out of the CLI.
VRF Configuration	<ul style="list-style-type: none"> ■ Configure VRF parameters for BGP/MPLS VPNs. 	<ul style="list-style-type: none"> ■ From Global Configuration mode, use the ip vrf command. ■ Prompt: host1(config-vrf)# 	<ul style="list-style-type: none"> ■ Use the exit command once to return to Global Configuration mode. ■ Press Ctrl + z to return to Exec mode.

Table 11: Command Mode Overview *(continued)*

Mode Name	Use of Mode	Access to Mode	Exit from Mode
VR Group Configuration	<ul style="list-style-type: none"> Configure a virtual router group for AAA broadcast accounting. 	<ul style="list-style-type: none"> From Global Configuration mode, use aaa accounting vr-group to enter VR Group Configuration mode. Prompt: host1(config-vr-group)# 	<ul style="list-style-type: none"> Use the exit command twice to return to Global Configuration mode. Press Ctrl + z to return to Exec mode.



NOTE: Within any configuration mode, the commands that are available to the user include the commands defined for that configuration mode and all commands defined for Global Configuration mode. See Figure 21 on page 30. For example, from Router Configuration mode, you could use the **interface** Global Configuration mode command without first explicitly going back to Global Configuration mode.

```
host1(router-config)# interface atm 4/0.3
host1(config-if)#
```

Exec Modes

There are two Exec modes: User Exec and Privileged Exec.

After you log in to the system, the CLI is in User Exec mode. By default, the commands you can execute from User Exec mode provide only user-level access; however, you should password protect it to prevent unauthorized use. The User Exec commands allow you to perform such functions as:

- Change terminal settings on a temporary basis.
- Perform **ping** and **trace** commands.
- Display system information.

```
host1>?
clear      Clear system information
default    Set a command to its default(s)
dir        Display a list of local files
disable    Reduce the command privilege level
enable     Enable access to privileged commands
erase      Erase configuration settings
exit       Exit from the current command mode
flash-disk Perform flash disk operations
help       Describe the interactive help system
ip         Configure IP attributes on an interface
ipv6       Configure IPv6 attributes
l2tp       L2TP operations
macro      Run a CLI macro
```

<code>mpls</code>	Execute MPLS commands
<code>mtrace</code>	Trace the path that packets will traverse from source to destination for a given group
<code>no</code>	Negate a command or set its default(s)
<code>ping</code>	Send echo request to remote host
<code>show</code>	Display system information
<code>sleep</code>	Make the Command Interface pause for a specified duration
<code>terminal</code>	Configure the terminal line settings
<code>test</code>	Test the outcome of a command
<code>traceroute</code>	Trace the path that packets traverse to their destination

Privileged Exec mode provides privileged-level access and therefore should also be password protected to prevent unauthorized use. Privileged Exec commands allow you to perform such functions as:

- Display system information.
- Set operating parameters.
- Gain access to Global Configuration mode.

Password Protection

If the system administrator has configured the system to have a password, the CLI prompts you to enter that password before you receive access to Privileged Exec mode. The password is case sensitive and appears as asterisks on the screen.

To access Privileged Exec mode:

1. At the prompt, type **enable** and press Enter.

```
host1>enable
Password:
```

2. At the password prompt, type your password and press Enter.

```
Password:*****
host1#
```



NOTE: The > character in the command-line prompt changes to the # character.

host1# ?	
baseline	Set a baseline for statistics
clear	Clear a state
clock	Set the system's clock
configure	Enter Global Configuration mode
copy	Copy files
debug	Configure debugging functions
default	Set a command to its default(s)
delete	Delete a local file
dir	Display a list of local files
disable	Reduce the command privilege level
disconnect	Disconnect remote CLI session

enable	Enable access to privileged commands
exit	Exit from the current command mode
flash-disk	Perform flash disk operations
halt	Halt the system in preparation for power down
help	Describe the interactive help system
ip	Configure IP attributes on an interface
ipv6	Configure IPv6 attributes
l2tp	L2TP operations
log	Configure logging settings
logout	Logout PPP Subscribers
macro	Run a CLI macro
more	Display contents of a file
mpls	Execute MPLS commands
mtrace	Trace the path that packets will traverse from source
to	destination for a given group
no	Negate a command or set its default(s)
ping	Send echo request to remote host
pppoe	Set PPPoE information
profile-reassign	Perform profile reassignment
redundancy	Perform a redundancy action
reload	Halt and perform a cold restart
rename	Rename a local file
send	Send a message to specified lines
show	Display system information
sleep	Make the Command Interface pause for a specified
duration	
srp	Perform SRP operations
synchronize	Manually synchronize redundant system controller file
system	
telnet	Access a remote system via telnet
terminal	Configure the terminal line settings
test	Test the outcome of a command
traceroute	Trace the path that packets traverse to their
destination	
undebg	Disable debug logging functions
virtual-router	Specify a virtual router
write	Write the system's running configuration to a
destination	

In addition, you can execute a script file (.scr), which is simply a file containing a sequence of CLI commands, through the **configure** command.

Global Configuration Mode

Within Global Configuration mode, you can:

- Apply features globally to a router.
- Enable a feature or function.
- Disable a feature or function.
- Configure a feature or function.
- Access all Configuration modes.

To access Global Configuration mode, you begin in Privileged Exec mode. Type **configure terminal** and press Enter.

```
host1#configure terminal
Enter configuration commands, one per line. End with ^Z.
host1(config)#
```

The system is now in Global Configuration mode.

Executing a Script File

To execute a script file:

1. From Privileged Exec mode, type **configure** and the filename you want to execute, and press Enter.

```
host1#configure file
File name:/myFile.scr
Proceed with configure? [confirm]
```



NOTE: The filename must end with an .scr extension, and the file must contain a series of valid CLI commands. The file can be a local file on the router or a remote file on a host system.

2. Press y or Enter to confirm; pressing any other key aborts the procedure.

```
host1#
```

For more information, see the section “Managing Files” on page 270 in “Managing the System” on page 235.

AAA Profile Configuration Mode

From this mode, you can restrict or allow the use of domain names, translate an original domain name to a new domain name, or create domain name aliases.

From Global Configuration mode, type the **aaa profile** command and a *profileName*, and then press Enter.

```
host1(config)#aaa profile charlie
host1(config-aaa-profile)#?
allow      Configure the authorization domain name
default    Set a command to its default(s)
deny       Configure the authorization domain name
do         Run an exec mode command (alias command run)
exit       Exit from the current command mode
help       Describe the interactive help system
log        Configure logging settings
macro      Run a CLI macro
no         Negate a command or set its default(s)
run        Run an exec mode command (alias command do)
```

`sleep` Make the Command Interface pause for a specified duration
`translate` Configure the translation map for domain name

Address Family Configuration Mode

From this mode, you can configure address family parameters for BGP VPN services or RIP VPN services.

From Global Configuration mode, type the **router bgp** command to enter Router Configuration mode for BGP. Type either the **address-family ipv4** or **address-family vpnv4** command, and then press Enter.

```
host1(config)#router bgp 100
host1(config-router)#address-family ?
  ipv4    Configure IPv4 address family
  vpnv4   Configure VPN-IPv4 address family
```

From Global Configuration mode, type the **router rip** command to enter Router Configuration mode for RIP. Type the **address-family ipv4** command, and then press Enter.

```
host1(config)#router rip 100
host1(config-router)#address-family ?
  ipv4    Configure IPv4 address family
```

ATM VC Configuration Mode

In this mode, you can configure individual attributes for an ATM data PVC. These attributes include the service category, encapsulation method, Inverse Address Resolution Protocol (Inverse ARP), and F5 Operation, Administration, and Management (OAM) parameters.

From Global Configuration mode, type the **interface** command and specify the ATM subinterface identifier to enter Subinterface Configuration mode. From Subinterface Configuration mode, type the **pvc** command and specify the virtual circuit descriptor (VCD), virtual path identifier (VPI) and virtual circuit identifier (VCI) values (in the format *vpi/vci*), and then press Enter.

```
host1(config)#interface atm 3/2.1
host1(config-subif)#pvc 100 0/100
host1(config-subif-atm-vc)#?
  cbr          Configure the Constant Bit Rate (CBR) service class
  class-vc     Assign a Virtual Circuit class to the Permanent Virtual
               Circuit
  default      Set a command to its default(s)
  do           Run an exec mode command (alias command run)
  encapsulation Configure the ATM encapsulation
  exit         Exit from the current command mode
  help         Describe the interactive help system
  inarp        Configure the Inverse Address Resolution Protocol (InARP)
               protocol
  log          Configure logging settings
  macro        Run a CLI macro
  no           Negate a command or set its default(s)
```

oam	Configure Operations, Administration, and Management (OAM)
oam-pvc	Configure Operations, Administration, and Management (OAM) for Permanent Virtual Circuit (PVC)
run	Run an exec mode command (alias command do)
sleep	Make the Command Interface pause for a specified duration
ubr	Configure the Unspecified Bit Rate (UBR) service class
vbr-nrt	Configure the Variable Bit Rate Non-Real Time (VBR-nrt) service class
vbr-rt	Configure the Variable Bit Rate Real Time (VBR-rt) service class

ATM VC Class Configuration Mode

In this mode, you can configure a class of attributes for an ATM data PVC. The VC class can include attributes for the service category, encapsulation method, F5 OAM options, and Inverse ARP. You then apply the set of attributes as a group by assigning the VC class to an individual PVC, to all PVCs created on a specified ATM major interface, to all PVCs created on a specified ATM 1483 subinterface, or to a base profile from which bulk-configured VC ranges are dynamically created.

From Global Configuration mode, type the **vc-class atm** command followed by an alphanumeric VC class name of up to 32 characters, and press Enter.

```

host1(config)#vc-class atm premium-subscriber-class
host1(config-vc-class)#?
  cbr          Configure the Constant Bit Rate (CBR) service class
  default      Set a command to its default(s)
  do           Run an exec mode command (alias command run)
  encapsulation Configure the ATM encapsulation
  exit         Exit from the current command mode
  help         Describe the interactive help system
  inarp        Configure the Inverse Address Resolution Protocol (InARP)
               protocol
  log          Configure logging settings
  macro        Run a CLI macro
  no           Negate a command or set its default(s)
  oam          Configure Operations, Administration, and Management (OAM)
  oam-pvc      Configure Operations, Administration, and Management (OAM) for
               Permanent Virtual Circuit (PVC)
  run          Run an exec mode command (alias command do)
  sleep        Make the Command Interface pause for a specified duration
  ubr          Configure the Unspecified Bit Rate (UBR) service class
  vbr-nrt      Configure the Variable Bit Rate Non-Real Time (VBR-nrt)
               service class
  vbr-rt       Configure the Variable Bit Rate Real Time (VBR-rt) service
               class

```

Classifier Group Configuration Mode

In this mode, you can configure the set of rules for a classification group in a policy list that you can attach to an interface.

From Policy List Configuration mode, type the **classifier-group** command and its attributes, and then press Enter.

```

host1(config-policy-list)#classifier-group ipCLACL10 precedence 75
host1(config-policy-list-classifier-group)#?
  color          Create a color policy
  default        Set a command to its default(s)
  do             Run an exec mode command (alias command run)
  exit           Exit from the current command mode
  filter         Create a filter policy
  forward        Create a forward policy
  help           Describe the interactive help system
  log            Configure logging settings
  macro          Run a CLI macro
  mark           Create a set TOS byte policy
  next-hop       Create a next-hop policy
  next-interface Create a next-interface policy
  no             Negate a command or set its default(s)
  rate-limit-profile Create a rate-limit policy
  run            Run an exec mode command (alias command do)
  sleep         Make the Command Interface pause for a specified duration
  suspend        Suspend a policy rule
  traffic-class  Create a traffic class policy
  user-packet-class Create a user packet class policy

```

Color Mark Profile Configuration Mode

In this mode, you can configure translation for a color to a type-dependent mark for TOS or EXP for an IP, IPv6 or MPLS interface.

From Rate Limit Profile Configuration mode, type the **color-mark-profile** command and specify a profileName, and then press Enter.

```

host1(config-rate-limit-profile)# mpls color-mark-profile myprofile
host1(config-color-mark-profile)#?
  default        Set a command to its default(s)
  do             Run an exec mode command (alias command run)
  exit           Exit from the current command mode
  green-mark     Apply TOS mark to IP packets classified Green by the rate limit
                 hierarchy
  help           Describe the interactive help system
  log            Configure logging settings
  macro          Run a CLI macro
  mask-value     Mask for all TOS values applied by the color-mark profile
  no             Negate a command or set its default(s)
  red-mark       Apply TOS mark to IP packets classified Red by the rate limit
                 hierarchy
  run            Run an exec mode command (alias command do)
  sleep         Make the Command Interface pause for a specified duration
  yellow-mark    Apply TOS mark to IP packets classified Yellow by the rate limit
                 hierarchy

```

Control Plane Configuration Mode

In this mode, you can configure policing for a specific protocol.

From Global Configuration mode, type the **control-plane** command and press Enter.

```

host1(config)#control-plane
host1(config-control-plane)#?
  default  Set a command to its default(s)
  do       Run an exec mode command (alias command run)
  exit     Exit from the current command mode
  help     Describe the interactive help system
  log      Configure logging settings
  macro    Run a CLI macro
  no       Negate a command or set its default(s)
  policer  Configure policing
  run      Run an exec mode command (alias command do)
  sleep    Make the Command Interface pause for a specified duration

```

Controller Configuration Mode

You can configure physical interfaces such as a T3 in Controller Configuration mode.

From Global Configuration mode, type the appropriate **controller** command and its attributes, and then press Enter.

```

host1(config)#controller t3 9/1
host1(config-controller)#
host1(config)#controller ?
  e1      Configure a channelized E1 controller
  e3      Configure a E3 controller
  sonet   Configure a Sonet controller
  t1      Configure a channelized T1 controller
  t3      Configure a T3 controller

```

DHCP Local Pool Configuration Mode

In this mode, you can configure DHCP local pools. For example, you can specify a DNS or NetBIOS server.

From Global Configuration mode, type the command **ip dhcp-local pool** and a *poolName*, and then press Enter.

```

host1(config)#ip dhcp-local pool charlie
host1(config-dhcp-local)#?
  default          Set a command to its default(s)
  default-router   The default-router to use for this pool
  dns-server       The dns-server to use for this pool
  do               Run an exec mode command (alias command run)
  domain-name      The domain name for the pool
  exit             Exit from the current command mode
  grace-period     The grace period to be applied to leases
  help             Describe the interactive help system
  lease            The lease time for addresses from this pool
  link             Link to another DHCP Pool
  log              Configure logging settings
  macro            Run a CLI macro
  netbios-name-server The netbios-name-server to use for this pool
  netbios-node-type The netbios-node-type to use for this pool
  network          The network specified for this pool
  no               Negate a command or set its default(s)
  reserve          Reserve an ip address for a specific Mac Address

```

run	Run an exec mode command (alias command do)
server-address	The DHCP Server address to send to clients
sleep	Make the Command Interface pause for a specified duration
snmpTrap	Enable snmp pool utilization traps
use-release-grace-period	Apply the grace period to released leases
warning	Configure utilization warnings

Domain Map Configuration Mode

In this mode, you can map a user domain name to a virtual router and loopback interface.

From Global Configuration mode, type the **aaa domain-map** command and the domain name value as found in the client's login name. Then press Enter.

```

host1(config)#aaa domain-map charlie76
host1(config-domain-map)#?
  address-pool-name  Configure the address-pool-name for the domain name
  atm               Configure ATM parameters
  default           Set a command to its default(s)
  do                Run an exec mode command (alias command run)
  exit              Exit from the current command mode
  help              Describe the interactive help system
  ip-hint           Configure the IP hint feature for the domain
  local-interface   Configure the local interface value for remote clients
  log               Configure logging settings
  loopback          Configure the loopback interface to use when RX has an
                    unnumbered interface to the PPP client
  macro             Run a CLI macro
  no                Negate a command or set its default(s)
  override-user     Configure the username and password values to use instead
                    of the values from the remote client
  padn              Configure pppoe active discovery network parameters for
                    the domain name
  router-name       Configure the virtual-router for the domain name
  run               Run an exec mode command (alias command do)
  sleep             Make the Command Interface pause for a specified duration
  strip-domain      Configure the domain name stripping feature for the domain
  tunnel            Configure tunnel tag
  virtual-router    Configure the virtual-router for the domain name

```

Domain Map Tunnel Configuration Mode

In this mode, you can configure tunnel parameters such as the tunnel's endpoint.

From Domain-Map Configuration mode, type **tunnel** and a *tunnelNumber*, and press Enter.

```

host1(config-domain-map)#tunnel 17
host1(config-domain-map-tunnel)#?
  address           Configure tunnel endpoint address
  client-name       Configure the client hostname of the tunnel
  default           Set a command to its default(s)
  exit              Exit from the current command mode
  do                Run an exec mode command (alias command run)

```

help	Describe the interactive help system
hostname	Configure the client hostname of the tunnel
identification	Configure tunnel identification
log	Configure logging settings
macro	Run a CLI macro
max-sessions	Configure maximum sessions for this tunnel
medium	Configure tunnel medium
no	Negate a command or set its default(s)
password	Configure tunnel password
preference	Configure tunnel preference
run	Run an exec mode command (alias command do)
server-name	Configure the remote hostname for the tunnel
sleep	Make the Command Interface pause for a specified duration
source-address	Configure tunnel source address
type	Configure tunnel type

DoS Protection Group Configuration Mode

In this mode, you can configure parameters for Denial of Service (DoS) protection groups.

From Global Configuration mode, type the `dos-protection-group` command and press Enter.

```
host1(config)#dos-protection-group
host1(config-dos-protection)#?
default  Set a command to its default(s)
do       Run an exec mode command (alias command run)
exit     Exit from the current command mode
help     Describe the interactive help system
log      Configure logging settings
macro    Run a CLI macro
no       Negate a command or set its default(s)
priority Specify the priority
protocol Specify the protocol
run      Run an exec mode command (alias command do)
sleep    Make the Command Interface pause for a specified duration
use      Configure usagehost1(config-dos-protection-group)#?
```

Drop Profile Configuration Mode

In this mode, you can configure drop profiles for QoS. Drop profiles control RED dropping behavior.

From Global Configuration mode, type the `drop-profile` command, and press Enter.

```
host1(config)#drop profile
host1(config-drop-profile)#?
average-length-exponent  Select TAQL coefficient
committed-threshold      Specify committed queue thresholds and maximum drop
                           probability
conformed-threshold       Specify conformed queue thresholds and maximum drop
                           probability
default                  Set a command to its default(s)
do                       Run an exec mode command (alias command run)
exceeded-threshold        Specify exceeded queue thresholds and maximum drop
```

	probability
exit	Exit from the current command mode
help	Describe the interactive help system
log	Configure logging settings
macro	Run a CLI macro
no	Negate a command or set its default(s)
run	Run an exec mode command (alias command do)
sleep	Make the Command Interface pause for a specified duration

Explicit Path Configuration Mode

From this mode, you can name and configure an explicit path within MPLS.

From Global Configuration mode, type `mpls explicit-path name` and the *explicitPathName*, and press Enter.

```

host1(config)#mpls explicit-path name xyz
host1(config-exp1-path)#?
  append-after  Add an entry after a specified index
  default       Set a command to its default(s)
  do            Run an exec mode command (alias command run)
  exit          Exit from the current command mode
  help          Describe the interactive help system
  index         Specify the index of the entry to be added or edited
  list          List part or all of the entries in current explicit path
  log           Configure logging settings
  macro         Run a CLI macro
  next-address  Configure an IP address at the last hop of the explicit path
  no            Negate a command or set its default(s)
  run           Run an exec mode command (alias command do)
  sleep        Make the Command Interface pause for a specified duration

```

Flow Cache Configuration Mode

In this mode, you can configure parameters for the aggregation cache.

From Global Configuration mode, type the `ip flow-aggregation cache` command and press Enter.

```

host1(config)#ip flow-aggregation cache
host1(config-flow-cache)#?
  cache         Configure Flow Stats cache parameters
  default       Set a command to its default(s)
  do            Run an exec mode command (alias command run)
  enabled       Start flow cache operation
  exit          Exit from the current command mode
  export        Configure Flow-Cache export parameters
  help          Describe the interactive help system
  log           Configure logging settings
  macro         Run a CLI macro
  no            Negate a command or set its default(s)
  run           Run an exec mode command (alias command do)
  sleep        Make the Command Interface pause for a specified duration

```


Interface Configuration Mode

From Interface Configuration mode, you can enable many system features for each interface you create. Interface Configuration commands allow you to:

- Create an interface.
- Modify the operation of an interface.
- Access Subinterface Configuration mode.

From Global Configuration mode, type **interface** and identify the interface you want to configure and press Enter.

```
host1(config)#interface atm 0/1
host1(config-if)#
```

The CLI is now in Interface Configuration mode.

```
host1(config)#interface ?
atm          ATM interface
fastEthernet IEEE 802.3 fastEthernet interface
gigabitEthernet IEEE 802.3 gigabitEthernet interface
hssi         High Speed Serial interface
ip           Ip shared interface
ipv6         Ipv6 shared interface
lag          Link Aggregation interface
loopback     Loopback interface
mlframe-relay Multilink frame-relay interface
mlppp        Multilink PPP interface
null         Null interface
pos          Packet over SONET interface
serial       Serial interface
tunnel       Tunnel interface
```

Some Interface Configuration commands can affect general interface parameters, such as bandwidth and clock rate. For interface-specific commands, such as commands for ATM interfaces, see the appropriate chapter in this documentation set.



NOTE: Although it appears in the list of configurable interfaces, you cannot configure any values on a null interface. For information about using the null interface, see *JUNOS IP Services Configuration Guide*.

IP NAT Pool Configuration Mode

In this mode, you can specify the information that the system uses in creating IP Network Address Translation (NAT) pools. From Global Configuration mode, type **ip nat pool multiplerange prefix-length** and press Enter.

```
host1(config)#ip nat pool multiplerange prefix-length 30
host1(config-ipnat-pool)#?
address  Configure address ranges
default  Set a command to its default(s)
```

```

do      Run an exec mode command (alias command run)
exit    Exit from the current command mode
help    Describe the interactive help system
log     Configure logging settings
macro   Run a CLI macro
no      Negate a command or set its default(s)
run     Run an exec mode command (alias command do)
sleep   Make the Command Interface pause for a specified duration

```

IP PIM Data MDT Configuration Mode

In this mode, you can specify parameters for data MDTs.

From Global Configuration mode, type `ip pim data-mdt`, and press Enter:

```

host1:pe1:pe13(config)#ip pim data-mdt
host1:western:eastern(config-ip-pim-data-mdt)#?
default      Set a command to its default(s)
do           Run an exec mode command (alias command run)
exit         Exit from the current command mode
help         Describe the interactive help system
log          Configure logging settings
macro        Run a CLI macro
mdt-data-delay  Configure MDT_DATA_DELAY timeout
mdt-data-holdown  Configure MDT_DATA_HOLDOWN timeout
mdt-data-timeout  Configure MDT_DATA_TIMEOUT
mdt-interval   Configure MDT_INTERVAL timer
no           Negate a command or set its default(s)
route-map     Configure route-map
run          Run an exec mode command (alias command do)
sleep        Make the Command Interface pause for a specified duration
tunnel        Configure tunnel parameters

```

IP Service Profile Configuration Mode

In this mode, you can specify the information that the system uses in creating IP service profiles.

From Global Configuration mode, type `ip service-profile` and the service profile name, and press Enter.

```

host1(config)#ip service-profile radius
host1(config-service-profile)#?
default      Set a command to its default(s)
do           Run an exec mode command (alias command run)
domain       Configure a username domain
exit         Exit from the current command mode
help         Describe the interactive help system
include      Configure an attribute to be included in a username
log          Configure logging settings
macro        Run a CLI macro
no           Negate a command or set its default(s)
password     Configure a user password
run          Run an exec mode command (alias command do)
sleep        Make the Command Interface pause for a specified duration

```

```

user-name      Configure a user name
user-prefix    Configure a username prefix

```

IPSec CA Identity Configuration Mode

In this mode, you can specify the information that the system uses in online certificate requests and during negotiations with its peers.

From Global Configuration mode, type **ipsec ca identity**, and press Enter.

```

host1(config)#ipsec ca identity
host1(config-ca-identity)#?
  crl          Certificate Revocation List checking
  default      Set a command to its default(s)
  do           Run an exec mode command (alias command run)
  enrollment    Configure enrollment parameters
  exit         Exit from the current command mode
  help         Describe the interactive help system
  issuer-identifier issuer identifier
  log          Configure logging settings
  macro        Run a CLI macro
  no           Negate a command or set its default(s)
  root         Specify root proxy
  run          Run an exec mode command (alias command do)
  sleep        Make the Command Interface pause for a specified

```

IPSec Identity Configuration Mode

In this mode, you can specify the information that the system uses in offline certificate requests and during negotiations with its peers.

From Global Configuration mode, type **ipsec identity**, and press Enter.

```

host1(config)#ipsec identity
host1(config-ipsec-identity)#?
  common-name  Common Name
  country      Country name
  default      Set a command to its default(s)
  do           Run an exec mode command (alias command run)
  domain-name  Domain name
  exit         Exit from the current command mode
  help         Describe the interactive help system
  log          Configure logging settings
  macro        Run a CLI macro
  no           Negate a command or set its default(s)
  organization Organization name
  sleep        Make the Command Interface pause for a specified duration

```

IPSec IKE Policy Configuration Mode

In this mode, you can create an IKE policy, which is used during IKE phase 1 negotiation.

From the Global Configuration mode, type **ipsec ike-policy-rule** and the *policyNumber*, and press Enter.

```

host1(config)#ipsec ike-policy-rule 10
host1(config-ike-policy)#?
  aggressive-mode  Allows aggressive mode negotiation for the tunnel
  authentication   Configure the authentication method
  default          Set a command to its default(s)
  do              Run an exec mode command (alias command run)
  encryption       Configure the encryption algorithm within an IKE policy
  exit            Exit from the current command mode
  group            Configure the Diffie-Hellman group identifier
  hash            Configure the hash algorithm within an IKE policy
  help            Describe the interactive help system
  lifetime         Configure the time an SA will live before expiration
  log             Configure logging settings
  macro           Run a CLI macro
  no              Negate a command or set its default(s)
  run             Run an exec mode command (alias command do)
  sleep           Make the Command Interface pause for a specified duration

```

IPSec Manual Key Configuration Mode

In this mode, you can enter the manual key that a peer uses for authentication during the tunnel establishment phase.

From the Global Configuration mode, type **ipsec key manual pre-share** and the *peerIPAddress*, and press Enter.

```

host1(config)#ipsec key manual pre-share 10.10.1.1
host1(config-manual-key)#?
  default          Set a command to its default(s)
  do              Run an exec mode command (alias command run)
  exit            Exit from the current command mode
  help            Describe the interactive help system
  key             Manually specify a key
  log             Configure logging settings
  macro           Run a CLI macro
  masked-key       Enter a masked key (not for manual entry, show config generates)
  no              Negate a command or set its default(s)
  run             Run an exec mode command (alias command do)
  sleep           Make the Command Interface pause for a specified duration

```

IPSec Peer Public Key Configuration Mode

In this mode, you can configure the ISAKMP/IKE public key that a remote peer uses for RSA authentication during the tunnel establishment phase without the need for a digital certificate.

From Global Configuration mode, type **ipsec key pubkey-chain rsa** and either the IP address or fully qualified domain name of the remote peer, and press Enter.

```

host1(config)#ipsec key pubkey-chain rsa address 192.168.50.5
host1(config-peer-public-key)#?
  default          Set a command to its default(s)
  do              Run an exec mode command (alias command run)
  exit            Exit from the current command mode
  help            Describe the interactive help system

```

key-string	Enter key string
log	Configure logging settings
macro	Run a CLI macro
no	Negate a command or set its default(s)
run	Run an exec mode command (alias command do)
sleep	Make the Command Interface pause for a specified duration

IPSec Transport Profile Configuration Mode

In this mode, you can configure an IP Security (IPSec) transport profile, which is used for Layer 2 Tunneling Protocol (L2TP) over IPSec connections.

From the Global Configuration mode, type **ipsec transport profile**, the *profileName*, **virtual-router** *vrName*, **ip address** *ipAddress*, and press Enter.

```
host1(config)#ipsec transport profile secureL2tp virtual-router default ip address 0.0.0.0
host1(config-ipsec-transport-profile)#?
  application  Configure the application type that is protected by the l2tp
  default      Set a command to its default(s)
  do           Run an exec mode command (alias command run)
  exit         Exit from the current command mode
  help         Describe the interactive help system
  lifetime     Configure the renegotiation time
  local        Configure local endpoint of the transport connection
  log          Configure logging settings
  macro        Run a CLI macro
  no           Negate a command or set its default(s)
  pfs          Configure perfect forward secrecy
  run          Run an exec mode command (alias command do)
  sleep        Make the Command Interface pause for a specified duration
  transform-set Configure the transform set used by ipsec transport profile
```

IPSec Tunnel Profile Configuration Mode

In this mode, you can configure a profile of an IPSec tunnel.

From Global Configuration mode, type **ipsec tunnel profile** and the *profileName*, and press Enter.

```
host1(config)#ipsec tunnel profile profile1
host1(config-ipsec-tunnel-profile)#?
  default      Set a command to its default(s)
  do           Run an exec mode command (alias command run)
  domain-suffix Configure a domain suffix to be appended to users on
               this profile
  exit         Exit from the current command mode
  extended-authentication Configure extended authentication parameters
  help         Describe the interactive help system
  ike          Configure IKE characteristics
  ip           Configure local IP characteristics
  lifetime     Configure the phase 2 life parameters
  local        Configure local characteristics
  log          Configure logging settings
  macro        Run a CLI macro
  max-interfaces Configure the maximum allowed dynamic interface
```

	instantiations
no	Negate a command or set its default(s)
peer	Configure peer characteristics
pfs	Configure the phase 2 perfect forward secrecy
run	Run an exec mode command (alias command do)
sleep	Make the Command Interface pause for a specified duration
transform	Configure the phase 2 transforms allowed on this IPSEC tunnel profile
tunnel	Configure tunnel parameters

IP Tunnel Destination Profile Mode

In this mode, you can specify parameters for GRE or DVMRP dynamic tunnels.

From Global Configuration mode, type **gre destination profile** or **dvmrp destination profile** and the destination profile name, and press Enter.

```

host1(config)#gre destination profile global
host1(config-dest-profile)#?
  default  Set a command to its default(s)
  do       Run an exec mode command (alias command run)
  enable   Enable a tunnel parameter
  exit     Exit from the current command mode
  help     Describe the interactive help system
  log      Configure logging settings
  macro    Run a CLI macro
  no       Negate a command or set its default(s)
  profile  Assign a profile
  run      Run an exec mode command (alias command do)
  sleep    Make the Command Interface pause for a specified duration
  tunnel   Configure a tunnel parameter
host1(config)#dvmrp destination profile global
host1(config-dest-profile)#?
  default  Set a command to its default(s)
  do       Run an exec mode command (alias command run)
  enable   Enable a tunnel parameter
  exit     Exit from the current command mode
  help     Describe the interactive help system
  log      Configure logging settings
  macro    Run a CLI macro
  no       Negate a command or set its default(s)
  profile  Assign a profile
  run      Run an exec mode command (alias command do)
  sleep    Make the Command Interface pause for a specified duration
  tunnel   Configure a tunnel parameter

```

L2 Transport Load-Balancing-Circuit Configuration Mode

In this mode, you can specify a member subinterface for a Martini layer 2 circuit that is associated with a load-balancing group.

From Global Configuration mode, type **mpls l2transport load-balancing-group**, specify a group number and a Martini circuit, and press Enter.

```

host1(config)#mpls l2transport load-balancing-group 100 mpls-relay 10.1.1.1 30
host1(config-l2transport-load-balancing-circuit)#?
  default  Set a command to its default(s)
  do       Run an exec mode command (alias command run)
  exit     Exit from the current command mode
  help     Describe the interactive help system
  log      Configure logging settings
  macro    Run a CLI macro
  member   Configure members of a l2transport load-balancing circuit
  no       Negate a command or set its default(s)
  run      Run an exec mode command (alias command do)
  sleep    Make the Command Interface pause for a specified duration

```

L2TP Destination Profile Configuration Mode

In this mode, you can create the destination profile that defines the location of an L2TP Access Concentrator (LAC) and define the attributes used when an L2TP Network Server (LNS) communicates with an LAC. The destination is necessary to enable an LAC to connect to the LNS.

From Global Configuration mode, type **l2tp destination profile**, the *profileName*, an *ipAddress*, and press Enter.

```

host1(config)#l2tp destination profile augusta ip address 123.45.76.16
host1(config-l2tp-dest-profile)#?
  default  Set a command to its default(s)
  do       Run an exec mode command (alias command run)
  exit     Exit from the current command mode
  help     Describe the interactive help system
  log      Configure logging settings
  macro    Run a CLI macro
  no       Negate a command or set its default(s)
  remote   Configure L2TP remote parameters
  run      Run an exec mode command (alias command do)
  sleep    Make the Command Interface pause for a specified duration

```

L2TP Destination Profile Host Configuration Mode

In this mode, you can set and modify L2TP host profile attributes, such as the proxy Link Control Protocol (LCP), the local hostname, the local IP address, or the interface profile.

From Global Configuration mode, enter L2TP Destination Profile mode (see above), and type **remote host** and a *hostName*, and press Enter.

```

host1(config-l2tp-dest-profile)#remote host george
host1(config-l2tp-dest-profile-host)#?
  default  Set a command to its default(s)
  disable  Disable L2TP parameter for remote host
  do       Run an exec mode command (alias command run)
  enable   Enable L2TP parameter for remote host
  exit     Exit from the current command mode
  help     Describe the interactive help system
  local    Configure L2TP local parameters for remote host
  log      Configure logging settings

```

```

macro      Run a CLI macro
no         Negate a command or set its default(s)
profile    Assign a profile for remote host
run        Run an exec mode command (alias command do)
sleep      Make the Command Interface pause for a specified duration
tunnel     Configure L2TP tunnel parameters for remote host

```

L2TP Tunnel Switch Profile Configuration Mode

In this mode, you can create an L2TP tunnel switch profile, which configures the L2TP tunnel switching behavior for the interfaces to which this profile is assigned. Issue the **avp** command from this mode to define the L2TP tunnel switching behavior for a specified L2TP attribute-value pair (AVP) type.

From Global Configuration mode, type the **l2tp switch-profile** command followed by an alphanumeric profile name of up to 64 characters, and press Enter.

```

host1(config)#l2tp switch-profile concord
host1(config-l2tp-tunnel-switch-profile)#?
avp          Configure AVP behavior
default      Set a command to its default(s)
do           Run an exec mode command (alias command run)
exit         Exit from the current command mode
help         Describe the interactive help system
log          Configure logging settings
macro        Run a CLI macro
no           Negate a command or set its default(s)
run          Run an exec mode command (alias command do)
sleep        Make the Command Interface pause for a specified duration

```

Layer 2 Control Configuration Mode

In this mode, you can define session timeout values and access the L2C Neighbor Configuration mode to specify the L2C neighbor.

From Global Configuration mode, type **l2c** and press Enter.

```

host1(config)#l2c
host1(config-l2c)#?
default      Set a command to its default(s)
do           Run an exec mode command (alias command run)
exit         Exit from the current command mode
help         Describe the interactive help system
log          Configure logging settings
macro        Run a CLI macro
neighbor     Configure l2c neighbor parameters
no           Negate a command or set its default(s)
run          Run an exec mode command (alias command do)
session-timeout Configure the l2c time-out attribute
sleep        Make the Command Interface pause for a specified duration

```

Layer 2 Control Neighbor Configuration Mode

In this mode, you can specify a neighbor ID and the maximum number of branches that the neighbor can have.

From Global Configuration mode, type **neighbor** and press Enter.

```
host1(config-l2c)#neighbor
host1(config-l2c-neighbor)#?
  default      Set a command to its default(s)
  do           Run an exec mode command (alias command run)
  exit         Exit from the current command mode
  help         Describe the interactive help system
  id           Configure neighbor-id associated with neighbor
  log          Configure logging settings
  macro        Run a CLI macro
  max-branches Configure max number of branches for neighbor
  no           Negate a command or set its default(s)
  run          Run an exec mode command (alias command do)
  sleep        Make the Command Interface pause for a specified duration
```

LDP Configuration Mode

In this mode, you can create and configure MPLS Label Distribution Protocol (LDP) profile parameters.

From Global Configuration mode, type `mpls ldp interface profile` and the *profileName*, and press Enter.

```
host1(config)#mpls ldp interface profile shell
host1(config-ldp)#?
  default      Set a command to its default(s)
  do           Run an exec mode command (alias command run)
  exit         Exit from the current command mode
  hello        Configure hello parameters
  help         Describe the interactive help system
  log          Configure logging settings
  macro        Run a CLI macro
  no           Negate a command or set its default(s)
  run          Run an exec mode command (alias command do)
  sleep        Make the Command Interface pause for a specified duration
```

Line Configuration Mode

In this mode, you can modify the operation of a virtual terminal (vty) line.

From Global Configuration mode, type the **line vty** command and either the *lineNumber* or the *rangeOfLineNumbers* you want to configure, and press Enter.



NOTE: The factory default is 5 vty lines. However, you can increase the number of vty lines available by typing the start number and end number of the vty line range. Once you execute the **line vty** command, you will have access to line numbers up to the ending line number.

```
host1(config)#line vty 0 29
host1(config-line)#?
  access-class      Restrict or permit telnet access based on an access list
```

data-character-bits	Set the number of bits per character used by the display
default	Set a command to its default(s)
do	Run an exec mode command (alias command run)
exec-banner	Enable the exec banner
exec-timeout	Set the inactivity timeout
exit	Exit from the current command mode
help	Describe the interactive help system
log	Configure logging settings
login	Require the use of passwords for vty logins
macro	Run a CLI macro
motd-banner	Enable the message of the day banner
no	Negate a command or set its default(s)
password	Configure the password for line access
run	Run an exec mode command (alias command do)
sleep	Make the Command Interface pause for a specified duration
timeout	Specify the login timeout value for the selected line(s)



NOTE: The **privilege** command is available in Line Configuration mode when the user is logged in at privilege level 15. For more information, see “Privileged-Level Access” on page 49 and “CLI Command Privileges” on page 52 .

Local IPSec Transport Profile Configuration

In this mode, you can configure preshared IKE keys for IPSec transport profiles.

From the IPSec Transport Profile Configuration mode, type **local ip address** and the *ipAddress*, and press Enter.

```
host1(config-ipsec-transport-profile)#local ip address 10.10.1.1
host1(config-ipsec-transport-profile-local)#?
  default      Set a command to its default(s)
  do           Run an exec mode command (alias command run)
  exit         Exit from the current command mode
  help        Describe the interactive help system
  log         Configure logging settings
  macro       Run a CLI macro
  no          Negate a command or set its default(s)
  pre-share   Specify pre-shared group key based on local ip address
  pre-share-masked A pre-encrypted key, generated by show config rather than
               interactive
  run         Run an exec mode command (alias command do)
  sleep       Make the Command Interface pause for a specified duration
```

Local User Configuration Mode

In this mode, you can configure parameters for user entries in local user databases.

From the Global Configuration mode, type either **aaa local username** and the *userName* and *databaseName* or **aaa local database** and the *databaseName*. Then press Enter.

```

host1(config)#aaa local username curt38 database westLocal12
host1(config-local-user)#?
  default      Set a command to its default(s)
  do           Run an exec mode command (alias command run)
  exit         Exit from the current command mode
  help        Describe the interactive help system
  ip-address   Specify an IP address for the user
  ip-address-pool Specify an IP address pool for the user
  log         Configure logging settings
  macro       Run a CLI macro
  no          Negate a command or set its default(s)
  operational-virtual-router Specify an operational virtual router for the
                        user
  password    Configure the password
  run        Run an exec mode command (alias command do)
  secret     Configure the secret
  sleep      Make the Command Interface pause for a specified
                        duration
  support    Enter Support mode

```

Map Class Configuration Mode

In this mode, you can specify Frame Relay End-to-End fragmentation and reassembly for a map class. Optionally, you can specify the maximum payload size of a fragment or specify fragmentation only or reassembly only.

From Global Configuration mode, type the **map-class frame-relay** command and the *mapClassName* you want to configure, and press Enter.

```

host1(config)#map-class frame-relay testmapclass
host1(config-map-class)#?
  default      Set a command to its default(s)
  do           Run an exec mode command (alias command run)
  exit        Exit from the current command mode
  frame-relay  Configure frame relay parameters
  help        Describe the interactive help system
  log         Configure logging settings
  macro       Run a CLI macro
  no          Negate a command or set its default(s)
  run        Run an exec mode command (alias command do)
  sleep      Make the Command Interface pause for a specified
                        duration

```

Map List Configuration Mode

In this mode, you can configure map list parameters. In Map List Configuration mode, commands such as **map-list** and **ip atm-vc** are used to configure ATM NBMA interfaces.

From Global Configuration mode, type **map-list** and a *mapListName*, and press Enter.

```

host1(config)#map-list mjt3330
host1(config-map-list)#?
  default      Set a command to its default(s)
  do           Run an exec mode command (alias command run)
  exit        Exit from the current command mode

```

```

help      Describe the interactive help system
ip        Add IP address to the map
log       Configure logging settings
macro     Run a CLI macro
no        Negate a command or set its default(s)
run       Run an exec mode command (alias command do)
sleep     Make the Command Interface pause for a specified duration

```

Parent Group Configuration Mode

In this mode, you can configure a parent group in a hierarchy.

From Global Configuration mode, type the **parent-group** command and specify a *parentGroupName*, and press Enter.

```

host1(config)#parent-group group1
host1(config-parent-group)#?
default      Set a command to its default(s)
do           Run an exec mode command (alias command run)
exit         Exit from the current command mode
help         Describe the interactive help system
log          Configure logging settings
macro        Run a CLI macro
next-parent  Specify the next parent group to call in hierarchy
no           Negate a command or set its default(s)
rate-limit-profile Specify a hierarchical rate limit profile
run          Run an exec mode command (alias command do)
sleep        Make the Command Interface pause for a specified

```

Policy List Configuration Mode

In this mode, you can configure a policy list—that is, a set of rules—that you can attach to an interface. You can modify a policy list and update it wherever the policy list is used in the configuration.

To create a policy list, from Global Configuration mode type **policy-list** command preceded by the type of policy and press Enter. For example,

```
host1(config)#l2tp policy-list routeL2tp100
```



NOTE: If you do not include the type of policy, the system creates an IP policy list.

```

host1(config)#ip policy-list routeForABBCorp
host1(config-policy-list)#?
classifier-group Specify the classifier list
color            Create a color policy
default          Set a command to its default(s)
do              Run an exec mode command
exit            Exit from the current command mode
filter           Create a filter policy
forward          Create a forward policy
help            Describe the interactive help system
log             Configure logging settings

```

macro	Run a CLI macro
mark	Create a set TOS byte policy
next-hop	Create a next-hop policy
next-interface	Create a next-interface policy
no	Negate a command or set its default(s)
rate-limit-profile	Create a rate-limit policy
run	Run an exec mode command (alias command do)
sleep	Make the Command Interface pause for a specified duration
suspend	Suspend a policy rule
traffic-class	Create a traffic class policy
traffic-shape-profile	Create a traffic-shape policy
user-packet-class	Create a user packet class policy

Policy List Parent Group Configuration Mode

In this mode, you can configure a parent group in a hierarchy.

From Policy List Configuration Mode, type the **parent-group** command and specify a *parentGroupName*, and press Enter.

```

host1(config)#policy-list grouppol1
host1(config-policy-list)#parent-group group1
host1(config-policy-list-parent-group)#?
  default      Set a command to its default(s)
  do           Run an exec mode command (alias command run)
  exit         Exit from the current command mode
  help        Describe the interactive help system
  log         Configure logging settings
  macro       Run a CLI macro
  no          Negate a command or set its default(s)
  rate-limit-profile Specify the hierarchical rate limit profile
  run         Run an exec mode command (alias command do)
  sleep       Make the Command Interface pause for a specified

```

Policy Parameter Configuration Mode

In this mode, you can configure a policy parameter.

From Global Configuration mode, type the **policy-parameter** command and specify a *policyParameterType*, the **hierarchical** keyword, and press Enter.

```

host1(config)#policy-parameter param1 hierarchical
host1(config-policy-parameter)#?
  aggregation-node Configure the aggregation node value
  default         Set a command to its default(s)
  do             Run an exec mode command (alias command run)
  exit           Exit from the current command mode
  help          Describe the interactive help system
  log           Configure logging settings
  macro         Run a CLI macro
  no            Negate a command or set its default(s)
  run           Run an exec mode command (alias command do)
  sleep         Make the Command Interface pause for a specified time

```

PPPoE Service Name Table Configuration Mode

In this mode, you can configure entries for a PPPoE service name table. PPPoE clients use these entries to request that an access concentrator (AC), such as an E-series router, support certain services. Issue the **service** command from this mode to configure a specific service name entry, or to specify that the AC should ignore (drop), rather than respond to (terminate, the default action), a PPPoE Active Discovery Initiation (PADI) request from a client containing the empty service name tag.

From Global Configuration mode, type the **pppoe-service-name-table** command followed by an alphanumeric table name of up to 32 characters, and press Enter.

```
host1(config)#pppoe-service-name-table serviceTable1
host1(config-pppoe-service-name-table)#?
  default  Set a command to its default(s)
  do       Run an exec mode command (alias command run)
  exit     Exit from the current command mode
  help     Describe the interactive help system
  log      Configure logging settings
  macro    Run a CLI macro
  no       Negate a command or set its default(s)
  run      Run an exec mode command (alias command do)
  service  Configure service-name table entries
  sleep    Make the Command Interface pause for a specified duration
```

Profile Configuration Mode

In this mode, you can configure a profile to subsequently configure dynamic IP interfaces.

From Global Configuration mode, type the **profile** command followed by a profile name of up to 80 characters, and press Enter.

```
host1(config)#profile germany78
host1(config-profile)#?
  default  Set a command to its default(s)
  do       Run an exec mode command (alias command run)
  exit     Exit from the current command mode
  help     Describe the interactive help system
  ip       Configure IP characteristics
  l2tp     Configure L2TP characteristics
  log      Configure logging settings
  macro    Run a CLI macro
  no       Negate a command or set its default(s)
  ppp      Configure PPP parameters
  pppoe    Pppoe information
  run      Run an exec mode command (alias command do)
  sleep    Make the Command Interface pause for a specified duration
```

QoS Interface Set Configuration Mode

In this mode, you can configure QoS interface sets.

From Global Configuration mode, type the **qos-interface-set** command followed by an *interfaceSetName*, and press Enter.

```

host1(config)#qos-interface-set video
host1(config-interface-set)#?
default          Set a command to its default(s)
do               Run an exec mode command (alias command run)
exit             Exit from the current command mode
help            Describe the interactive help system
log             Configure logging settings
macro           Run a CLI macro
member-interface-type Define the member interface type of the interface set
no              Negate a command or set its default(s)
qos-interface-parent Select a QoS interface super set as the parent of this
                  interface.
qos-parameter    Instantiate a QoS parameter for this interface
qos-profile      Attach/Detach a qos-profile
restricted       Define restricted interface
run             Run an exec mode command (alias command do)
sleep           Make the Command Interface pause for a specified
                  duration

```

QoS Interface Superset Configuration Mode

In this mode, you can can configure QoS interface supersets.

From Global Configuration mode, type the **qos-interface-superset** command followed by an *interfaceSupersetName*, and press Enter.

```

host1(config)#qos-interface-superet voice
host1(config-interface-set)#?
default          Set a command to its default(s)
do               Run an exec mode command (alias command run)
exit             Exit from the current command mode
help            Describe the interactive help system
log             Configure logging settings
macro           Run a CLI macro
no              Negate a command or set its default(s)
qos-interface-parent Define parent of the interface set
qos-parameter    Instantiate a QoS parameter for this interface
qos-profile      Attach/Detach a qos-profile
restricted       Define restricted interface
run             Run an exec mode command (alias command do)
sleep           Make the Command Interface pause for a specified
                  duration

```

QoS Parameter Definition Configuration Mode

In this mode, you can configure QoS parameter definitions.

From Global Configuration mode, type the **qos-parameter-define** command followed by a *QosParameterDefinitionName*, and press Enter.

```

host1(config)#qos-parameter-define vpSharedShaper1
host1(config-qos-parameter-define)#?
  controlled-interface-type Configure the valid interface types controlled by
                           this parameter
  default                  Set a command to its default(s)
  do                      Run an exec mode command (alias command run)

```

exit	Exit from the current command mode
help	Describe the interactive help system
instance-interface-type	Configure the interface types upon which parameters can be instantiated
log	Configure logging settings
macro	Run a CLI macro
no	Negate a command or set its default(s)
range	Set the valid range of a QoS parameter
run	Run an exec mode command (alias command do)
sleep	Make the Command Interface pause for a specified duration
subscriber-interface-type	Configure interface types representing subscriber interfaces

QoS Profile Configuration Mode

In this mode, you can specify queue profiles and scheduler profiles in combination with interface types.

From Global Configuration mode, type the **qos-profile** command followed by a *QosProfileName*, and press Enter.

```

host1(config)#qos-profile testabc
host1(config-qos-profile)#?
atm          ATM interface
  atm-vc      ATM-VC interface
  bridge      Bridge interface
  default     Set a command to its default(s)
  do          Run an exec mode command (alias command run)
  ethernet    Ethernet interface
  exit        Exit from the current command mode
  fr-vc       Frame Relay subinterface
  help        Describe the interactive help system
  ip          IP interface
  ip-tunnel   IP FROM-tunnel interface
  l2tp-tunnel L2tp FROM-tunnel interface
  log         Configure logging settings
  lsp         Lsp (MPLS) interface
  macro       Run a CLI macro
  no          Negate a command or set its default(s)
  run         Run an exec mode command (alias command do)
  serial      Serial interface
  server-port Server Port interface
  sleep       Make the Command Interface pause for a specified duration
  svlan       Stacked VLAN subinterface
  vlan        VLAN subinterface

```

QoS Shared Shaper Control Configuration

In this mode, you can configure variables within the simple shared shaper algorithm to control the minimum dynamic rate for all simple shared shapers on the router.

From Global Configuration mode, type the **qos-shared-shaper-control** command and press Enter.


```

host1(config)#qos-shared-shaper-control
host1(config-qos-shared-shaper-control)#?
  convergence-factor      Configure how quickly the simple shared shaper
                           converges to a calculated rate
  default                 Set a command to its default(s)
  do                      Run an exec mode command (alias command run)
  exit                    Exit from the current command mode
  help                    Describe the interactive help system
  log                     Configure logging settings
  macro                   Run a CLI macro
  maximum-voql            Configure the simple shared shaper's maximum
                           virtual output queue length
  minimum-dynamic-rate-percent
                           Configure the minimum dynamic rate for a simple
                           shared shaper as a percentage of the
                           shared-shaping-rate
  no                      Negate a command or set its default(s)
  reaction-factor         Configure how the simple shared shaper reacts
                           to changes in measured rate
  run                     Run an exec mode command (alias command do)
  sleep                   Make the Command Interface pause for a
                           specified duration

```

Queue Profile Configuration Mode

In this mode, you can configure queue profiles and various queue profile parameters, such as constraints on queue lengths or queue buffer weights.

From Global Configuration mode, type the **queue-profile** command followed by a *queueProfileName*, and press Enter.

```

host1(config)#queue-profile testabcd1234
host1(config-queue)#?
  buffer-weight           Set drop threshold in proportion to this weight
  committed-length        Set min and max constraints for committed threshold
  conformed-fraction      Set conformed threshold as a percentage of committed
  conformed-length        Set min and max constraints for conformed threshold
  default                 Set a command to its default(s)
  do                      Run an exec mode command (alias command run)
  exceeded-fraction        Set exceeded threshold as a percentage of committed
  exceeded-length         Set min and max constraints for exceeded threshold
  exit                    Exit from the current command mode
  help                    Describe the interactive help system
  log                     Configure logging settings
  macro                   Run a CLI macro
  no                      Negate a command or set its default(s)
  run                     Run an exec mode command (alias command do)
  sleep                   Make the Command Interface pause for a specified duration

```

RADIUS Configuration Mode

In this mode, you can configure various parameters of your RADIUS authentication, accounting, and dynamic-request servers.

From Global Configuration mode, type either the **radius authentication server**, **radius accounting server**, or **radius dynamic-request server** command with the server *ipAddress*, and press Enter.

```

host1(config)#radius authentication server 1.2.1.3
host1(config-radius)#?
  deadtime      Configure the amount of time a timed-out server is dropped for usage
  default       Set a command to its default(s)
  do            Run an exec mode command (alias command run)
  exit          Exit from the current command mode
  help          Describe the interactive help system
  key           Configure the secret used in RADIUS client to server exchange
  log           Configure logging settings
  macro         Run a CLI macro
  max-sessions  Configure the number of outstanding requests allowed to the server
  no            Negate a command or set its default(s)
  retransmit    Configure the number of times to retransmit RADIUS request
                before failing
  run           Run an exec mode command (alias command do)
  sleep         Make the Command Interface pause for a specified duration
  timeout       Configure the number of seconds to wait for a RADIUS response
                before retransmitting
  udp-port      Configure the RADIUS server's UDP port

```

RADIUS Relay Configuration Mode

In this mode, you can configure various parameters of your RADIUS relay authentication and accounting servers.

From Global Configuration mode, type either the **radius relay authentication server** or **radius relay accounting server** command, and press Enter.

```

host1(config)#radius authentication server
radius authentication serverhost1(config-radius-relay)#?
  default      Set a command to its default(s)
  do           Run an exec mode command (alias command run)
  exit         Exit from the current command mode
  help         Describe the interactive help system
  key          Configure the secret used in RADIUS client to relay server exchange
  log          Configure logging settings
  macro        Run a CLI macro
  no           Negate a command or set its default(s)
  run          Run an exec mode command (alias command do)
  sleep        Make the Command Interface pause for a specified duration
  udp-port     Configure the RADIUS relay server's udp port

```

Rate Limit Profile Configuration Mode

In this mode, you can set parameters for an IP or L2TP rate-limit profile, which is a set of bandwidth attributes and associated actions that become part of a policy list. The policy list is then applied to the ingress or egress of an interface.

To create a hierarchical rate-limit-profile for an IP interface, from Global Configuration mode type **rate-limit-profile** and a *profileName*, and add the keyword hierarchical, and press Enter.

To create an IP rate-limit profile, from Global Configuration mode type **ip rate-limit-profile** and a *profileName*, and press Enter.

To create an L2TP rate limit profile, from Global Configuration mode type **l2tp rate-limit-profile** and a *profileName*, and press Enter.



NOTE: If you do not include either the **ip** or **l2tp** keywords, the system creates an IP rate limit profile.

```
host1(config)#ip rate-limit-profile fm78930
host1(config-rate-limit-profile)#?
committed-action  Set the committed access rate action
committed-burst   Set the committed access rate burst size in Bytes
committed-rate    Set the committed access rate value in bits per second
conformed-action  Set the conformed access rate action
default           Set a command to its default(s)
do               Run an exec mode command (alias command run)
exceeded-action   Set the exceeded action
exit             Exit from the current command mode
help             Describe the interactive help system
log              Configure logging settings
macro            Run a CLI macro
mask-val         Set mask to be applied with mark values
no              Negate a command or set its default(s)
peak-burst       Set the peak burst size in Bytes
peak-rate        Set the peak access rate in bits per second
run              Run an exec mode command (alias command do)
sleep            Make the Command Interface pause for a specified duration
```

Redundancy Configuration Mode

In this mode, you can activate high availability (SRP switchover) by issuing the mode high-availability command.

From Global Configuration mode, type the **redundancy** command and press Enter.

```
host1(config-router)#redundancy
host1(config-redundancy)#?
default  Set a command to its default(s)
do       Run an exec mode command (alias command run)
exit     Exit from the current command mode
help     Describe the interactive help system
log      Configure logging settings
macro    Run a CLI macro
mode     Configure redundancy mode
no       Negate a command or set its default(s)
run      Run an exec mode command (alias command do)
sleep    Make the Command Interface pause for a specified duration
```

Remote Neighbor Configuration Mode

In this mode, you can configure remote neighbor parameters for Routing Information Protocol (RIP), Protocol Independent Multicast (PIM), and Open Shortest Path First (OSPF).

From Global Configuration mode, type either **router rip**, **router pim**, or **router ospf** and the *processID*. Press Enter. You are now in Router Configuration mode.

From Router Configuration mode, type the **remote-neighbor** command and the appropriate attributes, and press Enter.

```
host1(config-router)#remote-neighbor 10.13.5.61
host1(config-router-rn)#?
authentication      Configure authentication
default             Set a command to its default(s)
distribute-list     Specify an access list to be a distribute list
do                 Run an exec mode command (alias command run)
exit               Exit from the current command mode
exit-remote-neighbor Exit the remote-neighbor configuration mode
help               Describe the interactive help system
log                Configure logging settings
macro              Run a CLI macro
no                 Negate a command or set its default(s)
receive            Set reception characteristics
route-map           Specify a route map to apply to outgoing routes
run                Run an exec mode command (alias command do)
send               Set transmit characteristics
sleep              Make the Command Interface pause for a specified
                  duration
split-horizon       Enable Split-horizon
time-to-live        Configure ttl used to send to this neighbor
update-source       Source address to be used for transmit
```

Route Map Configuration Mode

In this mode, you can create and modify route maps.

From Global Configuration mode, type the **route-map** command and the appropriate *routeMapNumber*, and press Enter.

```
host1(config)#route-map unis889
host1(config-route-map)#?
default             Set a command to its default(s)
do                 Run an exec mode command (alias command run)
exit               Exit from the current command mode
help               Describe the interactive help system
log                Configure logging settings
macro              Run a CLI macro
match              Identify this entry as requiring an attribute match
match-set           Identify this entry to match and set attributes
no                 Negate a command or set its default(s)
run                Run an exec mode command (alias command do)
set                Configure this entry to set attributes
sleep              Make the Command Interface pause for a specified duration
```

Router Configuration Mode

In this mode, you can configure a routing protocol using router commands.

From Global Configuration mode, type the **router** command and the appropriate router attributes, and press Enter.

```

host1(config)#router bgp 2378
host1(config-router)#?
  address-family      Enter address family configuration mode
  aggregate-address    Create an aggregate entry in BGP routing table
  auto-summary         Automatic summarization of redistributed routes
                        to their natural network masks
  bgp                  Configure BGP
  default              Set a command to its default(s)
  default-fields        Set default fields for show commands
  default-information   Configure the distribution of default routing
                        information
  disable-dynamic-redistribute  disable dynamic importing of routing
                        information with the latest policy
  distance             Configure administrative distances for routes
  do                   Run an exec mode command (alias command run)
  exit                 Exit from the current command mode
  help                 Describe the interactive help system
  ip                   Configure the type of route to be contributed
                        by this BGP address family
  limits               Configure limits on internal BGP tables
  log                  Configure logging settings
  macro                Run a CLI macro
  maximum-paths         Configure the maximum number of equal-cost paths
  neighbor              Specify neighbor properties
  network              Identify a network for BGP to announce
  no                   Negate a command or set its defaults
  overload              Configure BGP behaviour when reaching overload
                        state (no more resources available)
  redistribute          Configure the redistribution of routing
                        information from another protocol
  rib-out              Configure rib-out storage for all BGP peers
  run                  Run an exec mode command (alias command do)
  sleep                Make the Command Interface pause for a
                        specified duration
  synchronization      Enable synchronization with the IGP
  table-map             Specify a table map to map external entry
                        attributes into routing table
  timers                Configure the keep-alive interval and the hold-time

```

RSVP Configuration Mode

In this mode, you can create and configure MPLS Resource Reservation Protocol (RSVP) parameters.

From Global Configuration mode, type **mpls rsvp interface profile** and the *profileName*, and press Enter.

```

host1(config)#mpls rsvp interface profile sprint
host1(config-rsvp)#?
  cleanup-timeout-factor  Configure the timeout factor
  default                 Set a command to its default(s)
  do                      Run an exec mode command (alias command run)
  exit                   Exit from the current command mode
  help                   Describe the interactive help system
  log                    Configure logging settings
  macro                  Run a CLI macro
  no                     Negate a command or set its default(s)

```

refresh-period	Configure refresh period
run	Run an exec mode command (alias command do)
sleep	Make the Command Interface pause for a specified duration

RTR Configuration Mode

In this mode, you can configure Response Time Reporter (RTR) parameters. The RTR feature allows you to monitor your network's performance and its resources by measuring response times and the availability of your network devices.

From Global Configuration mode, type **rtr** and the *mapNumber*, and press Enter.

```
host1(config)#rtr 784078348
host1(config-rtr)#?
  default      Set a command to its default(s)
  do           Run an exec mode command (alias command run)
  exit         Exit from the current command mode
  frequency    Specify the frequency interval
  help         Describe the interactive help system
  hops-of-statistics-kept Specify the hops capture
  log          Configure logging settings
  macro        Run a CLI macro
  max-response-failure Specify the maximum number of consecutive failures
  no           Negate a command or set its default(s)
  operations-per-hop Specify a number of operations per hop
  owner        Specify the owner of entry
  request-data-size Specify the request payload size
  run          Run an exec mode command (alias command do)
  samples-of-history-kept Specify the maximum history samples
  sleep        Make the Command Interface pause for a specified duration
  tag          Specify the user defined tag
  timeout      Specify the operation timeout
  tos          Specify a value for the ToS byte
  type         Specify the type of the entry
```

Scheduler Profile Configuration Mode

In this mode, you can configure a scheduler profile. You can then set the shaping rate value, enable the strict-priority scheduling for the scheduler node, or set the weighted-round-robin (WRR) value of the scheduler node or queue.

From Global Configuration mode, type **scheduler-profile** and the *scheduleProfileName* that you want to create or configure, and press Enter.

```
host1(config)#scheduler-profile A990
host1(config-scheduler-profile)#?
  default      Set a command to its default(s)
  do           Run an exec mode command (alias command run)
  exit         Exit from the current command mode
  help         Describe the interactive help system
  log          Configure logging settings
  macro        Run a CLI macro
  no           Negate a command or set its default(s)
  run          Run an exec mode command (alias command do)
```

shaping-rate	Shape the node or queue to the specified rate
sleep	Make the Command Interface pause for a specified duration
strict-priority	Dequeue strict priority packets ahead of other packets
weight	Set the relative weight of the node or queue

Service Session Profile Configuration Mode

In this mode, you can set and modify Service Manager service session profile attributes, such as time, volume, and statistics.

From Global Configuration mode, type the **service-management service-session-profile** command and the *profileName*, and then press Enter.

```
host1(config)#service-management service-session-profile vodISP1
host1(config-service-session-profile)#?
  default  Set a command to its default(s)
  do       Run an exec mode command (alias command run)
  exit     Exit from the current command mode
  help     Describe the interactive help system
  log      Configure logging settings
  macro    Run a CLI macro
  no       Negate a command or set its default(s)
  run      Run an exec mode command (alias command do)
  sleep    Make the Command Interface pause for a specified duration
  statistics Configure statistics
  time     Configure time
  volume   Configure volume
```

SNMP Event Manager Configuration Mode

In this mode, you can configure certain SNMP triggers for events, what occurs when an event is triggered, resource limits for triggers, and some trap notification options.

From Global Configuration mode, type the **snmp-server management-event** command and then press Enter.

```
host1(config)#snmp-server management-event
host1(config-mgmtevent)#?
  default  Set a command to its default(s)
  do       Run an exec mode command (alias command run)
  event    Specify what happens when an event is triggered
  exit     Exit from the current command mode
  help     Describe the interactive help system
  log      Configure logging settings
  macro    Run a CLI macro
  no       Negate a command or set its default(s)
  resource Specify the resource limits
  run      Run an exec mode command (alias command do)
  sleep    Make the Command Interface pause for a specified duration
  trigger  Specify the conditions that lead to events
```

Statistics Profile Configuration Mode

In this mode, you can configure a statistics profile. You can then set the rate period during which statistics are gathered, enable statistics gathering, and enable the counting of drop and forwarding events.

From Global Configuration mode, type **statistics-profile** and the *statisticsProfileName* that you want to create or configure, and press Enter.

```
host1(config)#statistics-profile statpro-1
host1(config-statistics-profile)#?
  committed-drop-threshold  Set threshold for logging a committed-drop event
  conformed-drop-threshold  Set threshold for logging a conformed-drop event
  default                   Set a command to its default(s)
  do                         Run an exec mode command (alias command run)
  exceeded-drop-threshold   Set threshold for logging an exceeded-drop event
  exit                      Exit from the current command mode
  forwarding-rate-threshold Set threshold for logging a forwarding-rate event
  help                      Describe the interactive help system
  log                       Configure logging settings
  macro                     Run a CLI macro
  no                         Negate a command or set its default(s)
  rate-period               Set the time period for calculating queue rates
  run                       Run an exec mode command (alias command do)
  sleep                     Make the Command Interface pause for a specified
                           duration
```

Subinterface Configuration Mode

In this mode, you can configure one or more virtual interfaces, called *subinterfaces*, on a single physical interface. The system supports this feature with ATM and Frame Relay.

Both ATM and Frame Relay provide permanent virtual circuits (PVCs) that can be grouped under separate subinterfaces configured on a single physical interface. Subinterfaces allow multiple encapsulations for a protocol on a single interface.

From Interface Configuration mode, indicate a subinterface by typing the **interface** command and an *interfaceSpecifier* in *slot/port.subinterface* format, and then press Enter. For example:

```
host1(config-if)#interface atm 3/2.6
host1(config-subif)#
```

Subscriber Policy Configuration Mode

In this mode, you can configure a policy (a set of forwarding and filtering rules) that defines how a subscriber (client) bridge group interface should handle various packet types. After you define the policy, use the **bridge subscriber-policy** command (from Global Configuration mode) to associate the policy with a bridge group interface.

From Global Configuration mode, type the **subscriber-policy** command followed by an alphanumeric policy name of any character length, and press Enter.


```

host1(config)#subscriber-policy client1
host1(config-policy)#?
  arp                Modify arp policy
  broadcast          Modify broadcast policy
  default            Set a command to its default(s)
  do                 Run an exec mode command (alias command run)
  exit              Exit from the current command mode
  help              Describe the interactive help system
  ip                Modify ip policy
  log               Configure logging settings
  macro             Run a CLI macro
  mpls              Modify mpls policy
  multicast          Modify multicast policy
  no                Negate a command or set its default(s)
  pppoe             Modify PPPoE policy
  relearn           Modify relearn policy
  run               Run an exec mode command (alias command do)
  sleep             Make the Command Interface pause for a specified
                    duration
  unicast           Modify user-to-user (Unicast) policy
  unknown-destination Modify unknown destination policy
  unknown-protocol  Modify unknown protocol policy

```

Traffic Class Configuration Mode

In this mode, you can create a traffic class and configure the level of service to packets assigned to the traffic class.

From Global Configuration mode, type the **traffic-class** command followed by a *trafficClassName*, and then press Enter.

```

host1(config)#traffic-class test123
host1(config-traffic-class)#?
  default            Set a command to its default(s)
  do                 Run an exec mode command (alias command run)
  exit              Exit from the current command mode
  fabric-strict-priority Allow packets in this class to be dequeued out of the
                    fabric ahead of other traffic classes
  help              Describe the interactive help system
  log               Configure logging settings
  macro             Run a CLI macro
  no                Negate a command or set its default(s)
  run               Run an exec mode command (alias command do)
  sleep             Make the Command Interface pause for a specified duration

```

Traffic Class Group Configuration Mode

In this mode, you can create and configure traffic-class groups, which can contain multiple traffic classes.

From Global Configuration mode, type the **traffic-class-group** command and a *trafficClassGroupName*, and press Enter.

```

host1(config)#traffic-class-group trafclanameabcd
host1(config-traffic-class-group)#?

```

<code>default</code>	Set a command to its default(s)
<code>do</code>	Run an exec mode command (alias command <code>run</code>)
<code>exit</code>	Exit from the current command mode
<code>help</code>	Describe the interactive help system
<code>log</code>	Configure logging settings
<code>macro</code>	Run a CLI macro
<code>no</code>	Negate a command or set its default(s)
<code>run</code>	Run an exec mode command (alias command <code>do</code>)
<code>sleep</code>	Make the Command Interface pause for a specified duration
<code>traffic-class</code>	Set the traffic class belong to this group

Tunnel Group Configuration Mode

In this mode, you can define up to 31 tunnels for a tunnel group.

From Global Configuration mode, type **aaa tunnel-group** and the *groupName*, and press Enter.

```
host1(config)#aaa tunnel-group storm
host1(config-tunnel-group)#?
default Set a command to its default(s)
do      Run an exec mode command (alias command run)
exit    Exit from the current command mode
help    Describe the interactive help system
log     Configure logging settings
macro   Run a CLI macro
no      Negate a command or set its default(s)
run     Run an exec mode command (alias command do)
sleep   Make the Command Interface pause for a specified duration
tunnel  Configure tunnel tag
```

Tunnel Group Tunnel Configuration Mode

In this mode, you can configure attributes for a tunnel group tunnel.

From Tunnel Group Configuration mode, type **tunnel** and the tag number (in the range 1–31) for the tunnel, and press Enter.

```
host1(config-tunnel-group)#tunnel 1
host1(config-tunnel-group-tunnel)#?
address      Configure tunnel endpoint address
client-name  Configure the client hostname of the tunnel
default     Set a command to its default(s)
do           Run an exec mode command (alias command run)
exit        Exit from the current command mode
help        Describe the interactive help system
identification Configure tunnel identification
log         Configure logging settings
macro       Run a CLI macro
max-sessions Configure maximum sessions for this tunnel
medium      Configure tunnel medium
no          Negate a command or set its default(s)
password    Configure tunnel password
preference  Configure tunnel preference
receive-window Configure the receive window size for this tunnel
router-name Configure the virtual-router for the domain name
```

<code>run</code>	Run an exec mode command (alias command <code>do</code>)
<code>server-name</code>	Configure the remote hostname for the tunnel
<code>sleep</code>	Make the Command Interface pause for a specified duration
<code>source-address</code>	Configure tunnel source address
<code>type</code>	Configure tunnel type

Tunnel Profile Configuration Mode

In this mode, you can create and configure MPLS tunnel profiles.

From Global Configuration mode, type **mpls tunnels profile** and the *profileName*, and press Enter.

```
host1(config)#mpls tunnels profile storm
host1(config-tunnelprofile)#?
default  Set a command to its default(s)
do       Run an exec mode command (alias command run)
exit     Exit from the current command mode
help     Describe the interactive help system
log      Configure logging settings
macro    Run a CLI macro
no       Negate a command or set its default(s)
run      Run an exec mode command (alias command do)
sleep    Make the Command Interface pause for a specified duration
tunnel   Configure tunnel interface parameters
```

Tunnel Server Configuration Mode

In this mode, you can configure (provision) the maximum number of tunnel-service interfaces to be used on a dynamic tunnel-server port.

From Global Configuration mode, type **tunnel-server** and the slot number and port number of the dynamic tunnel-server port, and press Enter.

```
host1(config)#tunnel-server 2/2
host1(config-tunnel-server)#?
default  Set a command to its default(s)
do       Run an exec mode command (alias command run)
exit     Exit from the current command mode
help     Describe the interactive help system
log      Configure logging settings
macro    Run a CLI macro
max-interfaces  Configure maximum number of tunnel-server interfaces for
dynamic server port
no       Negate a command or set its default(s)
run      Run an exec mode command (alias command do)
sleep    Make the Command Interface pause for a specified duration
```

VRF Configuration Mode

In this mode, you can create and configure VRF parameters for BGP/MPLS VPNs.

From Global Configuration mode, type **ip vrf** and the *vrfName*, and press Enter. Confirm the new VRF by pressing Enter.

```

host1(config)#ip vrf yankee
Proceed with new vrf creation? [confirm]
host1(config-vrf)#?
  default      Set a command to its default(s)
  description  Configure VRF specific description
  do           Run an exec mode command (alias command run)
  exit         Exit from the current command mode
  export       Specify VRF export characteristics
  help        Describe the interactive help system
  import       Specify VRF import characteristics
  ip          Configure IP characteristics
  log          Configure logging settings
  macro        Run a CLI macro
  maximum      Specify a maximum limit
  no           Negate a command or set its default(s)
  rd           Specify route distinguisher
  route-target Specify VPN extended community Target
  run          Run an exec mode command (alias command do)
  sleep        Make the Command Interface pause for a specified duration

```

VR Group Configuration Mode

In this mode, you can add up to four virtual routers to the virtual router group. The accounting servers of the virtual routers in the group can receive AAA broadcast accounting records.

From Global Configuration mode, type **aaa accounting vr-group** and the *vrGroupName*, and press Enter.

```

host1(config)#aaa accounting vr-group westVrGroup38
host1(config-vr-group)#?
  aaa          Configure authentication, authorization, and accounting
               characteristics
  default      Set a command to its default(s)
  do           Run an exec mode command (alias command run)
  exit         Exit from the current command mode
  help        Describe the interactive help system
  log          Configure logging settings
  macro        Run a CLI macro
  no           Negate a command or set its default(s)
  run          Run an exec mode command (alias command do)
  sleep        Make the Command Interface pause for a specified duration
  support      Enter Support mode

```

Chapter 3

Installing JUNOS Software

The JUNOS software resides on a nonvolatile storage (NVS) card located in the switch route processor (SRP) module. Each SRP module is shipped with an NVS card that contains a software release. Each SRP module is shipped with an NVS card that contains a software release. New software releases are shipped on a set of CDs. You can also download software releases from the Juniper Networks Web site.



CAUTION: See the *Release Notes* for extra information about installing and upgrading the software.

This chapter provides information on how to install a new software release on a router and contains the following sections:

- Overview on page 125
- Platform Considerations on page 127
- Installing Software When a Firewall Exists on page 127
- Installing Software When a Firewall Does Not Exist on page 132
- Copying Release Files from One Router to Another on page 140
- Upgrading Systems That Are Operating with Two SRP Modules on page 140
- Upgrading from Release 5.1.1 or Lower-Numbered Releases on page 142
- Downgrading JUNOS Software on page 145

Overview

If the router contains only one SRP module, we recommend you divert traffic to another router before installing a new software release because the router is unavailable during the installation process. Depending on whether a firewall separates the router from the network host, you can then complete the appropriate software installation. (See “Installing Software When a Firewall Exists” on page 127 or “Installing Software When a Firewall Does Not Exist” on page 132.) However, if the router contains two SRP modules, you can upgrade the software while the system is operating. (See “Upgrading Systems That Are Operating with Two SRP Modules” on page 140.)

When installing new JUNOS software, you must copy the contents of the release files to a network host and transfer the release files to at least one router in the network. Depending on the network configuration, you can copy the release files

from either the network host or the first router to the other routers in the network. (See “Copying Release Files from One Router to Another” on page 140.)



NOTE: Some line modules and SRP modules on ERX-14xx models, ERX-7xx models, and the ERX-310 router require a minimum amount of memory to be used with JUNOS Release 5.3.0 or a higher-numbered release. See the *ERX Module Guide* for module specifications.

Identifying the Software Release File

You can find the software release file on one of the following JUNOS software CDs:

- JUNOS <release> #1—Contains the release files for the ERX-7xx routers, the ERX-14xx routers, and the ERX-310 router
- JUNOS <release> #2—Contains the release file for the E120 and the E320 router, the MIB directory, and the *Release Notes*

You can also download a compressed version of the software release by logging on to <https://www.juniper.net/support/>. The .zip file that you download contains the software release file.

The release is in the software directory, which is identified by the release number. For example, if the release number is x.y.z, the name of the directory is x-y-z. See Table 12 on page 126.

Table 12: Software Release Files

Router	File Format (x-y-z is the release number)
E120 and E320	e320_x-y-z.rel
ERX-1440	erx40_x-y-z.rel
ERX-310	erx310_x-y-z.rel
All other E-series routers	erx_x-y-z.rel

To identify the software release file:

1. Access the software directory.
2. Find the files with the extension .rel.

The procedures outlined in the following sections provide detailed instructions for typical installations. For additional information about commands and troubleshooting, see “Command-Line Interface” on page 29 and *About The Documentation* in the *JUNOS Command Reference Guide*

Platform Considerations

You can install JUNOS software on all E-series routers.

For information about the modules supported on E-series routers:

- See the *ERX Module Guide* for modules supported on ERX-7xx models, ERX-14xx models, and the ERX-310 router.
- See the *E120 and E320 Module Guide* for modules supported on the E120 router and the E320 router.

Installing Software When a Firewall Exists

When a firewall separates the router from the network host, you must use FTP to transfer the software release files from the network host to the router. In this case, you must configure the FTP server on the router and ensure that FTP client software is installed on the network host.

For this network configuration, you must install the software from the normal operational mode of the command-line interface (CLI). You can access the CLI through either the local console or a Telnet session. If you have not yet configured the router to support Telnet, then you must use the local console.

To install the software, perform the following tasks. (See Table 13 on page 127.)

Table 13: Software Installation Procedure When a Firewall Exists

-
1. Obtain the required information for the installation.
 2. For routers that are currently operating, divert network traffic to another router.
 3. Access the Privileged Exec CLI command mode.
 4. Configure IP on an interface.
 5. Copy the release files on the network host.
 6. Configure access to the network host.
 7. Enable the FTP server on the router.
 8. Identify the files to transfer.
 9. Transfer the files to the user space on the router.
 10. Install the software release file to the system space on the router.
 11. Save the current configuration.
 12. Reboot the system.
-

Task 1: Obtain the Required Information

Before you install the software, obtain the following information:

- The password (if one is configured) that enables you to access Privileged Exec mode on the router
- The IP address of the network host

- The IP address of the router
- The IP address of the next hop to reach the destination network (for example, a gateway)
- The login name and password for the vty line
- The procedure for copying the release files to the network host

Task 2: Divert Network Traffic to Another Router

The system will be unavailable during the installation process.

Task 3: Access Privileged Exec Mode

To access this mode via the CLI:

1. Issue the enable command.

```
host1>enable
```

2. Type the password if the system prompts you.

Task 4: Configure IP on an Interface

Typically, you configure IP on the Fast Ethernet interface of the SRP module. To configure IP on an interface:

1. Determine the slot number of the module.

```
host1#show version
```

2. Determine the port number of the module.

3. Determine whether the interface already has an IP address.

- On ERX-7xx models, ERX-14xx models, and the ERX-310 router:

```
host1#show ip interface fastEthernet 6/0
```

- On the E120 router and the E320 router:

```
host1#show ip interface fastEthernet 6/0/0
```



NOTE: If an IP interface is not configured, an Invalid interface message appears.

If the interface already has an IP address, go to Step 5. Otherwise, proceed with Step 4.

4. Configure an IP address on the interface.

- On ERX-7xx models, ERX-14xx models, and the ERX-310 router:


```

host1#configure
Configuring from terminal or file [terminal]?
Enter configuration commands, one per line. End with CNTL/Z.
host1(config)#interface fastEthernet 6/0
host1(config-if)#ip address ipAddress [ mask ]

```

- On the E120 router and the E320 router:

```

host1#configure
Configuring from terminal or file [terminal]?
Enter configuration commands, one per line. End with CNTL/Z.
host1(config)#interface fastEthernet 6/0/0
host1(config-if)#ip address ipAddress [ mask ]

```

5. Press Ctrl + z to return to Privileged Exec mode.

Task 5: Copy the Release Files to the Network Host

If you downloaded the software from the Juniper Networks Web site as a .zip file, uncompress the files to a directory, and copy the release files to the network host.

If you are accessing the release files from one of the software CDs, you must mount the CD. The way you mount the release files on the network host depends on the type of computer you use, the operating system, and the network configuration. To find out how to mount the release files on the network host, review the manual for the operating system, or contact your network administrator.

Task 6: Configure Access to the Network Host

To configure access to the network host:

1. Use the **ping** command to determine whether the router can reach the network host.

```

host1#ping hostname

```

If the router can reach the network host, go to the next section. Otherwise, go to Step 2.

2. Determine whether a route exists between the router and the network host.

```

host1#show ip route

```

If the appropriate route is displayed, go to Step 5. Otherwise, proceed with Step 3.

3. Configure a route to reach the network host.

```

host1#configure
Configuring from terminal or file [terminal]?
Enter configuration commands, one per line. End with CNTL/Z.
host1(config)#ip route ipNetwork networkMask ipNextHop

```

4. Press Ctrl + z to return to Privileged Exec mode.

- Determine whether the router has been configured to recognize the network host.

```
host1#show host
```

If the network host is listed, go to Step 8. Otherwise, proceed with Step 6.

- Add an entry to the Static Host Table so that the router can access the network host. Use the **host** command to specify the network hostname and IP address.

```
host1#configure
Configuring from terminal or file [terminal]?
Enter configuration commands, one per line. End with CNTL/Z.
host1(config)#host hostName ipAddress ftp loginname password
```

- Press Ctrl + z to return to Privileged Exec mode.
- Use the ping command to determine whether the router can now reach the network host.

```
host1#ping hostname
```

If the router cannot reach the network host, verify that you correctly performed the previous steps in this procedure and that the network host is operational.

Task 7: Enable the FTP Server on the Router

The router divides its vty resources among Telnet, SSH, and FTP services. Each FTP session requires one vty line, and the FTP service uses the authentication method configured for the vty line. If you configured more than one vty line for Telnet access, the FTP service uses one of those lines. If you configured only one line for Telnet access, configure another vty line.

To enable the FTP server, use the **ftp-server enable** command.

```
host1(config)#ftp-server enable
```

Task 8: Identify the Files to Transfer

To identify all the files for the release, use a text editor to open the software release (.rel) file on the JUNOS software CD or from the directory in which you downloaded from the Juniper Networks Web site. The software release file contains a list of all the files associated with the release. You must transfer the software release file and all the files it contains to the user space.

Task 9: Transfer Files to the User Space

To transfer the files for the release to the user space, use the FTP client software on the network host to connect to the FTP server on the router. Transfer the files to a subdirectory within the incoming directory. If you specify a subdirectory that does not exist, the router creates the directory.



NOTE: Be sure to transfer the software release file and all the files it lists.

Task 10: Install Files on the System Space

Installing the software release file to the system space installs all files listed in the software release file. To install the software release file from the incoming directory in the user space to the router space, use the **copy** command.

Be sure to specify the correct software release (.rel) filename for the router you are using, as described in “Identifying the Software Release File” on page 126.



NOTE: The destination file must have a .rel extension.

For example:

```
host1#copy /incoming/releases/erx_x-y-z.rel erx_x-y-z.rel
```

The software release is copied from the user space to the system space. This process can take several minutes.

Task 11: Save the Current Configuration

To save the current configuration, use the **copy running-configuration** command:

```
host1#copy running-configuration filename.cnf
```

Task 12: Reboot the System

To reboot the system using the newly installed software:

1. Access Global Configuration mode.

```
host1#configure
Configuring from terminal or file [terminal]?
Enter configuration commands, one per line. End with CNTL/Z.
host1(config)#
```

2. Run the boot system command, specifying the .rel filename of the software release.

For example:

```
host1(config)#boot system erx_x-y-z.rel
```

The following message appears when you issue this command:

WARNING: We recommend that you copy the current running-configuration to a file prior to reloading a different release of software.

3. Press Ctrl + z to return to Privileged Exec mode.
4. Verify that the router is ready to boot with the new software release.

```
host1#show boot
```

If the old software version is still listed, verify that you completed the previous steps correctly.

5. Run the reload command.

```
host1#reload
```

The following message appears when you issue this command:

```
WARNING: Execution of this command will cause the system to reboot. Proceed
with reload? [confirm]
```

The system reboots. The reboot might take longer than normal because line modules initialize with the old version of the software, acquire the new version from the SRP module, and reinitialize. When you observe the LEDs on the line modules, the line modules appear to boot twice.

Installing Software When a Firewall Does Not Exist

If there is no firewall between the router and the network host to which you copied the release files, you can transfer the software release files from the network host to the router via the FTP server or by issuing the **copy** command. To transfer files via the FTP server, refer to the previous section, “Installing Software When a Firewall Exists” on page 127. This section describes how to transfer files by issuing the **copy** command.

If you use the **copy** command to transfer the files, the network host must be an FTP server. This command activates an FTP client on the router.

For this network configuration, you can install the software in the normal command line interface (CLI) operational mode or in boot mode.

Installing Software in Normal Operational Mode

For this procedure, you must access the CLI through either the local console or a Telnet session. If you have not yet configured the router to support Telnet, then you must use the local console.

To install the software, perform the following tasks. (See Table 14 on page 133.)

Table 14: Software Installation Procedure When a Firewall Does Not Exist

-
1. Obtain the required information for the installation.
 2. For routers that are currently operating, divert network traffic to another router.
 3. Access the Privileged Exec CLI command mode.
 4. Configure IP on an interface.
 5. Configure access to the network host.
 6. Copy the release files to the network host.
 7. Copy the software release file to the router.
 8. Save the current configuration.
 9. Reboot the system.
-

Task 1: Obtain the Required Information

Before you install the software, obtain the following information:

- The password (if one is configured) that enables you to access Privileged Exec mode on the router
- The IP address of the network host
- The IP address of the router
- The IP address of the next hop to reach the destination network (for example, a gateway)
- The login name and password for the FTP server
- The procedure for copying the release files to the network host

Task 2: Divert Network Traffic to Another Router

The system will be unavailable during the installation process.

Task 3: Access Privileged Exec Mode

To access this mode via the CLI:

1. Issue the enable command.


```
host1>enable
```
2. Type the password if the system prompts you.

Task 4: Configure IP on an Interface

Typically, you configure IP on the Fast Ethernet interface of the SRP module. To configure IP on an interface:

1. Determine the slot number of the module.

```
host1#show version
```

2. Determine the port number of the module.
3. Determine whether the interface already has an IP address.
 - On ERX-7xx models, ERX-14xx models, and the ERX-310 router:

```
host1#show ip interface fastEthernet 6/0
```

- On the E120 router and the E320 router:

```
host1#show ip interface fastEthernet 6/0/0
```



NOTE: If an IP interface is not configured, an Invalid interface message appears.

If the interface already has an IP address, go to Step 5. Otherwise, proceed with Step 4.

4. Configure an IP address on the interface.
 - On ERX-7xx models, ERX-14xx models, and the ERX-310 router:

```
host1#configure
Configuring from terminal or file [terminal]?
Enter configuration commands, one per line. End with CNTL/Z.
host1(config)#interface fastEthernet 6/0
host1(config-if)#ip address ipAddress [ mask ]
```

- On the E120 router and the E320 router:

```
host1#configure
Configuring from terminal or file [terminal]?
Enter configuration commands, one per line. End with CNTL/Z.
host1(config)#interface fastEthernet 6/0/0
host1(config-if)#ip address ipAddress [ mask ]
```

5. Press Ctrl + z to return to Privileged Exec mode.

Task 5: Configure Access to the Network Host

To configure access to the network host:

1. Use the ping command to determine whether the router can reach the network host.

```
host1#ping ipAddress
```

If the router can reach the network host, go to the next section. Otherwise, go to Step 2.

2. Determine whether a route exists between the router and the network host.

```
host1#show ip route
```

If the appropriate route is displayed, go to Step 4. Otherwise, proceed with Step 3.

3. Configure a route to reach the network host.

```
host1#configure
Configuring from terminal or file [terminal]?
Enter configuration commands, one per line. End with CNTL/Z.
host1(config)#ip route ipNetwork networkMask ipNextHop
```

4. Press Ctrl + z to return to Privileged Exec mode.
5. Determine whether the router has been configured to recognize the network host.

```
host1#show host
```

If the network host is listed, go to Step 8. Otherwise, proceed with Step 6.

6. Add an entry to the Static Host Table so that the router can access the network host. Use the host command to specify the network hostname and IP address.

```
host1#configure
Configuring from terminal or file [terminal]?
Enter configuration commands, one per line. End with CNTL/Z.
host1(config)#host hostName ipAddress ftp loginname password
```

7. Press Ctrl + z to return to Privileged Exec mode.
8. Use the ping command to determine whether the router can now reach the network host.

```
host1#ping hostname
```

If the router cannot reach the network host, verify that you correctly performed the previous steps in this procedure and that the network host is operational.

Task 6: Copy the Release Files to the Network Host

If you downloaded the software from the Juniper Networks Web site as a .zip file, uncompress the files to a directory, and copy the release files to the network host.

If you are accessing the release files from one of the software CDs, you must mount the CD. The way you mount the CD on the network host depends on the type of network host you use, the operating system, and the way your network is configured. To find out how to mount a CD on the network host, review the manual for the operating system, or contact your network administrator.

Task 7: Copy the Software Release File to the Router

To copy the software release file to the router, use the **copy** command.

Be sure to specify the correct software release (.rel) filename for the router you are using, as described in “Identifying the Software Release File” on page 126.



NOTE: The destination file must have a .rel extension.

For example:

```
host1#copy hostname:/cdrom/x-y-z/erx_x-y-z.rel erx_x-y-z.rel
```

The software release is copied from the network host to the router. This process can take several minutes.

Task 8: Save the Current Configuration

To save the current configuration, use the **copy running-configuration** command:

```
host1#copy running-configuration filename.cnf
```

Task 9: Reboot the System

To reboot the system using the newly installed software:

1. Access Global Configuration mode.

```
host1#configure
Configuring from terminal or file [terminal]?
Enter configuration commands, one per line. End with CNTL/Z.
host1(config)#
```

2. Run the boot system command, specifying the .rel filename of the software release. For example:

```
host1(config)#boot system erx_x-y-z.rel
```

The following message appears when you issue this command:

```
WARNING: We recommend that you copy the current running-configuration to a
file prior to reloading a different release of software.
```

3. Press Ctrl + z to return to Privileged Exec mode.
4. Make sure that the router is ready to boot with the new software release.

```
host1#show boot
```

If the old software version is still listed, verify that you completed the previous steps correctly.

5. Run the reload command.

```
host1#reload
```


The following message appears when you issue this command:

WARNING: Execution of this command will cause the system to reboot. Proceed with reload? [confirm]

The system reboots. The reboot might take longer than normal because line modules initialize with the old version of the software, acquire the new version from the SRP module, and reinitialize. When you observe the LEDs on the line modules, the line modules appear to boot twice.

Installing Software in Boot Mode

To install the software in Boot mode, you must access the CLI via the local console.

To install the software, perform the following tasks. (See Table 15 on page 137.)

Table 15: Software Installation Procedure in Boot Mode

-
1. Obtain the required information for the installation.
 2. For routers that are currently operating, divert network traffic to another router.
 3. Access the Boot mode.
 4. Assign an IP address to the router.
 5. Configure access to the network host.
 6. Reset the SRP module.
 7. Copy the release files to the network host.
 8. Copy the software release file to the router.
 9. Reboot the system.
-

Task 1: Obtain the Required Information

Before you install the software, obtain the following information:

- The IP address of the network host
- The IP address of the router
- The IP address of the next hop to reach the destination network (for example, a gateway)
- The login name and password for the FTP server
- The procedure for copying the release files to the network host

Task 2: Divert Network Traffic to Another System

The system will be unavailable during the installation process.

Task 3: Access the Boot Mode

To access Boot mode from the local console:

1. At the Privileged Exec prompt, type the reload command.

Information on the reloading process appears.

2. When the countdown begins, press the key sequence **mb**.

This action puts the CLI in Boot mode and the `:boot##` prompt appears.



NOTE: If you do not press the key sequence **mb** before the countdown ends, the reloading process continues and returns the CLI to the normal User Exec mode.

Task 4: Assign an IP Address

When you assign an IP address to the router in Boot mode, the address is configured on the Fast Ethernet port of the primary SRP module. To assign an Internet address to the router, use the **ip address** command.

```
:boot##ip address ipAddress [ mask ]
```

Task 5: Configure Access to the Network Host

To configure access to the network host:

1. Configure a gateway through which the router can reach the network host.

```
:boot##ip gateway ipAddress
```

2. Determine whether the router has been configured to recognize the network host.

```
:boot##show host
```

If the network host is listed, go to the next section. Otherwise, proceed with Step 3.

3. Add an entry to the Static Host Table so that the router can access the network host.

```
:boot##host hostName ipAddress ftp login-name password
```

Use the host command to specify the network host name and IP address.

Task 6: Resetting the SRP Module

To ensure that the IP addresses are properly activated, you must reset the SRP module. To reset the SRP module, issue the **reload** command from the `:boot##`

prompt or depress the recessed module reset button located on the front of the module.

Depressing the module reset button on the SRP module is equivalent to rebooting the router and causes all of the line modules to reboot.

Task 7: Copy the Release Files to the Network Host

If you downloaded the software from the Juniper Networks Web site as a .zip file, uncompress the files to a directory, and copy the release files to the network host.

If you are accessing the release files from one of the software CDs, you must mount the CD. The way you mount the CD on the network host depends on the type of network host you use, the operating system, and the way your network is configured. To find out how to mount a CD on the network host, review the manual for the operating system, or contact your network administrator.

Task 8: Copy the Software Release File to the Router

To copy the software release file to the router, use the **copy** command.

Be sure to specify the correct software release (.rel) filename for the router you are using, as described in “Identifying the Software Release File” on page 126.



NOTE: The destination file must have a .rel extension.

For example:

```
:boot##copy hostname:/cdrom/x-y-z/erx_x-y-z.rel erx_x-y-z.rel
```

The software release is copied from the network host to the router. This process can take several minutes.

Task 9: Reboot the System

To reboot the system using the newly installed software:

1. Run the **boot system** command, specifying the .rel filename of the software release. For example:

```
:boot##boot system erx_x-y-z.rel
```

The following message appears when you issue this command:

WARNING: We recommend that you copy the current running-configuration to a file prior to reloading a different release of software.

2. Run the reload command.

```
:boot##reload
```

The following message appears when you issue this command:

WARNING: Execution of this command will cause the system to reboot. Proceed with reload? [confirm]

The system reboots. The reboot might take longer than normal because line modules initialize with the old version of the software, acquire the new version from the SRP module, and reinitialize. When you observe the LEDs on the line modules, the line modules appear to boot twice.

Copying Release Files from One Router to Another

When you have copied the release files from a network host to one router, you can transfer files from that router to other routers on the network. This feature is useful when:

- The other routers are unreachable from the network host but have network connectivity to the router on which you installed the new software.
- The connection between routers is faster than the connection between a router and the network host to which it is connected.

The procedures for transferring release files from a source router to a destination router are almost identical to transferring release files from a network host to a router on the same side of the firewall.



NOTE: You must enable the FTP server on the source router.

To transfer release files from a source router to a destination router, follow the instructions in “Installing Software When a Firewall Does Not Exist” on page 132, with the following changes:

- Substitute the source router for the network host.
- Omit the step about copying the release files to the network host.
- Copy the file to the system space of the second router from the user space of the first router.

Be sure to specify the correct software release (.rel) filename for the router you are using, as described in “Identifying the Software Release File” on page 126.

For example:

```
host1#copy boston:/outgoing/releases/erx_x-y-z.rel erx_x-y-z.rel
```

Upgrading Systems That Are Operating with Two SRP Modules

Use this procedure when the system contains two SRP modules and is already operating with an earlier software release. Each SRP module keeps the system

operational while you upgrade the software on the other, so that you can minimize service interruption.



CAUTION: You must upgrade the software on the redundant SRP module when you upgrade the software on the primary SRP module. This action prevents the redundant SRP module from overwriting the new software on the primary SRP module if the primary SRP module fails and the redundant SRP module takes control.

To upgrade the software on a system that is operational and contains two SRP modules:

1. Turn off autosynchronization.

```
host1(config)#disable-autosync
```

2. Copy the new release of the software to NVS of the primary SRP module. Be sure to specify the correct software release (.rel) filename for the router you are using, as described in “Identifying the Software Release File” on page 126.

- If a firewall separates the router from the network host, transfer files to the user space with the FTP client on the network host, and install files on the system space (See “Installing Software When a Firewall Exists” on page 127.) For example:

```
host1#copy /incoming/releases/erx_x-y-z.rel erx_x-y-z.rel
```

- If no firewall separates the router from the network host, copy the files to the router (See “Installing Software When a Firewall Does Not Exist” on page 132.) For example:

```
host1#copy hostname:/cdrom/x-y-z/erx_x-y-z.rel erx_x-y-z.rel
```

- If you are transferring the files from one router to another, copy the file to the system space of the second router from the user space of the first router (See “Copying Release Files from One Router to Another” on page 140.) For example:

```
host1#copy boston:/outgoing/releases/erx_x-y-z.rel erx_x-y-z.rel
```

3. Save the current configuration. For example:

```
host1#copy running-configuration system2.cnf
```

4. Specify that the router should use the new software release when it reboots. For example:

```
host1(config)#boot system erx_x-y-z.rel
```

5. Synchronize the NVS file system of the redundant module with that of the primary module.

```
host1#synchronize
```

The redundant SRP module automatically reboots because the software release that it is configured to run differs from the software release it is running.



CAUTION: The secondary SRP module does not run the new software until it reboots. If you issue the **srp switch** command or the primary SRP module fails before the redundant SRP module reboots, then the secondary SRP module runs with the old release when it takes control.

6. Wait for the redundant SRP module to boot, initialize, and reach the standby state. When the module is in standby state, the REDUNDANT LED is on and the ONLINE LED is off. The State field in the **show version** display indicates the module is in standby.

After any type of reboot, the primary and redundant SRP module NVS file systems are unsynchronized again.

7. Synchronize the NVS file system of the redundant module with that of the primary module.

```
host1#synchronize
```

8. Switch from the primary SRP module to the redundant SRP module.

```
host1#srp switch
```

The redundant SRP module becomes the primary. The former primary SRP module reboots and becomes the redundant.

9. Reenable autosynchronization.

```
host1(config)#no disable-autosync
```

Upgrading from Release 5.1.1 or Lower-Numbered Releases

Release 5.1.1 or lower-numbered releases only support application images up to 172 MB. To install larger application images for Release 6.0.0 and higher-numbered releases, you must first install Release 5.1.2 (or the highest-numbered 5.x.x release). This enables the system to support application images greater than 172 MB. For example, you cannot go from Release 5.1.1 to Release 7.2.0 without first upgrading to Release 5.1.2. See Table 16 on page 142.

Table 16: Release Compatibility

JUNOS Release	Highest Release Able to Load	Cannot Load	Maximum Application Image
5.1.1 or lower-numbered release	5.3.5p0-2 or the highest-numbered 5.x.x release	6.x.x or higher-numbered release	~ 172 MB

Table 16: Release Compatibility (*continued*)

JUNOS Release	Highest Release Able to Load	Cannot Load	Maximum Application Image
5.1.2 or higher-numbered release	No limitation	Not applicable	~ 234 MB
7.2.0 or higher-numbered release	No limitation	Not applicable	~ 256 MB

Your software upgrades may be available remotely through Telnet or FTP, or may be delivered on a new NVS card. Depending on how you access the software updates, there are two different procedures to follow. See the appropriate section for instructions:

- “Upgrading Software Remotely Through Telnet or FTP” on page 143
- “Upgrading Software from an NVS Card” on page 143

Upgrading Software Remotely Through Telnet or FTP

Follow these steps to upgrade your system software remotely:

1. Copy the new release to your system (using Telnet or FTP).



NOTE: The release you are installing must be Release 5.1.2 or higher-numbered 5.x.x release.

2. Install and arm the release from the **config#** prompt using the normal upgrade procedures as described in this chapter.
3. Reload and configure the software.

After the system is configured with a 5.x.x release, newer releases are supported and can be installed.

Upgrading Software from an NVS Card

Follow these steps to upgrade your system software when the software is on an NVS card. The procedure you use depends on the number of SRP modules in the system.

Upgrading a System That Contains One SRP Module

If the system contains only one SRP module, you must power off the system before you upgrade the NVS card.

To upgrade the NVS card on a system that contains one SRP module:

1. Enter the **halt** command.
2. Connect your antistatic wrist strap to the ESD grounding jack on the router.
3. Power off the system.
4. Replace the NVS card on the SRP module.



NOTE: The release you are installing must be Release 5.1.2 or higher-numbered 5.x.x release.

5. Power on the system.

After the system is configured with a 5.x.x release, newer releases are supported and can be installed.

Upgrading a System That Contains Two SRP Modules

In a system that contains two SRP modules, you can upgrade the software without powering off the system.

To upgrade the software in a system that contains two SRP modules:

1. Connect your antistatic wrist strap to the ESD grounding jack on your router.
2. Turn off autosynchronization.

```
host1#enable
host1#configure
Configuring from terminal or file [terminal]?
Enter configuration commands, one per line. End with CNTL/Z.
host1 (config)#disable-autosync
host1 (config)#exit
```

3. Halt the redundant SRP module.

```
host1#halt standby-srp
Remove the redundant SRP module from the chassis.
```

4. Replace the NVS card on this SRP module.



NOTE: The release you are installing must be Release 5.1.2 or higher-numbered 5.x.x release.

5. Reinsert the SRP module into the chassis.
6. Force the redundant SRP module to take over from the primary SRP module.

```
host1#srp switch
```

7. Turn on autosynchronization.

```
host1#enable
```



```
host1#configure  
Configuring from terminal or file [terminal]?  
Enter configuration commands, one per line. End with CNTL/Z.  
host1 (config)#no disable-autosync  
host1 (config)#exit
```

The software is updated on the other SRP module.

After the system is configured with a 5.x.x release, newer releases are supported and can be installed.

Downgrading JUNOS Software

Downgrading JUNOS software requires factory defaults installed on the router, and can cause NVS and configuration script incompatibilities.



CAUTION: We do not recommend that you attempt to downgrade JUNOS software without the assistance of a Juniper Technical Assistance Center representative. Contact the Juniper Technical Assistance Center to obtain help.

Chapter 4

Configuring SNMP

This chapter provides information for configuring Simple Network Management Protocol (SNMP) on your E-series router.

This chapter contains the following sections:

- Overview on page 147
- Platform Considerations on page 157
- References on page 157
- Before You Configure SNMP on page 157
- SNMP Configuration Tasks on page 158
- Configuring Traps on page 166
- Configuring the SNMP Server Event Manager on page 177
- Collecting Bulk Statistics on page 194
- Using the Bulk Statistics Formatter on page 222
- Managing Virtual Routers on page 223
- Monitoring SNMP on page 223

Overview

SNMP is a protocol that manages network devices, such as your E-series router. The goal of SNMP is to simplify network management in two ways:

- By defining a single management protocol that can be used to manage any network device from any vendor.

This feature reduces the complexity of the network management application because the application does not need to support a large number of proprietary management protocols for the mix of vendors' devices in the network.

- By defining a single, consistent representation of managed information that is commonly deployed in network devices.

For example, SNMP uses a common form and semantics for interface statistics, a process that supports consistent interpretation and meaningful comparison.

SNMP is an application-level protocol that comprises the following three elements:

- An SNMP client (manager)
- An SNMP server (agent)
- A Management Information Base (MIB)

SNMP defines a client-server model in which a client (*manager*) obtains information from the server (*agent*) through two mechanisms:

- A request/response protocol by which the client configures and monitors the server. In this instance, the information is solicited.
- Asynchronous notifications (called *traps*) by which the server, on its own initiative, reports notable changes in the router's status to the client. In this instance, the information is unsolicited.

Terminology

Table 17 on page 148 provides definitions for the basic SNMP terms.

Table 17: SNMP Terminology

Term	Meaning
agent	Also referred to as server; a managed device, such as a router, that collects and stores management information
client	Sometimes called a network management station (NMS) or simply a manager; a device that executes management applications that monitor and control network elements
community	A logical group of SNMP-managed devices and clients in the same administrative domain
entity	Refers to both a server and a client
event	A condition or state change that may cause the generation of a trap message
managed object	A characteristic of something that can be managed, such as a list of currently active TCP circuits in a device
group	SNMPv3 term; a set of users with the same access privileges to the router
MIB	Management Information Base; a collection of managed objects residing in a virtual information store
network element	Also known as a managed device; a hardware device, such as a PC or a router
notification	A message that indicates a status change (equivalent to a trap)
server	Also referred to as agent; a managed device, such as a router, that collects and stores management information

Table 17: SNMP Terminology (continued)

Term	Meaning
trap	Message sent by an SNMP server to a client to indicate the occurrence of a significant event, such as a specifically defined condition or a threshold that was reached. Managed devices use traps to asynchronously report certain events to clients.
user	SNMPv3 term; an individual who accesses the router
view	SNMPv3 term; defines the management information available to the user: read, write, or notification

SNMP Features Supported

This SNMP implementation provides the following:

- Standard SNMP MIB support for services and interfaces as defined by the Internet Engineering Task Force (IETF)
- A set of AS number version 1 notated enterprise MIBs for all management functions not addressed by standard MIBs
- A multilingual SNMP server that supports SNMPv1, SNMPv2c, and SNMPv3 protocols
- Enhanced security and management features supported in SNMPv3
- Traps for alarm and state change events
- Bulk data collection and retrieval
- Management of virtual routers
- Secure audit logging for packet mirroring traps and Juniper-PACKET-MIRROR MIB access



NOTE: You can disable the management interface through SNMP. But, if you disable the management interface, you can no longer access the router through SNMP.



NOTE: JUNOS software supports SNMP packet mirroring traps; however, the packet mirroring-related SNMP commands, categories, and traps are visible in the CLI only to authorized users. See *JUNOS Policy Management Configuration Guide* for information about using SNMP with secure packet mirroring.

SNMP Client

The SNMP client runs on a network host and communicates with one or more SNMP servers on other network devices, such as routers, to configure and monitor the operation of those network devices.

SNMP Server

The SNMP server operates on a network device, such as a router, a switch, or a workstation. It responds to SNMP requests received from SNMP clients and generates *trap messages* to alert the client(s) about notable state changes in the network device.

The SNMP server implementation operates over UDP/IP only. It can receive requests directed to any IP address configured on the router. SNMP requests and responses are received or sent on UDP port 161. SNMP traps are sent from UDP port 162 by default or from a configurable port. For traps sent from UDP port 162, you can configure the destination UDP port for each recipient with the **snmp-server host** command.

SNMP MIBs

A MIB specifies the format of managed data for a device function. The goal of a MIB is to provide a common and consistent management representation for that function across networking devices.

Your router supports both standard and enterprise SNMP MIBs.

Standard SNMP MIBs

A standard MIB is defined by a body such as the IETF and fosters consistency of management data representation across many vendors' networking products.

Juniper Networks E-series Enterprise MIBs

An enterprise MIB is defined by a single vendor. In addition to providing consistency of management data representation across that vendor's product line, the enterprise MIB also accounts for proprietary functions and value-added features not addressed by standard MIBs.

For example, boot record extensions to the enterprise MIB enable configuration of the release (.rel) files for each router, slot, and subsystem. The extensions also enable booting through the factory defaults, the running configuration, or a configuration (.cnf) file.

Accessing Supported SNMP MIBs

For complete information about the SNMP MIBs supported by your router, see the *E-series System Software* CD, shipped with your router. In the MIBs folder you will find information about all supported standard and Juniper Networks E-series Enterprise (proprietary) MIBs.

SNMP Versions

This SNMP server implementation supports:

- SNMPv1 (defined in RFC 1157)
- SNMPv2c (Community-based SNMPv2, defined in RFC 1901 and RFC 3416)
- SNMPv3 (compliant with RFCs 3410–3418, STD 62)

The server encodes SNMP responses using the same SNMP version received in the corresponding request and encodes traps using the SNMP version configured for the trap recipient.

SNMPv2c supports the capabilities defined for SNMPv1 and provides greater power and flexibility through the addition of several features, including:

- More detailed error codes
- GetBulk operation for efficient retrieval of large amounts of data
- 64-bit counters

SNMPv3 is an extensible SNMP framework that supplements the SNMPv2c framework by supporting:

- Security for messages
- Explicit access control

Security Features

As users transfer more sensitive information, such as billing details, through the Internet, security becomes more critical for SNMP and other protocols. SNMPv3 provides the user-based security model (USM) to address authentication and data encryption.

Authentication provides the following benefits:

- Only authorized parties can communicate with each other. Consequently, a management station can interact with a device only if the administrator configured the device to allow the interaction.
- Messages are received promptly; users cannot save messages and replay them to alter content. This feature prevents users from sabotaging SNMP configurations and operations. For example, users can change configurations of network devices only if authorized to do so.

SNMPv3 authenticates users through the HMAC-MD5-96 or HMAC-SHA-96 protocols; CBC-DES is the encryption or privacy protocol. The SNMP agent recognizes up to 32 usernames that can have one of the following security levels:

- No authentication and no privacy (none)
- Authentication only (auth only)
- Authentication and privacy (priv)

In contrast, SNMPv1 and SNMPv2c provide only password protection, through the community name and IP address. When an SNMP server receives a request, the server extracts the client's IP address and the community name. The SNMP community table is searched for a matching community. If a match is found, its access list, if nonzero, is used to validate the IP address. If the access list number is zero, the IP address is accepted. A nonmatching community or an invalid IP address causes an SNMP authentication error. Each entry in the community table identifies:

- An SNMP community name
- An SNMP view name
- A user's privilege level
 - Read-only (ro)
 - Read-write (rw)
 - Administrator (admin)
- An IP access list name

Management Features

Management features of SNMPv3 allow you to specify who will receive notifications and to define MIB views that users in different groups can access:

- Notification—Message that informs you of a status change; the equivalent of a trap in SNMPv1.
- View—Definition of the management information that is available: read, write, or notification. Predefined views are available for each group:
 - everything—Includes all MIBs associated with the router, except the packetMirror MIB
 - user—Includes all MIBs associated with the router, except the packetMirror MIB and standard and enterprise MIBs used to configure SNMP operation
 - nothing—Excludes all MIBs
 - mirrorAdmin—Includes the packetMirror MIB
- User—An individual who requires access to the router. The router may provide authentication and privacy for the user through SNMPv3. Each user is associated with a group.
- Group—A set of users with the same access privileges to the router. Three predefined groups are available: admin, public, and private. Table 18 on page 152 shows the security levels and views associated with these groups.

Table 18: Relationship Among Groups, Security Levels, and Views

Group Name	Security Level	Read View	Write View	Notification/ Trap View
admin	authentication and privacy	everything	everything	everything

Table 18: Relationship Among Groups, Security Levels, and Views *(continued)*

Group Name	Security Level	Read View	Write View	Notification/ Trap View
mirror	authentication and privacy	mirrorAdmin	mirrorAdmin	mirrorAdmin
public	none	user	nothing	nothing
private	authentication only	user	user	user

Virtual Routers

All SNMP-related CLI commands operate in the context of a virtual router, which means that you must configure users, traps, communities, and so on for *each* server. You must set the context using the **virtual-router** command and then configure SNMP.

The **show snmp** commands show only statistics and configuration information for the server/SNMP agent that corresponds to the current virtual router context.

The exceptions to this convention are the **snmp-server contact** and the **snmp-server location** commands. With these commands, single instances of the contact and the location are created regardless of the number of virtual routers.

Creating SNMP Proxy

Your JUNOS software allows you to configure multiple virtual routers. Each virtual router has its own SNMP server. At router initialization, SNMP creates a server for each existing virtual router.

When router-specific data is required, the requestor can direct a request to a particular server for a virtual router through the base community string extension: for example, SNMP get public@megaRouter.



NOTE: In addition to the @ selector character, the system also supports the % selector character. For example, SNMP get public%megaRouter.

When any system server parses a request and detects an extended community string, it acts as proxy by forwarding the request to the server corresponding to the virtual router name in the extension (for example, *megaRouter*). The target server then processes the request and generates a response, which is then returned to the proxy server and subsequently transmitted to the requester.

The JUNOS implementation of SNMPv3 communicates with virtual routers by assigning each proxy agent an SNMP engine ID. This difference is unimportant to

users of the CLI. However, if you use other SNMPv3 applications to manage the router, refer to the following section.

Disabling and Reenabling SNMP Proxy

The ability to proxy SNMP from a virtual router (VR) is enabled by default whenever you create a virtual router agent. However, you can disable or reenab the proxy feature on each virtual router agent to address any network security issues. To disable proxy on an agent (router), you must use SNMP or the CLI `snmp-server proxy disable` command.



NOTE: Disabling the proxy function on a particular virtual router disables the use of proxy through that virtual router. You can, however, use the proxy function to access a proxy-disabled virtual router through another virtual router that does have the proxy function enabled.

Communicating with the SNMP Engine

The SNMP engine performs the following tasks for SNMPv3:

- Sends and receives messages.
- Prepares messages and extracts data from messages.
- Authenticates, encrypts, and decrypts messages.
- Determines whether access to a managed task is allowed.

Each SNMP engine has an `SnmpEngineID`, a hexadecimal number 15 octets long. Table 19 on page 154 shows the structure of the `SnmpEngineID`.

Table 19: SnmpEngineID Structure Object

Octet Assignment	Description
1 – 4	E-series router SNMP management private enterprise number
5	Indicates that octets 6–15 contain information determined by the E-series router
6 – 11	The MAC address for the device
12 – 15	The 32-bit (4 octet) router index (or routerUID)

Request protocol data units (PDUs) for the SNMP engine must contain the corresponding `contextEngineID` and `contextName` for the SNMP engine. When the system receives a PDU, it examines the `contextEngineID` and `contextName`, and forwards the request to the corresponding virtual router.

- The `contextEngineID` is the same as the `SnmpEngineID`.

- The `contextName` is an internally derived ASCII string associated with the router. It has the format *routerN*, where N is a number (with no leading zeros) in the range 1–16777215, corresponding to the least significant 24 bits of the 32-bit router index (or router UID). You can obtain the `contextName` for a specific router through the Juniper-ROUTER-MIB from the `juniRouterContextName` object in the `juniRouterTable`, which is indexed by the 32-bit router index (`juniRouterIndex`).

The following table shows examples of the E-series router SNMP engine objects that are associated with the default virtual router.

Object	Value
<code>SnmpEngineID</code>	0x80:00:13:0a:05:00:90:1a:00:04:6c:80:00:00:01
<code>contextEngineID</code>	0x80:00:13:0a:05:00:90:1a:00:04:6c:80:00:00:01
<code>contextName</code>	router1

SNMP Attributes

The software automatically maps predefined SNMPv1/v2c attributes to predefined SNMPv3 attributes, as shown in Table 20 on page 155.

Table 20: Relationship Between SNMPv1/v2c and SNMPv3 Attributes

Attribute	SNMPv1/v2C Value	SNMPv3 Value
Community	admin	admin
View		everything
Privilege	rw	rw
Community	public	public
View		user
Privilege	ro	ro
Community	private	private
View		user
Privilege	rw	rw

SNMP Operations

SNMP has the five operations defined in Table 21 on page 156.

Table 21: SNMP Operations

SNMP Operation	Definition
Get	Allows the client to retrieve an object instance from the server.
GetNext	Allows the client to retrieve the next object instance from a table or list within a server.
GetBulk	Makes it easier to acquire large amounts of related information without initiating repeated GetNext operations. GetBulk is not available in SNMPv1.
Set	Allows the client to set values for the objects managed by the server.
Notification	Used by the server to asynchronously inform the client of some event. (Called a trap in SNMPv1.)

SNMP PDU Types

SNMP offers the six types of PDUs defined in Table 22 on page 156.

Table 22: SNMP PDU Types

SNMP PDU Type	Definition
Get Bulk	Transmitted by the client to the server to obtain the identifiers and the values of a group or collection of variables rather than one variable at a time. GetBulk is not available in SNMPv1.
Get Next Request	Transmitted by the client to the server to obtain the identifiers and the values of variables located after the designated variables.
Get Request	Transmitted by the client to the server to obtain the values of designated variables.
Get Response	Transmitted by the server to the client in response to a Get Request, a Get Next Request, or a Set Request PDU.
Set Request	Transmitted by the client to the server to modify the values of designated variables.
Notification	Transmitted by the server, on its own initiative, to inform the client of a special event noted on a network device. (Called a trap in SNMPv1.)

Platform Considerations

SNMP is supported on all E-series routers.

For information about the modules supported on E-series routers:

- See the *ERX Module Guide* for modules supported on ERX-7xx models, ERX-14xx models, and the ERX-310 router.
- See the *E120 and E320 Module Guide* for modules supported on the E120 router and the E320 router.

References

For more information about SNMP, consult the following resources:

- RFC 1157—A Simple Network Management Protocol (SNMP) (May 1990)
- RFC 1901—Introduction to Community-based SNMPv2 (January 1996)
- RFC 2790—Host Resources MIB (March 2000)
- RFC 2864—The Inverted Stack Table Extension to the Interfaces Group MIB (June 2000)
- RFC 2493—Textual Conventions for MIB Modules Using Performance History Based on 15 Minute Intervals (January 1999)
- RFC 3014—Notification Log MIB (November 2000)
- RFC 3410—Introduction and Applicability Statements for Internet Standard Management Framework (December 2002)
- RFC 3411—An Architecture for Describing Simple Network Management Protocol (SNMP) Management Frameworks (December 2002)
- RFC 3412—Message Processing and Dispatching for the Simple Network Management Protocol (SNMP) (December 2002)
- RFC 3413—Simple Network Management Protocol (SNMP) Applications (December 2002)
- RFC 3414—User-based Security Model (USM) for version 3 of the Simple Network Management Protocol (SNMPv3) (December 2002)
- RFC 3415—View-based Access Control Model (VACM) for the Simple Network Management Protocol (SNMP) (December 2002)
- RFC 3416—Version 2 of the Protocol Operations for the Simple Network Management Protocol (SNMP) (December 2002)

Before You Configure SNMP

Before you configure SNMP, make sure that at least one IP address is configured on your router. See *Accessing ERX Routers* in the *ERX Hardware Guide* or *Accessing E-series Routers* in the *E120 and E320 Hardware Guide*.

Also make sure that you have the necessary configuration information for:

- Communities and their assigned privileges
- IP addresses of SNMP clients and trap recipients
- SNMPv3 users

SNMP Configuration Tasks

To configure the SNMP server:

1. Enable the SNMP server.

```
host1(config)#snmp-server
```

2. Configure at least one authorized SNMP community (SNMPv1/v2c) or user (SNMPv3), which provides SNMP client access.

```
host1(config)#snmp-server community boston view everything rw
host1(config)#snmp-server user fred group private auth sha fred-password priv
des password
```

3. (Optional) Set the server parameters—contact name and server location.

```
host1(config)#snmp-server contact Bob Smith
host1(config)#snmp-server location 3rdfloor
```

4. (Optional) Reconfigure the maximum SNMP packet size.

```
host1(config)#snmp-server packet-size 1000
```

5. (Optional) Configure memory warning parameters.

```
host1(config)#memory warning 80 70
```

6. (Optional) Configure the method the router uses to encode the ifDescr and ifName objects.

```
host1(config)#snmp interfaces description-format common
```

7. (Optional) Manage the interface sublayers (compress interfaces and control interface numbering).

```
host1(config)#snmp-server interfaces compress atmAal5
host1(config)#snmp-server interface compress-restriction ifadminstatusdown
host1(config)#snmp interfaces rfc1213 55000 100000
```

8. (Optional) Configure the dynamic group parameters.

```
host1(config)#snmp-server group grp1authpriv usm priv read grp1read write
grp1write notify grp1notify
```

9. (Optional) Configure the dynamic view parameters.

```
host1(config)#snmp-server view view1 1.3.6.1 included non-volatile
```

You can also set up SNMP traps and set up the router to collect bulk statistics. See “Configuring Traps” on page 166 and “Collecting Bulk Statistics” on page 194.

Enabling SNMP

To enable the SNMP server, use the following command.

snmp-server

- Use to enable SNMP server operation.
- Example

```
host1(config)#snmp-server
```

- Use the **no** version to disable the SNMP server operation.
- See snmp-server.

Configuring SNMP v1/v2c Community

For SNMPv1/v2c, access to an SNMP server by an SNMP client is governed by a proprietary SNMP community table that identifies those communities that have read-only, read-write, or administrative permission to the SNMP MIB stored on a particular server.

When an SNMP server receives a request, the server extracts the client’s IP address and the community name. The SNMP community table is searched for a matching community. If a match is found, its access list name is used to validate the IP address. If the access list name is null, the IP address is accepted. A nonmatching community or an invalid IP address results in an SNMP authentication error.

Each entry in the community table identifies:

- An SNMP community name
- A user’s privilege level
- An IP access list

Community Name

The community name acts as a password and is used to authenticate messages sent between an SNMP client and a router containing an SNMP server. The community name is sent in every packet between the client and the server.

Privilege Levels

SNMP has three privilege levels:

- Read-only—Read-only access to the entire MIB except for SNMP configuration objects
- Read-write—Read-write access to the entire MIB except for SNMP configuration objects
- Admin—Read-write access to the entire MIB

IP Access List

The IP access list identifies those IP addresses of SNMP clients permitted to use a given SNMP community.

snmp-server community

- Use to configure an authorized SNMP community for access to the SNMP MIBs and to associate SNMPv1/v2c communities with SNMP MIB views.
- The community name serves as a password and permits access to an SNMP server. The name can be up to 31 characters, and it must be enclosed in quotation marks.
- The maximum number of communities in each virtual router is 32.
- By default, an SNMP community permits only read-only access.
- The view name allows configuration with available dynamic views.
- Example

```
host1(config)#snmp-server community " boston" view view1 rw
```

- Use the **no** version to delete a community from the SNMP community table.
- See snmp-server community.

Configuring SNMPv3 Users

To configure SNMPv3 users, use the following command.

snmp-server user

- Use to create and modify SNMPv3 users.
- Example

```
host1(config)#snmp-server user fred auth sha fred-password priv des password
group user
```

- Use the **no** version to delete users.
- See snmp-server user.

Configuring SNMP Dynamic Groups and Views

With dynamic configurable views and groups you can fine-tune application features to a specific group. You can have 32 view entries (with distinct names) per virtual router. Because there is no limit to the number of entries within a distinct view name, you can configure complex views. You can also have 32 access entries (with distinct names) per virtual router. All views are on a per-virtual-router basis; although static views are on a per-virtual-router basis, they cannot be altered. If you modify a view, the system deletes the original entry and creates the new view. Therefore, if the new view fails, the original view is no longer available.

SNMP v3 configurations are allowed only at the maximum CLI privilege level (15).

snmp-server group

- Use to dynamically configure server groups. You must access the CLI at privilege level 15 to view or use this command.

- Example

```
host1(config-profile)#snmp-server group grp1authpriv usm priv read grp1read
write grp1write notify grp1notify
```

- Use the **no** version to remove the dynamically created group.
- See snmp-server group.

snmp-server view

- Use to dynamically configure an SNMP server view. You must access the CLI at privilege level 15 to view or use this command.

- Example

```
host1(config)#snmp-server view view1 1.3.6.1 included non-volatile
```

- Use the **no** version to remove the dynamically created view.
- See snmp-server view.

Setting Server Parameters

Setting the server's contact person and location provides helpful identifiers for the SNMP server. These identifiers are arbitrary and do not affect the server's function, but they are useful to have.

snmp-server contact

- Use these commands to configure the SNMP server's contact person and the server's location.
- The contact is the person who manages the server.
- The location is the server's physical location.
- Each of these parameters can be up to 64 characters.
- Example

```
host1(config)#snmp-server contact Bob Smith
host1(config)#snmp-server location 3rdfloor
```

- Use the **no** version of these commands to clear the contact or location identifier from the SNMP configuration.
- See snmp-server contact.

Configuring SNMP Packet Size

The SNMP server must support a PDU with an upper limit of 484 bytes or greater. There is no need to coordinate the maximum packet size across the entire network. Many requests and responses tend to be smaller than the maximum value.

snmp-server packetsize

- Use to set the SNMP server's maximum packet size.
- Increase this value to improve the efficiency of the GetBulk operation.
- Example

```
host1(config)#snmp-server packetsize 1000
```

- Use the **no** version to set the SNMP packet size to the default maximum size, 1500 bytes.
- See snmp-server packetsize.

Configuring Memory Warning

You can set up the router to send memory warning messages when memory utilization reaches a specified value.

memory

- Use to configure memory warning parameters. You set a high memory utilization value and an abated memory utilization value. When the system reaches the high utilization value, it sends warning messages. When memory usage falls to the abated utilization value, the system stops sending warning messages.
- Example

```
host1(config)#memory warning 80 70
```

- Use the **no** version to return to the default values, 85 for high utilization and 75 for abated memory utilization.
- See memory.

Configuring Encoding Method

You can control how the router encodes the ifDescr and ifName objects in the SNMP agent's interface table and in the bulkstats application.

There are two choices of encoding schemes: an E-series router proprietary method and a conventional industry method.

- The proprietary method identifies each interface sublayer with its type.
- The industry method bases the type information for each interface sublayer on the lowest layer 1 or layer 2 interface type.

For example a PPP interface configured on top of an ATM interfaces is:

- PPP3/0.1—Proprietary method
- ATM3/0.1—Industry method

snmp-server interfaces description-format

- Use to set the encoding scheme of the ifDescr and ifName objects. Include one of the following keywords:
 - **common**—Sets the encoding scheme to the conventional industry method and provides compatibility with software that uses the industry encoding scheme.
 - **legacy**—Sets the encoding scheme for legacy E-series routers.
 - **proprietary**—Sets the encoding scheme to the E-series router proprietary method.
- Example


```
host1(config)#snmp-server interfaces description-format common
```
- Use the **no** version to return to the default, the legacy encoding scheme.
- See snmp-server interfaces description-format.

Managing Interface Sublayers

You can set up the SNMP agent to compress the number of interface instances in the standard interface and stack tables. You can also control the interface numbering method used in the interface tables.

Compressing Interfaces

You can compress interfaces by interface type and by the administrative status of the interface. Compressing interfaces removes them from the ifTable, the ifStackTable, and the ipAddrTable, which increases table retrieval performance. For example, if you want statistics kept only on IP interfaces, then you can compress all interfaces except IP; subsequently, only IP interfaces will appear in the ifTable, the ifStackTable, and the ipAddrTable.

To compress interfaces that have an administrative status of down, use the **snmp-server interfaces compress-restriction** command.

To compress interfaces according to type, use the `snmp-server interfaces compress` command. To see the list of interfaces that you can remove, use the CLI help:

```
host1(config)#snmp-server interfaces compress ?
Atm Atm interface layer
Atm1483 Atm1483 interface layer
AtmAal5 AtmAal5 interface layer
. . .
SonetVT SonetVT interface layer
VlanMajor VlanMajor interface layer
VlanSub VlanSub interface layer <cr>
```

If you enter the `snmp-server interfaces compress` command without keywords, the following interface types are removed from the interface tables:

- ip
- ppp
- ethernetSubinterface
- hdlc
- ipLoopback
- ipVirtual
- pppLinkInterface
- pppoeInterface
- slepInterface/ciscoHdlc

snmp-server interfaces compress

- Use to remove interface sublayers from the `ifTable`, the `ifStackTable`, and the `ipAddrTable`.
- Example

```
host1(config)#snmp-server interfaces compress atmAal5
```

- Use the **no** version to add interface sublayers to the `ifTable`, the `ifStackTable`, and the `ipAddrTable`.
- See `snmp-server interfaces compress`.

snmp-server interfaces compress-restriction

- Use to exclude interfaces from the `ifTable`, the `ifStackTable`, and the `ipAddrTable` if the administrative status of the interface is down.
- Example

```
host1(config)#snmp-server interfaces compress-restriction ifadminstatusdown
```

- Use the **no** version to remove the restriction and allow interfaces with an administrative status of down in the ifTable, the ifStackTable, and the ipAddrTable.
- See `snmp-server interfaces compress-restriction`.

Controlling Interface Numbering

Each interface in the ifTable is assigned an ifIndex number. RFC 1213 required that ifIndexes use contiguous integers and that the ifIndex be less than the value of the total number of interfaces (ifNumber). More recent RFCs—1573, 2232, and 2863—removed these restrictions to accommodate interface sublayers. The E-series router implementation of SNMP derives index numbers in 32-bit values that are unique on a given router. This numbering scheme can result in large gaps in the ifIndex.

Legacy network management software that was designed to work with RFC 1213 implementations expects contiguous integers and can fail when the software encounters large gaps in the ifIndex.

By default, the router uses a numbering scheme based on RFC 2863. For compatibility with RFC 1213, you can set up the router to use contiguous numbers and to limit the values of the ifIndex and the ifNumber.

snmp-server interfaces rfc1213

- Use to set up the interface numbering method in the IfTable to use contiguous integers, which provides compatibility with versions of SNMP that are based on RFC 1213.
- The *maxIfIndex* option sets the maximum value of the ifIndex field that the system will allocate.
- The *maxIfNumber* option sets the maximum number of interfaces allowed in the interface tables.



CAUTION: Reducing the value of the maxIfIndex and/or maxIfNumber causes the router to automatically reboot to factory default settings.

- When the IfIndex and IfNumber maximums are reached, the system logs the event and ignores the creation of additional interfaces, which means that new interfaces are not visible in the interface table.
- Example

```
host1(config)#snmp-server interfaces rfc1213 55000 100000
```

```
WARNING: Execution of this command will cause all configuration settings to  
revert to factory defaults upon the next system reboot.
```

```
Proceed with 'snmp interfaces rfc1213'? [confirm]
```

- Use the **no** version to return to the default method of interface numbering.
- See `snmp-server interfaces rfc1213`.

Monitoring Interface Tables

Use the following command to view the configuration of your interface tables.

show snmp group

- Use to display a list of interface types that are compressed in the interface tables and the interface numbering method configured on the router.
- Field descriptions
 - Compressed(Removed) Interface Types—List of interface types that are removed from the `ifTable` and `ifStackTable`
 - Armed Interface Numbering Mode—Interface numbering method configured on the router: `RFC1213`, `RFC2863`
 - `maxIfIndex`—Maximum value that the system will allocate to the `ifIndex` field
 - `maxIfNumber`—Maximum number of interfaces allowed in the `ifTable`
 - Interface Description Setting—Method used to encode the `ifDescr` and `ifName` objects: `common`, `legacy`, `proprietary`
- Example

```
host1#show snmp interfaces
Compressed(Removed) Interface Types:
HDLC, FT1, ATM, ATM1483
Armed Interface Numbering Mode:
RFC1213, maxIfIndex=65535, maxIfNumber=65535
Interface Description Setting: proprietary
```

- See `show snmp group`.

Configuring Traps

This section provides information for:

- IP Hosts on page 167
- Trap Categories on page 167
- Trap Severity Levels on page 168
- Specifying an Egress Point for SNMP Traps on page 173
- Configuring Trap Queues on page 173
- Configuring Trap Notification Logs on page 174
- Recovering Lost Traps on page 176

The system generates SNMP traps according to operating specifications defined in supported MIBs.

IP Hosts

Traps are sent to IP hosts. The IP hosts are configured in a proprietary trap host table maintained by the router (the server). Each entry in the table contains:

- IP address of the trap destination
- Community name (v1 or v2c) or username (v3) to send in the trap message
- SNMP format (v1 or v2) of the notification (trap) PDU to use for that destination
- Types of traps enabled to be sent to that destination
- Trap filters configured for the destination

The maximum number of entries in the SNMP trap host table in each virtual router is eight.

Trap Categories

The router supports the following trap categories:

- addrPool—Local address pool traps
- atmPing—E-series router proprietary ATM ping traps
- bfdmib—BFD MIB traps
- bgp—BGP state change traps
- bulkstats—Bulk statistics file full and nearly full traps
- cliSecurityAlert—Security alert traps
- dhcp—Dynamic Host Configuration Protocol traps
- dismanEvent—Distributed management (disman) event traps
- dosProtectionPlatform—DoS protection platform traps
- dvmrp—Distance Vector Multicast Routing Protocol traps
- dvmrpProp—E-series router proprietary DVMRP traps
- environment—Power, temperature, fan, and memory utilization traps
- fileXfer—File transfer status change traps
- haRedundancy—High availability and redundancy traps
- inventory—System inventory and status traps
- ip—Internet Protocol traps
- ldp—LDP traps
- link—SNMP linkUp and linkDown traps
- log—System log capacity traps
- mobileIpv4—Mobile IPv4 traps

- `mplste`—Mplste traps
- `mrrouter`—Mrouter traps
- `ntp`—E-series router proprietary traps
- `ospf`—Open Shortest Path First traps
- `packetMirror`—Packet mirroring traps; packet mirroring-related SNMP categories and traps are visible only to authorized users. See *JUNOS Policy Management Configuration Guide* for information about using secure packet mirroring traps.
- `pim`—Protocol Independent Multicast traps
- `ping`—Ping operation traps in `disman remops` (remote operations) MIB
- `radius`—RADIUS servers fail to respond to accounting and authentication requests traps, or servers return to active service traps
- `routeTable`—Maximum route limit and warning threshold traps; when this trap is generated, the actual value of the exceeded warning threshold is displayed.
- `snmp`—SNMP `coldStart`, `warmStart`, `authenticationFailure`; the trap option. The **`snmp-server enable traps snmp authentication`** command allows customized treatment for SNMP authentication failure traps.
- `sonet`—SONET traps
- `traceroute`—Traceroute operation traps (in `disman remops` MIB)
- `trapFilters`—Global filters for SNMP trap recipients
- `vrrp`—Virtual Router Redundancy Protocol traps

To enable global trap categories, use the **`snmp-server enable traps`** command. To enable trap categories for a specific host, use the **`snmp-server host`** command.

Trap Severity Levels

The router provides a method of filtering traps according to severity. Table 23 on page 168 describes the supported severity levels.

Table 23: Trap Severity Descriptions

Severity Number	Severity Name	System Response
0	Emergency	System unusable
1	Alert	Immediate action needed
2	Critical	Critical conditions exist
3	Error	Error conditions exist
4	Warning	Warning conditions exist
5	Notice	Normal but significant conditions exist

Table 23: Trap Severity Descriptions *(continued)*

Severity Number	Severity Name	System Response
6	Informational	Informational messages
7	Debug	Debug messages

You can set up one or more of the following types of trap filters:

- Global—Filters traps by type and severity level across all trap categories
- Per-category—Filters traps for a specific category by type and severity level
- Host-specific—Filters traps on a specific host by type and severity level

Trap filters work as follows:

1. An event is posted to the SNMP agent.
2. The system determines whether the corresponding trap category is globally enabled and whether the trap meets the minimum severity level for the trap category. If the per-category filter is not defined for this trap, the global trap severity applies.
 - If the trap does not meet these criteria, the system discards the trap.
 - If the trap does meet these criteria, the trap goes to the trap host processor.
3. The trap host processor determines whether the trap category is enabled on the host and whether the trap meets the minimum severity level set for the host.
 - If the trap does not meet these criteria, the system discards the trap.
 - If the trap does meet these criteria, the trap is sent to the trap recipient.

To set up global severity filters, use the **snmp-server enable traps** command. To specify the trap severity level for a particular category, use the **snmp-server enable traps per-category-trapFilters** command. To set up a severity filter for a specific host, use the **snmp-server host** command.

snmp-server enable traps

- Use to enable and configure SNMP trap generation on a global basis.
- Traps are unsolicited messages sent from an SNMP server (agent) to an SNMP client (manager).
- You can enable the traps listed in “Trap Categories” on page 167.
- You can filter traps according to the trap severity levels described in Table 23 on page 168.
- If you do not specify a trap option, all options are enabled or disabled for the trap type.
- Example

```
host1(config)#snmp-server enable traps atmPing trapFilters critical
```

- Use the **no** version to disable SNMP trap generation.
- See `snmp-server enable traps`.

snmp-server enable traps per-category-trapFilters

- Use to specify the trap severity level for a particular category without overwriting the existing global severity level, which applies to all enabled categories configured on the router.
- If you change the global trap severity level (which applies to all enabled categories) after you set the per-category trap severity level, the global severity level takes precedence over the per-category severity level.
- If you do not configure the per-category severity level, the global trap severity level (which applies to all enabled categories) takes effect for that category.



NOTE: This command does not modify the severity level set for specific hosts using the **snmp-server host** command.

- If you configure global severity levels for different categories in succession, the last global severity level you configure is applied to all categories.
- Example 1—Configuring the per-category severity level without changing the global severity level
 1. Configure the global severity level as **critical** for all enabled trap categories by specifying the SONET trap category.

```
host1(config)#snmp-server enable traps sonet trapFilters critical
```

2. Configure the global severity level as **notice** for all enabled trap categories by specifying the BGP trap category.

```
host1(config)#snmp-server enable traps bgp trapFilters notice
```

3. Configure the per-category severity level as **debug** for the SONET trap category.

```
host1(config)#snmp-server enable traps sonet per-category-trapFilters debug
```

In this example, although you configure the category-specific severity level as **debug** for the SONET category in Step 3, the global severity level remains unchanged as **notice**. This behavior occurs because only the category-specific severity level was configured in the last operation.

- Example 2—Overwriting the global severity level to the last-configured setting
 1. Configure the global severity level as **critical** for all enabled trap categories by specifying the SONET trap category.

```
host1(config)#snmp-server enable traps sonet trapFilters critical
```

2. Configure the global severity level as **notice** for all enabled trap categories by specifying the BGP trap category.

```
host1(config)#snmp-server enable traps bgp trapFilters notice
```

Although you specify the type of SNMP trap category when you configure the global severity level, it takes effect for all enabled trap categories on the router. In this example, after you issue the second command, the global severity level is set as **notice** for all enabled trap categories.

- Example 3—Overriding the global severity level for a category with the per-category severity level

1. Configure the global severity level as **critical** for the SONET trap category in the command.

```
host1(config)#snmp-server enable traps sonet trapFilters critical
```

2. Change the global severity level to **notice** for all enabled trap categories.

```
host1(config)#snmp-server enable traps bgp trapFilters notice
```

3. Configure the per-category severity level as **debug** for the SONET trap category. This setting overrides the **notice** trap severity level that was applicable for the SONET trap category.

```
host1(config)#snmp-server enable traps sonet per-category-trapFilters debug
```

The global severity level is configured as **notice** for all enabled trap categories except SONET, whose severity level is set as **debug**. This configuration occurs because the global severity level is overwritten to the last configured value and the per-category severity level takes precedence over the global severity level.

- There is no **no** version.
- See `snmp-server enable traps`.

snmp-server host

- Use to configure an SNMP trap host to refine the type and severity to traps that the host receives.
- A trap destination is the IP address of a client (network management station) that receives the SNMP traps.
- You can configure up to eight trap hosts on each virtual router.
- You can enable the traps listed in “Trap Categories” on page 167.
- You can filter traps according to the trap severity levels described in Table 23 on page 168.
- Example

```
host1(config)# snmp-server host 126.197.10.5 version 2c westford udp-port  
162 snmp link trapfilters alert
```

- Use the **no** version to remove the specified host from the list of recipients.
- See snmp-server host.

snmp-server trap-source

- Use to specify the interface whose IP address is used as the source address for all SNMP traps.



NOTE: When there are multiple IP addresses configured on the IP interface that is chosen as the SNMP trap source, the SNMP agent automatically uses the primary IP address of the interface as the SNMP source address on SNMP traps.

- Example

```
host1(config)#snmp-server trap-source fastethernet 0/0
```

- Use the **no** version to remove the interface from the trap configuration.
- See snmp-server trap-source.

snmp trap ip link-status

- Use to enable link-status traps on an IP interface.
- Example

```
host1(config-if)#snmp trap ip link-status
```

- Use the **no** version to disable link-status traps on an IP interface.
- See snmp trap ip link-status.

snmp trap ip link-status

- Use to configure the SNMP link-status traps on a particular interface.
- A link-up trap recognizes that a previously inactive link in the network has come up.
- A link-down trap recognizes a failure in one of the communication links represented in the server's configuration.
- Example

```
host1(config-controll)#snmp trap link-status
```

- Use the **no** version to disable these traps for the interface.



NOTE: This command operates in Controller Configuration mode. It is supported only by the DS3, DS1, and FT1 interface layers.

- See snmp trap ip link-status.

traps

- Use to specify traps for OSPF.
- Example

```
host1(config-router-rn)#traps all
```

- Use the **no** version to delete the specified trap, group of traps, or all traps.



NOTE: For additional information about configuring OSPF-specific traps, see *JUNOS IP, IPv6, and IGP Configuration Guide*.

- See traps.

Specifying an Egress Point for SNMP Traps

You can enable SNMP trap proxy, which allows you to specify a single SNMP agent as the egress point for SNMP traps from all other virtual routers. This feature removes the need to configure a network path from each virtual router to a single trap collector.

You can enable SNMP trap proxy from either SNMP or the CLI. Only one SNMP trap proxy can exist for a physical router.

The SNMP trap proxy does not forward global traps that it receives from other virtual routers. The corresponding SNMP agent handles global traps locally and does not forward them to the SNMP trap proxy.

To configure the SNMP trap proxy:

1. Access the virtual router context.
2. Enable or disable the SNMP trap proxy.

snmp-server trap-proxy

- Use to enable or disable the SNMP trap proxy.
- Example

```
host1(config)#snmp-server trap-proxy enable
```

- Use the **no** version to disable the SNMP trap proxy.
- See snmp-server trap-proxy.

Configuring Trap Queues

You can control the SNMP trap egress rate, specify the method of handling a full queue, and specify the maximum number of traps kept in the queue.

snmp-server host

- Use to control the SNMP trap egress rate for the host that is receiving SNMP traps. Use one or more of the following keywords:
 - **drainRate**—Specifies the maximum number of traps per second sent to the host
 - **full**—Specifies the method for handling the queue full condition
 - **size**—Specifies the maximum number of traps kept in the queue
- Example


```
host1(config)#snmp-server host 10.10.10.10 trapqueue drainrate 600 full
droplastin size 50
```
- Use the **no** version to remove the SNMP host.
- See snmp-server host.

Configuring Trap Notification Logs

SNMP uses the User Datagram Protocol (UDP) to send traps. Because UDP does not guarantee delivery or provide flow control, some traps can be lost in transit to a destination address. The Notification Log MIB provides flow control support for UDP datagrams.

You should set up your management applications to periodically request the recorded traps to ensure that the host is up and the management applications have received all the generated traps.

To identify the location of traps logged in the notification log, the system assigns a consecutive index number to each SNMP trap message transmitted from the E-series router. Clients can use the index to detect missing traps.

To configure trap notification logs:

1. Configure the notification log.

```
host1(config)#snmp-server notificationlog log 10.10.4.4 adminStatus
includeVarbinds
```

2. (Optional) Specify when the notification log ages out.

```
host1(config)#snmp-server notificationlog ageout 5
```

3. (Optional) Specify the maximum number of entries kept in the notification log.

```
host1(config)#snmp-server notificationlog entrylimit 210
```

4. (Optional) Enable the snmpTrap log to severity level info.

```
host1(config)#log severity info snmpTrap
```



NOTE: Enabling the snmpTrap log provides the same information in the router log as appears in the snmp-server notification log. However, long trap strings may appear truncated.

log severity

- Use to set the severity level for a selected category or for systemwide logs.



NOTE: For more information about this command, see the *JUNOS System Event Logging Reference Guide*.

- Example

```
host1(config)#log severity info snmptrap
```

- Use the **no** version to return to the default severity value (error) for the selected category. To return all logs to their default severity setting, include an * (asterisk) with the **no** version.
- See log severity.

snmp-server notificationLog ageOut

- Use to set the ageout for traps in the notification log tables. The range is 0–214748364 minutes.
- Example

```
host1(config)#snmp-server notificationLog ageout 5
```

- Use the **no** version to return the ageout limit to the default value, 1440 minutes.
- See snmp-server notificationLog ageOut.

snmp-server notificationLog entryLimit

- Use to set the maximum number of notifications kept in all notification log tables.
- The range is 1–500, which means that you can allocate up to 500 notifications across all virtual routers on the router. As you allocate the entry limits for virtual routers, the available range changes to reflect the number of notifications that you have allocated.
- Example

```
host1(config)#snmp-server notificationLog entrylimit 210
```

- Use the **no** version to return the limit to the default value, 500.
- See snmp-server notificationLog entryLimit.

snmp-server notificationLog log

- Use to configure SNMP notification log tables.
- Use the **adminStatus** keyword to enable administrative status.
- Use the **includeVarbinds** keyword to include log names and log indexes in the trap's variable bindings.
- Example

```
host1(config)#snmp-server notificationLog log 10.10.4.4 adminStatus
includeVarbinds
```

- Use the **no** version to remove the notification log configuration.
- See snmp-server notificationLog log.

Recovering Lost Traps

SNMP traps can be lost during startup of the E-series router for one of the following reasons:

1. The SNMP agent begins sending SNMP traps to the host before the line module is initialized.
2. If the SNMP proxy virtual router is initialized after other virtual routers, traps generated by the other virtual routers and sent to the proxy router are lost.

To recover SNMP traps that are lost during system startup, the SNMP agent pings the configured trap host to identify that there is a communication path between E-series router and host. On successful ping acknowledgment, the lost traps are reconstructed for each virtual router. In the case of scenario 1, the reconstructed traps are sent to the proxy virtual router to be routed to the appropriate hosts. In the case of scenario 2, the traps are sent directly to the appropriate hosts.

You can configure the ping timeout window with the **snmp-server** host command. The following are guidelines for setting the maximum ping window:

- If you are losing traps because of scenario 1, base the maximum ping window time on the estimated time that it takes to establish connectivity in a particular network. (For some configurations it can take more than 30 minutes to establish connectivity.)
- If you are losing traps because of scenario 2, we recommend that you use the default value for the maximum ping window time, which is one minute.

snmp-server host

- Use to set the ping timeout for the host that is receiving SNMP traps.
- Use the **pingtimeout** keyword to set the ping timeout window; the range is 1–90 minutes.
- Example

```
host1(config)#snmp-server host 10.10.4.4 pingtimeout 2
```


- Use the **no** version to remove the SNMP host.
- See snmp-server host.

Configuring the SNMP Server Event Manager

The SNMP server event manager works in conjunction with the Event MIB (RFC 2981). The purpose of this application is to allow many management functions (for example, fault detection, configuration management, accounting management, and performance management). These functions are traditionally performed by the network management station. However, by using the SNMP server event manager, you can distribute some of these functions to E-series routers and automate them.

Event MIB Purpose

The rapid growth of networks has made it impractical to directly manage networks from a single network management station (NMS). This brought about a need for a model that both automated and distributed event management. The goal was to allow devices to monitor themselves and other devices, and to take action under certain conditions.

The Event MIB (RFC 2981) defines a method for creating trigger conditions, testing those conditions, and determining which action to take when a trigger meets those conditions.

The Event MIB allows you to define test conditions for object integers that are accessible in the agent, making it possible to monitor any aspect of a device without defining specific notifications and complicating the agent definition. In this model, because devices have the ability to monitor themselves or other devices, the processing is distributed throughout the network. Also, sending the information only to the NMS that uses an event model reduces both network overhead and processing drain on the NMS.

Event MIB Structure

The Event MIB has three major parts: the trigger table, the objects table, and the event table. These tables also contain subordinate MIB tables that contain more detailed information about the trigger tests.

Trigger Table

The trigger table (mteTriggerTable) lists any currently-defined trigger conditions. Triggers fall into three categories—existence, Boolean, and threshold.

An *existence* trigger tests for the existence of a MIB object instance; you can specify that the trigger occur by either the appearance, disappearance, or change in value of a MIB instance.

A *Boolean* trigger tests whether the value of a MIB object (base syntax integer) is equal, unequal, greater than, less than, less than or equal to, or greater than or equal to some defined value.

A *threshold* trigger verifies a MIB object (base syntax integer) in relation to either a rising threshold value, falling threshold value, or both.

You can configure both Boolean and threshold tests to trigger on an *absolute value* or a *delta value* over a determined polling interval.

Subordinate MIB tables exist within the trigger section of each type of trigger test. In other words, each type of trigger (existence, threshold, and Boolean) contains a table that stores added information about that type of trigger test.

For example, a trigger entry of a specific type of test in the `mteTriggerTable` creates a linked entry in the appropriate subtable. In turn, this subtable contains more specific information about the specific test.

A *delta* table also exists within the trigger tables. This table stores information about any delta values based on any Boolean and threshold triggers. The delta table stores a MIB object that indicates whether any discontinuities occurred for any delta trigger (for example, a router reset).



NOTE: When determining discontinuity, the MIB object must be a time-based counter or number. When a polling interval expires and the event agent (router) needs to perform a delta calculation, it first checks the discontinuity MIB object for that trigger. If a discontinuity occurs, the agent does not perform the test for that trigger until the next polling interval.

Objects Table

The objects table (`mteObjectsTable`) defines objects that you want to add to event messages. In other words, you can create a list of user-specified objects and bind them to a trigger event. This can provide a snapshot of other values on a router when the trigger occurs. You can bind objects to a specific trigger, a type of test (for example, existence or Boolean tests), or a type of event (for example, rising or falling events).



NOTE: This release does not support the objects table.

Event Table

The event table (`mteEventTable`) defines what action you want the device to take when a trigger occurs. This action can be in the form of a notification, setting a specified MIB object, or both. The results of these actions are controlled within two subordinate MIB tables—notification and set.

Notifications (`mteNotifications`), or traps, define what the router sends when an event occurs. These traps include the following:

- When a Boolean or existence trigger occurs, the router sends an `mteTriggerFired` trap.
- When a rising threshold trigger occurs, the router sends an `mteTriggerRising` trap.
- When a falling threshold trigger occurs, the router sends an `mteTriggerFalling` trap.
- If a trigger fails to complete a test for any reason, the router sends a global `mteTriggerFailure` trap.
- If an event fails to set, the router sends an `mteEventSetFailure` trap.

Sets define certain modifications to other MIB objects based on a particular event.

Configuration Tasks

To configure the SNMP server event manager:

1. Access the SNMP server management event application.

```
host1(config)#snmp-server management-event
host1(config-mgmtevent)#
```



NOTE: You must create a management event instance for each virtual router.

2. (Optional) Specify the maximum number of trigger entries that you want the virtual router to support.

```
host1(config-mgmtevent)#resource 275
```

3. Create an event for each trap notification (`mteTriggerFailure`, `mteTriggerFalling`, or `mteTriggerRising`) that you want to use by specifying an event owner and event name.

```
host1(config-mgmtevent)#event sysadmin failuretrigger
host1(config-mgmtevent-event)#exit
host1(config-mgmtevent)#event sysadmin fallingtrigger
host1(config-mgmtevent-event)#exit
host1(config-mgmtevent)#event sysadmin risingtrigger
host1(config-mgmtevent-event)#exit
```



NOTE: You must create a separate event for each trap notification that you want to use. However, you can specify the trap notification and enable the trap before exiting the event context.

4. Define each event to send a trap notification (`mteTriggerFailure`, `mteTriggerFalling`, and `mteTriggerRising`).

```
host1(config-mgmtevent)#event sysadmin failuretrigger
host1(config-mgmtevent-event)#notification id mteTriggerFailure
```

```

host1(config-mgmtevent-event)#exit
host1(config-mgmtevent)#event sysadmin fallingtrigger
host1(config-mgmtevent-event)#notification id mteTriggerFalling
host1(config-mgmtevent-event)#exit
host1(config-mgmtevent)#event sysadmin risingtrigger
host1(config-mgmtevent-event)#notification id mteTriggerRising
host1(config-mgmtevent-event)#exit

```



NOTE: The mteTriggerFailure notification is a global value. Once you create a failure event notification, it is automatically bound to every trigger with the same owner. If a failure occurs, and the trigger owner and the event owner are the same, the router sends the trap.

5. Enable the event, and exit the event configuration level.

```

host1(config-mgmtevent)#event sysadmin failuretrigger
host1(config-mgmtevent-event)#enable
host1(config-mgmtevent-event)#exit
host1(config-mgmtevent)#event sysadmin fallingtrigger
host1(config-mgmtevent-event)#enable
host1(config-mgmtevent-event)#exit
host1(config-mgmtevent)#event sysadmin risingtrigger
host1(config-mgmtevent-event)#enable
host1(config-mgmtevent-event)#exit
host1(config-mgmtevent)#

```



NOTE: Once enabled, you cannot edit an event or trigger configuration. To change an enabled event or trigger, you must delete it and re-create it.

6. Define the trigger that you want to use for an event by specifying a trigger owner and trigger name.

```

host1(config-mgmtevent)#trigger george trigger1
host1(config-mgmtevent-trigger)#

```

7. Specify a MIB object to sample.

```

host1(config-mgmtevent-trigger)#sample value-id 1.3.6.1.2.1.60.1.2.1.1.7

```

8. Specify the frequency (in seconds) at which you want the sampling to occur.

```

host1(config-mgmtevent-trigger)#frequency 100

```



NOTE: Unless you specify that you want to perform delta sampling, the values are absolute.

9. (Optional) Specify that you want to perform delta sampling on the sample value ID.

```
host1(config-mgmtevent-trigger)#delta-sampling
```

- (Optional) Enter the discontinuity MIB value ID that you want to test.

```
host1(config-mgmtevent-trigger)#delta-sampling discontinuity-id  
1.3.6.1.2.1.31.1.1.1.19.9
```

- (Optional) Enter the discontinuity type (timeStamp or timeTicks) that you want the test to use.

```
host1(config-mgmtevent-trigger)#delta-sampling discontinuity-id-type  
timeStamp
```

10. (Optional) Configure the desired SNMP security level for the agent that you want to poll.

```
host1(config)#snmp security read
```

11. Define the test values that you want this trigger to use.

You can define a Boolean test, existence test, or threshold test. See the following sections for procedures.

Defining a Boolean Test

You can configure a Boolean trigger to test whether the value of an integer object is equal, unequal, greater than, less than, less than or equal to, or greater than or equal to some defined value.

To define a Boolean test:

1. Define the Boolean-test comparison that you want this trigger to use.

```
host1(config-mgmtevent-trigger)#boolean-test comparison greater
```

2. (Optional) Specify that you do not want the Boolean test to perform a comparison when this trigger first becomes active.

```
host1(config-mgmtevent-trigger)#boolean-test startup
```

3. Specify the events that you want the Boolean-test trigger to use by entering an event owner name and event name.



NOTE: You do not need to bind a failure event to a trigger. If you create a failure event and a failure occurs, the router sends the trap if the event owner is the same as the trigger owner.

```
host1(config-mgmtevent-trigger)#boolean-test event george trigger1
```

When specifying an event, use the exact owner name and event name. Specify the Boolean value to which the test compares.

```
host1(config-mgmt-event-trigger)#boolean-test value 5175438
```

4. Specify the agent on which the object resides.

```
host1(config-mgmt-event-trigger)#agent context-name router1
```

You can obtain the agent context name for a virtual router from the **show snmp agent** command. The agent context name is independent of the virtual router name. Enable the trigger.

```
host1(config-mgmt-event-trigger)#enable
```

Once enabled, you cannot edit an event or trigger configuration. To change an enabled event or trigger, you must delete it and re-create it.

Defining an Existence Test

An existence test looks for the existence of a MIB object. The appearance, disappearance, or a change in value of the object can trigger the existence test.

To define an existence test:

1. Define the existence test test-type value that you want this trigger to use.

```
host1(config-mgmt-event-trigger)#existence-test test-type changed
```

2. Define the startup threshold condition—absent or present—that you want this trigger to use.

```
host1(config-mgmt-event-trigger)#existence-test startup absent
```

3. Specify the events that you want the existence-test trigger to use by entering an event owner name and event name.



NOTE: You do not need to bind a failure event to a trigger. If you create a failure event, if a failure occurs, and if the trigger owner and the event owner are the same, the router sends the trap.

```
host1(config-mgmt-event-trigger)#boolean-test event george trigger1
```

When specifying an event, make sure to use the exact owner name and event name.

4. Specify the agent on which the object resides.

```
host1(config-mgmt-event-trigger)#agent context-name router1
```

You can obtain the agent context name for a virtual router from the **show snmp agent** command. The agent context name is independent of the virtual router name.

5. Enable the trigger.

```
host1(config-mgmtevent-trigger)#enable
```

Once enabled, you cannot edit an event or trigger configuration. To change an enabled event or trigger, you must delete it and re-create it.

Defining a Threshold Test

To define a threshold test:

1. Define the threshold-test values that you want this trigger to use.



NOTE: The rising value must always be larger than the falling value. Entering a lower rising value than a falling value will provide invalid results or errors.

- absolute-value—Use when defining absolute threshold values

```
host1(config-mgmtevent-trigger)#threshold-test absolute-value rising 2000
falling 1900
```

- delta-value—Use when defining delta threshold values

```
host1(config-mgmtevent-trigger)#threshold-test delta-value rising 2000 falling
1900
```

2. Define the startup threshold condition that you predict the sample to initially follow—falling, rising, risingorfalling. For example, if you are sampling a MIB value that you know will start from zero and rise, you would specify a rising startup condition.

```
host1(config-mgmtevent-trigger)#threshold-test startup rising
```

3. Specify the events (rising or falling) that you want the threshold-test trigger to use by entering an event owner name and event name.



NOTE: You do not need to bind a failure event to a trigger. If you create a failure event, if a failure occurs, and if the trigger owner and the event owner are the same, the router sends the trap.

```
host1(config-mgmtevent-trigger)#threshold-test event falling sysadmin
fallingtrigger
host1(config-mgmtevent-trigger)#threshold-test event rising sysadmin risingtrigger
```

When specifying an event, make sure to use the exact owner name and event name.

4. Specify the agent on which the object resides.

```
host1(config-mgmt-event-trigger)#agent context-name router1
```

You can obtain the agent context name for a virtual router from the **show snmp agent** command. The agent context name is independent of the virtual router name.

5. Enable the trigger.

```
host1(config-mgmt-event-trigger)#enable
```

Once enabled, you cannot edit an event or trigger configuration. To change an enabled event or trigger, you must delete it and re-create it.

agent context-name

- Use to specify the virtual router SNMP agent on which you want to poll MIB objects.
- The default is the current context (virtual router).
- The *contextName* value is the virtual router number in the order the virtual router was created (for example, router1, router2, and so on). Use the **show snmp agent** command to obtain the context name for the virtual router.
- Use the **wildcard** keyword to specify that the context name is a wildcard value.



NOTE: Use caution when assigning wildcards. Wildcards can rapidly use up trigger resources.

- Use the **limit** keyword to specify the maximum number of agents to be polled.
- Example 1

```
host1(config-mgmt-event-trigger)#agent context-name router1 wildcard
```

- Example 2

```
host1(config-mgmt-event-trigger)#agent context-name router1 wildcard limit 15
```



NOTE: SNMP server security defaults to “no access.” When using a separate virtual router, you must use the **snmp-server security** command and provide “read” or “read-write” access to other virtual routers.

- Use the **no** version to return to the default context (virtual router).
- See agent context-name.

boolean-test

- Use to define Boolean test values for the trigger that you are configuring, including comparison settings, a Boolean value, a startup condition, and binding an event to the Boolean-test trigger.

- Example 1—Specifying a comparison setting

```
host1(config-mgmt-event-trigger)#boolean-test comparison less
```

- Example 2—Specifying a Boolean value to which the test compares

```
host1(config-mgmt-event-trigger)#boolean-test value 5175438
```

- Example 3—Binding an event to the Boolean-test trigger

```
host1(config-mgmt-event-trigger)#boolean-test event sysadmin booleanTrigger
```

- Example 4—Setting the trigger to not perform a Boolean test on startup

```
host1(config-mgmt-event-trigger)#boolean-test startup
```

- Use the no version to delete the Boolean-test values for this trigger or to remove either the startup condition or event binding.
- See boolean-test.

delta-sampling

- Use to specify delta sampling for the trigger you are configuring.
- Example

```
host1(config-mgmt-event-trigger)#delta-sampling
```

- (Optional) Use the **discontinuity-id** option to specify a discontinuity MIB ID for the sample. The discontinuity MIB ID monitors the sample for any discontinuity errors during the sample frequency. If a discontinuity error occurs, the router removes the sampling for that interval.
- (Optional) Use the **discontinuity-id-type** option to specify a discontinuity ID type (either timeStamp or timeTicks). The discontinuity ID type indicates the time value that you expect for a specific sample.
- Use the no version to turn off delta sampling and use absolute sampling (the default).
- See delta-sampling.

enable

- Use to enable an event configuration or trigger configuration.
- Example 1—Event Configuration Mode

```
host1(config-mgmt-event)#enable
```

- Example 2—Trigger Configuration Mode

```
host1(config-mgmt-event-trigger)#enable
```

- Once enabled, you cannot edit an event or trigger configuration (even when it is disabled). To change an enabled event or trigger, you must delete it and re-create it.
- There is no no version.
- See enable.

event

- Use to create an event and access the event configuration mode of the SNMP server event manager.
- Example

```
host1(config-mgmt-event)#event sysadmin failuretrigger
host1(config-mgmt-event-event)#
```

- To leave the event configuration mode, use the **exit** command.
- Use the no version to remove the event.
- See event.

existence-test

- Use to define existence test values for the trigger that you are configuring, including binding an event to the existence-test trigger, specifying a startup condition, and defining an existence-test type.
- You can specify one or both startup conditions in the same command. You can specify one, two, or all three test types in the same command.
- Example 1—Binding an event to the Boolean-test trigger

```
host1(config-mgmt-event-trigger)#existence-test event sysadmin existenceTrigger
```

- Example 2—Specifying a startup condition

```
host1(config-mgmt-event-trigger)#existence-test startup present
```

- Example 3—Specifying an existence test type

```
host1(config-mgmt-event-trigger)#existence-test test-type absent
```

- Use the no version to delete the existence-test values for this trigger or to remove either the startup condition or event binding.
- See existence-test.

frequency

- Use to set the frequency (in seconds) at which you want MIB sampling to occur.
- Example

```
host1(config-mgmt-event)#frequency 100
```

- Use the no version to restore the default frequency value (600 seconds).
- See frequency.

notification id

- Use to specify a trap notification for an event.
- Example

```
host1(config-mgmtevent-event)#notification id mteTriggerFailure
```

- Use the no version to remove the notification from the event. Removal returns the notification value to its default (0.0)
- See notification id.

resource

- Use to specify the total number of triggers that the virtual router allows.



CAUTION: When assigning wildcards, make sure to allow for enough trigger resources.

- Example

```
host1(config-mgmtevent-event)#resource 250
```

- Use the no version to restore the default resource value (50).
- See resource.

sample

- Use to specify the MIB object that you want to sample for the trigger that you are configuring.
- Example

```
host1(config-mgmtevent)#sample value-id 1.3.6.1.2.1.60.1.2.1.1.7
```

- Use the no version to remove the MIB object from the trigger. Removal returns the sample value-id to its default (0.0).
- See sample.

set

- Use to perform an SNMP set operation under certain event conditions.
- Example—Sets the administrative status of interface 123 to down (2)

```
host1(config-mgmtevent-event)#set context-name router1  
host1(config-mgmtevent-event)#set id 1.3.6.1.2.1.2.2.1.7.123  
host1(config-mgmtevent-event)#set value 2
```

- Use the **no** version to remove the set operation.
- See set.

snmp-server management-event

- Use to launch the SNMP server event manager mode on each virtual router on which you plan to manage events.
- Example

```
host1(config)#snmp-server management-event
host1(config-mgmtevent)#
```

- To leave the SNMP server event manager, use the **exit** command.
- Use the **no** version to delete all the management events.
- See snmp-server management-event.

snmp-server security

- Use to specify a security access level for the SNMP agent.
- Example

```
host1(config)#snmp-server security read
```

- Use the **no** version to return to the SNMP security level to its default (no-access).
- See snmp-server security.

threshold-test

- Use to define the threshold values for the trigger that you are configuring, including specifying rising and falling values, a startup threshold condition, and binding an event to the threshold-test trigger.
- Example 1—Specifying absolute values

```
host1(config-mgmtevent-trigger)#threshold-test absolute-value rising 2000 falling
1900
```

- Example 2—Specifying a startup threshold condition

```
host1(config-mgmtevent-trigger)#threshold-test startup rising
```

- Example 3—Binding an event to the threshold-test trigger

```
host1(config-mgmtevent-trigger)#threshold-test event sysadmin failureTrigger
```

- Use the **no** version to delete the threshold-test values for this trigger or remove either the threshold startup condition or event binding.
- See threshold-test.

trigger

- Use to create a trigger and access the trigger configuration mode of the SNMP server event manager.
- Example


```
host1(config-mgmtevent)#trigger fred trigger1
host1(config-mgmtevent-trigger)#
```
- To leave the trigger configuration mode, use the **exit** command.
- Use the no version to remove the trigger.
- See trigger.

Monitoring Events

To view the status of the SNMP agent, use the following **show snmp agent** command. To view statistics associated with events, resources, and triggers, use the **show snmp management-event** command.

show snmp agent

- Use to view SNMP MIB agent information.
- Field descriptions
 - context name—Router that contains the MIB agent
 - access permission level—Access permission level for other virtual routers that may want to access the agent
- Example


```
host1#show snmp agent
context name: router1
access permission level: no access
snmp proxy: enabled
```
- See show snmp agent.

show snmp management-event

- Use to view statistical SNMP event information for event table entries, router resources, and trigger table entries.
- Omit the **events**, **resource**, **statistics**, or **triggers** options to obtain a full output.
- Field descriptions
 - Resource
 - SampleMinimum—Minimum number of samples to be taken
 - SampleInstanceMaximum—Maximum number of samples to be taken
 - SampleInstances—Number of sample instances being monitored

- SampleInstancesHigh—Highest number of samples taken for any of the sample instances
- SampleInstancesLacks—Number of times this system could not take a new sample because that allocation would have exceeded the limit set by mteResourceSampleInstanceMaximum
- Triggers
 - Owner—Owner value assigned to the trigger
 - Name—Name value assigned to the trigger
 - Test—Type of trigger test to perform
 - SampleType—Type of sampling (absolute or delta) to perform
 - ValueID—Object ID of the MIB sample for this trigger
 - ValueIDLimit—Not supported in this release; reads as zero
 - ValueIDWildcard—Not supported in this release; reads as False
 - ContextName—Management context (for example, router1) from which to obtain mteTriggerValueID
 - ContextNameRgultExprssn—Not supported in this release
 - ContextNameLimit—Not supported in this release; reads as zero
 - ContextNameWildcard—Not supported in this release; reads as False
 - Frequency—Frequency at which this trigger is sampled
 - ObjectsOwner—Not supported in this release
 - Objects—Not supported in this release
 - Enabled—State (False [disabled] or True [enabled]) of the trigger
 - EntryStatus—Active/inactive status of the instance
- Boolean
 - Comparison—Comparison value for this trigger
 - Value—Object ID value to which this trigger compares
 - Startup—Whether or not this trigger performs a Boolean test on startup
 - ObjectsOwner—Owner of this object
 - Objects—Name of this object
 - EventOwner—Owner of this event
 - Event—Name of this event
- Existence

- Test—Test type for this trigger
- Startup—Startup condition for this trigger
- ObjectsOwner—Owner of this object
- Objects—Name of this object
- EventOwner—Owner of this event
- Event—Name of this event
- Statistics
 - trigger owner—Owner value assigned to the trigger
 - trigger name—Name value assigned to the trigger
 - current time—Current UTC time
 - started sampling—UTC time sampling started
 - last sampled—UTC time event last sampled
 - sample instances—Number of sample instances being monitored
 - times sampled—Number of times events sampled
 - event traps—Number of traps sent
 - event sets—Number of events set
 - failures—Number of event failures
 - sample overrun—Number of times the event manager missed sampling for the current value within the given time period
 - failure traps—Number of failure traps sent as a result of event failures
- Threshold
 - Startup—Startup threshold condition for this trigger
 - Rising—Rising threshold condition for this trigger
 - Falling—Falling threshold condition for this trigger
 - DeltaRising—Delta rising threshold condition for this trigger
 - DeltaFalling—Delta falling threshold condition for this trigger
 - ObjectsOwner—Not supported in this release
 - Objects—Not supported in this release
 - RisingEventOwner—Rising event owner value for this trigger
 - RisingEvent—Rising event name value for this trigger
 - FallingEventOwner—Falling event owner value for this trigger

- FallingEvent—Falling event name value for this trigger
- DeltaRisingEventOwner—Delta rising event owner value for this trigger
- DeltaRisingEvent—Delta rising event name value for this trigger
- DeltaFallingEventOwner—Delta falling event owner value for this trigger
- DeltaFallingEvent—Delta falling event name value for this trigger
 - Delta
 - DiscontinuityID—Discontinuity MIB ID for this trigger
 - DiscontinuityIDWildcard—Not supported in this release
 - DiscontinuityIDType—Discontinuity ID type for this trigger
- Events
 - Owner—Owner value for this event
 - Name—Name of this event
 - Actions—Action (for example, notification) that takes place when this event is triggered
 - Enabled—Enabled state (True [enabled] or False [disabled]) of this event
 - EntryStatus—Entry status for this event
- Notification
 - Notification—Notification trap setting for this event
 - ObjectsOwner—Not supported in this release
 - Objects—Not supported in this release
- Set
 - Object—Object ID that the trigger is setting
 - ObjectWildcard—Whether or not the object is a wildcard
 - Value—Value to which you are setting the object ID when the trigger fires
 - ContextName—Management context (for example, router1) from which to obtain mteTriggerValueID
 - ContextNameWildcard—Whether or not the context name is a wildcard
- Example

```
host1#show snmp management-event
```

```
Resource
```

```
-----
SampleMinimum: 1
SampleInstanceMaximum: 50
```



```

SampleInstances: 14
SampleInstancesHigh: 14
SampleInstancesLacks: 0

```

Triggers

```

-----
Owner: unitTest
Name: booleantest1
Test: boolean
SampleType: absoluteValue
ValueID: 1.3.6.1.2.1.92.1.1.2.0
ValueIDLimit: 0
ValueIDWildcard: False
ContextName: router1
ContextNameLimit: 0
ContextNameWildcard: False
Frequency: 40
ObjectsOwner: unitTest
Objects: test3
Enabled: False
EntryStatus: createAndWait
----- Boolean
Comparison: equal
Value: 300
Startup: False
ObjectsOwner:
Objects:
EventOwner: unitTest
Event: eventTest1
----- Trigger
Owner: unitTest
Name: booleantest2
Test: boolean
SampleType: absoluteValue
ValueID: 1.3.6.1.2.1.92.1.1.2.0
ValueIDLimit: 0
ValueIDWildcard: False
ContextName: router1
ContextNameLimit: 0
ContextNameWildcard: False
Frequency: 40
ObjectsOwner: unitTest
Objects: test3
Enabled: False
EntryStatus: createAndWait
----- Existence
Test: absent
Startup: absent
ObjectsOwner: unitTest
Objects: test3
EventOwner: unitTest
Event: eventTest3
----- Threshold
Startup: falling
Rising: 200
Falling: 100
DeltaRising: 0
DeltaFalling: 0
ObjectsOwner:
Objects:
RisingEventOwner: unitTest

```

```

RisingEvent: eventTest2
FallingEventOwner: unitTest
FallingEvent: eventTest3
DeltaRisingEventOwner:
DeltaRisingEvent:
DeltaFallingEventOwner:
DeltaFallingEvent:
----- Delta
DiscontinuityID: 1.3.6.1.2.1.92.1.1.2
DiscontinuityIDWildcard: True
DiscontinuityIDType: timeTicks

```

Objects

```

-----
Owner: unitTest Name: test1
Index: 1
ID: 1.3.6.1.2.1.11.1.0
IDWildcard: False
EntryStatus: active
Index: 2
ID: 1.3.6.1.2.1.11.2.0
IDWildcard: False
EntryStatus: active
Index: 5
ID: 1.3.6.1.2.1.11.30.0
IDWildcard: False
EntryStatus: active

```

Events

```

-----
Owner: unitTest
Name: eventTest1
Actions: notification set
Enabled: True
EntryStatus: active
----- Notification
Notification: mteTriggerFired
ObjectsOwner: unitTest
Objects: test3
----- Set
Object: 1.3.6.1.2.1.11.1.0
ObjectWildcard: False
Value: -20
ContextName: router
ContextNameWildcard: True

```

- See `show snmp management-event`.

Collecting Bulk Statistics

The router offers an efficient data collection and transfer facility for accounting applications. The E-series router SNMP MIBs extend the accounting data collection mechanism defined in the Accounting-Control-MIB (RFC 2513) to include support for connectionless networks.

Service providers need reasonably accurate data about customers' use of networks. This data is used for billing customers and must be available at a customer's request. Accounting applications based on SNMP polling models consume significant network bandwidth because they poll large volumes of data frequently.

Unfortunately, SNMP is not well suited for gathering large volumes of data, especially over short time intervals. It is inadequate for use by accounting applications because:

- The SNMP PDU layout has a low payload-to-overhead ratio.
- Processing SNMP PDUs is expensive because objects and tables need to be sorted in lexicographic order.

The router avoids the need for continuous polling of SNMP statistics by using applications known as *collectors* to retrieve data. You can configure up to six collectors. The router sends collected statistics through FTP to assigned hosts, known as *receivers*. You must assign a primary receiver to each collector, and you can assign a secondary receiver for redundancy.



NOTE: The basic-encoding-rules (BER)-encoding choice is not supported.

You can collect interface bulk statistics based on sets of virtual router groups. If sets of virtual router groups generally correspond to ISPs, you can then forward the relevant data to a particular ISP.

To configure a collector to include data from a specific list of virtual routers, you must first configure a collector and then associate a router set with it. A collector can have up to 64 virtual routers associated with it.

To collect bulk statistics for a subset of all configured subinterfaces, you can define the subinterfaces using the following syntax:

Slot/Port[.subInterfaceId]

Per virtual router collection is supported on the if-stats and igmp schemas. It is supported on all interface types supported by BulkStats. Collectors modified to use per virtual router collection or configured after a collector has started have a time delay (up to the configured time in seconds) until an active collector starts again.

The maximum number of interfaces for each type of interface and line module can differ. Bulk statistics can collect these statistics when you configure the slots with their respective interfaces to the corresponding maximum values. For information about maximum values see *JUNOS Release Notes, Appendix A, System Maximums*.



NOTE: Define all interface types before you map a collector to the if-stats schema to ensure that you display statistics for all configured interfaces in the first interval.

The name of the bulk statistics file that is transferred to the host when there is a collectorSequence attribute in the remote name is as follows:

fileName - z - mmddHHMM - s. sts

where:

- *fileName*—Name of the file, which includes sysName, sysUpTime, depending on the attributes specified
- -z—Receiver index value
- mmddHHMM—Timestamp when the receiver is created in month/day/hour/minute format
- -s—Actual sequence number

Interface Strings

Bulk statistics provides interface strings as described in Table 24 on page 196.

Table 24: Interface Strings

Type of Interface	Common Description Format-Mode Disabled	Common Description Format-Mode Enabled
IP interfaces	IP	Ip
PPP interfaces	PPP	Ppp
DS0 interfaces	Ds0	Ds0
DS1 interfaces	SERIAL	Ds1
DS3 interfaces	SERIAL	Ds3
Frame Relay Major interfaces	FR	FrameRelayMajor
Ethernet interfaces	ENET	Ethernet
Sonet interfaces	SONET	Sonet
Sonet Path interfaces	SONET	SonetPath
ATM interfaces	ATM	Atm
ATM AAL5 interfaces	ATM	AtmAal5
ATM 1483 interfaces	ATM	Atm1483
Ft1 interfaces	SERIAL	Ft1
HDLC interfaces	HDLCIntf	HDLC
IpLoopback interfaces	Loopback	IpLoopback
IpVirtual interfaces	IpVirtual	IpVirtual
Frame Relay Sub interfaces	FR	FrameRelaySub

Table 24: Interface Strings (continued)

Type of Interface	Common Description Format-Mode Disabled	Common Description Format-Mode Enabled
PppOE Major interfaces	PPPoE	PppoeMajor
PppOE Sub interfaces	PPPoE	PppoeSub
Bridged Ethernet	BRG-ET	BridgedEthernet
L2TP Tunnel	L2TP	L2tpTunnel
L2TP Session	L2TP	L2tpSession
PppLink interfaces	MLPPP	PppLink
HDLC interfaces	HDLCEncaps	Hdlc
L2TP Destinaiaon	L2TP	L2tpDestination
MPLS Major interfaces	MplsIfMajor	MplsMajor
MPLS Minor interfaces	MplsIfMinor	MplsMinor
Ppp Network interfaces	MLPPP	PppNetwork
Ethernet Sub interfaces	ENET	EthernetSub
MultiLink Frame Relay interfaces	MLFR	MultilinkFrameRelay
Ip Tunnel Interfaces	IP-TUNNEL	IpTunnel
Server Port Interfaces	ServerPort	ServerPort
Sonet VT interfaces	SONET	SonetVT
Vlan major interfaces	VLAN-MAJ	VlanMajor
Vlan sub interfaces	VLAN-SUB	VlanSub
Gtp interfaces	Gtp	Gtp
L2fTunnel interfaces	L2fTunnel	L2fTunnel
L2fSession interfaces	L2fSession	L2fSession
L2fDestination interfaces	L2fDestination	L2fDestination
IpSec Tunnel interfaces	IpSecTunnel	IpssecTunnel
Sg interfaces	SgInterface	SgInterface
MPLS L2 Shim interfaces	MplsL2Shim	MplsL2Shim
MPLS VC Sub interfaces	MplsL3Shim	MplsVcSub
LacGen interfaces	LacGen	LacGen

Table 24: Interface Strings *(continued)*

Type of Interface	Common Description Format-Mode Disabled	Common Description Format-Mode Enabled
Bridge interfaces	Bridgelf	Bridge
IPSec Transport interfaces	IPSecTransportIf	IpssecTransport
IPv6 interfaces	IPv6If	Ipv6
IPv6 Tunnel interfaces	IPv6TunnelIf	Ipv6Tunnel
IPv6 loopback interfaces	IPv6LoopbackIf	Ipv6Loopback
OSI interfaces	Osi	Osi
LAG interfaces	Lag	Lag
Ip Tunnel MDT interfaces	IpTunnelMdt	IpTunnelMdt

Understanding Counter Discontinuity

Interface counter discontinuity can occur when a counter wraps or after a line module is reloaded or reset. If one of these actions occurs, applications that utilize the counters in expressions or calculations generate erroneous values and misleading graphs.

Because counters are 64 bits long, the possibility of a counter's wrapping naturally would occur so infrequently (for example, in many hundreds of years) that this scenario is not recognized as an issue.

Counter discontinuity does occur, however, when you reload or reset a line module. To indicate reloading or resetting, bulk statistics files contain a record similar to the following:

```
{Controller down slot 3, TUE OCT 29 2004 14:25:10.370 UTC}
```

This record provides a mechanism by which applications can detect discontinuity events. To take advantage of this detection capability, the bulk statistics parsing entity should use the record to terminate expression or formula calculations for the indicated slot and to establish a new baseline.

Configuring Collectors and Receivers

To configure the router to collect statistics:

1. Add names to the FTP host table for the primary and secondary (optional) receivers.

See “Copying and Redirecting Files” on page 282 in “Managing the System” on page 235, for information about adding names to the host table.

2. Specify the type of interface on which you want to collect statistics.

```
host1(config)#bulkstats interface-type ppp collector 2
```

3. Specify the parameters for the receivers.

```
host1(config)#bulkstats receiver 1 remote-name js:/ftptest/bulk%%s.sts  
sysName sysUpTime
```

4. Assign the data collector.

```
host1(config)#bulkstats collector 2
```

5. Specify the method for data collection.

```
host1(config)#bulkstats collector 2 collect-mode auto
```

6. Assign the primary receiver.

```
host1(config)#bulkstats collector 2 primary-receiver 1
```

7. (Optional) Assign the secondary receiver.

```
host1(config)#bulkstats collector 2 secondary-receiver 5
```

8. (Optional) Specify the time for which the system transfers data.

```
host1(config)#bulkstats collector 2 interval 1000
```

9. (Optional) Set the maximum size of the bulk statistics file.

```
host1(config)#bulkstats collector 2 max-size 20480
```

10. (Optional) Add descriptive information to the bulk statistics file.

```
host1(config)#bulkstats collector 2 description customer xyz
```

11. (Optional) Set the encoding scheme of the ifDescr and ifName objects.

```
host1(config)#bulkstats interfaces description-format common
```

12. (Optional) Set the system to retrieve bulk statistics once only.

```
host1(config)#bulkstats collector 2 single-interval
```

13. (Optional) Configure bulk statistics traps.

```
host1(config)#bulkstats traps nearly-full
```

14. (Optional) Collect bulk statistics per virtual router.

```
host1(config)#bulkstats virtual-router-group collector 2 routerISP3
```



NOTE: The bulk statistics feature supports generating files on a per interface basis.

bulkstats collector

- Use to assign the data collector.
- Example

host1(config)#**bulkstats collector 2**

- Use the **no** version to delete the collector.
- See bulkstats collector.

bulkstats collector

- Use to specify the way the collector retrieves bulk statistics.
- Example

host1(config)#**bulkstats collector 2 collect-mode auto**

- Use the **no** version to specify that either the user or the system will initiate transfers manually.
- See bulkstats collector.

bulkstats collector

- Use to add descriptive information to the bulk statistics file.
- Example

host1(config)#**bulkstats collector 2 description customer xyz**

- Use the **no** version to remove descriptive text from the bulk statistics file.
- See bulkstats collector.

bulkstats collector

- Use to specify the time interval in seconds for which the collector transfers data to the receivers.
- Example

host1(config)#**bulkstats collector 2 interval 1000**

- Use the **no** version to set this time to the default, 360 seconds (6 minutes).
- See bulkstats collector.

bulkstats collector

- Use to set the maximum size of the bulk statistics file for all collectors combined. Even when you configure more than one collector, the first maximum file size configured is the combined size of all collectors.
- The maximum file size that you can configure is 20971520 bytes. However, if you do not configure a maximum size, then the maximum file size defaults to 5767168 bytes.
- Although the CLI accepts the commands, you cannot unconfigure or modify the configuration of the maximum file size until the router is rebooted.
- Example

```
host1(config)#bulkstats collector 2 max-size 20480
```

- Use the **no** version to set the size of the bulk statistics file to the default, 5767168 bytes.
- See bulkstats collector.

bulkstats collector

- Use to assign the primary receiver to which the system transfers data.
- The index for the receiver must match the index that you specified with the bulkstats receiver remote-name command.
- Example

```
host1(config)#bulkstats collector 2 primary-receiver 7
```

- Use the **no** version to clear the primary receiver and disable the collector.
- See bulkstats collector.

bulkstats collector

- Use to assign the secondary (that is, the backup) receiver to which the system transfers data.
- The index for the receiver must match the index you specified with the bulkstats receiver remote-name command.
- Example

```
host1(config)#bulkstats collector 2 secondary-receiver 5
```

- Use the **no** version to clear the secondary receiver.
- See bulkstats collector.

bulkstats collector

- Use to set the system to retrieve bulk statistics once only, rather than periodically.
- Example

```
host1(config)#bulkstats collector 2 single-interval
```

- Use the **no** version to set the system to retrieve bulk statistics periodically, the default situation.
- See bulkstats collector.

bulkstats interfaces description-format common

- Use to set the encoding scheme of the ifDescr object that the bulk statistics application reports to the conventional industry method.
- This command provides compatibility with software that uses the industry encoding scheme.
- For more information, see “Configuring Encoding Method” on page 162.
- Example

```
host1(config)#bulkstats interfaces description-format common
```

- Use the **no** version to return to the proprietary method of encoding.
- See bulkstats interfaces description-format common.

bulkstats interface-type

- Use to configure the interface or subinterface type on which you want to collect statistics.
- You can provide an interface specifier (location) to identify a specific interface on which you want to collect statistics.
- If you define more than one collector, you must specify a unique collector index, in the range 1–65535.
- The supported interface types are:
 - **atm**—Collects statistics on ATM interfaces
 - **atm1483**—Collects statistics on ATM 1483 interfaces
 - **ethernet**—Collects statistics on Ethernet interfaces
 - **frame-relay**—Collects statistics on Frame Relay interfaces
 - **frame-relay-sub**—Collects statistics on Frame Relay subinterfaces
 - **hdlc**—Collects statistics on Cisco HDLC interfaces
 - **ip**—Collects statistics on IP interfaces
 - **mplsMajor**—Collects statistics on MPLS major interfaces
 - **mplsMinor**—Collects statistics on MPLS minor interfaces
 - **mplsL2shim**—Collects statistics on MPLS shim interfaces
 - **ppp**—Collects statistics on PPP
 - **vlan**—Collects statistics on VLAN subinterfaces



NOTE: You cannot collect statistics on the SRP Ethernet interface.

- Example 1

```
host1(config)#bulkstats interface-type ppp 3/1 collector 2
```

- Example 2

```
host1(config)#bulkstats interface-type vlan 2/3:1 collector 1
```

- Example 3

```
host1(config)#bulkstats interface-type mplsMajor 2/3:1 collector 1
```

- Use the **no** version to delete the interface type from bulk statistics collection. Deletion of a particular interface type takes effect at the next collection interval.
- See `bulkstats interface-type`.

bulkstats receiver remote-name

- Use to configure the parameters for receivers.
- Bulk statistics transfers require the configuration of a remote FTP server.
- The receivers must appear in the FTP host table. The name of the host must match the name you specify with this command. The hostname is relative to the virtual router's context when you issue this command.
- When specifying the remote filename for bulk statistics, you must precede the filename with the hostname followed by the `:/` characters.
- Example

```
host1(config)#bulkstats receiver 1 remote-name js:/ftptest/bulk%s%s.sts  
sysName sysUpTime
```



NOTE: The % variables in the remote name are replaced at runtime with the `sysName` and `sysUpTime` parameters to produce variable filenames on the remote host.

- Use the **no** version to delete the receiver.
- See `bulkstats receiver remote-name`.

bulkstats traps

- Use to configure bulk statistics traps.
- You must configure SNMP correctly and specify a valid trap source. Otherwise, the system will not send SNMP traps.
- Example

```
host1(config)#bulkstats traps nearly-full
```

- Use the **no** version to disable the trap.
- See bulkstats traps.

bulkstats virtual-router-group

- Use to collect interface statistics for each virtual router.
- A collector can have a maximum of 64 virtual routers associated with it.
- Routers are identified by their assigned name or router index.
- Supported only on if-stats and igmp schemas.
- Supported on all interface types supported by the bulk statistics application.
- Collectors modified to use per virtual router collection or configured after a collector has started have a time delay until an active collector starts again.
- Example

```
host1(config)#bulkstats virtual-router-group collector 2 routerISP3
```

- Use the no version to prevent bulkstats from being reported for virtual router groups.
- See bulkstats virtual-router-group.

Deleting All Bulkstats Configurations

Although individual bulkstats commands allow you to disable or delete a specific bulkstats parameter, the CLI also allows you to remove all bulkstats configurations from the router at one time.

no bulkstats

- Use to remove all bulkstats configurations from the router at one time.
- Example

```
host1(config)#no bulkstats
```

- See no bulkstats.

Monitoring Collection Statistics

To view the parameters the router uses to collect statistics, use the following **show bulkstats** commands.

To include or exclude lines of output based on a text string that you specify, use the output filtering feature for **show** commands. For details, see “Command-Line Interface” on page 29.

show bulkstats

- Use to display the bulk statistics data collection configuration.
- Field descriptions

- AdminStatus—Administrative status of the bulk statistics application
- OperStatus—Operational status of the bulk statistics application, enabled or disabled
- Interface Description Setting—Method used to encode the ifDescr object: common, proprietary, industry-common
- File Format—End of the line format in bulkstats files, carriage return and line feed (CR + LF) or LF
- Current Time—Current system time used to compare with the collection stop/start time
- Intervals—Number of times the bulk statistics collector has cycled through a collection
- PrimaryXfers—Number of times the bulk statistics collector has attempted a data file transfer to a primary server
- PrimaryFails—Number of primary server transfer failures
- SecondaryXfers—Number of times the bulk statistics collector has attempted a data file transfer to a secondary server
- SecondaryFails—Number of secondary server transfer failures
- BulkStats Collector Information:
 - Index—Bulk statistics collector index number
 - CurrSize—Current size of the bulk statistics file in bytes
 - MaxSize—Maximum size configured for the bulk statistics file in bytes
 - Intrvl—Time interval between bulk collections in seconds
 - Mode—How often the collector is set up to collect statistics:
 - periodic—Collects statistics periodically
 - single-interval—Collects statistics once only
 - XferMode—Collect mode configured for the collector:
 - auto—Agent transfers file when interval expires
 - manual—Network management system or the user initiates transfers
 - onFull—Agent transfers file when it reaches the maximum size
 - State
 - inProg—Collector is properly configured and currently active
 - notInSvc—Collector has been decommissioned by a management client

- notReady—Collector does not have enough configuration information to go active
 - error—Configuration or operational error
- Index—Bulk statistics collector index number
- Primary-Receiver—Index number of the primary receiver to which the system transfers data, if defined
- Second-Receiver—Index of the secondary receiver to which the system transfers data
- Last Transfer Failure—Last time that the collector attempted to retrieve statistics and was unsuccessful
- Interval Start Time—Start of current interval of bulk collections. The collector began collecting bulk statistics at this time.
- Interval Stop Time—End of current interval of bulk collections.
- Schema Information:
 - Index—Index number of the schema
 - Subtree—Type of bulk statistics schema configured on the collector: if-stack, if-stats, or system
 - CollectorIndex—Bulk statistics collector index number
 - Create-Delete Time Stats—State of final statistics collection (enabled or disabled)
 - Create-Delete Interface Type—Interface type associated with final statistics collection (ATM 1483, IP, PPP)
 - State
 - active—Schema is properly configured and currently active
 - notInSvc—Schema has been decommissioned by a management client
 - notReady—Schema does not have enough configuration information to go active
 - error—Configuration or operational error
 - Subtree List—Types of statistics the schema is configured to receive
- Interface Types:
 - Index—Index number of the interface type entry
 - Type—Interface type for which bulk statistics collection is configured

- **CollectorIndex**—Index number of the collector to which the interface type applies
- **State**
 - **active**—Interface type is properly configured and currently active
 - **notInSvc**—Interface type has been decommissioned by a management client
 - **notReady**—Interface type does not have enough configuration information to go active
 - **error**—Configuration or operational error
- **Receiver Information:**
 - **Index**—Index number of the receiver
 - **RemoteFileName**—Hostname, path, and filename of the remote FTP server
 - **State**
 - **active**—Receiver is properly configured and currently active
 - **notInSvc**—Receiver has been decommissioned by a management client
 - **notReady**—Receiver does not have enough configuration information to go active
 - **error**—Configuration or operational error
 - **Status**
 - **Success**
 - **Copy source does not exist or is unreachable**
 - **Copy failed**
 - **File in use**
- **Virtual Router Groups:**
 - **Collector**—Number that identifies the particular data collector, in the range 1–65535
 - **Virtual-Routers**—Set of virtual router names (up to 64 names)
- **Example**

```
host1#show bulkstats
```

```
AdminStatus: enabled
OperStatus: enabled
Interface Description Setting: industry-common
File Format: CR+LF
Current Time: TUE AUG 15 2002 15:54:20 UTC
```

Intervals	PrimaryXfers	PrimaryFails	SecondaryXfers	SecondaryFails
0	0	0	0	0

BulkStats Collector Information:

Index	CurrSize	MaxSize	Intrvl	Mode	XferMode	State
1	490	3670016	600	periodic	manual	inProg
2	0	3670016	360	periodic	manual	notReady

Index	Primary-Receiver	Second-Receiver	Last Transfer Failure
1	1	not defined	
2	not defined	not defined	

Index	Interval Start Time	Interval Stop Time
1	TUE AUG 15 2000 15:52:33 UTC	TUE AUG 15 2000 16:02:33 UTC
2	Not started	N/A

Schema Information:

Index	Subtree
1	ifStats

Index	CollectorIndex	State
1	1	active

Index	Create-Delete Time Stats	Create-Delete Interface Types
1	enabled	IP

Index	Subtree List
1	all

Interface Types:

Index	Type	CollectorIndex	State
1	Ppp	1	active
6	Ethernet	1	active
11	Atm1483	1	active

Receiver Information:

Index	RemoteFileName
1	host:/upload/bulkStas.sts

Index	State	Status
1	notReady	Copy source does not exist or is unreachable

Collector Virtual-Routers

33	serviceProviderABC
655	default

- See show bulkstats.

show bulkstats collector description

- Use to display information about the collector's file description.
- Field descriptions
 - Index—Index number of the bulk statistics collector
 - FileDescription—Descriptive information added to the bulk statistics file with the **bulkstats collector description** command
- Example

```
host1#show bulkstats collector description
Index  FileDescription
-----
1      Bulk SNMP Statistics Collection
```

- See show bulkstats collector description.

show bulkstats collector interval

- Use to display information about the collector transfer interval configuration.
- Field descriptions
 - Index—Index number of the bulk statistics collector
 - Interval—Amount of time, in seconds, that the collector transfers data to the receiver
- Example

```
host1#show bulkstats collector interval
Index  Interval
-----
1      360
```

- See show bulkstats collector interval.

show bulkstats collector max-size

- Use to display information about the bulk statistics maximum file size configuration.
- Field descriptions
 - Index—Index number of the bulk statistics collector
 - MaxSize—Maximum size of the bulk statistics file in bytes
- Example

```
host1#show bulkstats collector max-size
Index  MaxSize
-----
1      2097152
```

- See `show bulkstats collector max-size`.

show bulkstats collector transfer-mode

- Use to display information about the bulk statistics transfer mode configuration.
- Field descriptions
 - Index—Index number of the bulk statistics collector
 - Transfer-Mode:
 - auto-xfer—Server automatically transfers the bulk statistics files to a remote FTP server
 - manual-xfer—Server expects the user to transfer bulk statistics files
 - on-file-full—Server transfers the bulk statistics file when the file reaches its maximum size
 - Primary-Receiver—Receives the bulk statistics sent by the collector
 - Secondary-Receiver—Serves as a backup to the primary receiver
- Example

```
host1#show bulkstats collector transfer-mode
Index  Transfer-Mode  Primary-Receiver  Secondary-Receiver
-----
1      auto-xfer    1                 2
```

- See `show bulkstats collector transfer-mode`.

show bulkstats interface-type

- Use to display information about the bulk statistics interface types configuration.
- Field descriptions
 - Interface Types:
 - Index—Index number of the interface type entry
 - Type—Interface type for which bulk statistics collection is configured
 - CollectorIndex—Index of the collector to which the interface type applies
 - State
 - active—Interface type is properly configured and currently active
 - notInSvc—Interface type has been decommissioned by a management client
 - notReady—Interface type does not have enough configuration information to go active
 - error—Configuration/operational error
- Example

```
host1#show bulkstats interface-type
```

Interface Types:

Index	Type	Collector	State
1	ppp	1	active

- See show bulkstats interface-type.

show bulkstats receiver

- Use to display information about the remote file configuration of the bulk statistics receiver.
- Field descriptions
 - Index—Index number of the receiver
 - RemoteFileName—Hostname, path, and filename of the remote FTP server
 - Index—Index number of the receiver
 - State
 - active—Receiver is properly configured and currently active
 - notInSvc—Receiver has been decommissioned by a management client
 - notReady—Receiver does not have enough configuration information to go active
 - error—Configuration/operational error
 - Status
 - Success
 - Copy source does not exist or is unreachable
 - Copy failed
 - File in use
- Example

```
host1#show bulkstats receiver
```

Index	RemoteFileName
1	f:/upload/bulkStas.sts

Index	State	Status
1	notReady	Copy source does not exist or is unreachable

- See show bulkstats receiver.

show bulkstats statistics

- Use to display bulk statistics counters.
- Field descriptions
 - AdminStatus—Administrative status of the bulk statistics application
 - OperStatus—Operational status of the bulk statistics application
 - HdwDetects—Number of times the bulk statistics application detected a line module bulkstat collector's presence
 - HdwCollectorCreates—Number of line module collectors created
 - CollectorCreateReqs—Number of times the bulk statistics application requested the creation of a line module collector
 - CollectorStopReqs—Number of times the bulk statistics application requested the line module collectors to stop
 - CollectorDeleteReqs—Number of times the bulk statistics application requested the deletion of a line module collector
 - CollectorStarts—Number of times the bulk statistics collector has started
 - CollectorIncompleteCfgs—Number of times the bulk statistics collector attempted to start a collector, but failed because the collector's configuration was incomplete
 - CollectorStopFailures—Number of times the bulk statistics collector failed during a collector stop request
 - DriverErrors—Number of bulk statistics driver errors
 - FileSizeFulls—Number of times the bulk statistics application ran out of storage space
 - CollectorFileNearlyFullTraps—Number of nearly full events posted to the SNMP agent on this router
 - CollectorFileFullTraps—Number of file full events posted to the SNMP agent on this router
 - Intervals—Number of times the bulk statistics collector has cycled through a collection
 - PrimaryXfers—Number of times the bulk statistics collector has attempted a data file transfer to a primary server
 - PrimaryFails—Number of primary server transfer failures
 - SecondaryXfers—Number of times the bulk statistics collector has attempted a data file transfer to a secondary server
 - SecondaryFails—Number of secondary server transfer failures
 - BulkStats Collector Statistics:
 - Index—Bulk statistics collector index
 - CurrSize—Current size of the bulk statistics storage file in bytes

- CreateErrs—Number of bulk statistics collector create errors
- Last Transfer Failure—Last time that the collector attempted to retrieve statistics and was unsuccessful
- Interval Start Time—Start of current interval or bulk collections. The collector began collecting bulk statistics at this time.
- Interval Stop Time—End of current interval of bulk collections
- Dynamic Interface Collector statistics:
 - Collector Index—Bulk statistics collector index
 - Slot#—Slot number from which the statistics were obtained
 - Received—Number of records for dynamic interfaces that were reported by the specified interface
 - Transferred—Number of record for dynamic interface that were written to the bulk statistics (.sts) file.
 - Dropped—Number of records for dynamic interfaces that were dropped (that is, not written to the bulk statistics [.sts] file)
- Example

host1#show bulkstats statistics

```

AdminStatus:          enabled
OperStatus:           enabled
HdwDetects:           4
HdwCollectorCreates:  8
CollectorCreateReqs:  2
CollectorStopReqs:    0
CollectorDeleteReqs:  0
CollectorStarts:       25
CollectorIncompleteCfgs: 3
CollectorStopFailures: 0
DriverErrors:         0
FileSizeFulls:        0
CollectorFileNearlyFullTraps: 0
CollectorFileFullTraps: 0

```

Intervals	PrimaryXfers	PrimaryFails	SecondaryXfers	SecondaryFails
24	18	5	0	0

BulkStats Collector Statistics:

Index	CurrSize	CreateErrs	Last Transfer Failure
1	331	0	MON JAN 24 2001 17:21:33 UTC
2	0	0	

Index	Interval Start Time	Interval Stop Time
1	MON JAN 24 2001 19:09:33 UTC	MON JAN 24 2001 19:15:33 UTC
2	Not started	N/A

Dynamic Interface Collector statistics:

CollectorIndex	Slot#	Received	Transferred	Dropped
1	1	0	0	0

- See show bulkstats statistics.

show bulkstats traps

- Use to display information about the bulk statistics traps configured to collect statistics.
- Field descriptions
 - Trap Type
 - nearly-full—Trap will be posted to the SNMP entity on this system when the threshold is reached
 - file-full—Trap will be posted to the SNMP entity on this system when the trap reaches 100 %
 - State—Configuration setting: enabled, disabled
 - Threshold—Nearly full trap will be posted to the SNMP entity on this system when this percentage is reached
 - Traps Sent—Number of times this event was posted to the SNMP entity on this system
- Example

```

host1#show bulkstats traps
Trap Type   State   Threshold   Traps Sent
-----
file-full   enabled N/A         0
nearly-full enabled 5          0

```

- See show bulkstats traps.

show bulkstats virtual-routers

- Use to display information about the bulk virtual router group configuration.
- Field descriptions
 - Collector—Number that identifies the particular data collector, in the range 1–65535
 - Virtual-Routers—Set of virtual router names (up to 64 names)
- Example

```

host1#show bulkstats virtual-routers

Collector   Virtual-Routers
-----

```

```
33          serviceProviderABC
655         default
```

- See show bulkstats virtual-routers.

Configuring Schemas

You can also set a management schema for bulk statistics. A schema is a group of attributes or counters that provide an efficient way to retrieve specific types of information about the router. The bulk statistics application supports five schema configurations: *igmp*, *if-stack*, *if-stats*, *policy*, and *system*.



NOTE: There are no explicit schema objects for the if-stack and system schemas.

Table 25 on page 215 shows the type of data each schema retrieves.

Table 25: Data Retrieved According to Schema

Schema	Retrieves
igmp	Statistics associated with various IGMP components.
if-stack	The interface and interface column configuration. It is a complete retrieval of the ifStackTable, and using it can dramatically reduce the time to discover the configured interfaces and their stacking relationship on a router.
if-stats	Usage data on sets of interface types. The interface usage data is the ifTable/ifXTable counters. Note that the ifXTable supports 64-bit counters and the data written into the bulk statistics file supports the 64-bit counters.
policy	Statistics associated with a specified policy, a policy type, or traffic tagged by a policy with a color tag.
system	Global system and per-module statistics and information. The global system statistics retrieved are the sysUpTime and nvsUtilPct. The per-module statistics and information retrieved include the intPhysicalDesc, the cpuUtilPct, and the memUtilPct.

igmp Objects

Table 26 on page 215 presents igmp objects you can configure using the **bulkstats schema subtree** command.

Table 26: Schema igmp Objects

Object	Definition
all	Configure IGMP schema for all attributes
dest-address	Configure IGMP schema for destination address

Table 26: Schema igmp Objects *(continued)*

Object	Definition
igmp-cmd	Configure IGMP schema for IGMP command
lower-interface	Configure IGMP schema for lower interface
multicast-group	Configure IGMP schema for multicast group
router-index	Configure IGMP schema for router index
source-address	Configure IGMP schema for source address
time-stamp	Configure IGMP schema for time stamp

if-stats Objects

Table 27 on page 216 presents if-stats objects you can configure using the **bulkstats schema subtree** command.

Table 27: Schema ifStats Objects

Object	Definition
all	Configure IfStats schema for all stats
correlator	Configure IfStats schema for correlator
in-bcast-pkts	Configure IfStats schema for in-bcast-pkts
in-discards	Configure IfStats schema for in-discards
in-errors	Configure IfStats schema for in-errors
in-mcast-octets	Configure IfStats schema for in-mcast-octets
in-mcast-pkts	Configure IfStats schema for in-mcast-pkts
in-octets	Configure IfStats schema for in-octets
in-policed-octets	Configure IfStats schema for in-policed-octets
in-policed-pkts	Configure IfStats schema for in-policed-pkts
in-spoofed-pkts	Configure IfStats schema for in-spoofed-pkts
in-ucast-pkts	Configure IfStats schema for in-ucast-pkts
in-unknown-protos	Configure IfStats schema for in-unknown-protos
lower-interface	Configure IfStats schema for lower-interface
out-bcast-pkts	Configure IfStats schema for out-bcast-pkts

Table 27: Schema ifStats Objects *(continued)*

Object	Definition
out-discards	Configure IfStats schema for out-discards
out-errors	Configure IfStats schema for out-errors
out-mcast-octets	Configure IfStats schema for out-mcast-octets
out-mcast-pkts	Configure IfStats schema for out-mcast-pkts
out-octets	Configure IfStats schema for out-octets
out-policed-octets	Configure IfStats schema for out-policed-octets
out-policed-pkts	Configure IfStats schema for out-policed-pkts
out-sched-octets	Configure IfStats schema for out-sched-octets
out-sched-pkts	Configure IfStats schema for out-sched-pkts
out-ucast-pkts	Configure IfStats schema for out-ucast-pkts
time-offset	Configure IfStats schema for time-offset

All the schema if-stats objects in Table 27 on page 216 apply to both layer 2 and layer 3 interfaces, except `usdAcctngSpoofedPkts`, which is specific to layer 3.

Defining all interface types before you map a collector to the if-stats schema ensures that you display statistics for all configured interfaces in the first interval.

You can get more accurate rate statistics by using the **time-offset** parameter. To use this parameter you must navigate to the **if-stats subtree**. The **time-offset** parameter is included in each bulk statistics interface record and is the offset from the master interval at which the record was collected.

policy Objects

Table 28 on page 217 presents policy objects you can configure using the **bulkstats schema subtree** command.

Table 28: Schema Policy Objects

Object	Definition
all	Configure policy schema for all statistics
green-bytes	Configure policy schema for green bytes
green-packets	Configure policy schema for green packets
red-bytes	Configure policy schema for red bytes

Table 28: Schema Policy Objects *(continued)*

Object	Definition
red-packets	Configure policy schema for red packets
upper-green-bytes	Configure policy schema for upper green bytes
upper-green-packets	Configure policy schema for upper green packets
upper-red-bytes	Configure policy schema for upper red bytes
upper-red-packets	Configure policy schema for upper red packets
upper-yellow-bytes	Configure policy schema for upper yellow bytes
upper-yellow-packets	Configure policy schema for upper yellow packets
yellow-bytes	Configure policy schema for yellow bytes
yellow-packets	Configure policy schema for yellow packets

bulkstats schema

- Use to create the schema for collecting bulk statistics.
- Example

```
host1(config)#bulkstats schema 4
```

- Use the **no** version to delete the specified schema.



NOTE: If you create a collector but there is no schema for that collector, the collector will not be active, and a schema will be created automatically for that collector to collect if-stats for all subtree attributes.

- See bulkstats schema.

bulkstats schema subtree

- Use to set the schema for collecting data. Specify one of the following keywords:
 - **if-stack**—Retrieves the interface and interface column configuration.
 - **if-stats**—Retrieves interface usage data on sets of interface types; using the **subtreelist** keyword along with the **if-stats** keyword lets you specify specific counters and lets you set the **time-offset** parameter; using the **if-create-delete-time-stats** keyword along with the **if-stats** keyword retrieves interface final statistics (interface statistics that may be lost during higher create or delete frequency) on a per-interface basis.
 - **igmp**—Retrieves IGMP usage data; using the **subtreelist** keyword along with the **igmplist** keyword lets you obtain statistics for one or more specific IGMP lists.

- **policy**—Retrieves policy usage data.
- **system**—Retrieves global system and per-module statistics and information.

- Example 1

```
host1(config)#bulkstats schema 1 subtree if-stats subtree list lower-interface
```

- Example 2

```
host1(config)#bulkstats schema 5 subtree if-stats if-create-delete-time-stats  
interfaceType ?
```

```
atm1483    Configure bulkstats for ATM 1483 sub-interfaces  
ip         Configure bulkstats for IP interfaces  
mplsL2Shim Configure bulkstats for MPLS shim Interfaces  
mplsMajor  Configure bulkstats for MPLS major Interfaces  
mplsMinor  Configure bulkstats for MPLS minor Interfaces  
ppp        Configure bulkstats for PPP interfaces  
vlan       Configure bulkstats for VLAN Sub-Interfaces
```

- Use to collect statistics on a specified policy, a policy type, or based on color-coded tags applied by a policy. Specify one of the following keywords:
 - **policy-name**—Collects statistics for a specified policy
 - **policy-type**—Collects data on input policies, local input policies, output policies, or secondary output policies
 - **policy-subtreelist**—Collects statistics based on color-coded tags applied by a policy
- You create policies using the **policy-list** command. See *JUNOS Policy Management Configuration Guide*.
- Example


```
host1(config)#bulkstats schema 4 subtree policy policy-name XMYpolicy
```
- Use the **no** version to delete the specified schema.
- See bulkstats schema subtree.

Monitoring Schema Statistics

You are able to display your configuration and monitor the data generated by schemas.

show bulkstats schema

- Use to display data on the bulk statistics schema.
- Field descriptions
 - Schema Information:
 - Index—Index number of the schema

- Subtree—Type of bulk statistics schema configured on the collector: igmp, if-stack, if-stats, policy, or system
- CollectorIndex—Bulk statistics collector index (same as the SNMP table index)
- State
 - active—Schema is properly configured and currently active
 - notInService—Schema has been decommissioned by a management client
 - notReady—Schema does not have enough configuration information to go active
 - error—Configuration/operational error
- Subtree List—Type(s) of statistics the schema is configured to receive
- Example 1

host1#show bulkstats schema

```

Schema Information:
Index  Subtree          CollectorIndex  State
-----
1      ifStack           1              active
2      system          2              active

Index  Subtree List
-----
1      N/A
2      N/A

```

- Example 2

host1#show bulkstats schema

```

Schema Information:
Index  Subtree          CollectorIndex  State
-----
1      ifStats          1              active
2      system          2              active

Index  Subtree List
-----
1      ifOutErrors; ifLowerInterface; ifTimeOffset
2      N/A

```

- See show bulkstats schema.

Configuring Interface Numbering Mode

E-series routers support the RFC 1213 interface numbering mode on bulkstats. This mode is contrasted with the default interface numbering mode.

The RFC 1213 numbering mode is based on a 32-bit contiguous integer value starting from 1 and ranging to ifNumber. This mode differs from the default interface numbering mode, which encodes a type field in the upper 8 bits of a 32-bit integer. The use of the upper 8 bits creates large gaps in the ifIndex numbering scheme.

There is no re-use of ifIndex values in RFC 1213 mode, whereas in the default interface numbering mode, ifIndex values can be re-used. In the default interface numbering mode, re-use of ifIndex values across reboots is permitted and is basically known as ifIndex re-numbering.

In RFC 1213 mode, however, the interface numbers are not re-used during a single initialization of the device and renumbering of ifIndexes occurs after a system reboot. In the default interface numbering mode, ifIndexes are persistent across system reboots and can be reused without resetting the value of sysUpTime.

In RFC 1213 mode, two parameters control the size of the ifIndex range and the total number of interfaces in the standard interface tables—maxIfIndex and maxIfNumber. There is no such control in the default interface numbering mode.

In RFC 1213 mode, interface creations should not result in gaps in the ifIndex range. A gap that results from the deletion of an interface is acceptable because it is handled by older network management applications. The gaps are eliminated after the router is rebooted. However, in the default interface numbering mode, large gaps occur from the creation of interfaces due to the use of the upper 8 bits of the ifIndex for interface type encoding. Gaps are not eliminated after a system reboot.

In RFC 1213 mode, small gaps can occur in the creation of IP interfaces when virtual routers are used. These gaps are minimized but not eliminated when the router is rebooted.

Rather than seeing an ifIndex value of 1 and 10066329, for example, a management client would see ifIndex values of 1 and 2.

bulkstats interfaces rfc1213

- Use to enable the RFC 1213 interface numbering mode on bulkstats.
- Example

```
host1(config)#bulkstats interfaces rfc 1213
```

- Use the **no** version to disable the RFC 1213 interface numbering mode on bulkstats.
- See bulkstats interfaces rfc1213.

Using the Bulk Statistics Formatter

The bulk statistics formatter allows you to set a remote filename dynamically and specify the format for the end of each line in the bulkstats file.

Setting Remote Filenames

The router supports the following special characters for remote filenames:

- %x—An integer in hexadecimal format (base 16)
- %s—A character string
- %u—An unsigned integer in decimal (base 10)
- %d—An integer in decimal (base 10)

The % variables in the remote name are replaced at runtime with the sysName and sysUpTime parameters to produce variable filenames on the remote host.

See the bulkstats receiver remote-name command.

```
host1(config)#bulkstats receiver 1 remote-name " bulk%s%d.sts" sysName
               collectorSequence
```

Guidelines

The current capabilities and limitations of the bulk statistics formatter are:

- If you add %d or any numeric formatter for a string value (such as sysName), the attribute name will be used (for instance, sysName). The opposite is also true, except for sysUptime, which will use %s as a %u.
- You can use %% if you want a % character to be part of the parsed name.
- You can use the same attribute multiple times. For example, you may want a name that has %x and %u of collectorSequence.
- Currently, there is no control over sequence numbers, except for the guarantee that the formatter will:
 1. Use sequential values, beginning from 1
 2. Persist through system reboot
- If you need the sequential number to restart, remove and then add the bulk statistics receiver again.
- You can use up to 128 characters for the remote file name. Anything beyond that is truncated when the filename is stored in nonvolatile memory, but this truncation is not visible until the next time the system reboots.

Specifying End of Line Format

By default, the bulk statistics application generates a DOS-compatible file that contains both a carriage return (CR) and line feed (LF) at the end of each line. The existence

of a carriage return at the end of a line may cause formatting issues with some applications that do not ignore or remove carriage returns.

You can set up the system to remove the carriage return and leave only a line feed at the end of each line.

bulkstats file-format endOfLine-LF

- Use to strip the carriage return from the end of each line in the bulkstats file.
- Example

```
host1(config)#bulkstats file-format endOfLine-LF
```

- Use the **no** version to return to the default, CR and LF.
- See bulkstats file-format endOfLine-LF.

Managing Virtual Routers

Your router supports SNMP management of virtual routers. This support is based on an SNMP community string proxy to select particular instances of virtual routers. The entity MIB is used to model the physical container to the logical relationship of the virtual router implementation. See “Configuring Virtual Routers” on page 609.

Monitoring SNMP

To monitor the status of SNMP operations on your network, enter Privileged Exec mode. You can then establish a baseline and use the **show** commands to view statistics.

Establishing a Baseline

SNMP statistics are stored in system counters. The only way to reset the system counters is to reboot the router. You can, however, establish a baseline for SNMP statistics by setting a group of reference counters to zero.

baseline snmp

- Use to establish a baseline for SNMP statistics.
- The system implements the baseline by reading and storing the statistics at the time the baseline is set and then subtracting this baseline whenever baseline-relative statistics are retrieved.
- To display statistics relative to the current baseline, use the **delta** keyword with SNMP **show** commands.
- SNMP operations (such as Get and Set) continue to use and report statistics from the system counters.
- See “Viewing SNMP Status” on page 224 for a sample display when you enter the **show snmp** command. If you establish a baseline and then enter **show snmp**, the statistics now have zero or low values.
- Example

```

host1#baseline snmp
host1#show snmp
Contact: Joe Administrator
Location: Network Lab, Bldg 3 Floor 1
2 SNMP packets input
  0 Bad SNMP version errors
  0 Unknown community name
  0 Illegal operation for community name supplied
  0 Encoding errors
  0 Number of requested variables
  0 Number of altered variables
  1 Get-request PDUs
  1 Get-next PDUs
  0 Set-request PDUs
  0 Unknown security models
  0 Unavailable contexts
2 SNMP packets out
  0 Too big errors (Maximum packet size 1500)
  1 No such name errors
  0 Bad values errors
  0 General errors
  2 Get-response PDUs
  0 SNMP trap PDUs
  0 Invalid Message Report PDUs
  0 Unknown PDU Handler Report PDUs
  0 Unknown Context Report PDUs
  0 Unsupported Security Level Report PDUs
  0 Not in time Window Report PDUs
  0 Unknown Username Report PDUs
  0 Unknown Engine ID Report PDUs
  0 Wrong Digest Report PDUs
  0 Decryption Error Report PDUs

```

- There is no **no** version.
- See baseline snmp.

Viewing SNMP Status

To view SNMP status on your network, use the following **show** commands.

show snmp

- Use to display all the information about SNMP status.
- To display statistics relative to the current baseline, use the **delta** keyword.
- Field descriptions
 - Contact—Router's contact person
 - Location—Router's location
 - SNMP packets input—Total number of SNMP packets received by the router
 - Bad SNMP version errors—Number of SNMP PDUs with a bad version number
 - Unknown community name—Number of SNMP PDUs that had an unrecognized community name

- Illegal operation for community name supplied—Number of access violations based on the configured privilege level for community strings
- Encoding errors—Number of AS number version 1 encoding and decoding errors
- Number of requested variables—Number of variable bindings processed by the SNMP agent
- Number of altered variables—Number of variable bindings processed successfully in SNMP **set** commands
- Get-request PDUs—Number of get-exact SNMP PDUs processed
- Get-next PDUs—Number of get-next SNMP PDUs processed
- Set-request PDUs—Number of set SNMP PDUs processed
- Unknown security models—Number of SNMP PDUs with unrecognized security
- Unavailable contexts—Number of SNMP proxy requests to unknown entities
- SNMP packets out—Total number of SNMP packets sent by the router
 - Too big errors—Number of processed PDUs that resulted in SNMP PDUs too large to encode
 - No such name errors—Number of requests that resulted in noSuchName errors. If interfaces configured on modules that do not support 64-bit counters are accessed, the system returns a noSuchName message.
 - Bad values errors—Number of requests that resulted in badValues errors
 - General errors—Number of general errors
 - Get-response PDUs—Number of requests that resulted in getResponse PDUs
 - SNMP trap PDUs—Number of SNMP trap PDUs generated by this agent
 - SNMP trap proxied—Number of traps generated by this agent that are sent via trap-proxy
 - Invalid Message Report PDUs—Number of packets received by the SNMP engine that were dropped because there were invalid or inconsistent components in the SNMP message
 - Unknown PDU Handler Report PDUs—Number of packets received by the SNMP engine that were dropped because the PDU in the packet could not be passed to an application responsible for handling the PDU type; for example, no SNMP application had registered for the proper combination of the context engine ID and PDU type
 - Unknown Context Report PDUs—Number of packets received by the SNMP engine that were dropped because the context contained in the message was unknown

- Unsupported Security Level Report PDUs—Number of packets received by the SNMP engine that were dropped because they requested a security level that was unknown to the SNMP engine or otherwise unavailable
- Not in time Window Report PDUs—Number of packets received by the SNMP engine that were dropped because they appeared outside the authoritative SNMP engine window
- Unknown Username Report PDUs—Number of packets received by the SNMP engine that were dropped because they referenced a user that was not known to the SNMP engine
- Unknown Engine ID Report PDUs—Number of packets received by the SNMP engine that were dropped because they referenced an snmpEngineID that was not known to the SNMP engine
- Wrong Digest Report PDUs—Number of packets received by the SNMP engine that were dropped because they did not contain the expected digest value
- Decryption Error Report PDUs—Number of packets received by the SNMP engine that were dropped because they could not be decrypted

■ Example

```

host1#show snmp
Contact: Joe Administrator
Location: Network Lab, Bldg 3 Floor 1
538 SNMP packets input
  0 Bad SNMP version errors
  0 Unknown community name
  0 Illegal operation for community name supplied
  0 Encoding errors
  695 Number of requested variables
  0 Number of altered variables
  26 Get-request PDUs
  512 Get-next PDUs
  0 Set-request PDUs
  0 Unknown security models
  0 Unavailable contexts
538 SNMP packets out
  0 Too big errors (Maximum packet size 1500)
  10 No such name errors
  0 Bad values errors
  0 General errors
  538 Get-response PDUs
  0 SNMP trap PDUs
  0 Invalid Message Report PDUs
  0 Unknown PDU Handler Report PDUs
  0 Unknown Context Report PDUs
  0 Unsupported Security Level Report PDUs
  0 Not in time Window Report PDUs
  0 Unknown Username Report PDUs
  0 Unknown Engine ID Report PDUs
  0 Wrong Digest Report PDUs
  0 Decryption Error Report PDUs

```

- See show snmp.

show snmp access

- Use to display information about the groups you configured.
- Field descriptions
 - Group Name—Name of the group
 - Model—Security model; for example, user-based security model (USM)
 - Level—Method for authentication and privacy
 - none—No authentication and no privacy
 - auth—Authentication only
 - priv—Authentication and privacy
 - Read—Name of the view for read access
 - Write—Name of the view for write access
 - Notify—Name of the view for notification
 - Storage—SNMP storage type, volatile or nonvolatile
- Example

```

host1#show snmp access
Group Name      Model  Level  Read      Write      Notify
-----
admin           usm    priv   everything everything everything
mirror         usm    priv   mirrorAdmin mirrorAdmin mirrorAdmin
public          usm    none   user       none        none
private         usm    auth   user       user        user

```

- See show snmp access.

show snmp community

- Use to display information about the SNMP communities.
- Field descriptions
 - Community—Name of the community and the associated virtual router
 - View—Name of the view
 - Priv—Access privilege for the view
 - ro—Read-only access
 - rw—Read-write access
 - admin—All privileges
 - AccList—Number of access lists associated with this community
- Example

```

host1#show snmp community

```

Community	View	Priv	AccList
admin@default	everything	rw	0
private@default	user	rw	0
public@default	user	ro	0

- See `show snmp community`.

show snmp group

- Use to display the list of available groups. Detailed information is available through the **`show snmp access`** command.
- Field descriptions
 - groupName—Name of the group
 - securityModel—SNMP security model
 - v1—SNMPv1
 - v2c—SNMPv2c
 - usm—SNMPv
 - authenticationLevel—Method for authentication and privacy
 - none—No authentication and no privacy
 - auth—Authentication only
 - priv—Authentication and privacy
 - readView—Name of the view for read access
 - writeView—Name of the view for write access
 - notifyView—Name of the view for notification
 - storageType—SNMP storage type
 - volatile—Loses contents when power is lost
 - nonVolatile—Does not lose contents when power is lost
- Example

```
host1#show snmp group
```

Group Name	Storage Type
group1	Volatile
group2	NonVolatile
admin	Permanent
mirror	Permanent
public	Permanent
private	Permanent

- See `show snmp group`.

show snmp notificationLog

- Use to display the configuration of the SNMP notification log.
- Field descriptions
 - Global Age Out Value—Ageout for traps in the notification log tables
 - Global Entry Limit Value—Maximum number of notifications kept in all notification log tables
- Example

```
host1#show snmp notificationLog
Global Age Out Value:      1440 minutes
Global Entry Limit Value : 500
No notification log name information is available
```

- See show snmp notificationLog.

show snmp trap

- Use to display configuration information about SNMP traps and trap destinations.
- Field descriptions
 - Enabled Categories—Trap categories that are enabled on the router.
 - SNMP authentication failure trap—Enabled or disabled.
 - Trap Source—Interface whose IP address is used as the source address for all SNMP traps.
 - Trap Source Address—IP address used as the source address for all SNMP traps.
 - Trap Proxy—Enabled or disabled.
 - Global Trap Severity Level—Global severity level filter; if a trap does not meet this severity level, it is discarded. If the per-category trap severity level is not set for a particular category, the severity displayed here is used for that category.
 - Trap Severity Level—Severity level filter for a trap category; this severity level overrides the globally configured trap severity level.
 - TrapCategories—Types of traps enabled on the router for which trap severity is configured at the category level.
 - Address—IP address of the trap recipient.
 - Security String—Name of the SNMP community.
 - Ver—SNMP version (v1 or v2) of the SNMP trap packet.
 - Port—UDP port on which the trap recipient accepts traps.
 - Trap Categories—Types of traps that the trap recipient can receive.
 - TrapSeverityFilter—Severity level filter for this SNMP host.

- Ping Timeout—Configured ping timeout in minutes.
- Maximum QueueSize—Maximum number of traps to be kept in the trap queue.
- Queue DrainRate—Maximum number of traps per second to be sent to the host.
- Queue Full discard method—Method used to discard traps when the queue is full:
 - dropFirstIn—Oldest trap in the queue is dropped.
 - dropLastIn—Most recent trap is dropped .
- Example

```

host1# show snmp trap
Enabled Categories: Bgp, Ospf, Sonet
SNMP authentication failure trap is disabled
Trap Source: FastEthernet 6/0, Trap Source Address:172.27.120.78
Trap Proxy: enabled
Global Trap Severity Level: 7 - debug

Trap Severity Level      TrapCategories
-----
7 - debug                ospf

Address      Security String      Ver  Port  Trap
Categories
-----
192.168.1.10  public                v1    162  BgpOspf

Address      TrapSeverityFilter  Ping  Maximum  Queue  Queue Full
methd
-----
192.168.1.10  2 - critical      1     32      0      dropLastIn

```

- See show snmp trap.

show snmp trap statistics

- Use to display statistics for all SNMP traps on the virtual router, as well as statistics for each SNMP host configured on the virtual router.
- Field descriptions
 - Trap request(s)—Number of local traps requested
 - Proxy trap request(s)—Number of proxy traps requested
 - Trap(s) discarded—Total number of traps discarded

- No system memory—Traps discarded because there was not enough system memory
 - No queue resources—Traps discarded because there were no queue resources available
 - SNMP agent disabled—Traps discarded because the SNMP agent was disabled
 - Global trap category disabled—Traps discarded because they were filtered by the **snmp enable trap** command
 - Global minimum severity level—Traps discarded because they did not match the severity level set with the **snmp enable traps trapfilters** command.
- Trap(s) out—Total number of traps sent by the virtual router
 - Trap(s) proxied—Total number of traps proxied by the virtual router
 - Address—IP address of the host
 - TrapsDiscarded Severity/Category—Severity level and category of the discarded traps
 - TrapsDiscarded bad encoding—Traps discarded because of bad encoding
 - TrapsDiscarded Queue Full—Traps discarded because the queue was full
 - TrapsDiscarded NoHostRespons—Traps discarded because the host did not respond to pings sent to the host
 - Trap PDUs sentOut—Number of trap PDUs sent by this host

```
host1#show snmp trap statistics
Trap request(s):3112
Proxy trap request(s):0
Trap(s) discarded:4
No system memory:0
No queue resources:0
SNMP agent disabled:0
Global trap category disabled:4
Global minimum severity level:0
Trap(s) out:3108
Trap(s) proxied:0
Address          TrapsDiscarded   TrapsDiscrded TrapsDiscrdded TrapsDiscrdded
                  Severity/Category bad encoding  Queue Full    NoHostRespons
-----
1.1.1.1           1081              0              511            32
10.10.132.137    0                 0              0              0

Address          Trap PDUs
                  sentOut
-----
1.1.1.1           536
10.10.132.137    3108
```

- See show snmp trap statistics.

show snmp user

- Use to display information about users.
- Field descriptions
 - User—Name of the user
 - Auth—Authorization protocol for this user
 - no—No authorization protocol
 - md5—HMAC-MD5-96 authorization protocol
 - sha—HMAC-SHA-96 authorization protocol
 - Priv—Privacy protocol for this user
 - no—No privacy protocol
 - des—DES encryption algorithm for privacy
 - Group—Name of the group to which the user belongs
- Example SNMPv3 display.

host1#**show snmp user**

User	Auth	Priv	Group
-----	----	----	-----
josie	md5	des	admin
nightfly	md5	no	private
steelydan	no	no	public

- See show snmp user.

show snmp view

- Use to display information about the views you created.
- Field descriptions
 - View Name—Name of the view
 - View Type—Access privilege for the view
 - included—Specified object identifier (OID) trees are available in this view
 - excluded—Specified OID trees are not available in this view
 - Oid Tree—OID of the AS number version 1 subtree
 - Storage—SNMP storage type, volatile or nonvolatile
- Example

host1#**show snmp view**

View Name	View Type	Oid Tree
-----	-----	-----
user	included	1.3.6.1.
user	excluded	1.3.6.1.4.1.4874.2.2.16.
user	excluded	1.3.6.1.6.3.11.
user	excluded	1.3.6.1.6.3.12.
user	excluded	1.3.6.1.6.3.13.
user	excluded	1.3.6.1.6.3.14.
user	excluded	1.3.6.1.6.3.15.
user	excluded	1.3.6.1.6.3.16.
user	excluded	1.3.6.1.6.3.18.
nothing	excluded	1.3.6.1.
everything	included	1.3.6.1.
everything	excluded	1.3.6.1.4.1.4874.2.2.77.
mirrorAdmin	included	1.3.6.1.4.1.4874.2.2.77.

- See show snmp view.

Output Filtering

You can use the output filtering feature of the **show** commands to include or exclude lines of output based on a text string you specify. See “Command-Line Interface” on page 29, for details.

Chapter 5

Managing the System

This chapter describes general tasks associated with managing the E-series router.

This chapter contains the following sections:

- Overview on page 236
- Platform Considerations on page 236
- Naming the System on page 236
- Configuring the Switch Fabric Bandwidth on page 237
- Configuring Timing on page 237
- Using the CLI on page 239
- Managing vty Lines on page 242
- Clearing Lines on page 245
- Monitoring the Current Configuration on page 245
- Configuring the System Automatically on page 256
- Saving the Current Configuration on page 257
- Using the Desktop Tool for Viewing Uncompressed Text Configuration on page 260
- Customizing the User Interface on page 261
- Sending Messages on page 268
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- Configuring DNS on page 300
- Troubleshooting the System on page 303
- Managing and Monitoring Resources on page 315
- Monitoring the System on page 317

Overview

Managing the E-series router involves a variety of tasks. This chapter covers those tasks associated with the router in general rather than specific networking protocols. Each section in the chapter covers a different topic; where appropriate, a section contains an overview of the topic, configuration tasks, and information about monitoring the associated settings.

For additional management information, CLI commands, and procedures, refer to the following table.

Task	Reference
Find detailed information about commands described in this chapter.	<i>JUNOS Command Reference Guide</i>
Configure the system as an SNMP agent.	“Configuring SNMP” on page 147
Set system passwords.	“Managing the System” on page 235
Write CLI macros.	“Managing Modules” on page 335
Boot the system.	“Booting the System” on page 579
Manage line modules and SRP modules.	“Managing Modules” on page 335

Platform Considerations

System management is supported on all E-series routers.

For information about the modules supported on E-series routers:

- See the *ERX Module Guide* for modules supported on ERX-7xx models, ERX-14xx models, and the ERX-310 router.
- See the *E120 and E320 Module Guide* for modules supported on the E120 and E320 router.

Naming the System

When you receive the router, it has a factory default host name. To rename the router, use the **hostname** command.

hostname

- Use to rename the router.
- The assigned name is displayed in the command-line interface (CLI) prompts.
- Example

```
router1(config)#hostname host1
host1(config)#
```

- There is no **no** version.
- See hostname.

Configuring the Switch Fabric Bandwidth

By default, the switch fabric for the ERX-1440, ERX-310, E120, and E320 routers uses a bandwidth weighting ratio of 15:2 for multicast-to-unicast weighted round robin (WRR). In the absence of strict-priority traffic, and when both unicast and multicast traffic compete for switch fabric bandwidth, the switch fabric allocates 15/17ths of the available bandwidth to multicast traffic and 2/17ths of the available bandwidth to unicast traffic.

The **fabric weights** command enables you to specify a ratio for multicast-to-unicast traffic on the router switch fabric. The **no** version of the command reverts the weighting ratio back to its default.

fabric weights

- Use to define the multicast-to-unicast traffic ratio for the switch fabric for the ERX-1440, ERX-310, E120, and E320 routers
- Example


```
host1(config-traffic-class)# fabric weights multicast 2 unicast 1
```
- Use the **no** version to return the switch fabric to its default multicast-to-unicast ratio (15:2).
- See fabric weights.

Configuring Timing

You can use the timing source command to configure three timing sources for the system. These sources are known as the primary, secondary, and tertiary sources. The system periodically polls the status of the current timing source. If the system discovers that the current source has become unavailable, it polls the timing source you specified as next in line. If this source is available, it switches to this source; if not, it then polls the next source in line. If the lowest source is unavailable, the system maintains the SRP clock as the source.

If you enable auto-upgrade, in the event of a source failure, the system—after switching to a lower source—polls all higher configured sources and automatically switches back to the highest timing source when that source becomes available.

The timing select command enables you to specify which source (primary, secondary, or tertiary) the system is to use by default. The system will never attempt to upgrade to a source higher than the selected source.

timing disable-auto-upgrade

- Use to disable the auto-upgrade feature of the system's timing selector.
- The system starts out by setting the operational timing selector to the administratively configured selector. See the **timing select** command.
- Example

```
host1(config)#timing disable-auto-upgrade
```

- Use the **no** version to restore the factory default, which is auto-upgrade enabled.
- See timing disable-auto-upgrade.

timing select

- Use to specify which of the configured timing sources is used by default.
- Primary timing source is preferred over secondary, and secondary is preferred over tertiary. See the **timing source** command.
- If you enable the auto-upgrade feature, the system does not try to upgrade beyond the administratively configured selector.
- Example

```
host1(config)#timing select secondary
```

- There is no **no** version.
- See timing select.

timing source

- Use to specify how the SRP module exchanges timing signals with an interface.
- You can specify primary, secondary, and tertiary timing sources.
- You can specify one external source received on an I/O module or IOA other than the SRP I/O module or SRP IOA.
- You can specify two or more internal sources or external sources received through the SRP I/O module or SRP IOA external timing ports.
- On the E120 and E320 routers, you can specify sonet for only two of the available three timing sources (primary, secondary, or tertiary).
- The available sources to choose are:
 - ds1—DS1 interface
 - ds3—DS3 interface
 - e1—E1 interface
 - e3—E3 interface
 - sonet—SONET interface
 - internal—Internal system controller (SC) oscillator
 - line—External timing input on SRP module

- Example

```
host1#timing source secondary sonet 3/0
```

- There is no **no** version.
- See timing source.

Monitoring Timing

Use the **show timing** command to view the timing settings for the system.

show timing

- Use to display the timing settings and the operational status of the system timing.
- If a timing source fails, the system uses the next time source in the hierarchy, and a message appears in the system log at the warning level. If auto-upgrade is enabled, the system upgrades to a higher-priority timing source when one becomes available, and a message appears in the system log at the notice level.
- Example

```
host1#show timing
timing: tertiary (failover from primary)
primary: external SC E1 (A) (ERROR)
secondary: ds3 3/0 (ERROR)
tertiary: internal SC oscillator (ok)
auto-upgrade enabled
```

- See show timing.

Using the CLI

Use the commands described in this section to navigate the CLI. For a complete description of the CLI, see “Command-Line Interface” on page 29.

configure

- Use to enter Global Configuration mode.
- Global Configuration mode provides access to other configuration modes, such as Interface Configuration mode. See “Command-Line Interface” on page 29.
- This command allows other commands to be executed from a terminal or a file.
- This command is not allowed for a short time after a warm restart (warm switchover) occurs. This delay allows some applications time to complete their warm-restart initialization. However, if the warm restart is not complete in 5 minutes, the warm start is cancelled and configuration access is restored.
- Example 1

```
host1#configure
Configuring from terminal or file [terminal]?
Enter configuration commands, one per line. End with CNTL/Z.
```

```
host1(config)#
```

- Example 2

```
host1#configure
Configuring from terminal or file [terminal]? file
File name: system1.scr
Proceed with configure? [confirm]
host1(config)#
```

- There is no **no** version.
- See configure.

disable

- Use to exit Privileged Exec mode and return to User Exec mode.
- Use to move to a lower Privileged Exec mode level without returning to User Exec mode. Specifying a privilege level after the **disable** command changes the Privileged Exec mode to the lower level that you specify; you do not return to User Exec mode.

- Example 1

```
host1#disable
host1>
```

- Example 2

```
host1#show privilege
Privilege level is 10
host1#disable 5
host1#show privilege
Privilege level is 5
```

- There is no **no** version.
- See disable.

do

- Use to issue an Exec mode command from any CLI configuration command mode.
- Example

```
host1(config)#do show configuration | begin interface
```

- The **do** command functions the same as the **run** command.
- There is no **no** version.
- See do.

enable

- Use to move from User Exec to Privileged Exec mode.
- Privileged Exec mode allows you to access all other user interface modes. From here you can configure, monitor, and manage all aspects of the router.
- You can access the Privileged Exec commands using one of 16 levels of command privilege. If you do not enter a privilege level and you are not accessing the router through a RADIUS authentication account, the default CLI access level is 10. For information about CLI levels of access, see “Privileged-Level Access” on page 49 in “Command-Line Interface” on page 29.
- Set a password for this mode by using either the **enable password** or the **enable secret** command in Global Configuration mode. This protects the system from any unauthorized use.
- Once a password is set, anyone trying to use Privileged Exec mode will be asked to provide the password.
- Example 1 (accessing Privileged Exec mode at the default level 10)

```
host1>enable
password:*****
host1#
```

- Example 2 (accessing Privileged Exec mode at the highest level 15; a password is not set for this example)

```
host1>enable 15
host1#
```

- There is no **no** version.
- See **enable**.

end

- Use to exit Global Configuration mode or any of the other Configuration modes. You may also use Ctrl + z to exit these modes.
- Executing this command returns you to the User Exec mode.
- Example

```
host1(config)#end
host1#
```

- There is no **no** version.
- See **end**.

exit

- Use to exit the current command mode or the system when issued from the User Exec mode.
- Example

```
host1#exit
host1>
```

- There is no **no** version.
- See exit.

help

- Use to display basic information about the interactive help system.
- Example

```
host1#help
Use the help options as follows:
```

```
?, or command<Space>? - Lists the set of all valid next keywords or
                        arguments
partial-keyword?       - Lists the keywords that begin with a certain
                        character string
partial-keyword<Tab> - Completes the partial keyword
```

- There is no **no** version.
- See help.

run

- Use to issue an Exec mode command from any CLI configuration command mode.
- Example

```
host1(config)#run show configuration | begin interface
```

- The **run** command functions the same as the **do** command.
- There is no **no** version.
- See run.

sleep

- Use to make the CLI pause for a specified period of time (in seconds).
- Pausing is very useful in configuration script files.
- Example

```
host1#sleep 60
```

- There is no **no** version.
- See sleep.

Managing vty Lines

The system supports 30 virtual tty (vty) lines for Telnet, SSH, and FTP services. Each Telnet, SSH, or FTP session requires one vty line. When you connect to the router

through a vty line, the number of the vty line is not assigned sequentially; instead, the system assigns the first vty line that passes the host access list check rules.

Configuring vty Lines

By default five vty lines (0–4) are open. You can open additional lines using the **line vty** command. Once lines are open, login is enabled by default. Before users can access the lines, you must configure a password, disable login using the **no login** command, or configure AAA authentication on the lines.

line vty

- Use to open or configure vty lines.
- You can specify a single line or a range of lines. The range is 0–29.
- Example

```
host1(config)#line vty 6 10
host1(config-line)#
```

- Use the **no** version to remove a vty line or a range of lines from the configuration. Lines that you remove will no longer be available for use by Telnet, FTP, or SSH. When you remove a vty line, the system removes all lines above that line. For example, **no line vty 6** causes the system to remove lines 6 through 29. You cannot remove lines 0 through 4.
- See line.

password

- Use to specify a password on a single line or a range of lines.
- If you enable login but do not configure a password, the system will not allow you to access virtual terminals.
- Specify a password in plain text (unencrypted) or cipher text (encrypted). In either case, the system stores the password as encrypted.
- You can use the following keywords:
 - 0 (zero)—Specifies an unencrypted password
 - 5—Specifies a secret
 - 7—Specifies an encrypted password
- Example 1 (unencrypted password)


```
host1(config-line)#password 0 mypassword
```
- Example 2 (secret)


```
host1(config-line)#password 5 y13_x
```
- Example 3 (encrypted password)


```
host1(config-line)#password 7 x13_2
```

- Use the `no version` to remove the password. By default, **no password** is specified.
- See `password`.

For more information about configuring security for vty lines, see “Managing the System” on page 235.

Monitoring vty Lines

Use the **show line vty** command to monitor vty lines.

show line vty

- Use to display the configuration of a vty line.
- Field descriptions
 - `access-class`—Access class associated with the vty line
 - `data-character-bits`—Number of bits per character
 - 7—Setting for the standard ASCII set
 - 8—Setting for the international character set
 - `exec-timeout`—Time interval that the terminal waits for expected user input
 - Never—Indicates that there is no time limit
 - `exec-banner`—Status for the exec banner: enabled or disabled. This banner is displayed by the CLI after user authentication (if any) and before the first prompt of a CLI session.
 - `motd-banner`—Status for the MOTD banner: enabled or disabled. This banner is displayed by the CLI when a connection is initiated.
 - `login-timeout`—Time interval during which the user must log in.
 - Never—Indicates that there is no time limit
- Example

```
host1#show line vty 0
no access-class in
data-character-bits 8
exec-timeout 3w 3d 7h 20m 0s
exec-banner enabled
motd-banner enabled
login-timeout 30 seconds
```

- See `show line vty`.

Clearing Lines

Use the **clear line** command to clear any line on the system (vty or console). Using this command terminates any service, such as an FTP session, on this line and closes any open files.

clear line

- Use to remove any services on a line and close any files opened as a result of services on that line.
- You can specify the absolute number to clear any line. For each line on the system, the absolute number is listed in the line number field of the **show users** command output.
- You can specify the line type and the relative number to clear a specific type of line. For each line on the system, the relative number is listed in the line name field of the **show users** command output.

- Example 1

```
host1#clear line 2
```

- Example 2

```
host1#clear line console 0
```

- There is no **no** version.
- See clear line.

Monitoring the Current Configuration

Use the commands described in this section to monitor the current (running) configuration of the system.

You can use the **show configuration** command to display information when the router is in Automatic Commit mode. In Automatic Commit mode, the system automatically saves any change to the system configuration to nonvolatile storage (NVS).

You can use the **show running-configuration** command to display information when the router is in Manual Commit mode. In Manual Commit mode, any configuration change affects only the current (running) system configuration.

For more information about saving the current configuration in Automatic Commit mode or Manual Commit mode, see “Saving the Current Configuration” on page 257.

Defining the Configuration Output Format

The JUNOS **show configuration** command displays the entire system configuration. For very large configurations, the show configuration report can take a long time to generate and display.

The **service show-config format** command enables you to run the **show configuration** command using one of two formats—original format (format 1; the default) and a format that provides a much faster output (format 2). Using format 2 can significantly reduce the amount of time it takes to generate and display configurations that contain three or more virtual routers and a large number of interfaces.

The primary difference between format 1 and format 2 output is the way in which each displays layer 2 and layer 3 interface configurations. Table 29 on page 246 indicates where layer 2 and layer 3 interface configurations appear within the **show configuration** command output when the system is using format 1 or format 2.

Table 29: Output Locations for Layer 2 and Layer 3 Interface Configurations

Format	Layer 2 Only Interfaces	Layer 3 Only Interfaces	Layer 2 and Layer 3 Combination Interfaces
Format 1	Entire configuration appears in the default router output	Entire configuration appears in the layer 3 virtual router output	Layer 2 configuration appears in the default router the layer 3 virtual router output
Format 2	Entire configuration appears in the default router output	Entire configuration appears in the layer 3 virtual router output	Layer 2 configuration appears in the default router output; layer 3 configuration appears in the layer 3 virtual router output

The following examples show the differences between format 1 and format 2 output:

Example 1 Format 1 output

```
virtual-router default
...
interface null 0
interface loopback 0
  ip address 127.0.0.1 255.0.0.0
!
interface ip shAtm50126
  ip share-interface atm 5/0.126
!
interface ip MikeShare2
  ip share-interface atm 5/1.1
!
interface atm 5/0
interface atm 5/0.100 point-to-point
  atm pvc 100 0 100 aal5snap 0 0 0
  encapsulation pppoe
  pppoe sessions 1
!
interface atm 5/0.100.1
  encapsulation ppp
  ppp authentication chap
  ip address 102.0.1.1 255.255.255.0
!
interface atm 5/0.102 multipoint
  atm pvc 1021 0 1021 aal5snap 0 0 0
  atm pvc 1022 0 1022 aal5snap 0 0 0
```

```

    atm pvc 1023 0 1023 aal5snap 0 0 0
    ip address 102.0.2.1 255.255.255.0
    !
interface atm 5/0.103 point-to-point
    atm pvc 103 0 103 aal5snap 0 0 0
    encapsulation bridge1483
    ip address 100.0.0.1 255.255.255.0
    pppoe
    !
pppoe subinterface atm 5/0.103.1
    encapsulation ppp
    ppp authentication pap
    ip address 100.0.1.1 255.255.255.0
    !
interface atm 5/0.104 point-to-point
    atm pvc 104 0 104 aal5snap 0 0 0
    ip address 150.0.1.1 255.255.255.0
    ipv6 address 2000:0:17::1/60
    !
interface atm 5/0.126 point-to-point
    !
interface atm 5/1
interface atm 5/1.1 point-to-point
interface atm 5/1.100 point-to-point
    atm pvc 100 0 100 aal5snap 0 0 0
    encapsulation pppoe
    pppoe sessions 1
    !
interface atm 5/1.100.1
    encapsulation ppp
    ppp authentication chap
    !
interface atm 5/1.102 multipoint
    atm pvc 1021 0 1021 aal5snap 0 0 0
    atm pvc 1022 0 1022 aal5snap 0 0 0
    atm pvc 1023 0 1023 aal5snap 0 0 0
    !
interface atm 5/1.103 point-to-point
    atm pvc 103 0 103 aal5snap 0 0 0
    encapsulation bridge1483
    pppoe
    !
pppoe subinterface atm 5/1.103.1
    encapsulation ppp
    ppp authentication pap
    !
interface atm 5/1.104 point-to-point
    atm pvc 104 0 104 aal5snap 0 0 0
    !
interface atm 5/1.125 point-to-point
    !
interface fastEthernet 0/0
    ip address 10.13.5.196 255.255.128.0
    !
interface mlppp joe
    !
ip route 0.0.0.0 0.0.0.0 10.13.5.1
ip route 40.0.0.0 255.0.0.0 atm5/0.104
ip route 172.28.32.70 255.255.255.255 10.13.5.1
no ip source-route
    !

```

```

!
ipv6
!
! =====
virtual-router foo
...
interface null 0
interface loopback 0
  ip address 127.0.0.2 255.0.0.0
!
interface atm 5/1.100.1
  ip address 102.0.1.2 255.255.255.0
!
interface atm 5/1.102
  ip address 102.0.2.2 255.255.255.0
!
interface atm 5/1.103
  ip address 100.0.0.2 255.255.255.0
!
interface atm 5/1.103.1
  ip address 100.0.1.2 255.255.255.0
!
interface atm 5/1.104
  ip address 150.0.1.2 255.255.255.0
  ipv6 address 2000:0:17::2/60
!
ip route 30.0.0.0 255.0.0.0 atm5/1.104
no ip source-route
!
!
ipv6

```

Example 2 Format 2 output

```

service show-config format 2
...
virtual-router default
...
interface atm 5/0
interface atm 5/0.100 point-to-point
  atm pvc 100 0 100 aal5snap 0 0 0
  encapsulation pppoe
  pppoe sessions 1
!
interface atm 5/0.100.1
  encapsulation ppp
  ppp authentication chap
!
interface atm 5/0.102 multipoint
  atm pvc 1021 0 1021 aal5snap 0 0 0
  atm pvc 1022 0 1022 aal5snap 0 0 0
  atm pvc 1023 0 1023 aal5snap 0 0 0
!
interface atm 5/0.103 point-to-point
  atm pvc 103 0 103 aal5snap 0 0 0
  encapsulation bridge1483
  pppoe
!
pppoe subinterface atm 5/0.103.1
  encapsulation ppp
  ppp authentication pap

```



```

!
interface atm 5/0.104 point-to-point
 atm pvc 104 0 104 aal5snap 0 0 0
!
interface atm 5/0.126 point-to-point
!
interface atm 5/1
interface atm 5/1.1 point-to-point
interface atm 5/1.100 point-to-point
 atm pvc 100 0 100 aal5snap 0 0 0
 encapsulation pppoe
 pppoe sessions 1
!
interface atm 5/1.100.1
 encapsulation ppp
 ppp authentication chap
!
interface atm 5/1.102 multipoint
 atm pvc 1021 0 1021 aal5snap 0 0 0
 atm pvc 1022 0 1022 aal5snap 0 0 0
 atm pvc 1023 0 1023 aal5snap 0 0 0
!
interface atm 5/1.103 point-to-point
 atm pvc 103 0 103 aal5snap 0 0 0
 encapsulation bridge1483
 pppoe
!
pppoe subinterface atm 5/1.103.1
 encapsulation ppp
 ppp authentication pap
!
interface atm 5/1.104 point-to-point
 atm pvc 104 0 104 aal5snap 0 0 0
!
interface atm 5/1.125 point-to-point
!
interface fastEthernet 0/0
interface null 0
interface loopback 0
 ip address 127.0.0.1 255.0.0.0
!
interface ip shAtm50126
 ip share-interface atm 5/0.126
!
interface ip MikeShare2
 ip share-interface atm 5/1.1
!
interface mlppp joe
interface fastEthernet 0/0
 ip address 10.13.5.196 255.255.128.0
!
interface atm 5/0.100.1
 ip address 102.0.1.1 255.255.255.0
!
interface atm 5/0.102
 ip address 102.0.2.1 255.255.255.0
!
interface atm 5/0.103
 ip address 100.0.0.1 255.255.255.0
!
interface atm 5/0.103.1

```

```

    ip address 100.0.1.1 255.255.255.0
    !
interface atm 5/0.104
    ip address 150.0.1.1 255.255.255.0
    ipv6 address 2000:0:17::1/60
    !
ip route 0.0.0.0 0.0.0.0 10.13.5.1
ip route 40.0.0.0 255.0.0.0 atm5/0.104
ip route 172.28.32.70 255.255.255.255 10.13.5.1
no ip source-route
!
!
ipv6
!
! =====
virtual-router foo
...
interface null 0
interface loopback 0
    ip address 127.0.0.2 255.0.0.0
    !
interface atm 5/1.100.1
    ip address 102.0.1.2 255.255.255.0
    !
interface atm 5/1.102
    ip address 102.0.2.2 255.255.255.0
    !
interface atm 5/1.103
    ip address 100.0.0.2 255.255.255.0
    !
interface atm 5/1.103.1
    ip address 100.0.1.2 255.255.255.0
    !
interface atm 5/1.104
    ip address 150.0.1.2 255.255.255.0
    ipv6 address 2000:0:17::2/60
    !
ip route 30.0.0.0 255.0.0.0 atm5/1.104
no ip source-route
!

```

Customizing the Configuration Output

You can customize the configuration information by including or excluding lines of output based on the keywords described in this section.

Using a keyword with the **show configuration** command might be more effective than using **show configuration | begin**. When **show configuration** is used with a specific keyword, the current configuration is quickly determined and displayed for *only* that specified keyword. Executing **show configuration | begin** causes all output of **show configuration** to be generated, but the output is not displayed until the **begin** criterion is met.

Use the **virtual-router** keyword to display the current configuration of a specified virtual router. You can combine the **virtual-router** keyword with the **category** keyword to display the current configuration of specific settings for a virtual router.

Use the **interface** keyword to display the current configuration of a particular interface. Use the **type** keyword to target specific interface types. You can exclude information about particular types of interfaces using the **exclude-category interface** keyword. You can exclude information about particular types of interfaces using the **exclude-category interface** keyword.

Use the **category** keyword to display the current configuration of a specific group of router settings. The settings are organized in categories by function.

Use the **tag-group** keyword with the category interfaces keywords to tag interfaces as belonging to a specific group and display all interfaces within a group.

Use the **tag-group** command to configure an interface tag group. Any number of interfaces can be in a tag group. The following interface types cannot be added to tag groups: tunnel, lag, mlppp, and mlframe-relay. An interface can be in only one tag group.

Table 30 on page 251 describes the categories of router settings and the type of information displayed for each category.

Table 30: Categories of Router Settings

Category	Configuration Displayed
aaa	Authentication, authorization, and accounting (AAA) settings, such as the default authentication protocol and the RADIUS accounting server
address-assignment	Address assignment settings for Dynamic Host Configuration Protocol (DHCP) and the local address server
flow-management	Flow management settings, such as firewalls, Network Address Translation (NAT), and IP flow statistics
interfaces	Physical interfaces (types and specifiers); this is the only category that displays information about interfaces
ip-protocols	Internet protocols, such as Border Gateway Protocol (BGP) and Open Shortest Path First (OSPF)
link-layer-forwarding	Link-layer settings, such as bridged interfaces and link-layer interface types
management	Router management settings, such as the CLI, bulk statistics, and Telnet
physical-layer-protocols	Physical layer protocols, such as DS1, DS3, and SONET/SDH
policy	Policy settings, such as policy lists, classifier groups, and rate-limit profiles
qos	Quality of service (QoS) settings, such as traffic class, drop profile, and scheduler profile
system	System-level settings, such as timing, logging, and redundancy

Table 30: Categories of Router Settings (continued)

Category	Configuration Displayed
tunneling	Tunneling protocols, such as IP Security (IPSec), Multiprotocol Label Switching (MPLS), and Layer Two Tunneling Protocol (L2TP)

Many of the categories described in Table 30 on page 251 contain subcategories of router settings. For example, you can specify **show configuration category management cli** to display only the configuration for the CLI. To display the names of subcategories that you can specify for each category, issue the **show configuration category categoryName ?** command.

You can combine the **category** keyword with the **virtual-router** keyword to display the current configuration of specific settings for a virtual router.



NOTE: When you specify categories with the **show configuration** command, the output might display additional configuration data that is not explicitly associated with the categories that you specified.

service show-config

- Use to define the **show configuration** command display output.
- Specify format 1 to display the show configuration command output in its original format.
- Specify format 2 to significantly reduce the amount of time it takes to generate and display output for configurations that contain three or more virtual routers and a large number of interfaces.
- Example


```
host1#service show-config format 2
```
- Use the **no** version to revert the **show configuration** command output format to its default (format 1).
- See service show-config.

show configuration

- Use to display the current configuration of the system, a specified virtual router, a specified interface, or a specified category of router settings.
- This command was formerly documented as **show config**; that abbreviation is still supported.
- You can create a configuration script from the output by saving it as a file with the .scr extension.
- This command provides configuration information based on the privilege level of the session (user). The output does not display any configuration data for

commands that have privilege levels higher than that of the session. For example, if the session is enabled at level 5, issuing the **show configuration** command displays only output for commands at level 5 and below. For more information, see “CLI Command Privileges” on page 52.

- You can use the output filtering feature of the **show** command to include or exclude lines of output based on a text string you specify. See “Command-Line Interface” on page 29, for details.
- Example

```

host1# show configuration
! Configuration script being generated on TUE JAN 29 200X 00:31:12 UTC! Juniper Networks Edge Routing
Switch ERX-700
! Version: x.y.z (January 18, 200X 15:01)
! Copyright (c) 1999-200X Juniper Networks, Inc. All rights reserved.
Commands displayed are limited to those available at privilege level 10
! Juniper Networks Edge Routing Switch ERX-700
boot config running-configuration
boot system erx_x-y-z.rel
no boot backup
no boot subsystem
no boot backup subsystem
no boot force-backup
!
! Note: The following commands are here to ensure that all virtual routers and
! vrfs are created before other commands that may need to reference them.
! These commands will be repeated further on as each virtual router and vrf
! has its configuration presented.
!
virtual-router default
virtual-router boston
!
ip vrf vpna
virtual-router vrA
!
hostname host1
exception protocol ftp anonymous null
!
controller t1 6/0
channel-group 2 timeslots 1,3-8,10 speed 64
.
.
.
!
virtual-router vrA
aaa authentication ppp default radius
aaa accounting ppp default radius
!
ip address-pool local
interface null 0
ip bgp-community new-format
no ip source-route
!
snmp-server
!
! End of generated configuration script.
Example using interface keyword:
host1# show configuration interface serial 4/0
interface atm 4/0

```

```

atm vc-per-vp 1024
atm uni-version 3.0
!
interface atm 4/0.1 point-to-point
  profile pppoe myProfile
  qos-profile myQosProfile
!
interface atm 4/0.2 point-to-point
  qos-profile myQosProfile
  ip description TestIP
!
interface atm 4/0.3 point-to-point
Example using category keyword:
host1# show configuration category system file-system
boot config running-configuration
boot system m.rel
no boot backup
no boot subsystem
no boot backup subsystem

```

- See show configuration.

show running-configuration

- Use to display the configuration currently running on the router, a specified virtual router, a specified interface, or a specified category of router settings.

- Example

host1#**show running-configuration**

- Example 2

host1#**show running-configuration interface serial 4/0**

- Example 3

host1#**show running-configuration category system file-system**

- See show running-configuration.

tag-group

- Use to configure an interface tag group.
- Any number of interfaces can be in a tag group.
- Interface types tunnel, lag, mlppp, and mlframe-relay cannot be added to tag groups.
- An interface can be in only one tag group.
- Example

host1(config-if)#**tag-group red**

- Use the **no** version to remove the tag group.
- See tag-group.

Detecting Corrupt File Configurations

You can detect corruption of running configuration files and CNF files on both the primary and the standby SRP when the corruption is due to a fatal duplicate key error. CNF files must be present on the active file system to monitor them; you cannot monitor CNF files that reside alone on the standby SRP.

You can use the **service check-config** command to control the mode of detection for corruption detection of the running configuration. Auto mode provides a background monitoring task that periodically checks the validity of running configurations. The **service config-monitor-periodicty** command enables you to set the time for background monitoring of the active and standby SRP. By default, background monitoring is not running. Manual mode is the default detection mode. For corruption detection of the CNF files, you must use manual mode.

A critical message to take further corrective action is logged in all the cases of corruption detection to ensure that an SRP reset does not occur and that the system recovers with the last known good configuration.

When duplicate key corruption is detected in either the active or standby SRP:

- File synchronization between the active and standby SRP occurs when HA is enabled. Configuration files are not synchronized to the standby SRP. You can restart file synchronization of configuration files only when you reinitialize the flash file system on the corrupted SRP.
- If HA is disabled, you cannot enable HA until you reinitialize the flash file system on the corrupted system. HA is disabled because of the redundancy corruption criteria. HA cannot be reenabled until the flash file system is reinitialized on the corrupted system.
- You cannot initialize unified ISSU until you reinitialize the flash file system on the corrupted system. If the corruption is detected after unified ISSU is initialized, HA is disabled, which then sets a redundancy criteria for corruption that prevents unified ISSU from starting.
- If monitoring is configured to run in auto mode when unified ISSU starts, monitoring reverts back to manual mode to prevent monitoring during a unified ISSU upgrade. After a successful unified ISSU upgrade, monitoring switches back to the originally configured mode on both SRPs.

File synchronization and monitoring the file system are separate operations. Depending on the wake up time of the monitoring task, there is a period of time when corruption can occur and the file systems are synchronized. We recommend that you run the manual command to check the file system before you enable HA or perform any unified ISSU-related operations

service check-config

- Use to detect corruption of running configuration files and CNF files on the primary SRP and the standby SRP when it is due to a fatal duplicate key error. You cannot monitor CNF files on the standby SRP.
- Auto mode checks the running configuration at regular intervals; auto mode cannot be used for CNF files.
- Use the default version to restore the default setting, manual detection.

- Example

```
host1(config)#service config-check auto
```

- Use the **no** version to restore the default action, manual detection.
- See service check-config.

service config-monitor-periodicity

- Use to set the time for background monitoring of the active and standby SRP. By default, background monitoring is not running. For corruption detection of the CNF files, you must use manual mode.
- Auto mode checks the running configuration at regular intervals; auto mode cannot be used for CNF files.
- Use the default version to restore the default setting, manual detection.
- Example

```
host1(config)#service config-monitor-periodicity 2000
```

- There is no **no** version.
- See service config-monitor-periodicity.

show service config-monitor-periodicity

- Use to display the time of the monitoring task for detecting corruption of a running configuration on both the primary SRP and the standby SRP.
- Example

```
host1#show service config-monitor-periodicity  
config-monitor-periodicity = 2000
```

- See show service config-monitor-periodicity.

Configuring the System Automatically

You can create an autoconfiguration script that runs whenever you reset the router. The following guidelines apply:

- You must name the script autocfg.scr.
- Add the commands desired to configure the system.
- For some configuration tasks, you might need to pause the CLI for about 10 seconds by adding a **sleep seconds** command. The exact period must be determined empirically because it depends on your configuration and the software release version.



NOTE: The `autocfg.scr` script is bypassed if you arm the system to load from a script (not `autocfg.scr`) through the **boot config** command or **boot backup** command.

Saving the Current Configuration

By default, the system automatically saves any change to the system configuration to nonvolatile storage (NVS). This feature is known as Automatic Commit mode, but has no effect on the CLI prompt. For more information about displaying the current configuration of the system while in Automatic Commit mode, see “show configuration” on page 252 on “show configuration” on page 252.

You can disable this feature by issuing the **service manual-commit** command. In Manual Commit mode (again with no effect on the CLI prompt), any configuration change affects only the current system configuration (the running configuration). For more information about displaying the running configuration of the system while in Manual Commit mode, see “show running-configuration” on page 254 on “show running-configuration” on page 254.

If you are in Manual Commit mode and want to save the configuration changes to NVS, you must issue either the **write memory** command or the **copy running-configuration startup-configuration** command.

If you change the configuration while in Manual Commit mode and issue the **reload** command without saving the changes to the startup configuration, the system provides a warning, allowing you to save the changes before reloading.

You can use the **include-text-config** keyword with the **copy running-configuration** command to add the text configuration to the system configuration file in compressed format. Storing the text configuration in compressed format reduces the size of the system configuration file and the amount of space that the file occupies on the local flash card or network host. If you change from commit mode to manual-commit mode, the configuration that is available at that point in time is written into the `.cnf` file. A Perl script is provided in the Tools folder on one of the two *JUNOS software* CDs, depending on whether you want to install the software on an ERX model or an E120 and E-320 model, shipped with your router that enables you to view the text configuration in a configuration file that contains both binary and text configuration. The Perl script supports multiple platforms. The “Usage and Troubleshooting document for desktop tool” file in PDF format provides an explanation of how to extract the system configuration file, using the `extractScrFromCnf.pl` script. For more information about using the Perl script, see “Using the Desktop Tool for Viewing Uncompressed Text Configuration” on page 260.



NOTE: To avoid any discrepancies between the text-generated file and the system configuration file, do not change the configuration when the **copy running-configuration** command is running.

copy running-configuration

- Use to save the current configuration to a system configuration (*.cnf) file.
- Use the **include-text-config** keyword to add the text configuration to the system configuration file in compressed format.
- Although this command is available in either Automatic Commit mode or Manual Commit mode, use this command only in Manual Commit mode. Issuing this command in Automatic Commit mode has no effect.
- The destination filename must have a .cnf extension.
- The destination file can be either a local or a network file.
- If you want to restore a previously saved configuration, use the **boot config** *cnfFileName* command.
- Example 1—Saves the current configuration on the router to the system 2.cnf file

```
host1#copy running-configuration system2.cnf
```

- Example 2—Saves the current configuration on the router to the system 2.cnf file and adds the text configuration to the system 2.cnf file in compressed format

```
host1#copy running-configuration system2.cnf include-text-config
```

- There is no **no** version.
- See copy running-configuration.

copy running-configuration startup-configuration

- Use to save all outstanding (unsaved) configuration changes to NVS.
- This command is an exact alias of the **write memory** command.
- This command is available if the system is in either Automatic Commit mode or Manual Commit mode. If issued while in Automatic Commit mode, the CLI notifies you that the command is not necessary, but allows you to proceed.
- If automatic synchronization between the primary and standby SRP modules is enabled (the default system behavior) and the system is in Manual Commit mode (the nondefault system behavior), issuing this command triggers file system synchronization immediately after the system writes, or commits, all outstanding configuration changes to NVS.
- This command is prevented during the high availability initialization state. If issued during this state, the CLI notifies you of the state and requests that you try again later.
- Example

```
host1#copy running-configuration startup-configuration
```

- There is no **no** version.
- See copy running-configuration startup-configuration.

copy startup-configuration

- Use to copy the previously saved startup configuration to a system configuration (*.cnf) file. If you have made but not saved any configuration changes, those changes are not in the startup configuration.
- This command is available only if the system is in Manual Commit mode.
- Example

```
host1#copy startup-configuration system1.cnf
```

- There is no **no** version.
- See copy startup-configuration.

service manual-commit

- Use to stop the system from automatically saving configuration changes to NVS.
- Issuing this command places the system into Manual Commit mode. This mode has no effect on the CLI prompt.
- Issuing this command causes an immediate save of configuration data not yet committed to NVS.
- If issued when high availability is initializing, the CLI notifies you of the state and requests that you try again later.
- Example

```
host1(config)#service manual-commit
```

- The **no** version returns the system to Automatic Commit mode; the **no** version has no effect if the system is already in Automatic Commit mode.
- See service manual-commit.

write memory

- Use to save all outstanding (unsaved) configuration changes to NVS.
- This command is an exact alias of the **copy running-configuration startup-configuration** command.
- This command is available if the router is in either Automatic Commit mode or Manual Commit mode. If issued while in Automatic Commit mode, the CLI notifies you that the command is not necessary, but allows you to proceed.
- If automatic synchronization between the primary and standby SRP modules is enabled (the default system behavior) and the system is in Manual Commit mode (the nondefault system behavior), issuing this command triggers file system synchronization immediately after the system writes, or commits, all outstanding configuration changes to NVS.
- Example

```
host1#write memory
```

- There is no **no** version.
- See write memory.

Using the Desktop Tool for Viewing Uncompressed Text Configuration

You can use a desktop tool that resides on your local client system to view the text configuration embedded in the system configuration file. You need to copy the system configuration file to your client system and run the desktop tool to view the uncompressed text configuration. This tool uses an executable to decompress the output of the **show configuration** command in the system configuration file. This executable is generated using the freely available GNU gcc compiler, which is platform-specific. The tool generates a temporary file in the directory where the Perl script is being run during the process of execution.

The desktop tool does not perform any CRC checking of the system configuration file before decompressing it. If the compressed data in the system configuration file is corrupt, a compression failure message is displayed. You must configure execute permissions for the files and executables that you install from the *JUNOS Software* CD.

Installation Prerequisites for the Desktop Tool

The desktop tool has the following prerequisites for the installation of necessary executables, depending on the operating system that is running on your client system:

Requirements for Microsoft Windows Systems

The desktop tool has the following requirements for client systems running on Microsoft Windows platform:

1. The tool to extract the decompressed text configuration must be run in a shell environment. If a shell environment is not available on your Windows XP and Windows Vista system, you can download and install the Cygwin software from the following site:

<http://www.cygwin.com/setup.exe>

2. You must install the GCC compiler from the following site:

<http://www.mingw.org/>

This compiler is required to run the tool on all Windows platforms.

3. Choose the option to install "g+ + compiler" when prompted during installation. The PATH environment variable must be set properly for the GCC compiler.

If Perl libraries are not available on your Windows XP and Windows Vista platforms, you must install Active Perl from the following site:

<http://www.activestate.com>

Requirements for Sun Solaris Systems

The desktop tool has the following requirements for client systems running on Sun Solaris platforms. You must have execute permissions for the files.

1. By default, the GCC compiler is not available on Solaris 9 and Solaris 10 platforms, but is required to run the desktop tool on Solaris platforms. Install the compiler from the following site:

<http://www.sunfreeware.com/>

For example, type **/usr/sbin/pkgadd -d gcc-3.4.6-sol10-x86-local**.

2. If the Solaris patch is not available by default on your client system, install it from the following site:

<http://www.sunfreeware.com/>

For example, type **/usr/sbin/pkgadd -d libiconv-1.11-sol10-x86-local**.

3. Set the LD_LIBRARY_PATH environment variable by issuing the following command:

```
export LD_LIBRARY_PATH = "/usr/local/bin"
```

where **/usr/local/bin** is the directory in which the libraries are bundled.

Requirements for Linux Systems

The GCC compiler is available with Linux 5.0 and Linux 5.1 platforms. If the GCC compiler is not installed on your Linux system, install the required RPMs from the Linux installation disk. Perl is also available with Linux 5.0 and Linux 5.1 installation.

Usage Notes for the Perl Script

Issue the following command from the directory in which Perl is installed on your system:

```
perl_install_dir extractScrFromCnf.pl combinedCnf File
```

where

- *perl_install_dir* is the directory in which Perl is installed. You can find this directory by issuing the which perl command from the command prompt.
- **extractScrFromCnf.pl** is the Perl script that extracts the text configuration portion from the system configuration file.
- *combinedCnf File* is the .cnf file generated in compressed format that includes the text configuration.

We recommend that you copy the *combinedCnf File* to the directory in which the **extractScrFromCnf.pl** script is stored.

Customizing the User Interface

You can access the CLI through a console connected directly to the system or through a Telnet session. This section describes how you can customize the user interface.

Some commands apply to the console, and some commands apply to vty lines that support Telnet sessions.

Setting the Console Speed

You can specify the console speed for only the current console session or for the current console session and all subsequent console sessions.

speed

- Use to set the speed for the current and all subsequent console sessions immediately.

- Example

```
host1(config)#line console 0
host1(config-line)#speed 14400
```

- Use the **no** version to revert to the default, 9600 bps.
- See **speed**.

terminal speed

- Use to set the speed for the current console session.
- Example

```
host1#terminal speed 14400
```

- There is no **no** version.
- See **terminal speed**.

Configuring the Display Terminal

You can specify the number of lines that appear on a terminal screen and the number of characters that appear on a line.

terminal length

- Use to set the number of lines on a screen.
- If a command generates more lines than the number configured, the output pauses after each screen.
- Set the number of lines on a screen in the range 0–512.
- Use 0 for no pausing.
- Example

```
host1#terminal length 25
```

- There is no **no** version.
- See **terminal length**.

terminal width

- Use to set the width of the display terminal.
- Set the number of characters on a screen line in the range 30–512.
- Example

```
host1#terminal width 80
```

- There is no **no** version.
- See terminal width.

Specifying the Character Set

You can specify the number of data bits per character for the current vty session and for all subsequent sessions on the specified vty lines. This feature allows you to display international characters on the terminal's screen.

data-character-bits

- Use to set the number of bits per character on the terminal's screen for all future sessions on the specified lines.
- Use the default setting, 8, to view the full set of 8-bit international characters. Be sure that the software on other devices in the network also supports international characters.
- Set the number of bits to 7 to view only characters in the standard ASCII set.
- Example

```
host1(config)#line vty 1 3
host1(config-line)#data-character-bits 7
```

- There is no **no** version.
- See data-character-bits.

terminal data-character-bits

- Use to set the number of bits per character on the terminal's screen for the current session.
- Use the default setting, 8, to view the full set of 8-bit international characters. Be sure that software on other devices in the network also supports international characters.
- Set the number of bits to 7 to view only characters in the standard ASCII set.
- Example

```
host1#terminal data-character-bits 7
```

- There is no **no** version.
- See terminal data-character-bits.

Configuring Login Conditions

You can issue the **dsr-detect** command to configure the system so that a data set ready (DSR) signal is required to log in to the console. If a session is in progress and the DSR signal is lost, the user is logged out automatically.

```
host1(config)#line console 0
host1(config-line)#dsr-detect
```

DSR is carried on pin 6 of the SRP module's RS-232 (DB-9) connector. The DSR input must be connected to the DSR output of a modem or the DTR output of another data terminal device, such as a terminal server, that supports this signal.

dsr-detect

- Use to require that a DSR signal be detected on the line for a user to log in to the console.
- By default, DSR is not required and DSR detection is disabled.
- Example

```
host1(config-line)#dsr-detect
```

- Use the no version to remove the DSR requirement for login.
- See dsr-detect.

Setting Time Limits for User Login

You can specify a time interval that the CLI waits for a user to provide a password when logging in to the console or a vty line. To do so:

1. Access the line configuration mode using either the console or vty keyword.
2. Specify the time during which the user must enter the password. For example:

```
host1(config)#line console 0
host1(config-line)#login
host1(config-line)#timeout login response 15
```

timeout login response

- Use to set the time interval that the console or vty lines wait for the user to log in.
- If the interval passes and the user has not responded, the system closes the session or lines.
- Specify an interval in the range 0–300 seconds. A value of 0 means that there is no time limit during which the user must respond.
- The default value is 30 seconds.
- Example

```
host1(config-line)#timeout login response 15
```


- Use the no version to restore the default interval, 30 seconds.
- See timeout login response.

Setting Time Limits for User Input

You can specify a time interval that the CLI waits for user input on the console or vty lines. To do so:

1. Access the line configuration mode using either the console or vty keyword.
2. Specify the time during which the user must enter information. For example:

```
host1(config)#line vty 0
host1(config-line)#exec-timeout 4192 13
```

exec-timeout

- Use to set the time interval that the console or vty lines wait for expected user input.
- If the interval passes and the user has not responded, the system closes the session or lines.
- Specify a time limit in the range 0–35791 minutes, and optionally specify the number of seconds.
- By default, there is no time limit.
- Example

```
host1(config-line)#exec-timeout 4192 13
```

- Use the no version to remove the time limit.
- See exec-timeout.

Configuring CLI Messages

You can configure text banners for the CLI to display to users at different times in the connection process.

banner

- Use to configure message-of-the-day (MOTD), login, or exec banner to be displayed by the CLI:
 - motd—Displays the banner when a console or vty connection is initiated.
 - login—Displays the banner before any user authentication (line or RADIUS authentication). The banner is also displayed if user authentication is not configured.

- **exec**—Displays the banner after user authentication (if any) and before the first prompt of a CLI session.
- If you do not specify an option, the default behavior is to display the banner as an MOTD.
- The first character in the banner string must be repeated at the end of the string; these characters delimit the banner. The CLI prompts you if you fail to repeat the opening delimiter. All text following the second occurrence of the delimiter is ignored without warning. The delimiter is case sensitive.
- Banner text can span multiple lines. It is truncated after 1,024 characters.
- Insert `\n` where you want the banner text to split and start a new line. Alternatively, you can press Enter on the CLI when you want the text to break. In the second case, you will be prompted for the remainder of the text after you press Enter. To display a backslash as part of the message, it must be immediately preceded by another backslash, like this: `\\`. Do not use a backslash as a delimiter or end a line with a backslash.
- To insert a `?` character inside the text of a banner, you must enter `Ctrl + v` before entering the `?` character. Failure to do so may produce undesired results.
- Examples


```

host1(config)#banner motd x This is an MOTD banner x
host1(config)#banner Y This is also an MOTD banner Y
host1(config)#banner "Quotes make good delimiters"
host1(config)#banner Xno space is required between the delimiter and the real banner textX
host1(config)#banner b bad choice for a delimiter; everything after that second b was ignored b
host1(config)#banner "This is one way\nto specify a multiple line banner"
host1(config)#banner "This is another way to specify a
Enter remainder of text message. End with the character '"'.
multiple line banner"

```
- Use the **default** version to restore the default setting, in which the banner is displayed on all lines.
- You can configure MOTD or exec banners, but not login banners, for the CLI to display on a per-line basis.
- Use the **no** version to remove the banner.
- See banner.

exec-banner

- Use to display an exec banner on a particular line after user authentication (if any) and before the first prompt of a CLI session.
- Banners on the lines are enabled by default; the **no** version does not reenables banners on the lines.
- See the “banner” on page 265 command description for more information about configuring an exec banner.
- Example

host1(config-line)#**exec-banner**

- Use the **default** version to restore the default setting, in which the banner is displayed on all lines.
- Use the **no** version to disable the exec banner on the line. If both the exec and MOTD banners are enabled on a line, issuing the **no exec-banner** command disables both the exec banner and the MOTD banner. The **no motd-banner** command behaves differently from the **no exec-banner** command.
- See exec-banner.

motd-banner

- Use to display an MOTD banner on a particular line when a connection is initiated.
- Banners on the lines are enabled by default; the no version does not reenables banners on the lines.
- See the “banner” on page 265 command description for more information about configuring an MOTD banner.
- Example

host1(config-line)#**motd-banner**

- Use the **default** version to restore the default setting, in which the banner is displayed on all lines.
- Use the **no** version to disable the MOTD banner on the line. If both MOTD and exec banners are enabled on a line, issuing the **no motd-banner** command disables the MOTD banner and leaves the exec banner enabled. The **no motd-banner** command behaves differently from the **no exec-banner** command.
- See motd-banner.

Monitoring the Console Settings

You can use the following commands to monitor console settings.

show line console 0

- Use to view the parameters configured for all future console sessions and the current console session.
- Example

```
host1#show line console 0
dsr-detect disabled
configured speed 9600, current speed 9600
exec-timeout never
```

- See show line console 0.

show terminal

- Use to view parameters of the current console session.
- Field descriptions
 - Length—Number of lines on the screen
 - Width—Number of characters on each line of the screen
 - data-character-bits—Number of bits per character
 - 7—Setting for the standard ASCII set
 - 8—Setting for the international character set
 - Speed—Speed of the console session
 - dsr-detect—Status of DSR signal detection
 - enabled—DSR signal must be detected for a user to log in to the console.
 - disabled—DSR signal need not be detected for a user to log in to the console.
 - exec-timeout—Time interval that the terminal waits for expected user input
 - Never—Indicates that there is no time limit
 - exec-banner—Status for the exec banner: enabled or disabled. This banner is displayed by the CLI after user authentication (if any) and before the first prompt of a CLI session.
 - motd-banner—Status for the MOTD banner: enabled or disabled. This banner is displayed by the CLI when a connection is initiated.
 - login-timeout—Time interval during which the user must log in.
 - Never—Indicates that there is no time limit
- Example


```
host1#show terminal
Length: 25 lines, Width: 80 columns
data-character-bits: 8 bits per character
Speed: 9600 bits per second
dsr-detect disabled
exec-timeout never
exec-banner enabled
motd-banner enabled
login-timeout 30 seconds
```
- See show terminal.

Sending Messages

You can send a message to one or more terminals with the **send** command. You can specify a line number, a console number, or a vty number. You can also send the message to all terminals.

The following command sends the message “hello console” to line 0:

```
host1#send 0 “hello console”
```

The following command sends the message “hello everyone” to all terminals:

```
host1#send * “hello everyone”
```

If you begin the message on the same line as the **send** command, the first character of the message is considered to be a delimiter. You must use the same character to terminate the message. In both examples above, the delimiter was a double quotation mark (“”).

If you press Enter without typing the second delimiter, the CLI prompts you for more message text and reminds you to complete the message with the delimiter, as shown in the following example:

```
host1#send vty4 XYou can start a message on the same line
Enter remainder of text message. End with the character 'X'.
and continue it on subsequent lines; the CLI prompts you for
Enter remainder of text message. End with the character 'X'.
more message text until you enter the second delimiterX
Proceed with send? [confirm]
```

If you do not begin the message on the same line as the **send** command, the CLI prompts you for the message text after you press Enter. The CLI does not recognize delimiters for these messages; you must enter Ctrl+Z, as shown in the following example:

```
host1#send 0
Enter remainder of text message. End with ^Z.
Good morning, Major Tom^Z
Proceed with send? [confirm]
```

The receiving terminals display the message without regard to other output currently displayed on the terminal. Pagination is not affected.

The sending terminal is not affected by the state of the intended receiving terminal. For example, if the receiving terminal is flow-controlled off or at a --More-- prompt, the message is still sent, and the sending terminal is available for further commands. The receiving terminal in this case displays the message when subsequently flow-controlled on or when the user responds to the --More-- prompt.

The receiving terminal displays the message, the line number of the sender, the username of the sender if the user was authenticated through RADIUS, and the time the message was sent.

send

- Use to send a message to one or more terminals. You can specify a line number, a console number, or a vty number. You can use the `*` keyword to send the message to all terminals.
- If you begin the message on the same line as the **send** command, the first character of the message is considered to be a delimiter. You must use the same character to terminate the message.
- The CLI prompts you for message text if you do not begin or complete the message on the same line as the **send** command. The CLI reminds you to signal the end of the message either with the delimiter or Ctrl + z.
- Example


```
host1#send 0 " hello console"
```
- There is no **no** version.
- See **send**.

Managing Memory

The system performs most memory management tasks automatically. The system allocates some memory permanently and some memory temporarily. When applications are deleted, memory that the system assigned temporarily becomes available again.

The system releases available memory on an SRP module or line module automatically if that module requires extra memory for an application. However, you can force the system to release available memory on the primary SRP module if you issue either the **show processes memory** command or the **show utilization** command.

For information about the **show processes memory** command, see “Managing Files” on page 270. For information about the **show utilization** command, see “Managing Modules” on page 335.



NOTE: When you issue the **show utilization** command, the system releases available memory on the SRP module immediately; however, the display appears a few seconds later.

Managing Files

You are responsible for file management. Table 31 on page 270 shows the types of system files and their corresponding extensions.

Table 31: Types of System Files and Corresponding Extensions

Type of File	Extension	Description
Configuration	*.cnf	Snapshot of the system’s configuration

Table 31: Types of System Files and Corresponding Extensions *(continued)*

Type of File	Extension	Description
Core dump	*.dmp	File you can create for troubleshooting if a module fails
History	*.hty (reboot.hty)	Details of when and why modules rebooted
Log	*.log	A series of messages that describe events that occurred on the system
Macro	*.mac	A macro program
Release	*.rel	Software releases you can install in the system
Script	*.scr	A sequence of CLI commands. When you run a script file, the system executes the commands as though they were entered at the terminal
Secure Shell (SSH) Server public key	*.pub	Host key for the SSH server
Statistics	*.sts	Bulk statistics created when you run the bulkstats commands
Text	*.txt	Text file

System files may reside in four locations:

- The system space
- The user space
- A network host
- The standby SRP module

The system space contains files for system operation. For example, the current software configuration is stored in the system space.

The user space is reserved for FTP server operations and has the typical directory structure of a secure FTP server. The root or top level directory is a read-only directory that contains two subdirectories:

- `/incoming`—Read-write directory to and from which an FTP client can send and retrieve files.
- `/outgoing`—Read-only directory from which an FTP client can retrieve files.

Users can transfer files through FTP to the user space from a network host and vice versa. However, users cannot access the system space through FTP. To install a file from the user space to the system space, use the **copy** command. For detailed information about transferring files between locations, see “Transferring Files” on page 281.

To conserve NVS and minimize the installation time, files are not stored in both the system space and the user space. When you issue the **copy** command to install a file from user space to system space, the E-series router establishes a link to the file, but does not make a physical copy.

Managing the User Space from a Network Host

If you enable the system's FTP server (see "Configuring the FTP Server" on page 289), you can manage files on the user space from an FTP client on a network host. Table 32 on page 272 lists the FTP protocol commands that the E-series router supports. Whether you can perform these functions on the user space depends on the features that the FTP client offers.

Table 32: FTP Commands That the System Supports

FTP Command	Function
HELP	List supported commands.
USER	Verify username.
PASS	Verify password for the user.
QUIT	Quit the session.
LIST	List contents of a directory.
NLST	List directory contents using a concise format.
RETR	Retrieve a file.
STOR	Store a file.
CWD	Change working directory.
CDUP	Change working directory to parent.
TYPE	Change the data representation type.
PORT	Change the port number.
PWD, XPWD	Get the name of current working directory.
STRU	Change file structure settings (only stream mode supported).
MODE	Change file transfer mode (only stream mode supported).
PASV	Make the server listen on a port for data connection.
NOOP	Do nothing.
DELE	Delete a file.
MKD, XMKD	Make directory.
RMD, XRMD	Remove directory.

Table 32: FTP Commands That the System Supports *(continued)*

FTP Command	Function
RNFR	Rename from.
RNTO	Rename to.

File Commands and FTP Servers

Commands—**copy**, **configure file**, and **macro**—that invoke a remote FTP server take place in the context of the current virtual router rather than the default virtual router. You must configure the remote FTP server so that any traffic destined for the virtual router can reach the virtual router; typically, you configure the FTP server to reach the default address of the system, which will always be able to reach the virtual router.

Renaming Files

To rename files, use the **rename** command. Table 33 on page 274 shows the types of files you can rename in different locations.

rename

- Use to rename a local file.
- You can change the base name but not the extension of a file.
- Example

```
host1#rename boston1.cnf boston2.cnf
```

- There is no **no** version.

Table 33: File Types You Can Rename

Destination				
Source	System Space	User Space (Linked Files and Unlinked Files)	Network Host Within a Firewall	Standby SRP Module
System	*.cnf	*.cnf	*.sts	None
	*.dmp	*.dmp		
	*.hty	*.hty		
	*.log	*.log		
	*.mac	*.mac		
	*.rel	*.scr		
	*.scr	*.txt		
	*.txt			
	Nonsystem files			
User Space	*.cnf	*.cnf	None	None
	*.hty (excluding reboot.hty)	*.dmp		
		*.hty		
	*.log (excluding system.log)	*.log		
	*.mac	*.mac		
	*.scr	*.pub		
	*.txt	*.rel		
		*.scr		
		*.sts		
		*.txt		
		Nonsystem files		
Network Host Within a Firewall	None	None	None	None
Standby SRP Module	None	None	None	None

- See rename.

Deleting Files

Use the **delete** command to delete files in NVS. Table 34 on page 276 shows the types of files you can delete in different locations.

delete

- Use to delete files in NVS.
- To delete a file in user space, specify the incoming or outgoing directory on the FTP server. You can specify the name of a subdirectory in the incoming or outgoing directory.
- You can include an asterisk (*) as a wildcard at any position in a specified filename. The asterisk substitutes for zero or more characters in the name. You cannot use an asterisk in a directory or subdirectory name.
- You cannot delete reboot.hty or system.log files when you use a wildcard.
- When you do not use a wildcard, the CLI deletes the file immediately without prompting you for confirmation. When you use a wildcard, the CLI prompts you for confirmation unless you also specify the **force** keyword; in that case the deletion takes place without confirmation.
- The **force** keyword causes the immediate deletion of the directory or file even when it is not empty. However, if a file in the specified directory, or a specified file, is marked by the file system as in use because it is required for the current operation or configuration, the **force** keyword cannot force the deletion.
- The **force** keyword is ignored when you attempt to delete any .dmp or .tsa file (unless the deletion is issued from a .mac or .scr file); this means that the CLI always prompts for confirmation for these file types.
- Examples

```
host1#delete test-2.txt
host1#
```

```
host1#del test*.txt
Delete disk0:test-1.txt? [confirm] -> press n
disk0:test-1.txt: not deleted (per user request)
Delete disk0:test-2.txt? [confirm] -> press y
disk0:test-2.dmp: Deleted
Deleted 1 file, matched 2 files
```

```
host1#del test*.txt force
disk0:test-1.txt: deleted
disk0:test-2.txt: deleted
Deleted 2 files, matched 2 files
```

```
host1#del *.dmp force
WARNING: The force option is ignored for this file type.
Delete disk0:sample-1.dmp? [confirm] -> press n
disk0:sample-1.dmp: not deleted (per user request)
Delete disk0:sample-2.dmp? [confirm] -> press y
disk0:sample-2.dmp: Deleted
Deleted 1 file, matched 2 files
```

```
host1#delete /outgoing/test.scr
```

- There is no **no** version.

Table 34: File Types You Can Delete

Location			
System Space	User Space (Linked Files and Unlinked Files)	Network Host Within a Firewall	Standby SRP Module
*.cnf	*.cnf	None	*.dmp
*.dmp	*.dmp		
*.hty	*.hty		
*.log	*.log		
*.mac	*.mac		
*.rel	*.pub		
*.scr	*.rel (deletes *.rel file only and not associated files)		
*.sts			
*.txt	*.scr		
	*.sts		
	*.txt		
	Nonsystem files		

- See delete.

Monitoring Files

Use the **dir** command to view files in NVS.



NOTE: When high availability is enabled on the router, it is possible that files or file attributes may appear unsynchronized when they are not. When enabled, high availability mirrors configuration changes instantly from the active SRP to the standby SRP. However, although these changes are reflected immediately in memory, the standby SRP NVS is updated at 5 minute intervals.

dir

- Use to show a list of files in NVS.
- Specify a directory path, a local filename, a local device name, or some combination of these to view any local files or directories. You cannot use the **dir** command on a network device.
- You can include an asterisk (*) at any position in a specified filename as a wildcard. The asterisk substitutes for zero or more characters in the name. You cannot use a wildcard in a path.
- Bulk statistics .sts files are stored in volatile storage on a RAM disk, and are displayed only when bulkstats is configured.



NOTE: When you issue the **dir** command from Boot mode, a reduced set of file types is displayed.

- Field descriptions
 - file—Name of file or directory (DIR indicates a directory)
 - size—Physical size of file
 - unshared size—Size of file in user space
 - Value of zero indicates that this file has been installed onto the system space and that there is a link to this file.
 - Value other than zero indicates that the file has not been installed onto the system space and equals the physical size of the file.
 - date—Date that file was created
 - in use—An exclamation point (!) indicates that the system is using this file
- Example 1

```
host1#dir
Please wait.....

Active/standby file systems are synchronized.
```

file	size	unshared size
-----	-----	-----
disk0:/incoming <DIR>	0	
disk0:/outgoing <DIR>	0	
disk0:810beta13.cnf	280944	280944
disk0:800beta12.cnf	327011	327011
disk0:bng__1.txt	11092	11092
disk0:bng__2.txt	11092	11092
disk0:bng__3.txt	11092	11092
disk0:erx701rel.cnf	255400	255400
disk0:730beta19.cnf	283141	283141
disk0:730beta18.cnf	284503	284503
disk0:erx_8-0-0b0-24.cnf	327404	327404
disk0:7.3run.cnf	301635	301635

disk0:80beta_bce_backup.cnf	333228	333228
disk0:800beta5.cnf	300575	300575
disk0:820beta5.cnf	311616	311616
disk0:810beta16.cnf	297764	297764
disk0:SRP-10Ge_3_SC_08_22_2006_07_39.dmp	153268924	153268924
disk0:SRP-10Ge_3_SC_04_12_2007_09_47.dmp	182385184	182385184
disk0:reboot.hty	402368	402368
disk0:system.log	702	702
disk0:erx_9-0-0a1-7.rel	176128192	160912356
disk0:erx_8-1-0b1-2.rel	164065212	148633854
disk0:erx_8-2-0b1-5.rel	166117319	150685961
disk0:testing_cat.txt	21848	21848
standby-disk0:SRP-10Ge_1_SC_08_21_2006_13_48.dmp	153547479	153547479
standby-disk0:SRP-10Ge_1_SC_04_12_2007_10_04.dmp	194849368	194849368
standby-disk0:reboot.hty	123136	123136
standby-disk0:system.log	855	855

in	file	date (UTC)
use		
-----		-----

disk0:/incoming <DIR>		02/08/2008 15:06:42
disk0:/outgoing <DIR>		02/08/2008 15:06:42
disk0:810beta13.cnf		02/06/2007 15:13:44
disk0:800beta12.cnf		09/29/2006 16:31:54
disk0:bng___1.txt		02/12/2008 07:05:20
disk0:bng___2.txt		02/12/2008 07:05:28
disk0:bng___3.txt		02/12/2008 06:59:46
disk0:erx701rel.cnf		10/07/2005 13:01:02
disk0:730beta19.cnf		07/12/2006 07:21:22
disk0:730beta18.cnf		06/19/2006 15:23:46
disk0:erx_8-0-0b0-24.cnf		11/02/2006 12:23:38
disk0:7.3run.cnf		08/21/2006 11:19:52
disk0:80beta_bce_backup.cnf		10/04/2007 09:01:36
disk0:800beta5.cnf		01/02/2007 16:01:36
disk0:820beta5.cnf		05/09/2007 14:29:58
disk0:810beta16.cnf		03/15/2007 06:58:14
disk0:SRP-10Ge_3_SC_08_22_2006_07_39.dmp		08/22/2006 07:43:14
disk0:SRP-10Ge_3_SC_04_12_2007_09_47.dmp		04/12/2007 09:51:08
disk0:reboot.hty		01/09/2008 13:57:02
disk0:system.log		11/12/2007 09:56:14
disk0:erx_9-0-0a1-7.rel		10/04/2007 08:40:06
!		
disk0:erx_8-1-0b1-2.rel		03/15/2007 06:50:32
disk0:erx_8-2-0b1-5.rel		05/09/2007 14:22:22
disk0:testing_cat.txt		03/13/2006 17:42:12
standby-disk0:SRP-10Ge_1_SC_08_21_2006_13_48.dmp		08/21/2006 13:51:42
standby-disk0:SRP-10Ge_1_SC_04_12_2007_10_04.dmp		04/12/2007 10:08:38
standby-disk0:reboot.hty		01/09/2008 13:53:10
standby-disk0:system.log		04/12/2007 09:47:24

	Disk capacity		
Device	Capacity (bytes)	Free (bytes)	Reserved (bytes)

disk0:	1054900224	167372414	68157440
standby-disk0:	1054900224	153330775	68157440

■ Example 2

```
host1#dir *.txt
Please wait.....
```

Active/standby file systems are synchronized.

file	size	unshared size
disk0:bng__1.txt	11092	11092
disk0:bng__2.txt	11092	11092
disk0:bng__3.txt	11092	11092

in	file	date (UTC)
use		

	disk0:bng__1.txt	02/12/2008 07:05:20
	disk0:bng__2.txt	02/12/2008 07:05:28
	disk0:bng__3.txt	02/12/2008 06:59:46

	Disk capacity		
Device	Capacity (bytes)	Free (bytes)	Reserved (bytes)
disk0:	1054900224	167372414	68157440
standby-disk0:	1054900224	153330775	68157440

■ Example 3

```
host1#dir /incoming
```

file	size	unshared size	date (UTC)	in use
disk0:3-0-0a3-7.rel	256	0	12/19/2000 07:14:01	
disk0:srp.exe	30012312	0	12/19/2000 07:14:12	
disk0:srpIc.exe	1801208	0	12/19/2000 07:20:32	
disk0:srpDiag.exe	6984222	0	12/19/2000 07:22:08	

	Disk capacity		
Device	Capacity (bytes)	Free (bytes)	Reserved (bytes)
disk0:	220200960	120616448	36700160

■ Example 4

```
host1#dir /outgoing
```

file	size	unshared size	date (UTC)	in use
disk0:test.scr	1204	0	12/18/2000 03:01:04	
disk0:foo.scr	1278	1278	12/20/2000 04:02:12	

Disk capacity			
Device	Capacity (bytes)	Free (bytes)	Reserved (bytes)
disk0:	220200960	120616448	36700160

- There is no **no** version.
- See `dir`.

Viewing Files

Use the **more** command to display the contents of a macro, script, or text file. The file can reside in NVS on the primary SRP module, in NVS on the redundant (standby) SRP module, or on a remote server that you access using FTP.

more

- Use to display the contents of a macro, script, or text file that resides in NVS on the primary SRP module, in NVS on the redundant SRP module, or on a remote server that you access using FTP.
- Specify the file you want to display using one of the following formats, depending on the location of the file:
 - *fileName*—Name of the file that resides in NVS on the primary SRP module
 - *standby:fileName*—Name of the file that resides in NVS on the redundant (standby) SRP module
 - *serverName:filePathName*—Name of the remote server on which the file resides and the complete pathname of the file
- Example 1—Displays the contents of a text file named `erxconfig.txt` that resides in NVS on the primary SRP module

```
host1#more erxconfig.txt
```

- Example 2—Displays the contents of a macro file named `mysetup.mac` that resides in NVS on the redundant (standby) SRP module

```
host1#more standby:mysetup.mac
```

- Example 3—Displays the contents of a script file named `myconfig.scr` that resides on a remote server named `fileserver1`

```
host1#more fileserver1:/startup/scripts/myconfig.scr
```

- There is no **no** version.
- See `more`.

Transferring Files

You may need to transfer files between the following locations:

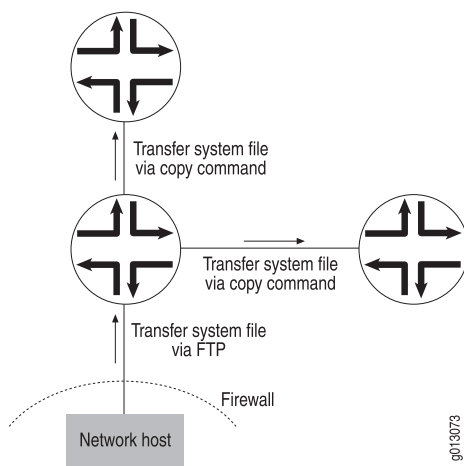
- System space
- User space
- Network host
- Standby SRP module

You can transfer files in any of three ways: the **copy** command, the system's FTP server, or a remote host that is configured as an FTP or a TFTP server. Table 35 on page 283 lists the types of files that you can transfer between the locations using the **copy** command, which activates a hidden FTP or TFTP client on the E-series router.

You can use the system's FTP server to transfer files between a network host and the user space. When a firewall separates the E-series router from the network host, you must use the FTP server to transfer files to the user space. You can then install the files from the user space to the system space by using the **copy** command. However, if there is no firewall between the E-series router and the network host, you can use the **copy** command, the remote FTP server, or the remote TFTP server to transfer files.

For example, you can transfer a file from a network host to an E-series router through FTP, and then transfer the file through the **copy** command from the E-series router to other E-series routers. See Figure 22 on page 281.

Figure 22: Transferring System Files to the E-series Router



References

For more information about file transfer protocols, consult the following resources:

- RFC 959—File Transfer Protocol (FTP) (October 1985)
- RFC 1350—Trivial File Transfer Protocol (TFTP) (Revision 2) (July 1992)

Copying and Redirecting Files

You have two options for copying or redirecting files to or from a remote FTP or TFTP server:

- Include all remote file data in the copy command. You can specify remote files using the URL format and the file redirect option for the related show commands.
- Use the **host** command to define the host and the appropriate file transfer protocol. FTP is the default if you do not specify a file transfer protocol or when Domain Name System (DNS) service is used to map IP addresses to the hostname.

If you include the remote file data, the copy command contains a source and destination filename, either of which (but not both) can be remote files. The following URL format is supported for both source and destination files:

```
protocol://[username[:password]@]location[/directory]/filename
```

The location can be a hostname or an IP address.

The two versions of the URL format are as follows:

```
ftp://[username[:password ]@]location[/directory]/filename
tftp://location[/directory]/filename
```



NOTE: The TFTP protocol does not support username and password. Entering a username and password in the TFTP version results in a command error.

The protocol specified in the command always overrides the protocol associated with the host entry, if any, in the host table. Some protocols, such as FTP, require a username and password with each request. For the URL version of the copy command, the following sequence is followed:

- If the command contains a username, the username and password specified in the command are used. The password null is used if the command does not contain a password.
- If the location in the URL is a hostname with a corresponding host entry (created by the **host** command), the username and password of the host entry are used. A host entry that is created without an explicit user name is created with the default username of anonymous and password of null.

The location is the IP address or hostname of the remote file server. The directory/filename is the full path of the file relative to the user login root path.

The characters in the URL format can be encoded. Any of the delimiter characters can be used in the host, username, password, and directory and file fields when added as encoded characters. The encoded characters must be three characters, starting with a percent and followed by the two hexadecimal digits that are the ASCII equivalent. The system converts all printable characters before passing them to the protocol support. Unprintable characters (0-012F and 0x7f-0x7F) are not converted and are passed directly to the protocol. Printable characters (0x20–0x7E) are decoded and all others (0x80–0xFF) are rejected.

In the following example, the username contains the @ delimiter character encoded as %40, and the directory passed to the FTP protocol layer is /dirA/dirB/dirC. The delimiter between the hostname and directory is a forward slash (/) character. To add a slash to the start of the directory specification, add the encoded slash after the host and directory delimiter.

```
ftp://user%40%40name:pwd@mary/%2fdirA/dirB/dirc/fileA
```

In the following example, the directory passed to the FTP protocol layer is dirA/dirB/dirC.

```
ftp://username:pwd@mary/dirA/dirB/dirc/fileA
```

Using the copy Command

Table 35 on page 283 shows the types of files that you can transfer between the locations by using the **copy** command.

Table 35: File Types You Can Transfer Using the copy Command

Destination				
Source	User Space			
	System	(Linked Files and Unlinked Files)	Network Host Within a Firewall	Standby SRP Module
System	*.cnf	*.cnf	*.cnf	None
	*.hty (excluding reboot.hty)	*.hty	*.dmp	
	*.log (excluding system.log)	*.log	*.hty	
	*.mac	*.mac	*.log	
	*.pub	*.pub	*.mac	
	*.scr	*.scr	*.pub	
	*.txt	*.txt	*.scr	
			*.sts	
			*.txt	

Table 35: File Types You Can Transfer Using the copy Command copy copycopy (continued)

Destination				
Source	User Space			
	System	(Linked Files and Unlinked Files)	Network Host Within a Firewall	Standby SRP Module
User Space	*.cnf	*.cnf	None	None
	*.mac	*.hty		
	*.rel	*.log		
	*.scr	*.mac		
	*.txt	*.pub		
		*.rel (*.rel file only, not files associated with the *.rel file)		
		*.scr		
		*.txt		
		Nonsystem files		
Network Host Within a Firewall	*.cnf	None	None	None
	*.mac			
	*.rel			
	*.scr			
	*.txt			
Standby SRP Module	system.log	system.log	system.log	None
	reboot.hty	reboot.hty	reboot.hty	
		*.dmp	*.dmp	

To transfer files using the **copy** command between the system space and a network host:

1. Determine whether there is a route to the network host, and create one if necessary. See *JUNOS 9.3.x IP, IPv6, and IGP Configuration Guide*.
2. Configure the network host as an FTP server, or use a remote host that is configured as a TFTP server.



NOTE: This command takes place in the context of the current virtual router (VR) rather than the default VR. You must configure the FTP server so that any traffic destined for the VR can reach the VR; typically, you configure the FTP server to reach the default address of the E-series router, which will always be able to reach the VR.

3. Add the FTP server to the static host table, and specify the file transport protocol (FTP or TFTP), so that the E-series router can access the network host.
4. (Optional) Specify a source interface to use in FTP packets leaving the router.
5. Copy the files.

copy

- Use to copy a file from one location to another.



NOTE: You cannot copy script (.scr) or macro (.mac) files while in Boot mode. You can copy only .cnf, .hty, and .rel files. If you issue the **dir** command from Boot mode, existing .scr and .mac files are not displayed.

- See Table 35 on page 283 for the types of files that you can copy.
- Specify a network path to copy to or from another device on the network.
- Specify the incoming or outgoing directory to copy to or from the user space.
- Specify a subdirectory name to create a subdirectory within the incoming or outgoing directory in the user space.
- You cannot use wildcards.
- You cannot create or copy over files generated by the system; however, you can copy such files to an unreserved filename.
- Examples

```
host1#copy host1:westford.cnf boston.cnf
host1#copy /incoming/releases/2-8-0a3-7.rel 2-8-0a3-7.rel
host1#copy /shconfig.txt ftp://joe:passwd@173.28.32.156/ftpDir
/results/shConfigJoe.txt
```

- There is no **no** version.
- See copy.

host

- Use to add or modify an entry to the host table. You can enter the optional username and password in plain text (unencrypted). Or, if you know the correct encrypted forms of the username and password, you can enter the encrypted forms (see below).
- This command supports both IPv4 and IPv6 address formats.
- This command allows network files to be accessible from a host.

- This command supports both FTP and TFTP for copying and redirecting files.
- You cannot invent an encrypted string to be used with the algorithm **8** option. You must use plain text (unencrypted) strings for the initial configuration. The only way to obtain a valid encrypted string is to enable password encryption (by issuing the **service password-encryption** command) and then examine the output of the **show configuration** command. Username and password encryption is made available primarily so that scripts generated from the **show configuration** output can be saved, used, and transferred without fear of password exposure.

- Example

```
host1(config)#host westford 10.10.8.7 ftp user25 easy53
```

- To determine the encrypted values for usernames and passwords entered in cleartext, you must do the following:
 1. Issue the **service password-encryption** command. This causes subsequently issued **show configuration** commands to generate encrypted forms of the username and password for this command, as well as for all other commands that support encryption. See “Managing the System” on page 235, for more information about the **service password-encryption** command.
 2. Issue the **show configuration** command and search for the **host** command. The encrypted forms are preceded by the number 8.
 3. You can copy and paste the command showing the encrypted forms into a macro or script to use as desired. Specify the number 8 before the username and before the password to enter an encrypted value.

- Example for encrypted values

```
host1(config)#service password-encryption
host1(config)#host test 10.2.3.4 ftp nick nick
host1(config)#end
host1#show config | inc host
hostname "host1"
host test 10.2.3.4 ftp 8 CU&l,XM(S 8 X=emZn>'S
```

- Use the **no** version to remove a specified host.
- See host.

ip ftp source-address

- Use to specify an operational interface by IP address as the source interface for FTP packets sent by the system’s FTP client.
- This command overrides a setting you configured previously with the **ip ftp source-interface** command.
- If you issue this command, the output of the **show configuration** command includes an entry of the following format:

```
ip ftp source-address ipAddress
```

This entry also appears in the output if you delete an interface or change its IP address after issuing the **ip ftp source-interface** command, in which case the IP address is the one that was configured on the interface before you issued the **ip ftp source-interface** command.

- Example

```
host1(config)#ip ftp source-address 10.10.5.21
```

- Use the **no** version to restore the default, in which the source address in the FTP packets is that of the interface where the FTP connection is made.
- See ip ftp source-address.

ip ftp source-interface

- Use to specify an operational interface by interface type and location as the source interface for FTP packets sent by the system's FTP client.
- The interface you specify must have an IP address.
- This command overrides a setting you configured previously with the **ip ftp source-address** command.
- If you issue this command and the interface is valid, the output of the **show configuration** command includes an entry of the following format:

```
ip ftp source-interface interfaceType interfaceSpecifier
```

- *interfaceType*—Type of interface
- *interfaceSpecifier*—Location of the interface

For information about interface types and specifiers, see Interface Types and Specifiers.

- If you delete the interface or change its IP address, the output of the **show configuration** command appears as if you had entered the **ip ftp source-address** command:

```
ip ftp source-address ipAddress
```

- *ipAddress*—IP address of the interface when you issued the **ip ftp source-interface** command

- Example

```
host1(config)#ip ftp source-interface loopback1
```

- Use the **no** version to restore the default, in which the source address in the FTP packets is that of the interface where the FTP connection is made.
- See ip ftp source-interface.

copy Command Examples

The examples in this section assume that the following host entries have been defined in the host table:

- host mary 172.28.32.156 ftp mike mikePwd
- host joe 172.28.32.99 ftp joe jPasswd

Example 1 Copy a remote file to a local file by using the CLI file copy command format. The following command creates or replaces the local file autocfg.scr by copying the remote file autocfg.scr located in the directory ftpDir/scripts on the host mary. The username mike and password mikePwd from the host entry mary are used to access the remote file.

```
copy mary:ftpDir/scripts/autocfg.scr autocfg.scr
```

Example 2 Copy a local file to a remote file by using file **copy** command format. The following command creates or replaces the remote file shConfigForJoe.txt in the directory ftpDir/results on the host joe by copying the local file shConfig.txt. The username joe and password jPasswd from the host entry joe are used to access the remote file.

```
copy shConfig.txt joe:ftpDir/results/shConfigForJoe.txt
```

Example 3 Copy a remote file to a local file by using the URL format, use the hostname to specify the location, and specify the user name and password in the command. The following command creates or replaces the local file autocfg.scr by copying the remote file autocfg.scr located in the directory ftpDir/scripts on the host mary. The username fred and the password passwd in the command are used; the username and password in the host entry are ignored.

```
copy ftp://fred:passwd@mary/ftpDir/scripts/autocfg.scr autocfg.scr
```

Example 4 Copy a remote file to a local file by using the URL format, use the hostname to specify the location, specify the user name in the command, and use the default value of the password. The following command creates or replaces the local file autocfg.scr by copying the remote file autocfg.scr located in the directory ftpDir/scripts on the host mary. The username fred from the command and the default password null are used; the username and password in the host entry are ignored.

```
copy ftp://fred@mary/ftpDir/scripts/autocfg.scr autocfg.scr
```

Example 5 Copy a remote file to a local file by using the URL format, and use the hostname to specify the location. The protocol TFTP, which does not support usernames or passwords, is the protocol in the URL. The following command creates or replaces the local file autocfg.scr by copying the remote file autocfg.scr located in the directory ftpDir/scripts on the host mary. The protocol specified in the command is used; the protocol for the host entry mary is ignored.

```
copy tftp://mary/ftpDir/scripts/autocfg.scr autocfg.scr
```

Example 6 Copy a remote file to a local file by using the URL format, use the hostname to specify the location, and use the username and password from the host entry. The following

command creates or replaces the local file `autocfg.scr` by copying the remote file `autocfg.scr` located in the directory `ftpDir/scripts` on the host `mary`. The username `mike` and password `mikePwd` from the host entry are used.

```
copy ftp://mary/ftpDir/scripts/autocfg.scr autocfg.scr
```

Example 7 Copy a remote file to a local file by using the URL format. Use the host's IP address to specify the location. The following command creates or replaces the local file `autocfg.scr` by copying the remote file `autocfg.scr` located in the directory `ftpDir/scripts` on the host `172.28.32.156`. Use the username `fred` to access the remote file.

```
copy ftp://fred@172.28.32.156/ftpDir/scripts/autocfg.scr autocfg.scr
```

Example 8 Copy a local file to a remote file by using the URL format, and use the host's IP address to specify the location. The following command creates or replaces the remote file `shConfigJoe.txt` in the directory `ftpDir/results` on the host `172.28.32.156` by copying the local file `shConfig.txt`. The username `joe` and the password `passwd` from the command are used to access the remote file.

```
copy shConfig.txt ftp://joe:passwd@172.28.32.156/ftpDir/results/shConfigJoe.txt
```

Example 9 Redirect the output of a command to a remote file by using the URL format, and use the host's IP address to specify the location. Execute **show config**, and redirect the output to the remote file `shConfigJoe.txt` in directory `ftpDir/results` on host `172.28.32.156` using username `joe` and password `passwd`.

```
show config > ftp://joe:passwd@172.28.32.156/ftpDir/results/shConfigJoe.txt
```

Using TFTP to Transfer Files

You can use TFTP to copy files and redirect output from the E-series router to a remote server if the remote host supports TFTP. Before transferring files by the remote TFTP server, you must use the **host** command to define the host and to specify TFTP as the file transfer protocol.

The maximum file size is 32 MB for file transfer. The release package for JUNOS Release 6.1.0 and higher-numbered releases includes a split version of all release images that exceed 32 MB. Each chunk is less than 32 MB. You can therefore use TFTP with JUNOS Release 6.1.0 and higher-numbered releases to transfer large software images. The JUNOS software copies the split images and reassembles them to full size on the router. The file system on the router does not contain any additional images as a result of this operation.

Configuring the FTP Server

To transfer files by the system's FTP server, you must configure the FTP server and ensure that FTP client software is installed on the network host.

Although you can transfer any type of file by FTP to the E-series router, the principal aim of this feature is to allow the transfer of system files to NVS. You can transfer files by FTP to the user space. You can then install files from the user space onto the

system using the **copy** command. It is not possible to access the system files directly through FTP operations.

FTP sessions on the E-series router use the vty lines. The E-series router divides its vty resources between Telnet, SSH, and FTP services. Each FTP session requires one vty line. The FTP service uses the authentication method configured for the vty lines.

Features

The system supports the following FTP features:

- Compliance with *RFC 959—File Transfer Protocol (FTP) (October 1985)*
- FTP passive mode
- Efficient NVS organization
- User authentication by RADIUS or password checking

FTP Passive Mode

Normally, when a client connects to an FTP server, the client establishes the control channel with the server, and the server responds by opening a data channel to the client. However, when the FTP client and server are on opposite sides of a firewall that prohibits inbound FTP connections, the server cannot open a data channel to the client.

FTP passive mode overcomes this connection limitation. In passive mode, the client opens a control channel to the server, tells the server it wants to operate in passive mode, and opens the data channel to the server. This method of establishing the FTP connection allows both the control channel and the data channel to pass through the firewall in the allowed direction.

Configuring Authentication

Before you enable the FTP server, configure the authentication procedure for the vty lines, as follows:

1. Configure host access lists.
2. Configure user authentication methods.
3. Configure the vty lines to use the host access lists and user authentication methods.

You can specify authentication by a RADIUS server or by password checking. If you choose no authentication service, any client can access the FTP server. For information about authentication on vty lines, see “Managing the System” on page 235.

Configuration Tasks

FTP is disabled by default. You must enable the FTP server with the **ftp-server enable** command before the system allows FTP clients to connect.

ftp-server enable

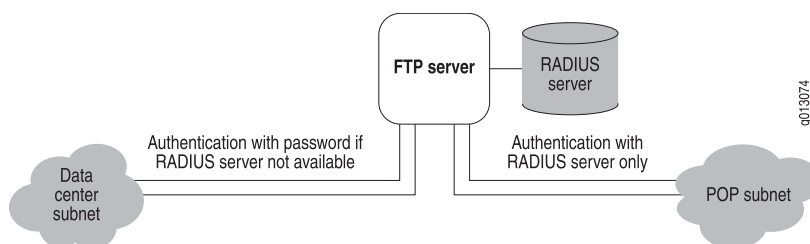
- Use to enable the FTP server and to monitor the FTP port for attempts to connect to the FTP server.
- You can enable the FTP server on the default virtual router only.
- Example

```
host1(config)#ftp-server enable
```

- Use the no version to terminate current FTP sessions and to disable the FTP server.
- See ftp-server enable.

Configuration Example

Figure 23 on page 291 shows the scenario for this configuration example.

Figure 23: FTP Configuration Example

In this example, two FTP lines are required for administrators on the data center subnet, and two more lines are required for users on the POP subnet. The system verifies passwords of administrators on the data center subnet through either a RADIUS server or through simple line authentication if the RADIUS server is unreachable. However, the system verifies passwords of users on the POP subnet only through the RADIUS server.

The following example shows all steps for configuring this scenario, from specifying a RADIUS server to enabling the FTP line:

1. Configure the RADIUS server.

```
host1(config)#radius authentication server 10.6.131.51
host1(config-radius)#key abc123
host1(config-radius)#udp-port 1645
```

2. Configure two access lists—one named “DataCenter,” permitting only the data center subnet, and one named “Pops,” permitting only the POP subnet.

```
host1(config)#access-list DataCenter permit 10.6.128.0 255.255.128.0
host1(config)#access-list DataCenter deny any
host1(config)#access-list Pops permit 199.125.128.0 255.255.128.0
host1(config)#access-list Pops deny any
```

3. Configure two authentication method lists, named “ RadiusAndLine” and “ RadiusOnly.”

```
host1(config)#aaa new-model
host1(config)#aaa authentication login RadiusAndLine radius line
host1(config)#aaa authentication login RadiusOnly radius
```

4. Configure two FTP lines to be used by data center administrators.

```
host1(config)#line vty 0 1
host1(config-line)#password foobar
host1(config-line)#access-class DataCenter in
host1(config-line)#login authentication RadiusAndLine
```

5. Configure the remaining FTP lines to be used by POP administrators.

```
host1(config)#line vty 2 4
host1(config-line)#password foobar
host1(config-line)#access-class Pops in
host1(config-line)#login authentication RadiusOnly
```

6. Enable the FTP server.

```
host1(config)#ftp-server enable
```

Monitoring the FTP Server

Use the **dir** command to monitor files on the FTP server. Use the **show ftp-server** and **show users** commands to monitor settings of the FTP server.

show ftp-server

- Use to display information about the FTP server.
- Field descriptions
 - FTP Server state—Status of the FTP server: enabled or disabled
 - Open connections—Number of open connections to the FTP server
 - Statistics since server was last started—Data about the connection attempts since you enabled the FTP server
 - Statistics since last system reload—Data about the connection attempts since you last booted the system
 - attempts—Number of attempts to connect
 - failed hosts—Number of connection attempts that failed because of disallowed host addresses
 - failed users—Number of connection attempts that failed because users were not authenticated
- Example

```

host1#show ftp-server
FTP Server state: enabled, 0 open connections
Statistics since server was last started:
    attempts: 32
    failed hosts: 5
    failed users: 7
Statistics since last system reload:
    attempts: 35
    failed hosts: 5
    failed users: 8

```

- See show ftp-server.

show users

- Use to display information about users of the vty lines.
- Specify the **all** keyword to view information for all configured lines (both connected and not connected).
- Specify the **detail** keyword to view detailed information.
- Field descriptions
 - line number—Number of the line to which the user is connected
 - line name—Name of the line, the service the line offers, and the relative line number
 - user—Name of the user
 - connected from—Location or IP address of the user
 - connected since—Date and time that the user connected to the line
 - idle time—Amount of time it has been since an entry was made from this line (detail only)
 - virtual router—Virtual router used by this line user (detail only)
 - privilege level—Privilege level of this line user (detail only)
 - current command—Command currently being executed by the user over this line (detail only)
- Example 1

```

host1#show users
line
number  line name  user    connected  connected since
-----  -
0*      console 0
4       vty 3 (ftp)  fred    10.10.0.64 02/12/2001 20:04
5       vty 4 (telnet) 10.10.0.64 02/12/2001 20:04

```

Note: '*' indicates current user.

- Example 2

```

host1#show users detail
line
number      line name      user      connected
            from          connected since      idle
            -----
0           console 0      console   08/14/2003 08:01 00:23:50
1*          vty 0 (telnet) 10.10.120.90 08/15/2003 10:37
line
number      virtual privilege
            router      level      current command
-----
0           default 10
1*          default 10      show users detail
Note: '*' indicates current user.

```

- See show users.

Copying Partial Releases

You can shorten the time it takes to copy a release from a server and reduce the amount of storage needed for a release. At the default setting, all subsystems are included when you copy a release from a server. Use the **exclude-subsystem** command to specify subsystems that you do not want to copy from the server. Use the **show subsystems** command to verify which files are included and excluded when you copy a release from a server.

Follow this example:

1. Determine which subsystems are included in the release on the server.

```
host1#show subsystems file m:/x/images/x-y-z.rel
```

2. Exclude any subsystems in the release that you do not need for the configuration.

```
host1#(config)#exclude-subsystem coc12
host1#(config)#exclude-subsystem oc12s
```

3. (Optional) Remove a subsystem from the exclude list.

```
host1#(config)#no exclude-subsystem oc12s
```

4. (Optional) Verify the subsystems that will be included and excluded in future release copies.

```
host1#show configuration
...
exclude-subsystem coc12
```

5. (Optional) After copying a release, view which subsystems were excluded.

```
host1#show subsystems file x8.rel
```

6. (Optional) Determine whether the currently running software is a result of a copy with excluded subsystems. The word “Partial” indicates that subsystems were excluded.

```
host1#show version
Juniper Networks, Inc. Operating System Software
Copyright (c) 200X Juniper Networks, Inc. All rights reserved.
System Release: x-y-z.rel Partial
```

exclude-subsystem

- Use to exclude any subsystems that are in a release that you do not need for the system configuration.
- Example

```
host1(config)#exclude-subsystem coc12
```

- The subsystems that you indicate are added to the “exclude list.” All subsequent release copies will exclude the images for these subsystems from the release copy.
- Example

```
host1(config)#no exclude-subsystem coc12
```

- Use the **no** version of this command *with the subsystem name* to remove a subsystem from the exclude list. Use the **no** version of this command *without a subsystem name* to remove *all* subsystems from the exclude list.
- See exclude-subsystem.

show subsystems

- Use to determine which subsystems are included in the current software release on the system or in a specified software release file.
- Specify either a local filename or a remote path and filename to view the subsystems that are included in a software release file other than the current software release on the system.
- Field descriptions
 - Required—Number of bytes of data for the required portion of the release.
 - Included Subsystems—Number of bytes of data for the included subsystems listed. All included subsystems in the release are listed.
 - Excluded Subsystems—Number of bytes of data for the excluded subsystems listed. All excluded subsystems in the release are listed.
- Use the command before you copy a release to verify which subsystems are present in the release.
- Example

```
host1#show subsystems file m:/x/images/x-y-z.rel
oc3
```

```

oc12p
oc12a
ge
fe8
coc12
oc12s

```

- Use the command after copying a release to verify which subsystems are included and excluded.
- Example

```

host1#show subsystems file x8.rel
Required: 1423005 bytes
Included Subsystems: 27882192 bytes
oc12p
oc12a
ge
fe8
coc12
oc12s

Excluded Subsystems: 6840211 bytes
oc3

```

- See show subsystems.

Configuring the NFS Client

You can configure a virtual router on the E-series router as a Network File System (NFS) client to provide remote file access for E-series applications that need NFS-based transport.

The system provides NFS client support only for E-series applications designed to use NFS-based transport. Unlike the typical implementation on UNIX workstations, the E-series NFS client does not provide services such as mounting or unmounting of files through the CLI.

This section describes how to configure the NFS client if you are using an E-series application that requires NFS-based transport.

References

The NFS client complies with the following standards:

- RFC 1094—Network File System Protocol Specification (March 1989)
- RFC 1057—Remote Procedure Call Protocol Specification (June 1988)

Prerequisites

The E-series NFS client requires a remote host to act as an NFS server. The remote host must support NFS server protocol version 2 or higher.

Configuration Tasks

To configure a virtual router as an NFS client:

1. Access the virtual router context.
2. Add the remote host to the host table.
3. Configure the remote host as an NFS server for this virtual router.
4. Specify the E-series interface that this virtual router will use to exchange NFS communications with this server.

host

- Use to add or modify an entry to the host table.
- Example

```
host1:boston(config)#host host50 10.2.3.4
```

- Use the **no** version to remove a specified host.
- See host.

ip nfs

- Use to specify the E-series interface that the current virtual router will use to exchange messages with the NFS server.
- Specify either the **source-address** keyword with the IP address of the interface or the **source-interface** keyword with the interface type and specifier. For information about interface types and specifiers, see Interface Types and Specifiers.
- Issuing this command provides connectivity between the E-series router and the remote host if the network configuration restricts communications between devices.
- Example

```
host1:boston(config)#ip nfs source-address 10.1.1.1  
host1:boston(config)#ip nfs source-interface atm 3/2.6
```

- Use the **no** version to delete the name server.
- See ip nfs.

ip nfs host

- Use to configure a remote host as an NFS server for the current virtual router.
- Optionally, specify a user identity and a group identity that a user must specify to connect to the remote host. The default user identity is 2001, and the default group identity is 100.
- Example

```
host1:boston(config)#ip nfs host host50 user 1500 group 150
```

- Use the **no** version to disassociate this NFS server from the current virtual router.
- See `ip nfs host`.

Monitoring the NFS Client

Use the “show hosts” on page 323 command (see “Monitoring the System” on page 317) to monitor information about connected NFS servers. Use the “show ip nfs” on page 298 command to display information about the interface that the current virtual router uses to exchange messages with the NFS server.

show ip nfs

- Use to display information about the interface that the current virtual router uses to exchange messages with the NFS server.
- Field descriptions
 - Source address—IP address of the interface that the current virtual router uses to exchange messages with the NFS server.
 - Source interface—Type and specifier of the interface that the current virtual router uses to exchange messages with the NFS server. For information about interface types and specifiers, see *Interface Types and Specifiers*.
- Example

```
host1#show ip nfs
Source address is 1.1.1.1
```

- See `show ip nfs`.

Using a Loopback Interface

The loopback interface provides a stable address for protocols (for example, BGP, Telnet, or LDP) to use so that they can avoid any impact if a physical interface goes down.

The loopback interface sends packets back to the router or access server for local processing. Any packets routed from the loopback interface, but not destined to the loopback interface, are dropped.



NOTE: Do not confuse loopback with the null 0 interface. Traffic routed to null 0 is discarded on the line module.

The **no** version deletes the loopback interface.

interface loopback

- Use to access and configure the loopback interface.
- Provides a stable address to minimize impact of a physical interface going down.

- Example

```
host1(config)#interface loopback 20
host1(config-if)#ip address 10.10.20.5 255.255.255.254
```

- Use the **no** version to delete the loopback interface.
- See interface loopback.

Using the Telnet Client

The system has an embedded Telnet client that enables you to connect to remote systems. You can configure a Telnet daemon to listen in virtual routers other than the default virtual router. You must be in the context of the desired virtual router to issue the command.

telnet

- Use to open a Telnet connection to a remote system.
- Specify the IP address or name of the remote host.
- You can specify a VRF context in which the request takes place.
- Depending on how the remote system accepts Telnet requests, you can specify a port number or port name through which the system will connect to the remote host. In the Transmission Control Protocol (TCP), ports define the ends of logical connections that carry communications. In most cases, you can accept the default, port number 23, the Telnet port. For more information about port numbers and associated processes, see www.iana.org.
- You can force Telnet to use the IP address of an interface that you specify as its source address.
- Example

```
host1#telnet 192.168.35.13 fastEthernet 0
```

- There is no **no** version.
- See telnet.

telnet listen

- Use to create a Telnet daemon to listen in a virtual router.
- Example

```
host1(config)#virtual-router 3
host1:3(config)#telnet listen port 3223
```

- Use the **no** version of the command to delete the daemon.
- See telnet listen.

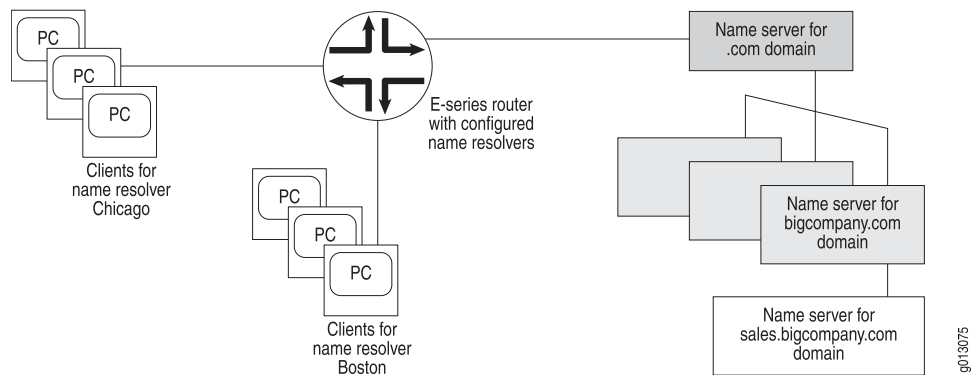
Configuring DNS

You can configure virtual routers to act as *name resolvers* for Domain Name Service (DNS). DNS is a client/server mechanism that maps IP addresses to hostnames.

The name resolver is the client side of DNS and receives address-to-hostname requests from its own clients when they want to contact hosts on other networks. By polling *name servers*, the name resolver learns name-to-address translations for the hosts its clients want to contact.

A name server may provide the translation from its cache or may poll servers lower in the DNS hierarchy to obtain a translation. Typically, name servers at the top of the hierarchy recognize top level domain names and know which servers to contact for information about more detailed domain names. See Figure 24 on page 300.

Figure 24: DNS Hierarchy Example



DNS messages from a name resolver to a name server must include the domain name for the resolver's clients. Consequently, you must specify a default domain name for the clients. The default domain name is appended to unqualified hostnames (those without domain names).

The name resolver must be able to access at least one name server. Accordingly, you must configure a static route to a gateway that provides access to the name server and assign the name server to the name resolver. For more information, see “Assigning Name Servers” on page 301.

Each virtual router can have its own name resolver and domain name. However, if two virtual routers use the same name servers and belong to the same local domain, you do not need to configure name resolvers on both virtual routers. For more information, see “Using One Name Resolver for Multiple Virtual Routers” on page 302.

References

For more information about the DNS, consult the following resources:

- RFC 1035—Domain Names – Implementation and Specification (November 1987)
- RFC 2308—Negative Caching of DNS Queries (DNS NCACHE) (March 1998)

Assigning Name Servers

To assign name servers to the system:

1. Access the virtual router context.
2. Define static routes to the gateways that provide access to the name servers.
3. Enable the virtual router to query name servers.
4. Specify a default domain name for the hosts.
5. Specify the name servers.

Example

```
host1(config)#virtual-router boston
host1:boston(config)#ip route 0.0.0.0 0.0.0.0 gatewayIpAddress
host1:boston(config)#ip domain-lookup
host1:boston(config)#ip domain-name urlsofinterest.com
host1:boston(config)#ip name-server 10.2.0.3
host1:boston(config)#ip name-server 10.2.5.5
```

ip domain-lookup

- Use to enable the system to query the configured DNS name servers when it needs an IP-hostname-to-IP-address translation.
- Domain lookup is disabled by default.
- Example

```
host1(config)#ip domain-lookup
```

- Use the **no** version to disable domain lookup.
- See ip domain-lookup.

ip domain-name

- Use to define a default domain name for the clients that a name resolver serves.
- You must define a default domain name for each name resolver. Multiple name resolvers can use the same default domain name.
- If you map an unqualified hostname (one without a domain name) to an IP address with the **host ftp** command, the domain name is appended to the hostname before the name is stored in the host table.
- Example

```
host1(config)#ip domain-name bigcompany.com
```

- Use the **no** version to delete the domain name; that is, the domain name will no longer be appended to hostnames in the static host table.
- See ip domain-name.

ip name-server

- Use to specify a DNS name server that the system can query for hostname-to-IP-address resolution.
- This command supports both IPv4 and IPv6 addressing formats.
- Example

```
host1(config)#ip name-server 192.168.25.100 1:2:3:4:5:6:7:8:9:0:a:b:c:d:e:f
```

- Use the **no** version to delete the name server.
- See ip name-server.

Using One Name Resolver for Multiple Virtual Routers

You can use one name resolver for multiple virtual routers if those virtual routers use the same name servers and belong to the same local domain. To do so, complete the following steps:

1. Configure a name resolver for the first virtual router.
2. Access the context for the second virtual router.
3. Specify that the second virtual router should use the name resolver you configured for the first virtual router.
4. Repeat Steps 2 and 3 for other virtual routers that you want to point to this name resolver.

Example To configure the virtual router *boston* to use the same name servers as the default router, enter the following commands.

```
host1(config)#virtual router boston
host1:boston(config)#ip domain-lookup transit-virtual-router default
```

ip domain-lookup

- Use to configure a virtual router to use the name servers you configured for another virtual router.
- Example

```
host1:boston(config)#ip domain-lookup transit-virtual-router default
```

- Use the **no** version to stop a virtual router from using the same name servers you configured for another virtual router.
- See ip domain-lookup.

Monitoring DNS

After you configure DNS, you can use the **show ip domain-lookup** command to view information about the name servers.

show ip domain-lookup

- Use to display the name servers that you have specified on the system with the **ip name-server** command.
- Field descriptions
 - Bind to client—Name of the virtual router context in parentheses, followed by the name of the virtual router providing the name resolver
 - Using following Domain Name Servers—Name servers you assigned
 - Using following Local Domain Names—Default domain names you specified
- Example—The virtual router *boston* uses the name resolver on the default virtual router.

```
host1#show ip domain-lookup
Bind to client: (boston)default
Using following Domain Name Servers:
10.2.0.3
11.1.1.1
10.1.1.1
1:2:3:4:5:6:7:8:9:0:a:b:c:d:e:f
Using following Local Domain Names :
urlofinterest.com
concord
```

- See show ip domain-lookup.

Troubleshooting the System

You can use **log** commands to discover and isolate problems with the system. For information about using the log commands, see the *JUNOS System Event Logging Reference Guide*. Juniper Networks Customer Service can use core dump files to troubleshoot line module and SRP module failures.

Creating Core Dump Files

You can enable the system to create a core dump file if a module fails. You can choose to send the core dump file to an FTP server or save the file to NVS. Juniper Networks Customer Service can then access the core dump file and analyze it to determine what went wrong. Local core dumps—stored in NVS—are enabled by default. You can enable the core dump from Boot mode or Global Configuration mode.



CAUTION: Create a core dump file only under the direction of Juniper Networks Customer Service. Network function can be disrupted if you create a core dump file while the system is running in a network.

On the E120 router and the E320 router, the failure of some components on a line module generates multiple core dumps to provide more complete information about system state at the time of the failure. Other E-series routers generate only a single

core dump for line module failures. When you contact Juniper Networks Customer Service for assistance, send all of the generated core dump files.

Boot Mode

To enable the core dump from Boot mode:

1. Access Boot mode by reloading the SRP module; then press the mb key sequence (case insensitive) during the countdown.
2. Specify where the system should transfer the core dump file.
3. Set the IP address and mask of the system interface over which you want to send the core dump file.
4. Specify the gateway through which the system sends the core dump file to the FTP server.
5. (Optional) Set a username and password for FTP access to the server where you transferred the core dump file.
6. Reload the operating system.

Example **:boot##exception dump 192.168.56.7 CORE_DUMPS**
:boot##exception protocol ftp user_name user_password
:boot##exception gateway 192.168.12.3
:boot##exception source 10.10.33.8 255.255.255.0
:boot##reload

Global Configuration Mode

To enable the core dump from Global Configuration mode:

1. Access Global Configuration mode.
2. Specify where the system should transfer the core dump file.
3. Set the IP address and mask of the system interface over which you want to send the core dump file.
4. Specify the gateway through which the system sends the core dump file to the FTP server.
5. (Optional) Set a username and password for FTP access to the server where you want to transfer the core dump file.
6. (Optional) View parameters associated with creating a core dump file.

Example **host1(config)#exception dump 192.168.56.7 CORE_DUMPS**
host1(config)#exception protocol ftp username userpassword
host1(config)#exception gateway 192.168.12.3
host1(config)#exception source 10.10.33.8 255.255.255.0
host1(config)#reload

exception dump

- Use to specify where the system should transfer the core dump file.

- To send the file to an FTP server, enter the IP address of the FTP server and the name of the directory on the server to which the system will transfer the file.
- To send the core dump file to NVS memory, use the local keyword.
- Local core dumps—stored in NVS—are enabled by default.
- Example

host1(config)#**exception dump 192.168.56.7 CORE_DUMPS**

- Use the **no** version to disable the core dump.
- See exception dump.

exception gateway

- Use to specify the gateway through which the system sends the core dump file to the FTP server.
- Example

host1(config)#**exception gateway 10.10.1.15**

- Use the **no** version to return the value to its default (null).
- See exception gateway.

exception protocol ftp

- Use to set a username and password for FTP access to the server where you transferred a core dump file. The default settings are the username anonymous and no password.
- Specify the number 8 before the username and before the password to encrypt these values. By default, the username and password are not encrypted.
- Example

host1(config)#**exception protocol ftp 8 user_core 8 user_password**

- Use the **no** version to restore the default settings.
- See exception protocol ftp.

exception source

- Use to set the IP address and mask of the system interface over which you want to send the core dump file to the FTP server.
- You can optionally include an IP address mask.
- Example

host1(config)#**exception source 192.168.1.33 255.255.255.0**

- Use the **no** version to return the value to its default, null.
- See exception source.

reload

- Use to reload the software on the router immediately.
- Reloads the system software (.rel) file and the configuration (.cnf) file.
- Reloading the standby SRP causes high availability to be temporarily disabled until the standby SRP reloads and resynchronizes with the active SRP.
- Example

```
host1#reload
```

- There is no **no** version.
- See reload.

show exception dump

- Use to display the parameters associated with the core dump operation.
- Field descriptions
 - Dump host IP address—Address of the host where the system is configured to transfer the dump file
 - Dump directory—Name of directory on the host where the system is configured to transfer the dump file
 - Dump protocol—Protocol used to send the core dump file; currently only FTP is supported
 - User name—Name configured for access to the core dump file on the FTP server
 - Password—Password configured for access to the core dump file on the FTP server
 - Interface IP address—Address of the system interface configured to send the core dump file
 - Interface netmask—Mask of the system interface configured to send the core dump file
 - Gateway IP address—Address of gateway configured between the system and the FTP server
- Example

```
host1#show exception dump
Dump host IP address: 192.168.56.7
Dump directory: CORE_DUMPS/
Dump protocol: FTP
User name: user_name
Password: user_password
Interface IP address:
Interface netmask:
Gateway IP address:
```

- See show exception dump.

Managing Core Dump Files

When a core dump occurs on a redundant SRP and you have the router configured to store network core dumps, the SRP that experiences the trouble retains the management Ethernet port to perform the core dump. This prevents the standby SRP from taking over operations until the core dump is complete.

When a router uses local NVS to store a core dump, the SRP does not need the management Ethernet port. However, because of the immense size of local core dump files, using NVS to store core dumps is not practical.

The SRP-120 available on the E120 router and the SRP-320 available on the E120 and E320 routers has a second NVS card which is dedicated to storing core dump files.

The core dump monitor eliminates the impact that core dumps may have on redundant routers by allowing you to manage core dump files in NVS. The core dump monitor allows you to automatically transfer core dump files from NVS to an FTP server location for storage. The core dump monitor can also automatically delete transferred core dump files.

The core dump monitor attempts to delete transferred files when all of the following conditions have been met:

- The router attempts to write a core dump file to NVS.
- NVS contains insufficient space to hold the new core dump file.
- The core dump files have already been transferred from NVS to an FTP server location using the automatic core dump monitor transfer process.

Only those core dump files that have already been transferred from NVS are considered for deletion. Of those, the oldest files are deleted first, and the router generates a log message for each core dump file it deletes.



NOTE: If the router NVS does not contain sufficient space to hold a new core dump file even after deleting all possible core dump files, the core dump fails and the router generates a log message for this condition.

Enabling and Disabling the Core Dump Monitor

The core dump monitor is disabled by default. To enable the core dump monitor, use the **exception monitor** command. Use the **no** version of this command to disable the core dump monitor.

exception monitor

- Use to enable the router core dump monitor and specify the location to which you want the router to transfer core dump files.
- To send the file to an FTP server, enter the IP address of the FTP server and the name of the directory on the server to which the system will transfer the file.

- Enabling the core dump monitor specifies that future core dump files be saved to NVS. See the “exception dump” on page 304 command for details.
- Example

```
host1(config)#exception monitor 192.168.56.7 CORE_DUMPS
```

- Use the **no** version to disable the core dump monitor.



NOTE: You can use the “exception protocol ftp” on page 305 command to assign a username and password to the targeted FTP server. If you choose not to define a username or password, the router uses the values of “anonymous” and “null,” respectively.

- See exception monitor.

Specifying the Core Dump Monitor Interval

To specify the length of time that the router waits between checking for core dump files, use the **exception monitor interval** command. Use the **no** version of this command to revert the core dump monitor interval to its default value of 60 minutes (1 hour).

exception monitor interval

- Use to specify the interval (in minutes) at which you want the router to check NVS for core dump files.
 - Example
- ```
host1(config)#exception monitor interval 1000
```
- Use the **no** version to revert the core dump monitor interval to its default value, 60 minutes.
  - See exception monitor interval.

### Viewing Core Dump Monitor Status

To view information about core dump monitor status and configuration, use the **show exception monitor** command.

#### ***show exception monitor***

- Use to display information about the core dump monitor status and configuration.
- Field descriptions
  - Core dump monitor—Status (enabled or disabled) of the core dump monitor
  - Next dump monitor check time—Time at which the core dump monitor will next check for any new core dump files

- Host—IP address of the FTP host on which the core dump monitor saves core dump files
- Directory—Directory or directory path on the host to where the core dump files are located
- Core dump monitor interval—Time interval (in minutes) at which the core dump monitor checks for any new core dump files
- Files on flash which have been transferred—A list of core dump files in the router NVS that have already been transferred to the FTP host
- Files on flash which have not been transferred—A list of core dump files in the router NVS that have not yet been transferred to the FTP host
- Example

```

host1#show exception monitor
Core dump monitor is enabled
Next dump monitor check time: WED AUG 16 2003 15:50:38 UTC
Host: 10.10.120.99
Directory: monitor
Core dump monitor interval(minutes): 10

Files on flash which have been transferred

standby:OC12Atm(P2)_5_IC_ERX-10-16-5b_09_15_2002_11_59.dmp
SRP-5GPlus_1_SC_tImBo-lAb-3_09_18_2002_19_39.dmp

Files on flash which have not been transferred

standby:SRP-10Ge_1_SC_ERX-10-24-36_09_24_2002_11_04.dmp
OC12-SERVER_5_FC1_E_ERX-10-24-36_03_28_2003_12_44.dmp
E3_1_IC_ERX-10-0f-ab_10_08_2002_16_10.dmp

```

- See show exception monitor.

## Accessing the Core Dump File

If a module fails and saves a core dump file to NVS memory (which can take several minutes), and you have not configured the Core Dump Monitor for automatic transfer, you must transfer the file to a network host before it can be examined. You can transfer the core dump file when the module is back online or has assumed a redundant status. For information about the status of modules, see *ERX Hardware Guide, Chapter 9, Troubleshooting*. To transfer the core dump file to a network host, use the **copy** command.

In a system with two SRP modules, the following behavior applies if you have configured the SRP modules to save core dump files to an FTP server:

- If the primary SRP module fails, it saves the core dump file to the FTP server before the standby SRP module assumes control.
- If the standby SRP module fails, it must save the core dump file to NVS because it has no access to any configured network host.

The **show version** command output indicates the failed SRP module state as not responding during the save process. Consequently, when the failed SRP module recovers and assumes the role of redundant module, the **show version** command output indicates the SRP module state as standby and displays output for the standby SRP. The standby SRP can notify the primary SRP during a core dump. Output from the **show version** command displays core dumping for the Standby SRP.

If the standby SRP boot image encounters a problem loading the diagnostics or operational image, the state of the standby SRP appears as disabled (image error). When standby SRP diagnostics encounter a test failure, the primary SRP is notified and the state is set to hardware error.

You can now transfer the core dump file to a network host for examination. For example, to transfer the file *SRP\_1\_SC\_05\_24\_2000\_02\_20.dmp* from NVS of the failed SRP module to the host server1, enter the following command:

```
host1#copy SRP_1_SC_05_24_2000_02_20.dmp
host:/public/server1/SRP-5G_1_SC_05_24_2000_02_20.dmp
```

#### **copy**

- Use to copy a core dump file.
- You cannot use wildcards.
- You can copy core dump files only to network locations.
- You cannot create or copy over files generated by the system; however, you can copy such files to an unreserved filename.
- Example

```
host1#copy fault.dmp host:/public/server1/fault.dmp
```

- There is no **no** version.
- See copy.

## **Capturing and Writing Core Dumps**

You can capture and write a core dump to a file for an active or a standby SRP module or the line modules. You can store the file on the file system or on a network host. The SRP core dump files are stored on the respective SRP flash memory. The line module core dump files are stored on the active SRP flash memory at the instance of the core dump event. The core dump files are not synchronized between the active and the standby SRP module. You can use the resulting information to help diagnose a problem or to verify whether the core settings are correct (primarily for the network settings).

#### **write core**

- Use to reboot the active SRP module, the standby SRP module, or the module in a specified slot, and write the core dump to a file.
- If you specify the force keyword, you are prompted for confirmation to reboot when the router is in a state that can lead to loss of configuration data or NVS corruption.



**NOTE:** The **force** keyword enables you to specify a slot only if that slot is an SRP module slot.

- If you do not specify a reason, Write Core is the default reason recorded in the reboot history.
- Example 1—Prompts for confirmation to reboot

```
host1#write core force
```

- Example 2—Reboots the module in slot 7 and writes a core memory file

```
host1#write core slot 7
```

- There is no **no** version.
- See write core.

## Understanding the Core Dump File

The dump file indicates which module has failed by referencing that module's hardware slot number. The hardware slot number is the slot number designation on the systems's backplane. This slot number is different from the chassis slot number that appears on the front of the chassis and in screen displays (for example, in the display resulting if you issue the **show version** command).

Table 36 on page 311 shows how the chassis slot numbers relate to the hardware slot numbers.

**Table 36: Chassis Slot Numbers Versus Hardware Slot Numbers**

| Slot Number on Chassis | ERX-7xx Model Hardware Slot Number | ERX-14xx Model Hardware Slot Number | E320 Model Hardware Slot Number |
|------------------------|------------------------------------|-------------------------------------|---------------------------------|
| 0                      | 1                                  | 0                                   | 16                              |
| 1                      | 3                                  | 1                                   | 17                              |
| 2                      | 4                                  | 2                                   | 18                              |
| 3                      | 5                                  | 3                                   | 19                              |
| 4                      | 6                                  | 4                                   | 20                              |
| 5                      | 7                                  | 5                                   | 21                              |
| 6                      | 8                                  | 7                                   | 8                               |
| 7                      | 9                                  | 9                                   | 10                              |
| 8                      | –                                  | 10                                  | 9                               |

**Table 36: Chassis Slot Numbers Versus Hardware Slot Numbers** *(continued)*

| Slot Number on Chassis | ERX-7xx Model Hardware Slot Number | ERX-14xx Model Hardware Slot Number | E320 Model Hardware Slot Number |
|------------------------|------------------------------------|-------------------------------------|---------------------------------|
| 9                      | –                                  | 11                                  | 12                              |
| 10                     | –                                  | 12                                  | 13                              |
| 11                     | –                                  | 13                                  | 25                              |
| 12                     | –                                  | 14                                  | 26                              |
| 13                     | –                                  | 15                                  | 27                              |
| 14                     | –                                  | –                                   | 28                              |
| 15                     | –                                  | –                                   | 29                              |
| 16                     | –                                  | –                                   | 30                              |

## Tracking IP Prefix Reachability

You can use the **track** command to define an IPv4 prefix object and track its reachability. The **show track** command displays the tracked information for any specified objects.

### show track

- Use to display tracking details for the object you specify.
- Field descriptions
  - Track—Name of the object being tracked
  - IP Route—IP prefix being tracked
  - Virtual router—Virtual router on which the object resides
  - First-hop interface—Outgoing interface to reach the prefix
  - changes—Number of times the object has changed state
  - Tracked by—Application that is doing the tracking
- Example

```
host1(config)#show track ERX_Bangalore
```

```
Track ERX_Bangalore
IP Route 1.1.1.0 255.255.255.0 reachability
in virtual router 1
Reachability is Up
First-hop interface is FastEthernet3/0
2 change(s)
```



```
Tracked by:
Vrrp in virtual router 1
```

- See show track.

### **show track brief**

- Use to display a one-line summary of all objects being tracked.
- Field descriptions
  - Object—Name of the object being tracked
  - Type—Type of object being tracked
  - Parameter—Parameter type being tracked
  - Value—State of the object being tracked
- Example

```
host1(config)#show track brief
```

| Object  | Type     | Parameter    | Value |
|---------|----------|--------------|-------|
| ERX-WF  | IP-route | reachability | Up    |
| ERX-BNG | IP-route | reachability | Up    |

- See show track brief.

### **track**

- Use to create an IPv4 object and to track its reachability.
- The name of the object must be unique for the chassis.
- Use the **vrf** keyword to specify the VRF on which the IP prefix resides.
- Example

```
host1(config)#track ERX_Bangalore vrf VR1 ip-route 10.10.24.6 255.255.0.0
reachability
```

- Use the **no** version to delete the object and stop tracking for that object.
- See track.

## **Gathering Information for Customer Support**

When you report a problem with your router, customer support personnel from the Juniper Networks Technical Assistance Center (JTAC) may request that you issue the **show tech-support** command. This command was created to help streamline the information-gathering process by providing a large amount of router information from one command and avoiding the need to access certain diagnostic commands.

The **show tech-support** command functions like any other show command, and you can issue this command the same way you issue any other show commands on the router. This means that you can redirect the output from the command to a file.

For information about redirecting show command output, see “Redirection of show Command Output” on page 40.

Another command that customer support personnel might ask you to use is the **tech-support encoded-string** command. Customer support will provide you with an encoded string of commands that this command then executes.

### **tech-support encoded-string**

- Use to execute an encoded command string provided by Juniper Networks customer support personnel.
- This command requires privilege level 15 access.
- Optionally, specify a slot number on the router.
- Optionally, specify a reliable or fast connection type; fast does not work under some conditions. The default connection type is reliable.
- Example 1

```
host1(config)#tech-support encoded-string debug 1
```

- Example 2

```
host1(config)#tech-support slot 0 connection fast encoded-string debug1
```

- There is no **no** version.
- See tech-support encoded-string.

### **show tech-support**

- Use to display technical support information used by Juniper Networks customer support personnel to assist in troubleshooting the router.
- Example

```
host1#show tech-support
Show Technical Support
```

```

System Name : host1
Time : THU JUL 15 2004 17:12:48 UTC
System up since : WED JUN 30 2004 16:07:51 UTC
Software release : 1088523900
Boot Flags : 0x100663296
Slot Number : 0
Serial Number : 7100170293
Assembly Number : 3400003701
Assembly Rev : A07
Description :
```

```
Command List:
CLI:show version
CLI:show boot
CLI:show hardware
CLI:show redundancy
```

```

CLI:show environment
CLI:show users detail
CLI:show utilization
CLI:show process cpu
CLI:show process memory
....

```

- See show tech-support.

## Managing and Monitoring Resources

---

The resource threshold monitor (RTM) allows you to set the rising and falling thresholds and trap hold-down times for certain interfaces. You can also view the resource threshold information.

### *Enabling and Disabling the Resource Threshold Monitor*

You may want to set thresholds for certain interface resources on the router. The RTM allows you to specify rising and falling thresholds as well as hold-down times for certain interfaces by using the **resource if-type** and **resource threshold** commands.

#### **resource if-type**

- Use to specify rising and falling thresholds and hold-down times for certain interfaces on a slot or systemwide basis.
- Example

```
host1(config)#resource if-type ip slot 4 falling 500
```

- Use the **no** version to set the threshold parameter to its default value (for rising, 90 percent of the maximum value of the resource; for falling, 1 percent of the maximum value of the resource; for hold-down time, 300 seconds).
- See resource if-type.

#### **resource threshold**

- Use to disable the issuance of trap messages when the router reaches preset threshold limits.
- Example

```
host1(config)#resource threshold disable traps
```

- Use the **no** version to reenables traps for resource threshold conditions.
- See resource threshold.

## Viewing Resource Threshold Information

The RTM allows you to view information about resource use on the router. The `show resource` command displays statistical information about resources and their current threshold configurations.

### `show resource`

- Use to display statistical information about resources and their current threshold configurations.
- Field descriptions
  - Resource Threshold Trap—Status (enabled or disabled) of the resource threshold trap
  - type—Interface type
  - location—Location of the interface (system or slot location)
  - max capacity—Maximum capacity of the interface at either the system or slot level
  - current value—Current capacity of the interface at either the system or slot level
  - rising threshold—Rising threshold setting for the interface at either the system or slot level
  - falling threshold—Falling threshold setting for the interface at either the system or slot level
  - hold-down time—Hold-down time setting for the interface at either the system or slot level
- Example 1

```
host1#show resource
```

```
Resource Threshold Trap: enabled
```

| type                        | location | max capacity      | current value  | rising threshold |
|-----------------------------|----------|-------------------|----------------|------------------|
| -----                       |          |                   |                |                  |
| ip interface                | system   | 32000             | 1              | 28800            |
| ip interface                | slot 3   | 8192              | 0              | 7373             |
| ip interface                | slot 4   | 4095              | 0              | 3686             |
| atm-sub-if interface        | system   | 65536             | 0              | 58982            |
| atm-vc interface            | system   | 65536             | 0              | 58982            |
| ppp-link interface          | system   | 32768             | 0              | 29491            |
| ppp-link interface          | slot 3   | 2048              | 0              | 1843             |
| ppp-link interface          | slot 4   | 6                 | 0              | 5                |
| atm-active-sub-if interface | system   | 65536             | 0              | 58982            |
| type                        | location | falling threshold | hold-down time |                  |
| -----                       |          |                   |                |                  |
| ip interface                | system   | 320               | 300            |                  |
| ip interface                | slot 3   | 82                | 300            |                  |
| ip interface                | slot 4   | 41                | 300            |                  |
| atm-sub-if interface        | system   | 655               | 300            |                  |
| atm-vc interface            | system   | 655               | 300            |                  |
| ppp-link interface          | system   | 328               | 300            |                  |

|                             |        |     |     |
|-----------------------------|--------|-----|-----|
| ppp-link interface          | slot 3 | 20  | 300 |
| ppp-link interface          | slot 4 | 0   | 300 |
| atm-active-sub-if interface | system | 655 | 300 |

- Example 2

```
host1#show resource threshold trap
Resource Threshold Trap: enabled
```

- See show resource.

## Monitoring the System

---

This section provides basic system commands that allow you to display information about the router's state. The **show configuration** command, for example, allows you to display the router's entire configuration.

### **baseline show-delta-counts**

- Use to configure the system to always display statistics relative to the most recent appropriate baseline.
- The system collects many statistics during its operation. Various show commands are available to display these statistics. Baselining allows the user to identify a point in time relative to which such statistics can be reported.
- Typically, the optional **delta** keyword is used with show commands to specify that baselined statistics are to be shown. This command applies the “delta” function implicitly.
- Example

```
host1#baseline show-delta-counts
```

- Use the **no** version to have access to the total statistics.
- See baseline show-delta-counts.

### **show configuration**

- Use to display the current (running) configuration of the router, a specified virtual router, a specified interface, or a specified category of router settings.
- See full description and examples in “show configuration” on page 252 on “show configuration” on page 252.
- See show configuration.

### **show environment**

- Use to display information about the router's physical environment, such as voltage or temperature.
- Optionally, specify the **all** keyword to view both the system environment information and the detailed temperature status table, or specify the **table** keyword to view only the temperature status table.

- The system displays a message if the voltage or temperature exceeds normal operating limits.
- The system enters thermal protection mode if the temperature exceeds maximum operating limits or if the fan system on the E120 router or the E320 router reports a critical error. For information about thermal protection mode on ERX-7xx models, ERX-14xx models, and the ERX-310 router, see *ERX Hardware Guide, Chapter 9, Troubleshooting*. For information about thermal protection mode on the E120 and E320 routers, see *E120 and E320 Hardware Guide, Chapter 9, Troubleshooting*.
- Field descriptions
  - chassis—Number of slots, midplane identifier, and hardware revision number
    - 14Slot—5 Gbps, 14 slot midplane
    - midplaneId7Slot—5 Gbps, 7 slot midplane
    - midplaneIdRx1400—10 Gbps ASIC compatible, 12 line module slots, 2 SRP module slots for ERX-14xx models
    - midplaneIdRx700—10 Gbps ASIC compatible, 5 line module slots, 2 SRP module slots for ERX-7xx models
    - 17 slot—100 or 320 Gbps, 17-slot midplane for the E120 router
    - 11 slot—320 Gbps, 11-slot midplane for the E120 router
  - fabric—Capacity and hardware revision of the fabric
  - fans—Status of fans
  - nvs—Status and capacity of NVS and amount of space used
  - power—States of power feeds
  - AC power—For ERX-310 routers only; states of power feeds
  - srp redundancy—Availability of a redundant SRP module
  - slots: cards missing or offline—Status of each slot
    - online
    - standby
    - offline
    - empty
  - line redundancy—Number of redundancy groups installed
    - width—Number of slots the redundant midplane covers
    - spare—Slot that contains a spare line module
    - primary—Slot that contains the primary line module
  - fabric redundancy—Status of redundancy on the switch fabric on the E120 and E320 routers

- ok
- none
- temperature—Status of the system temperature
- timing—Source of the timing signal
  - primary—Type and status of the primary timing signal
  - secondary—Type and status of the secondary timing signal
  - tertiary—Type and status of the tertiary timing signal
  - auto-upgrade—Status of the auto-upgrade parameter, which enables the system to revert to a higher-priority timing source after switching to a lower-priority timing source.
- system operational—Status of the system
- slot—Number of the slot in which the module resides
- type—Type of module in the slot on the E120 and E320 routers
- temperature—Temperature of the line module, SRP module, or SFM on the E120 and E320 routers
- processor temperature—Temperature of the line module or SRP module
- processor temperature status—Temperature condition of the line module
  - normal—Temperature is in normal range
  - too hot—Module is too hot; system will go into thermal protection mode if the temperature of any module exceeds 80° C
  - too cold—Module is too cold; system will go into thermal protection mode if the temperature of any module drops below –5° C
- IOA temperature—Temperature of the corresponding I/O module or IOA
- IOA temperature status—Temperature condition of the corresponding I/O module or IOA
  - normal—Temperature is in normal range
  - too hot—Module is too hot; system will go into thermal protection mode if the temperature of any module exceeds 80° C
  - too cold—Module is too cold; system will go into thermal protection mode if the temperature of any module drops below –5° C
- processor temperature ranges—Displays the temperature ranges for the line modules and SRP modules
- IOA temperature ranges—Displays the temperature ranges for the I/O modules on ERX-7xx models, ERX-14xx models, and the ERX-310 router or IOAs on the E120 and E320 routers

- fabric temperature ranges—Displays the temperature ranges for the SRP modules and SFMs on the E120 and E320 routers
- Example 1—Displays the environment of an ERX-7xx model

```

host1#show environment all
 chassis: 14 slot (id 0x3, rev. 0x0)
 fabric: 5 Gbps (rev. 1)
 fans: ok
 nvs: ok (81MB flash disk, 54% full)
 power: A ok, B not present
 AC power: A not present, B not present
 srp redundancy: none
*** slots: cards missing or offline
 online: 6 9
 standby: 8
 offline: 2
 empty: 0 1 3 4 5 7 10 11 12 13
 line redundancy: 1 redundancy group(s)
 width 6, spare 8, primary 9
 temperature: ok
 timing: primary
 primary: internal SC oscillator (ok)
 secondary: internal SC oscillator (ok)
 tertiary: internal SC oscillator (ok)
 auto-upgrade enabled
*** system operational: no

```

| slot | processor<br>temperature<br>(10C - 70C) | processor<br>temperature<br>status | IOA<br>temperature<br>(10C - 70C) | IOA<br>temperature<br>status |
|------|-----------------------------------------|------------------------------------|-----------------------------------|------------------------------|
| 0    | 31                                      | normal                             | 30                                | normal                       |
| 3    | 31                                      | normal                             | 30                                | normal                       |
| 5    | 31                                      | normal                             | 30                                | normal                       |
| 7    | 31                                      | normal                             | 30                                | normal                       |

```

processor temperature ranges
 below -5C is too cold
 above 80C is too hot
 low temperature warning below 10C
 high temperature warning above 70C
IOA temperature ranges
 below -5C is too cold
 above 80C is too hot
 low temperature warning below 10C
 high temperature warning above 70C

```

- Example 2—Displays the environment of an E320 router

```

host1#show environment all

 chassis: 17 slot (id 0x3, rev. 0x0)
 fabric: 100 Gbps (rev. 1)
 fans: fanSubsystem0k
 nvs: ok (977MB flash disk, 29% full), matches running config
 power: A ok, B not present
 srp redundancy: mode is file-system-synchronization auto-sync
 enabled, switch-on-error enabled
 status unknown

```



```

*** slots: cards missing or offline
online: 0 6 13
offline: 7
empty: 1 2 3 4 5 11 12 14 15 16
fabric slots: ok
online: 6 7 8 9 10
line redundancy: none
temperature: ok
timing: primary
primary: internal SC oscillator (ok)
secondary: internal SC oscillator (ok)
tertiary: internal SC oscillator (ok)
auto-upgrade enabled
fabric redundancy: ok

*** system operational: no

```

| slot | type     | temperature<br>(10C - 70C) | temperature<br>status |
|------|----------|----------------------------|-----------------------|
| 0    | LM-4     | 42                         | normal                |
| 0/1  | GE-4 IOA | 23                         | normal                |
| 6    | SRP-100  | 32                         | normal                |
| 6    | SFM-100  | 32                         | normal                |
| 6/0  | SRP IOA  | 25                         | normal                |
| 7    | SFM-100  | 30                         | normal                |
| 8    | SFM-100  | 23                         | normal                |
| 9    | SFM-100  | 25                         | normal                |
| 10   | SFM-100  | 24                         | normal                |
| 13   | LM-4     | 24                         | normal                |
| 13/0 | GE-4 IOA | 23                         | normal                |

```

fabric temperature ranges
 below -5C is too cold
 above 80C is too hot
 low temperature warning below 10C
 high temperature warning above 70C
processor temperature ranges
 below -5C is too cold
 above 80C is too hot
 low temperature warning below 10C
 high temperature warning above 70C
IOA temperature ranges
 below -5C is too cold
 above 80C is too hot
 low temperature warning below 10C
 high temperature warning above 70C

```

■ Example 3—Displays the environment on an E120 router

```

host1#show environment all
chassis: 11 slot (id 0x8, rev. 0x0)
fabric: 120 Gbps (rev. 1)
fans: fanSubsystem0k
nvs: ok (998MB flash disk, 14% full), matches running config
power: A ok, B not present
srp redundancy: mode is file-system-synchronization auto-sync
enabled, switch-on-error enabled
in sync

```

```

slots: ok
online: 1 2 6
standby: 7
empty: 0 3 4 5
fabric slots: ok
online: 6 7 8 9 10
line redundancy: none
temperature: ok
timing: primary
primary: internal SC oscillator (ok)
secondary: internal SC oscillator (ok)
tertiary: internal SC oscillator (ok)
auto-upgrade enabled
fabric redundancy: ok

```

```
system operational: yes
```

| slot | type     | temperature<br>(10C - 56C) | temperature<br>status |
|------|----------|----------------------------|-----------------------|
| 1    | LM-10    | 37                         | normal                |
| 1/1  | GE-8 IOA | 35                         | normal                |
| 2    | LM-10    | 37                         | normal                |
| 2/1  | GE-8 IOA | 39                         | normal                |
| 6    | SRP-120  | 40                         | normal                |
| 6    | SFM-120  | 40                         | normal                |
| 6/0  | SRP IOA  | 30                         | normal                |
| 7    | SRP-120  | 41                         | normal                |
| 7    | SFM-120  | 41                         | normal                |
| 8    | SFM-120  | 31                         | normal                |
| 9    | SFM-120  | 32                         | normal                |
| 10   | SFM-120  | 32                         | normal                |

```

fabric temperature ranges
 below -5C is too cold
 above 79C is too hot
 low temperature warning below 10C
 high temperature warning above 56C
processor temperature ranges
 below -5C is too cold
 above 79C is too hot
 low temperature warning below 10C
 high temperature warning above 51C
IOA temperature ranges
 below -5C is too cold
 above 79C is too hot
 low temperature warning below 10C
 high temperature warning above 56C

```

- Example 4—Displays the temperature status table on an E120 router

```
host1#show environment table
```

| slot | type     | temperature<br>(10C - 56C) | temperature<br>status |
|------|----------|----------------------------|-----------------------|
| 1    | LM-10    | 37                         | normal                |
| 1/1  | GE-8 IOA | 35                         | normal                |
| 2    | LM-10    | 37                         | normal                |

```

2/1 GE-8 IOA 39 normal
6 SRP-120 40 normal
6 SFM-120 40 normal
6/0 SRP IOA 30 normal
7 SRP-120 41 normal
7 SFM-120 41 normal
8 SFM-120 31 normal
9 SFM-120 32 normal
10 SFM-120 32 normal

```

```

fabric temperature ranges
 below -5C is too cold
 above 79C is too hot
 low temperature warning below 10C
 high temperature warning above 56C
processor temperature ranges
 below -5C is too cold
 above 79C is too hot
 low temperature warning below 10C
 high temperature warning above 51C
IOA temperature ranges
 below -5C is too cold
 above 79C is too hot
 low temperature warning below 10C
 high temperature warning above 56C

```

- See show environment.

### **show fabric weights**

- Use to display multicast-to-unicast ratio for the router switch fabric.
- Field descriptions
  - multicast—Ratio value of multicast bandwidth
  - unicast—Ratio value of unicast bandwidth
- Example

```
host1#show fabric weights
```

```
Fabric scheduler weights: multicast = 1 , unicast = 8
```

- See show fabric weights.

### **show hosts**

- Use to display a list of configured network servers.
- Field descriptions
  - Static Host Table—Information about the connected static hosts
    - name—Name of the host
    - ip address—IPv4 or IPv6 address of the host
    - type of host—Type of host; for example, ftp means an FTP server
  - NFS Host Table—Information about connected NFS servers

- name—Name of the NFS server
- userid—Identity for the user
- groupid—Identity for the group

■ Example

```

host1#show hosts
 Static Host Table

 name ip address type
 ---- -
 host1 10.2.0.124 ftp
 hFtp 10.5.6.7 ftp
 hTftp 10.5.6.7 tftp
 Static Host Table

 name ip address type
 ---- -
 george 1111:2222:3333:4444:5555:6666:7777:8888 ftp
 dsw 10.10.121.42 ftp
 deab 10.6.128.12 ftp
 mFtp 10.10.121.11 ftp
 mTftp 10.10.121.11 tftp
 mary 10.10.121.11 ftp
 sd 10.10.121.80 ftp

 NFS Host Table

 name userid groupid
 ---- -
 deab 2001 100

```

- See show hosts.

**show processes cpu**

- Use to display the CPU use.
- Field descriptions
  - task name—Name of the process
  - times invoked—Number of times the process has been invoked
  - invocations per second—Frequency of the process invocation
  - total running time (msec)—Time the process has been running
  - percent running time—Percentage of the total running time attributable to this process
  - average time per invocation (usec)—Average number of microseconds per invocation of this process
  - 5 second utilization (%)—CPU use by the process for the last 5 seconds

- 1 minute utilization (%)—CPU use by the process for the last minute
- 5 minute utilization (%)—CPU use by the process for the last 5 minutes
- Example

host1# **show processes cpu**

| Process Statistics |                        |                              |                                    |                            |
|--------------------|------------------------|------------------------------|------------------------------------|----------------------------|
| -----              |                        |                              |                                    |                            |
| task name          | times<br>invoked       | invocations<br>per<br>second | total<br>running<br>time<br>(msec) | percent<br>running<br>time |
| -----              | -----                  | -----                        | -----                              | -----                      |
| aaaAtm1483Config   | 1                      | 0                            | 0                                  | 0%                         |
| aaaServer          | 52                     | 0                            | 260                                | 0%                         |
| agent1             | 399                    | 0                            | 3600                               | 0%                         |
| ar1EthHelp         | 362856                 | 4                            | 590                                | 0%                         |
| .                  |                        |                              |                                    |                            |
| .                  |                        |                              |                                    |                            |
| .                  |                        |                              |                                    |                            |
| templateMgr        | 48                     | 0                            | 540                                | 0%                         |
| timerd             | 2346566                | 32                           | 0                                  | 0%                         |
| ~GONE~             | 405202                 | 5                            | 184700                             | 0%                         |
| ~IDLE~             | 0                      | 0                            | 360                                | 0%                         |
| ~INTERRUPT~        | 8840490                | 121                          | 51050                              | 0%                         |
| -----              |                        |                              |                                    |                            |
|                    | average<br>time<br>per | 5<br>second                  | 1<br>minute                        | 5<br>minute                |
| utilization        | invocation             | utilization                  | utilization                        |                            |
| task name          | (usec)                 | (%)                          | (%)                                | (%)                        |
| -----              | -----                  | -----                        | -----                              | -----                      |
| aaaAtm1483Config   | 0                      | 0                            | 0                                  |                            |
| 0                  |                        |                              |                                    |                            |
| aaaServer          | 5000                   | 0                            | 0                                  |                            |
| 0                  |                        |                              |                                    |                            |
| agent1             | 9022                   | 0                            | 0                                  |                            |
| 0                  |                        |                              |                                    |                            |
| ar1EthHelp         | 1                      | 0                            | 0                                  |                            |
| 0                  |                        |                              |                                    |                            |
| ar1InternalNetwork | 19                     | 0                            | 0                                  |                            |
| 0                  |                        |                              |                                    |                            |
| .                  |                        |                              |                                    |                            |
| .                  |                        |                              |                                    |                            |
| .                  |                        |                              |                                    |                            |
| ~IDLE~             | ---                    | 0                            | 0                                  |                            |
| 0                  |                        |                              |                                    |                            |
| ~INTERRUPT~        | 5                      | 0                            | 0                                  |                            |
| 0                  |                        |                              |                                    |                            |

- See show processes cpu.

#### **show processes memory**

- Use to display the amount of memory-related resources used by system processes. Because the router allocates memory to system processes in chunks, issuing this command performs a cleanup process to gather unused, available memory for reallocation.
- You can display different output variations by using the **application**, **slot**, and **virtual-router** keywords. In addition, you can combine these keywords in specific ways to display information combinations of application, slot, and virtual router.
- The appearance of parentheses in the output is significant. The parentheses indicate “partial accountability” of the current memory size. In other words, the values are accurate for the row in which they appear, but the memory value used for calculating the sum total for the column may be smaller than the value displayed. This can result in the sum total for the “current size” column not matching the sum of the values that appear within the column. This disparity can occur under shared memory conditions where a portion of the memory size for one or more of the virtual routers may be accounted for elsewhere, resulting in a lower column total.
- Field descriptions
  - Memory usage summary—Statistical information about the memory usage information being displayed
  - application—Name of the application being viewed (if applicable); asterisk (\*) if no application is specified
  - router—Name of the virtual router being viewed (if applicable); asterisk (\*) if no virtual router is specified
  - app—Application to which the statistics information applies
  - rtr—Virtual router to which the statistics information applies
  - vrf—Virtual routing and forwarding instance to which the statistics information applies
  - \_unassoc\_—Special virtual router output category that summarizes all memory that is not currently associated with any particular virtual router
  - current size—Amount of memory reserved by the listed application or virtual router
  - utilization—Percentage of reserved memory currently used for the listed application or router
  - headroom—Amount of memory overage available to each listed application or virtual router (if needed); 100 % indicates an unlimited headroom (that is, no memory limits are set for the application or virtual router)
- Example 1

```
host1#show processes memory application
```

```
*** Memory usage summary (by application, 37 total) ***
 application: *
 router: *
```

| app        | current<br>size | utilization | headroom |
|------------|-----------------|-------------|----------|
| aaa        | 98K             | 3%          | 100%     |
| bgp        | 90K             | 28%         | 100%     |
| bridge     | 1M              | 4%          | 100%     |
| cli        | 3K              | 8%          | 100%     |
| dcm        | 64K             | 7%          | 100%     |
| dhcp       | 644K            | 0%          | 100%     |
| dns        | 4K              | 6%          | 100%     |
| dvmrp      | 36K             | 0%          | 100%     |
| ethernet   | 3K              | 75%         | 100%     |
| forwarding | 20K             | 50%         | 100%     |
| gplaan     | 52K             | 0%          | 100%     |
| igmp       | 1K              | 0%          | 100%     |
| .          |                 |             |          |
| .          |                 |             |          |

#### ■ Example 2

```
host1#show processes memory virtual-router
```

```
*** Memory usage summary (by router, 4 total) ***
application: *
router: *
```

| rtr       | current<br>size | utilization | headroom |
|-----------|-----------------|-------------|----------|
| _____     | _____           | _____       | _____    |
| _unassoc_ | (40M)           | 7%          | 99%      |
| default   | (339K)          | 23%         | 100%     |
| test      | (366K)          | 23%         | 100%     |
| vr5       | (327K)          | 18%         | 100%     |
| _____     | _____           | _____       | _____    |
| Total:    | 41M             | 7%          | 99%      |

#### ■ Example 3

```
host1#show processes memory virtual-router vr5 application ip
```

```
*** Memory usage summary (by VRF) ***
application: ip
router: vr5
```

| vrf | current<br>size | utilization | headroom |
|-----|-----------------|-------------|----------|
| --- | -----           | -----       | -----    |
| vr5 | (19K)           | 48%         | 100%     |

#### ■ See show processes memory.

### **show reboot-history**

- Use to display the history of system and module resets.
- You can display the current reboot.hty file or a saved reboot history file.

- If you have a redundant router, it can be convenient to copy the redundant module's `reboot.pty` file to another filename for viewing with this command.
- Field descriptions
  - Entry—Number of entry in the reboot history; numbers range from lowest (most recent reset) to highest (oldest reset)
  - time of reset—Timestamp for reset
  - run state—State of system at reset
  - image type—Type of image running when the record is written
    - boot—Module is running the boot file
    - diagnostics—Module is running the diagnostics file
    - application—Module is running the software file
  - location—Slot that reset; location is offset by two slots at slot 7 and above (the SRP module in slot 6 shows location as slot 7, the SRP module in slot 7 shows location as slot 9, and slots 8-13 show location as 10-15, respectively).
  - build date—Build date of software version
  - reset type—Cause of reset
- Example

```

host1#show reboot-history
*** Entry 1 ***
time of reset: TUE APR 10 2001 20:25:59 UTC
run state: unknown
image type: diagnostics
location: slot (7)
build date: 0x3abf4337 MON MAR 26 2001 13:25:11 UTC
reset type: user reboot, task "scheduler", reason "not specified"
*** Entry 2 ***
time of reset: TUE APR 10 2001 20:25:44 UTC
run state: unknown
image type: diagnostics
location: slot (8)
build date: 0x3abf5d5f MON MAR 26 2001 15:16:47 UTC
reset type: user reboot, task "scheduler", reason "not specified"
*** Entry 3 ***
time of reset: TUE APR 10 2001 20:25:03 UTC
run state: unknown
image type: diagnostics
location: slot (4)
build date: 0x3abf3ee0 MON MAR 26 2001 13:06:40 UTC
reset type: user reboot, task "scheduler", reason "not specified"

```

- See `show reboot-history`.

### ***show running-configuration***

- Use to display the configuration currently running on the router, a specified virtual router, a specified interface, or a specified category of router settings.



- See full description and examples in “show running-configuration” on page 254.
- See show running-configuration.

### **show version**

- Use to display the armed and running releases for every slot in the router and the operational status of the SRP module and line modules for all E-series routers.
- Use the **all** keyword with the E120 router and the E320 router to display the operational status of the IOAs.
- Field descriptions
  - Model identification
  - Copyright—Copyright details for the system software
  - System Release—Filename, version, and date of the system software currently running on the router
  - System running for—How long the router has been running (time elapsed since the last boot of the router), date and time of last boot; does not reflect the uptime of a particular SRP module
  - slot—Physical slot that contains the line module
  - state—Status of the line module
    - booting—Line module is booting
    - disabled (assessing)—Router is evaluating the status of this line module
    - disabled (admin)—Line module disabled by **slot disable** command
    - disabled (cfg error)—Use of the line module in this slot violates the permitted configuration for the router. For example, the fabric cannot supply sufficient bandwidth to the line module in this position.
    - disabled (image error)—Software for this line module is missing or corrupted
    - disabled (mismatch)—Line module in this slot is a different type from that specified in the software. Correct the condition by inserting the original module, or use the **slot accept** command to find information about the new module.
    - hardware error—Line module has a hardware fault
    - inactive—On ERX routers, either the I/O module is not present or the primary line module is fully booted and ready to resume operation. In the latter case, the standby is currently providing services. On E120 and E320 routers, one of the following conditions exists: the primary line module has no IOAs; or the primary line module has IOAs, but they have failed diagnostics; or the standby line module has taken over for the primary line module, and has control of the IOAs.

- initializing—Transitional state before the line module proceeds to the online, standby, or inactive state; diagnostics are complete, module is initializing software
- online—Line module is operating
- not present—Line module configured for this slot is missing
- not responding—Line module has a hardware or ROM problem
- standby—Spare line module or SRP module is fully booted and ready to operate if the primary line module or active SRP module fails
- unknown—Transitional state while the SRP is initializing
- type—Kind of module; an “e” at the end of an SRP module type (for example, SRP-5Ge) indicates that the module includes error checking code (ECC)
- admin—Status of the slot in the software
  - enabled—Slot is enabled
  - disabled—Slot is disabled
- spare—Line module is a spare for line module redundancy
- running release—Software that is running on the line module
- slot uptime—Length of time for which the module has been operational; a value of --- indicates that the module is not available.
- The following symbols and notices may be displayed at the end of the report:
  - # This release is a result of a subsystem override
  - \* This release is a result of a “boot slot” override
  - # The running or armed release on the slot is the same as the armed release for a subsystem. A subsystem is all the line modules of one type, such as OC3.
  - \* This release reflects whichever release the router is armed with at startup.
- Example 1—Displays the version of an ERX-7xx model

```
host1#show version
```

```
Juniper Edge Routing Switch ERX-700
Copyright (c) 1999-2005 Juniper Networks, Inc. All rights reserved.
System Release: erx_7-1-0.rel Partial
Version: 7.1.0 [BuildId 4518] (December 21, 2005 11:23)
System running for: 25 days, 3 hours, 31 minutes, 5 seconds
(since THU DEC 22 2005 11:36:41 UTC)
```

```
slot state type admin spare running release slot uptime

```

```

0 standby SRP-10Ge enabled --- erx_7-1-0.rel ---
1 online SRP-10Ge enabled --- erx_7-1-0.rel 25d03h:28m:49s
2 --- --- --- --- ---
3 --- --- --- --- ---
4 online CT3-12 enabled --- erx_7-1-0.rel 25d03h:24m:46s
5 online OC3-4A-APS enabled --- erx_7-1-0.rel 25d03h:24m:22s
6 online GE enabled --- erx_7-1-0.rel 25d03h:24m:44s

```

■ Example 2—Displays the version of an E320 router

```

host1# show version
Juniper Edge Routing Switch E320
Copyright (c) 1999-2005 Juniper Networks, Inc. All rights reserved.
System Release: 7b12.rel
 Version: 7.0.0 [BuildId 3468] (April 29, 2005 10:46)
System running for: 2 days, 19 hours, 16 minutes, 17 seconds
 (since FRI MAY 13 2005 15:10:54 UTC)

```

| slot | state   | type    | admin   | spare | release  | slot uptime   |
|------|---------|---------|---------|-------|----------|---------------|
| 0    | online  | LM-4    | enabled | ---   | 7b12.rel | 2d19h:13m:24s |
| 1    | ---     | ---     | ---     | ---   | ---      | ---           |
| 2    | online  | LM-4    | enabled | ---   | 7b12.rel | 2d19h:13m:19s |
| 3    | ---     | ---     | ---     | ---   | ---      | ---           |
| 4    | ---     | ---     | ---     | ---   | ---      | ---           |
| 5    | ---     | ---     | ---     | ---   | ---      | ---           |
| 6    | online  | SRP-100 | enabled | ---   | 7b12.rel | 2d19h:14m:48s |
| 6    | online  | SFM-100 | enabled | ---   | ---      | 2d19h:14m:47s |
| 7    | standby | SRP-100 | enabled | ---   | 7b12.rel | ---           |
| 7    | online  | SFM-100 | enabled | ---   | ---      | 2d19h:14m:42s |
| 8    | online  | SFM-100 | enabled | ---   | ---      | 2d19h:14m:44s |
| 9    | online  | SFM-100 | enabled | ---   | ---      | 2d19h:14m:39s |
| 10   | online  | SFM-100 | enabled | ---   | ---      | 2d19h:14m:40s |
| 11   | ---     | ---     | ---     | ---   | ---      | ---           |
| 12   | online  | LM-4    | enabled | ---   | 7b12.rel | 2d19h:13m:13s |
| 13   | ---     | ---     | ---     | ---   | ---      | ---           |
| 14   | online  | LM-4    | enabled | ---   | 7b12.rel | 2d19h:13m:08s |
| 15   | ---     | ---     | ---     | ---   | ---      | ---           |
| 16   | ---     | ---     | ---     | ---   | ---      | ---           |

■ Example 3—Displays the version of an E320 router using the **all** keyword

```

host1# show version all
Juniper Edge Routing Switch E320
Copyright (c) 1999-2006 Juniper Networks, Inc. All rights reserved.
System Release: 7-3-0.rel
 Version: 7.3.0 [BuildId 5759] (July 27, 2006 10:40)
System running for: 3 days, 1 hour, 37 minutes, 4 seconds
 (since FRI JUL 28 2006 09:08:14 UTC)

```

| slot | state   | type     | admin   | spare | release   | slot uptime   |
|------|---------|----------|---------|-------|-----------|---------------|
| 0    | online  | LM-4     | enabled | ---   | 7-3-0.rel | 3d01h:29m:01s |
| 0/0  | present | 10GE IOA | enabled | ---   | ---       | ---           |
| 0/1  | ---     | ---      | ---     | ---   | ---       | ---           |

| 1       | online  | LM-4                |         | enabled | ---   | 7-3-0b.re1 | 3d01h:26m:36s |
|---------|---------|---------------------|---------|---------|-------|------------|---------------|
| 1/0     | present | OC12/STM4-2         | POS IOA | enabled | ---   |            | ---           |
| 1/1     | ---     | ---                 | ---     | ---     | ---   | ---        | ---           |
| 2       | online  | LM-10 Uplink        |         | enabled | ---   | 7-3-0.re1  | 2d18h:27m:46s |
| 2/0     | present | 10GE PR IOA         |         | enabled | ---   |            | ---           |
| 2/1     | ---     | ---                 | ---     | ---     | ---   | ---        | ---           |
| 3       | online  | LM-4                |         | enabled | ---   | 7-3-0.re1  | 2d19h:03m:53s |
| 3/0     | present | 10GE IOA            |         | enabled | ---   |            | ---           |
| 3/1     | ---     | ---                 | ---     | ---     | ---   | ---        | ---           |
| 4       | online  | LM-10 Uplink        |         | enabled | ---   | 7-3-0.re1  | 3d01h:24m:39s |
| 4/0     | present | 10GE PR IOA         |         | enabled | ---   |            | ---           |
| running |         |                     |         |         |       |            |               |
| slot    | state   | type                |         | admin   | spare | release    | slot uptime   |
| 4/1     | ---     | ---                 | ---     | ---     | ---   | ---        | ---           |
| 5       | ---     | ---                 | ---     | ---     | ---   | ---        | ---           |
| 5/0     | ---     | ---                 | ---     | ---     | ---   | ---        | ---           |
| 5/1     | ---     | ---                 | ---     | ---     | ---   | ---        | ---           |
| 6       | standby | SRP-320             |         | enabled | ---   | 7-3-0.re1  | ---           |
| 6       | online  | SFM-320             |         | enabled | ---   | ---        | 3d01h:33m:48s |
| 7       | online  | SRP-320             |         | enabled | ---   | 7-3-0.re1  | 3d01h:34m:04s |
| 7       | online  | SFM-320             |         | enabled | ---   | ---        | 3d01h:33m:59s |
| 7/0     | present | SRP IOA             |         | enabled | ---   |            | ---           |
| 8       | online  | SFM-320             |         | enabled | ---   | ---        | 3d01h:34m:03s |
| 9       | online  | SFM-320             |         | enabled | ---   | ---        | 3d01h:33m:50s |
| 10      | online  | SFM-320             |         | enabled | ---   | ---        | 3d01h:33m:53s |
| 11      | online  | LM-4                |         | enabled | ---   | 7-3-0.re1  | 3d01h:26m:43s |
| 11/0    | present | OC12/STM4-2 ATM IOA |         | enabled | ---   |            | ---           |
| 11/1    | ---     | ---                 | ---     | ---     | ---   | ---        | ---           |
| 12      | online  | LM-4                |         | enabled | ---   | 7-3-0.re1  | 2d18h:26m:59s |
| 12/0    | present | GE-8 IOA            |         | enabled | ---   |            | ---           |
| 12/1    | present | GE-8 IOA            |         | enabled | ---   |            | ---           |
| 13      | online  | LM-4                |         | enabled | ---   | 7-3-0.re1  | 2d18h:17m:34s |
| 13/0    | present | GE-4 IOA            |         | enabled | ---   |            | ---           |
| 13/1    | ---     | ---                 | ---     | ---     | ---   | ---        | ---           |
| 14      | online  | LM-4                |         | enabled | ---   | 7-3-0.re1  | 3d01h:27m:06s |
| 14/0    | ---     | ---                 | ---     | ---     | ---   | ---        | ---           |
| 14/1    | present | OC12/STM4-2 POS IOA |         | enabled | ---   |            | ---           |

```

15 online LM-4 enabled --- 7-3-0.rel 3d01h:26m:28s
15/0 --- --- --- --- --- ---

15/1 present OC12/STM4-2 ATM IOA enabled --- ---

16 online LM-4 enabled --- 7-3-0.rel 3d01h:25m:17s
16/0 present OC3/STM1-8 ATM IOA enabled --- ---

16/1 present OC3/STM1-8 ATM IOA enabled --- ---

```

■ Example 4—Displays the version of an E120 router

```

host1# show version
Juniper Edge Routing Switch E120
Copyright (c) 1999-2007 Juniper Networks, Inc. All rights reserved.
System Release: 8-2-0b0-9.rel
 Version: 8.2.0 beta-0.9 [BuildId 7030] (April 2, 2007 13:04)
System running for: 1 day, 8 hours, 38 minutes, 0 seconds
 (since MON APR 09 2007 05:57:30 UTC)
running
slot state type admin spare release slot uptime
---- -
0 --- --- --- --- --- ---
1 online LM-10 enabled --- 8-2-0b0-9.rel 1d08h:32m:29s
2 online LM-10 enabled --- 8-2-0b0-9.rel 1d08h:32m:24s
3 --- --- --- --- --- ---
4 --- --- --- --- --- ---
5 --- --- --- --- --- ---
6 online SRP-120 enabled --- 8-2-0b0-9.rel 1d08h:34m:46s
6 online SFM-120 enabled --- --- 1d08h:34m:45s
7 standby SRP-120 enabled --- 8-2-0b0-9.rel ---
7 online SFM-120 enabled --- --- 1d08h:34m:35s
8 online SFM-120 enabled --- --- 1d07h:31m:04s
9 online SFM-120 enabled --- --- 1d08h:34m:26s
10 online SFM-120 enabled --- --- 1d08h:34m:30s

```

■ Example 5—Displays the version of an E120 router using the **all** keyword

```

host1# show version all
Juniper Edge Routing Switch E120
Copyright (c) 1999-2007 Juniper Networks, Inc. All rights reserved.
System Release: 8-2-0b0-9.rel
 Version: 8.2.0 beta-0.9 [BuildId 7030] (April 2, 2007 13:04)
System running for: 1 day, 8 hours, 38 minutes, 6 seconds
 (since MON APR 09 2007 05:57:30 UTC)
running
slot state type admin spare release slot uptime
---- -
0 --- --- --- --- --- ---
0/0 --- --- --- --- --- ---
0/1 --- --- --- --- --- ---
1 online LM-10 enabled --- 8-2-0b0-9.rel 1d08h:32m:35s
1/0 --- --- --- --- --- ---
1/1 present GE-8 IOA enabled --- --- ---
2 online LM-10 enabled --- 8-2-0b0-9.rel 1d08h:32m:29s
2/0 --- --- --- --- --- ---
2/1 present GE-8 IOA enabled --- --- ---

```

```

3 --- --- --- --- --- ---
3/0 --- --- --- --- --- ---
3/1 --- --- --- --- --- ---
4 --- --- --- --- --- ---
4/0 --- --- --- --- --- ---
4/1 --- --- --- --- --- ---
5 --- --- --- --- --- ---
5/0 --- --- --- --- --- ---
5/1 --- --- --- --- --- ---
6 online SRP-120 enabled --- 8-2-0b0-9.rel 1d08h:34m:51s
6 online SFM-120 enabled --- --- 1d08h:34m:51s
6/0 present SRP IOA enabled --- --- ---
7 standby SRP-120 enabled --- 8-2-0b0-9.rel ---
7 online SFM-120 enabled --- --- 1d08h:34m:41s
8 online SFM-120 enabled --- --- 1d07h:31m:09s
9 online SFM-120 enabled --- --- 1d08h:34m:32s
10 online SFM-120 enabled --- --- 1d08h:34m:36s

```

- See show version.

## Chapter 6

# Managing Modules

This chapter describes how to manage line modules, switch route processor (SRP) modules, switch fabric modules (SFMs), I/O modules, and I/O adapters (IOAs) in E-series routers.

This chapter contains the following sections:

- Overview on page 335
- Platform Considerations on page 336
- Disabling and Reenabling Line Modules, SRP Modules, and SFMs on page 340
- Disabling and Reenabling IOAs on page 342
- Removing an SRP Module on page 343
- Replacing Line Modules on ERX Routers, the E120 Router, and the E320 Router on page 344
- Replacing IOAs on the E120 Router and the E320 Router on page 347
- Software Compatibility on page 352
- Configuring Performance Rate of Line Modules on ERX-7xx Models and the ERX-1410 Router on page 352
- Line Module Redundancy on page 358
- Monitoring Line Module and SRP Module Redundancy on page 370
- Managing Flash Cards on SRP Modules on page 373
- Updating the Router with JUNOS Hotfix Files on page 388
- Managing the Ethernet Port on the SRP Module on page 398
- Enabling Warm Restart Diagnostics on Modules on page 400
- Ignoring Diagnostic Test Failures on page 402
- Monitoring Modules on page 404

## Overview

---

When managing modules, you need to consider both software and hardware procedures. For example, before you remove an SRP module, you must enter the **halt** command to prevent damage to nonvolatile storage (NVS).

This chapter describes the software issues associated with managing modules. Each section in the chapter covers a different topic; where appropriate, a section contains

an overview of the topic, configuration tasks, and information about monitoring the associated settings.

## Platform Considerations

---

Procedures for managing modules vary depending on the type of E-series router that you have. The following sections describe the types of modules that you can manage for each type of E-series router and the general software procedures associated with them.

### ***ERX-7xx Models, ERX-14xx Models, and the ERX-310 Router***

You can manage line modules, I/O modules, and SRP modules on ERX-7xx models, ERX-14xx models, and the ERX-310 router. For more information about these modules, see the *ERX Module Guide*.

For information about upgrading software on SRP modules, see “Installing JUNOS Software” on page 125. For information about related procedures and installing modules, see *ERX Hardware Guide, Chapter 4, Installing Modules*.

#### **Line Modules and I/O Modules**

Most line modules available with these E-series models pair with a corresponding I/O module; however, some line modules do not require a corresponding I/O module. For example, the Service Module (SM) does not have a corresponding I/O module.

By configuring the performance line rate for a line module in the ERX-705, ERX-710, and ERX-1410 routers, you can enable the line modules either to operate at full line rate performance or to allow line modules to operate at a rate dependent on the resources available. For more information, see “Configuring Performance Rate of Line Modules on ERX-7xx Models and the ERX-1410 Router” on page 352.

The ERX-1440 router has two turbo slots (numbered 2 and 4). You can install certain line modules in the turbo slots to achieve greater line rate performance than when the modules are installed in other slots. For more information, see *JUNOS Physical Layer Configuration Guide*.

Redundancy is supported for some line modules on these models. For more information, see “Line Module Redundancy” on page 358.

For more information about interface types and specifiers for ERX-7xx models, ERX-14xx models, and the ERX-310 router, see *Interface Types and Specifiers*.

#### **SRP Modules**

If you want to configure the performance line rate for a line module on supported routers, you must consider the bandwidth requirements of the SRP module that is installed on the router. For more information, see “Configuring Performance Rate of Line Modules on ERX-7xx Models and the ERX-1410 Router” on page 352 .

Redundancy is supported for SRP modules on certain E-series routers; for more information, see “SRP Module Redundancy” on page 362.



SRP modules have a corresponding SRP I/O module that contains a Fast Ethernet management port. You can configure this port to access the router from a Telnet session or SNMP. For more information, see “Managing the Ethernet Port on the SRP Module” on page 398 .

For information about using high availability mode for stateful SRP switchover, see “Managing Modules” on page 335.

## **E120 Router and E320 Router**

You can manage line modules, SRP modules, SFMs, and IOAs on the E120 router and E320 router. For more information about these modules, see the *E120 and E320 Module Guide*.

For information about related procedures and installing modules, see *E120 and E320 Hardware Guide, Chapter 4, Installing Modules*. For information about upgrading software on SRP modules, see the *E120 and E320 Hardware Guide*.

### **Line Modules and IOAs**

Line modules on the E120 and E320 routers act as frameforwarding engines for the physical interfaces, which are the IOAs.

You cannot configure the performance line rate of line modules for E120 and E320 routers. Redundancy is supported for line modules on this router. For more information, see “Line Module Redundancy” on page 358.

On the E120 router, line modules can be installed in slots 0–5. On the E320 router, line modules can be installed in slots 0–5 and 11–16. Both the E120 and E320 routers have two turbo slots, numbered 2 and 4. When a line module is installed in a turbo slot, it spans slots 2–3 and 4–5. The bandwidth of slot 3 or slot 5 is used for a line module in slot 2 or slot 4 if that line module requires the turbo slot.



**NOTE:** If a line module is installed in slot 3 or slot 5, and the line module in slot 2 or 4 requires bandwidth, the system configures the line module it detects first. The state of the other line module is displayed in the “show version” on page 373 command output as disabled (cfg error).

---

The 100 Gbps switch fabric that is available with the SRP 100 on the E320 router allocates 3.4 Gbps of overall bandwidth to each regular line module slot and 10 Gbps of overall bandwidth to each of the turbo slots. With a 100 Gbps fabric configuration, you must install the ES2 10G Uplink LM in the turbo slots. For more information, see *JUNOS Physical Layer Configuration Guide*.

The 120 Gbps switch fabric on the E120 router allocates 10 Gbps of overall bandwidth to each line module slot. Similarly, the 320 Gbps switch fabric on the E320 router allocates 10 Gbps of overall bandwidth to each line module slot. For both configurations, you can install any line module in any of the slots.

A line module on the E120 and E320 routers can accommodate one full-height IOA or up to two half-height IOAs per slot. In the software, adapter 0 identifies the right

IOA bay (E120 router) and the upper IOA bay (E320 router); adapter 1 identifies the left IOA bay (E120 router) and the lower IOA bay (E320 router).

You can configure the slot by using the command-line interface (CLI), as well as the individual IOAs. For example, if you want to disable the line module installed in slot 3, issue the **slot disable 3** command. If you want to disable the IOA in the upper bay or left bay of slot 3, issue the **adapter disable 3/0** command. Table 37 on page 338 lists the IOA bay values that you use to manage half-height and full-height IOAs.

For some IOAs, issuing the **adapter disable 3/0** command reboots the line module. Modules that support hot-swapping enable you to remove and add an IOA in a slot without rebooting the line module. If the slot is populated with another active IOA, it continues to operate.

Depending on the IOA type, you can manage IOAs from certain slots or bays. Table 37 on page 338 lists the IOA management information, including valid IOA combinations and hot-swapping support.

**Table 37: IOA Management Information**

| IOA             |      | Right Bay<br>(E120)<br>Upper Bay<br>(E320)<br>(Adapter 0) | Left Bay<br>(E120)<br>Lower<br>Bay<br>(E320)<br>(Adapter 1) | Both Bays<br>Concurrently | Combined with<br>Other IOAs in<br>Same Slot                                                                         | Hot-Swapping<br>Support |
|-----------------|------|-----------------------------------------------------------|-------------------------------------------------------------|---------------------------|---------------------------------------------------------------------------------------------------------------------|-------------------------|
| ES2-S1          | GE-4 | Yes                                                       | Yes                                                         | No                        | No                                                                                                                  | Yes                     |
| ES2-S1          | GE-8 | Yes                                                       | Yes                                                         | Yes                       | Yes (GE-8 when paired with ES2 4G LM or ES2 10G LM; GE-8, OC3/STM1 , and OC12/STM4 IOAs when paired with ES2 4G LM) | Yes                     |
| ES2-S3<br>GE-20 |      | Yes<br><br>(Full-height IOA)                              | Not applicable                                              | Not applicable            | Not applicable                                                                                                      | No                      |
| ES2-S1          | 10GE | Yes<br><br>(Full-height IOA)                              | Not applicable                                              | Not applicable            | Not applicable                                                                                                      | No                      |
| ES2-S2<br>PR    | 10GE | Yes<br><br>(Full-height IOA)                              | Not applicable                                              | Not applicable            | Not applicable                                                                                                      | No                      |

**Table 37: IOA Management Information** (continued)

| IOA                          | Right Bay<br>(E120)<br>Upper Bay<br>(E320)<br>(Adapter 0)  | Left Bay<br>(E120)<br>Lower<br>Bay<br>(E320)<br>(Adapter<br>1) | Both Bays<br>Concurrently | Combined with<br>Other IOAs in<br>Same Slot            | Hot-Swapping<br>Support |
|------------------------------|------------------------------------------------------------|----------------------------------------------------------------|---------------------------|--------------------------------------------------------|-------------------------|
| ES2-S1<br>OC3-8 STM1<br>ATM  | Yes                                                        | Yes                                                            | Yes                       | Yes (GE-8,<br>OC3/STM1, and<br>OC12/STM4 IOAs<br>only) | Yes                     |
| ES2-S1<br>OC12-2<br>STM4 ATM | Yes                                                        | Yes                                                            | Yes                       | Yes (GE-8,<br>OC3/STM1, and<br>OC12/STM4 IOAs<br>only) | Yes                     |
| ES2-S1<br>OC12-2<br>STM4 POS | Yes                                                        | Yes                                                            | Yes                       | Yes (GE-8,<br>OC3/STM1, and<br>OC12/STM4 IOAs<br>only) | Yes                     |
| ES2-S1<br>OC48<br>STM16 POS  | Yes                                                        | Yes                                                            | No                        | No                                                     | Yes                     |
| ES2-S1<br>Service            | Yes<br><br>(Full-height<br>IOA)                            | Not<br>applicable                                              | Not<br>applicable         | Not applicable                                         | No                      |
| ES2-S1<br>Redund             | Yes<br><br>(Full-height<br>IOA; slots 0<br>and 11<br>only) | Not<br>applicable                                              | Not<br>applicable         | Not applicable                                         | No                      |

For more information about interface types and specifiers for the E120 and E320 routers, see *Interface Types and Specifiers*.

### SRP Modules and SFMs

The router accommodates up to two SRP modules and three SFMs that act as an integrated system controller (SC) and switch fabric system. The SC is located on the SRP modules; the router's switch fabric is distributed between the SRP modules and SFMs. The switch fabric is divided into fabric slices; each SRP module and SFM has a resident fabric slice. At least four of the five possible fabric slices must be installed for the E120 and the E320 routers to operate.

You can configure the E120 router with a 320 Gbps fabric by installing SRP 120 modules and SFM 120 modules, or SRP 320 modules and SFM 320 modules.

You can configure the E320 router with a 100 Gbps fabric by installing SRP 100 modules and SFM 100 modules. To achieve increased switch fabric capacity and speed, you can configure the E320 router with a 320 Gbps fabric by installing SRP 320 modules and SFM 320 modules.

You can configure the SC and the fabric slices on the SRP modules separately. For example, if you disable the fabric slice on the standby SRP module by using the **slot disable 7 fabric** command, the SC on that SRP module is still enabled.

Redundancy is supported for SRP modules on the E120 and E320 routers. For more information, see “SRP Module Redundancy” on page 362.

SRP modules on the E120 and E320 routers have two slots for flash cards; other E-series routers have only a single slot. Cards installed in the second slot can be used only for core dump (.dmp) files. For more information, see “Managing Flash Cards on SRP Modules” on page 373.

SRP modules on the E120 and E320 routers have a corresponding SRP IOA that contains a Fast Ethernet management port. You can configure this port to access the router from the CLI or SNMP. For more information, see “Managing the Ethernet Port on the SRP Module” on page 398 .

For information about using high availability mode for stateful SRP switchover, see “Managing Modules” on page 335.

## Disabling and Reenabling Line Modules, SRP Modules, and SFMs

Disabling a line module, an SRP module, or an SFM has the same effect as removing that module from a slot. A disabled module cannot operate, although its configuration remains in NVS. For the module to operate, you must reenabling it.

### **slot disable**

- Use to disable the module in the specified slot.
- You can use this command to disable a module so that you can run diagnostic tests on the module.
- You cannot use this command on a standby SRP module.
- If you specify a slot on the E120 router or the E320 router that contains an SRP module, you disable the SC subsystem on that slot by default. You do not, however, disable the fabric slice that resides on the slot.
  - Use the **srp** keyword to disable only the portion of the SC subsystem that resides on a specified SRP module.
  - Use the **fabric** keyword to disable only the fabric slice that resides on the specified SRP module.
- If you specify a slot that contains a line module, you disable only the line module; you do not disable the line module and the I/O modules and IOAs associated with it. To disable a specific IOA on the E120 router or the E320 router, issue the “adapter disable” on page 342 command.
- Example 1—Disables the module in slot 3

host1(config)#**slot disable 3**

- Example 2—Disables the SRP module and the SC subsystem in slot 7 (applies only to the E120 and E320 routers)

host1(config)#**slot disable 7**

- Example 3—Disables only the fabric slice on the SRP module in slot 7 (applies only to E120 and E320 routers)

host1(config)#**slot disable 7 fabric**

- There is no **no** version.
- See slot disable.

### **slot enable**

- Use to enable the module in the specified slot.
- Allows you to restart the module that was installed in the slot.
- You cannot use this command on a standby SRP module.
- If you specify a slot on the E120 router or the E320 router that contains an SRP module, you enable the SC subsystem on that slot by default. You do not, however, enable the fabric slice that resides on the slot.
  - Use the **srp** keyword to enable only the portion of the SC subsystem that resides on a specified SRP module.
  - Use the **fabric** keyword to enable only the fabric slice that resides on the specified SRP module.
- If you specify a slot that contains a line module, you enable only the line module; you do not enable the line module and the I/O modules and IOAs associated with it. To enable a specific IOA on the E120 router or the E320 router, use the “adapter enable” on page 342 command.
- The default is enable.
- Example 1—Enables the module in slot 3

host1(config)#**slot enable 3**

- Example 2—Enables the SRP module and the SC subsystem in slot 7 (applies only to E120 and E320 routers)

host1(config)#**slot enable 7**

- Example 3—Enables only the fabric slice on the SRP module in slot 7 (applies only to E120 and E320 routers)

host1(config)#**slot enable 7 fabric**

- There is no **no** version.
- See slot enable.

## Disabling and Reenabling IOAs

---

Disabling an IOA on the E120 router or the E320 router has the same effect as removing that IOA from a slot. A disabled IOA cannot operate, although its configuration remains in NVS. To allow the IOA to operate, you must reenale it.

### ***adapter disable***

- Use to disable the IOA in the specified IOA bay.
- You can use this command to disable an IOA so that you can run diagnostic tests on it.
- On IOAs that support hot-swapping, issuing this command does not reboot the line module. On unsupported IOAs, issuing this command does reboot the line module associated with the IOA, but does not disable the line module. Issue the **slot disable** command to disable the line module. For a list of IOAs that support hot-swapping, see Table 37 on page 338.
- When you issue the **adapter disable** command in a redundancy configuration, the line module (primary or spare) currently associated with that IOA is rebooted. If the IOA is protected by a line module redundancy group, an automatic line module redundancy switchover or revert can be triggered by the line module reboot. To prevent undesired line module redundancy actions, issue the **redundancy lockout** command for the primary line module slot before issuing the **adapter disable** command. For more information, see “Line Module Redundancy” on page 358 .
- In the software, adapter 0 identifies the right IOA bay (E120 router) and the upper IOA bay (E320 router); adapter 1 identifies the left IOA bay (E120 router) and the lower IOA bay (E320 router).
- Example—Disables the IOA residing in the upper bay of slot 5 in an E320 router

```
host1(config)#adapter disable 5/0
```

- There is no **no** version.
- See adapter disable.

### ***adapter enable***

- Use to enable the IOA in the specified IOA bay.
- Enables you to restart the IOA that was installed in the slot.
- The default is enable.
- On IOAs that support hot-swapping, issuing this command does not reboot the line module. On unsupported IOAs, issuing this command reboots the line module associated with the IOA, but does not enable the line module. Issue the **slot enable** command to enable the line module. For a list of IOAs that support hot-swapping, see Table 37 on page 338.
- When you issue the **adapter enable** command in a redundancy configuration, the line module (primary or spare) currently associated with that IOA is rebooted. If the IOA is protected by a line module redundancy group, an automatic line module redundancy switchover or revert can be triggered by the line module reboot. To prevent undesired line module redundancy actions, issue the

**redundancy lockout** command for the primary line module slot before issuing the **adapter enable** command. For more information, see “Line Module Redundancy” on page 358 .

- In the software, adapter 0 identifies the right IOA bay (E120 router) and the upper IOA bay (E320 router); adapter 1 identifies the left IOA bay (E120 router) and the lower IOA bay (E320 router).
- Example—Enables the IOA residing in the upper bay of slot 5 in an E320 router

```
host1(config)#adapter enable 5/0
```

- There is no **no** version.
- See adapter enable.

## Removing an SRP Module

Before you remove an SRP module, you must issue the **halt** command, which stops operation on that module. If the router contains both primary and redundant SRP modules, you can specify which modules the command should affect. You can also configure the router to prompt you when the modules are in a state that might lead to loss of configuration data or NVS corruption.



**CAUTION:** If you do not use the **halt** command before removing or powering down an SRP module, the router’s NVS may become corrupted.

For information about physically removing an SRP module, see *ERX Hardware Guide, Chapter 4, Installing Modules*.

### **halt**

- Use to stop the router’s operation before you remove or power down an SRP module
- The following guidelines apply when you issue the **halt** command in Privileged Exec mode:
  - Specify neither the **primary-srp** nor the **standby-srp** keyword to stop operation on both SRP modules.
  - Specify the keyword **primary-srp** to stop operation on the primary SRP module only. This action causes the redundant SRP module to assume the primary role.
  - Specify the keyword **standby-srp** to stop operation on the redundant SRP module only.
  - If you do not specify the **force** keyword, the procedure fails if:
    - The SRP modules are in certain states, such as during a synchronization. In these cases, the router will display a message that indicates that the procedure cannot currently be performed and the reason why. However, if the SRP modules are in other states that could lead to a loss of

configuration data or NVS corruption, the router displays a message that explains the state of the SRP modules and asks you to confirm (enter yes or no) whether you want to proceed.

- The SRP modules are in any state that could lead to loss of configuration data or NVS corruption, and the router will display a message that explains why the command failed.
- In Boot mode, you cannot issue any keywords with this command.
- When the high availability state is active or pending, this command ensures that the router configuration, up to when you issued the **halt** command, is mirrored to the standby SRP.
- When you issue this command, the router prompts you for a confirmation before the procedure starts.
- Remove or power down the SRP module within 2 minutes of executing the **halt** command. Otherwise, the SRP module will automatically reboot.
- Examples
 

```
host1#halt
host1#halt primary-srp
host1#halt standby-srp force
```

- There is no **no** version.
- See `halt`.

## Replacing Line Modules on ERX Routers, the E120 Router, and the E320 Router

You can install line modules in slots previously occupied by different types of line modules. For example, on the ERX-1440 router, you can replace a GE-2 line module and a GE-2 SFP I/O module in a slot that previously contained an OCx/STMx/DS3-ATM line module and an OC3-4 I/O module.

When you configure a line module and an I/O module or IOAs, the router stores the configuration in NVS. In some cases, you must erase the interface configuration on the slot and reconfigure it after you have installed the new line module. However, some line modules on E120 and E320 routers enable you to replace the line module without reconfiguring the interfaces on the slot.

Tasks to replace a line module are:

- “Replacing a Line Module by Erasing the Slot Configuration” on page 344
- “Replacing a Line Module Without Erasing the Slot Configuration” on page 345

### Replacing a Line Module by Erasing the Slot Configuration

Use this procedure when you must erase the slot configuration to replace line modules on the ERX routers or on E120 and E320 routers.



For information about replacing the ES2 4G LM or an ES2 10G LM without erasing the slot configuration, see “Replacing Line Modules on ERX Routers, the E120 Router, and the E320 Router” on page 344 .

To replace a line module:

1. Copy your slot configuration so you can reconfigure the interfaces after replacing the line module.
2. (Optional) If line module redundancy is configured for the slot, disable redundancy for the slot.

```
host1(config)#redundancy lockout 7
```

3. Disable the slot.

```
host1(config)#slot disable 7
```

4. Remove the current line module and insert the new line module.
5. Issue the **slot accept** command for the affected slot.

```
host1(config)#slot accept 7
```

The **slot accept** command erases the configuration and enables you to reconfigure the new line module.

6. When the replacement line module has come online, reconfigure the interfaces.
7. If you disabled redundancy in Step 2, enable redundancy for the slot when the replacement line module has come online.

```
host1(config)#no redundancy lockout 7
```

### ***Replacing a Line Module Without Erasing the Slot Configuration***

Use this procedure when you are replacing an ES2 4G LM with an ES2 10G LM, or vice-versa. Both line modules must already be paired with an ES2-S1 GE-8 IOA or the ES2-S1 Redund IOA.

You can replace a single line module or all of the line modules in a redundancy group using this procedure.



**NOTE:** In some cases, the ES2 4G LM and ES2 10G LM support different system maximums and protocols. Before you replace an ES2 4G LM with an ES2 10G LM, make sure that:

- The ES2 10G LM supports the features already configured on the slot for the ES2 4G LM.
- The ES2 10G LM can support the existing system maximums configured on the ES2 4G LM.

If you have a configuration on the ES2 4G LM that is not supported on the ES2 10G LM, you must erase the configuration before replacing the line module. For more information, see “Replacing a Line Module by Erasing the Slot Configuration” on page 344 .

To replace a line module without erasing the slot configuration:

1. (Optional) If line module redundancy is configured for the slot, disable redundancy.

```
host1(config)#redundancy lockout 1
```

2. Disable the slot.

```
host1(config)#slot disable 1
```

3. After the line module has booted, issue the **show version** command to ensure that the status of the line module is disabled (admin).

```
host1#show version
Juniper Edge Routing Switch E120

.....

slot state type admin spare running slot uptime

0 --- --- --- --- ---
1 online LM-10 disabled (admin) --- 9-1-0b0-9.re1 1d08h:32m:29s
2 online LM-10 enabled --- 9-1-0b0-9.re1 1d08h:32m:24s
3 --- --- --- --- ---

.....
```

4. Remove the current line module and insert the new line module without removing the IOA.

For example, remove the ES2 4G LM and insert the new ES2 10G LM. Do not remove the ES2-S1 GE-8 IOA or the ES2-S1 Redund IOA.

5. After the new line module has booted, issue the **show version** command to ensure that the status of the line module is disabled (mismatch).

```

host1#show version
Juniper Edge Routing Switch E120

.....

slot state type admin spare running slot uptime

0 --- --- --- --- ---
1 online LM-4 disabled (mismatch) --- 9-1-0b0-9.re1 1d08h:32m:29s
2 online LM-10 enabled --- 9-1-0b0-9.re1 1d08h:32m:24s
3 --- --- --- --- ---

.....

```

6. Issue the **slot replace** command on the slot.

```
host1(config)#slot replace 1
```



**TIP:** If the line module is in a redundancy group and you did not disable redundancy in Step 1, the system switches to the spare line module. The system reloads both the replaced line module and the spare line module when you issue the **slot replace** command.

7. If you disabled redundancy for the slot in Step 1, enable redundancy when the replacement line module has come online.

```
host1(config)#no redundancy lockout 1
```

8. (Optional) If the following settings were configured before replacing the module, reconfigure the settings:
  - a. Configure the Ethernet physical interface configuration using an SNMP set request for entPhysicalAssetID and entPhysicalAlias.
  - b. Specify the threshold values for specific interface types for the slot.

```
host1(config)#resource if-type ip slot 1 threshold
```

- Related Topics**
- redundancy lockout command
  - resource if-type command
  - slot accept command
  - slot replace command
  - snmp-server command

## Replacing IOAs on the E120 Router and the E320 Router

When you configure an IOA in an IOA bay on the E120 and E320 routers, the router stores the configuration in NVS.

When you replace an IOA that supports hot-swapping with the same type of IOA, the line module goes online immediately. When you replace an IOA that *does not* support hot-swapping with the same type of IOA, the line module reboots.

Before you install an IOA that was previously occupied by another IOA in the E120 router or the E320 router—for example, an ES2-S1 GE-4 IOA in an IOA bay that previously contained an ES2-S1 OC3-8 STM1 ATM IOA—consider whether the IOA that you are replacing supports hot-swapping. For example:

- When you replace an IOA that does not support hot-swapping, the line module reboots. Before installing the different type of IOA, issue the **adapter erase** or **slot erase** command for the slot that contains the IOA bay.
- When you replace an IOA that supports hot-swapping, the line module becomes inactive with a “ mismatch” state. After installing the different type of IOA, issue the **adapter accept** command or the **slot erase** command for the slot that contains the IOA bay.

## Replacing SRP Modules and SFMs

If you remove a standby SRP module or an SFM, you must issue the **slot erase** command to delete the configuration. If you fail to issue the **slot erase** command, then the E-series router cannot guarantee that the SRP modules were synchronized. In this situation, the E-series router does not properly execute a simple **reload** command.

To reload the router you must do either of the following:

- Issue the **reload force** command.
- Issue the **slot erase** command followed by the **reload** command.

If you perform one of the following actions, you must reset the configuration of the router to factory default:

- Replace a 5-Gbps SRP module with a 10-Gbps SRP module or vice versa.
- Transfer an SRP module from an ERX-7xx router to an ERX-1410 router or vice versa.

You cannot use the **slot accept** command to force the router to accept the new SRP module.

When you have installed the SRP module in the new location, reset the configuration of the router to factory defaults as follows:

1. Reload the operating router, then press mb key sequence (case-insensitive) during the countdown.

```
host1#reload
```

2. Reboot the router with the factory defaults.

```
:boot##boot config factory-defaults
```

3. Reload the operating router.

```
:boot##reload
```

For more information about the **reload** and **boot config** commands, see “Booting the System” on page 579.

### **adapter accept**

- Use to delete the configuration of the IOA in the specified IOA bay after you install a different type of IOA.
- This command enables you to create a fresh configuration for the module installed in the IOA bay.
- You can also use this command to accept an empty IOA bay that was previously occupied.
- Issuing this command reboots the line module associated with the IOA, but it does not erase the line module’s configuration. To erase the configuration of the line module and its associated IOAs, issue the “slot accept” on page 350 command.
- Issuing this command erases the interfaces associated with the specified IOA. To erase the interfaces for both IOAs installed in a slot, issue the **slot accept** command.
- Depending on the previous configuration of the slot, the system might take a few moments to execute this command.
- Example—Accepting the IOA in the upper bay of slot 5 in an E320 router

```
host1(config)#adapter accept 5/0
```

- There is no **no** version.
- See adapter accept.

### **adapter erase**

- Use to delete the configuration of the specified IOA in the specified IOA bay before you install a different type of IOA.
- This command enables you to create a fresh configuration for the IOA to be installed in the IOA bay.
- Issuing this command reboots the line module associated with the IOA, but it does not erase the line module’s configuration. To erase the configuration of the line module and its associated IOAs, issue the “slot erase” on page 351 command.
- Issuing this command erases the interfaces associated with the specified IOA. To erase the interfaces for both IOAs installed in a slot, issue the **slot erase** command.
- Example—Erasing the IOA in the upper bay of slot 5 in an E320 router

```
host1(config)#adapter erase 5/0
```

- There is no **no** version.
- See adapter erase.

**slot accept**

- Use to delete the configuration of the module in the selected slot after you install a different type of module.
- This command enables you to create a fresh configuration for the module installed in the slot.
- You can also use this command to accept an empty slot that was previously occupied.
- You cannot use this command on a primary SRP module; however, you can use it on a standby SRP module.
- You can use this command only when the state of the module in the slot is not present or disabled (mismatch).
- If you specify a slot on an E120 router or an E320 router that contains an SRP module, you accept the configuration of the SC subsystem on that slot by default. You do not, however, accept the configuration of the fabric slice that resides on the slot.
  - Use the **srp** keyword to accept only the configuration of the portion of the SC subsystem that resides on a specified SRP module.
  - Use the **fabric** keyword to accept only the configuration of the fabric slice that resides on the specified SRP module.
- If you specify a slot that contains a line module, you erase the configuration of the line module and the I/O modules or IOAs associated with it. To erase the configuration of a specific IOA on the E120 router or the E320 router, use the “adapter accept” on page 349 command.
- Depending on the slot’s previous configuration, the router might take a few moments to execute this command.
- The following is a sample log message resulting from putting an OC3 line module in a slot that was previously configured for a line module:

```
ERROR 02/07/2003 15:16:20 system (slot 3): boardId mismatch: read 0x6 (OC3
dual port without classifier), configured 0x2e (OC12 ATM)
ERX-00-17-04(config)# slot accept 3
Please wait....
ERX-00-17-04(config)#ERROR 02/07/2003 15:16:31 system (slot 3):
unrecognized board type (0x6)
```

To resolve the problem, issue the slot accept command for slot 3.

- Example 1—Accepts the configuration of the module in slot 3
 

```
host1(config)#slot accept 3
```
- Example 2—Accepts the configuration of the specified SRP module and the SC subsystem in slot 7 (applies only to E120 and E320 routers)

host1(config)#**slot accept 7**

- Example 3—Accepts the configuration of the SC on the SRP module in slot 7 (applies only to E120 and E320 routers)

host1(config)#**slot accept 7 srp**

- There is no **no** version.
- See slot accept.

### **slot erase**

- Use to delete the configuration of the module in the selected slot before you install a different type of module.
- This command enables you to create a fresh configuration for the module installed in the slot.
- You cannot use this command on a primary SRP module; however, you can use it on a standby SRP module.
- If you specify a slot on the E120 router or the E320 router that contains an SRP module, you erase the configuration of the SC subsystem on that slot by default. You do not, however, erase the configuration of the fabric slice that resides on the slot.
  - Use the **srp** keyword to erase only the configuration of the portion of the SC subsystem that resides on a specified SRP module.
  - Use the **fabric** keyword to erase only the configuration of the fabric slice that resides on the specified SRP module.
- If you specify a slot that contains a line module, you erase the configuration of the line module and the I/O modules or IOAs associated with it. To erase the configuration of a specific IOA on the E120 router or the E320 router, use the “adapter erase” on page 349 command.
- Example 1—Erases the configuration of the module in slot 3

host1(config)#**slot erase 3**

- Example 2—Erases the configuration of the specified SRP module and the SC subsystem in slot 7 (applies only to E120 and E320 routers)

host1(config)#**slot erase 7**

- Example 3—Erases the configuration of the SC on the SRP module in slot 7 (applies only to E120 and E320 routers)

host1(config)#**slot erase 7 srp**

- There is no **no** version.
- See slot erase.

## Software Compatibility

---

An E-series software release supports a specific set of line modules and associated I/O modules or IOAs. Before you install a new line module, I/O module, or IOA, you should install a software release that supports the new module.

### Line Modules

If the router uses a software version that does not support a line module that you install, you see the message `unrecognized board type`, and the router disables the module. When you issue a **show version** command, the state of the line module is disabled (admin).

If you subsequently boot the router with software that supports the line module, the line module becomes available and its state is enabled.

### I/O Modules and IOAs

If the router uses a software version that does not support an I/O module or IOA that you install, the I/O module or IOA will be unavailable, and you will not be able to upgrade the software on the router. To upgrade the software:

1. Remove the I/O module or IOA.
2. Reboot the line module that corresponds to this I/O module or IOA. See “Booting the System” on page 579.
3. When the line module has rebooted, install the I/O module or IOA.
4. Upgrade the software on the router. See “Installing JUNOS Software” on page 125.

## Configuring Performance Rate of Line Modules on ERX-7xx Models and the ERX-1410 Router

---



**NOTE:** The information in this section does not apply to the ERX-1440 router, ERX-310 router, E120 router, or the E320 router. It also does not apply to the OC48 line module, which is supported only by the ERX-1440 router.

---

Line modules in an ERX-1440 router or an ERX-310 router always operate at line rate performance. However, you can configure ERX-7xx models and the ERX-1410 router to enable the line modules either to operate at full line rate performance or to allow line modules to operate at a rate dependent on the resources available.

Operating at full line rate performance restricts the combination of line modules in the router. Operating at a rate dependent on the resources available allows a much more extensive combination of line modules in the router and is known as *bandwidth oversubscription*.

To configure performance:



1. Choose a combination of line modules appropriate for the performance. See “Choosing a Combination of Line Modules” on page 353.
2. Disable slots that contain unwanted line modules, or modify the combination of line modules in the router. See “Disabling and Reenabling Line Modules, SRP Modules, and SFMs” on page 340, and *ERX Hardware Guide, Chapter 4, Installing Modules*.
3. Specify the type of performance. See “Specifying the Type of Performance” on page 356.

### **Choosing a Combination of Line Modules**

For line rate performance, the total bandwidth required by the line modules in the slot group must not exceed the bandwidth available from the SRP module. In this case, the combination of line modules that can reside in a slot group depends on the following:

- The number of slots per group
- The bandwidth available from the SRP module
- The bandwidth required by each line module
- In the case of the SRP-5G + and SRP-10G modules, the switches (upper and lower) that the line module can use.

### **Slot Groups**

The number of slots in a group depends on the E-series model. For information about slot groups, see *ERX Hardware Guide, Chapter 4, Installing Modules*.

### **SRP Modules Bandwidth**

Different SRP modules offer different bandwidths:

- The SRP-10G module provides 2.5 Gbps bandwidth per slot group.
- The SRP-5G + module (ERX-705 router only) provides:
  - 2.5 Gbps bandwidth per slot group
  - 5 Gbps bandwidth per router

### **Line Modules Bandwidth and Switch Usage**

The SRP-5G + and SRP-10G modules comprise two switches; each switch provides 50 percent of the bandwidth.

The line modules in a slot group cannot operate at line rate if:

- The sum of their bandwidths exceeds the bandwidth that the SRP module can supply per slot group.
- The sum of the bandwidths they require from one SRP switch exceeds the bandwidth that the SRP switch can supply per slot group.

Table 38 on page 354 shows the bandwidth that each line module requires for line rate performance and the switches that the line module can use on the SRP-5G + and SRP-10G modules.

**Table 38: Bandwidth Statistics for Line Modules**

| Line Module    | Total Bandwidth Required (Gbps) | Switches Used on SRP-5G+ and SRP-10G Modules |
|----------------|---------------------------------|----------------------------------------------|
| cOCx/STMx      | 2.46                            | Both switches                                |
| COCX-F3        | 2.46                            | Both switches                                |
| CT3/T3-F0      | 2.46                            | Both switches                                |
| GE/FE          | 2.46                            | Both switches                                |
| IPSec Service  | 2.46                            | Both switches                                |
| OC3/STM1 GE/FE | 2.46                            | Both switches                                |
| OCx/STMx ATM   | 1.22                            | Both switches                                |
| OCx/STMx POS   | 2.46                            | Both switches                                |
|                |                                 |                                              |
|                |                                 |                                              |
|                |                                 |                                              |

### Allowed Combinations for Line Rate Performance

The SRP-5G + and SRP-10G modules support all the line modules listed in Table 38 on page 354.

Only certain combinations of line modules allow line rate performance (see Table 39 on page 355 through Table 41 on page 356). However, if performance lower than line rate is acceptable, you can use any combination of line modules in a slot group.

For example, the SRP-10G module offers a total bandwidth of 2.5 Gbps for each slot group. The GE line module requires 2.46 Mbps bandwidth for operation at line rate, and can use both switches in the SRP-10G module. If you require line rate from a GE line module, install only one GE line module in the slot group. However, if lower performance is acceptable, you can install two or three GE line modules in a slot group and enable bandwidth oversubscription.

When bandwidth oversubscription is enabled, all line modules optimize use of the resources available. For example, if two GE line modules are installed in a slot group, each line module is allocated 50 percent of the available bandwidth. However, if one line module is using less bandwidth than it is allocated, the other line module can use more bandwidth than it is allocated and can operate at a greater rate.

Table 39 on page 355, Table 40 on page 355, and Table 41 on page 356 indicate combinations of line modules that allow line rate performance.

**Table 39: Combinations of Line Modules for Line Rate Performance—SRP-10G Module in an ERX-7xx Model**

| Possible Combinations of Line Modules                                                                                                                                                                                                                                                                                            | Examples of Allowed Combinations                                                                                                                                                                                                                                                                                | Examples of Forbidden Combinations                                                                                                                                     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>One supported line module and one empty slot in slot group 1<br/><b>NOTE:</b> The SRP-10G module supports all line modules listed in Table 38 on page 354.</li> <li>Two OCx/STMx ATM line modules in slot group 1</li> <li>One supported line module in slot groups 2, 3 and 4</li> </ul> | <ul style="list-style-type: none"> <li>One OCx/STMx POS line module in slot group 1, a GE/FE line module in slot group 2, and one OCx/STMx ATM line module in slot group 4</li> <li>Two OCx/STMx ATM line modules in slot group 1, one GE/FE line module in slot group 2, and one SM in slot group 3</li> </ul> | <ul style="list-style-type: none"> <li>A GE/FE line module and any other line module in slot group 1</li> <li>Two OCx/STMx POS line modules in slot group 1</li> </ul> |

**Table 40: Combinations of Line Modules for Line Rate Performance—SRP-10G Module in an ERX-1410 Router**

| Possible Combinations of Line Modules                                                                                                                                                                                                                                                                                                                                                                                                      | Examples of Allowed Combinations                                                                                                                                               | Examples of Forbidden Combinations                                                                                                                    |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>One supported line module and two empty slots in any slot group<br/><b>NOTE:</b> The SRP-10G module supports all line modules listed in Table 38 on page 354.</li> <li>Two OCx/STMx ATM line modules and one GE/FE module and one empty slot in any slot group (bandwidth oversubscription enabled)</li> <li>One OC3/STM1 GE/FE module in any slot (bandwidth oversubscription disabled)</li> </ul> | <ul style="list-style-type: none"> <li>One COCX-F3 line module in slot group 1, a GE/FE line module in slot group 2, and a OCx/STMx POS line module in slot group 3</li> </ul> | <ul style="list-style-type: none"> <li>Three OCx/STMx ATM line modules in any slot group</li> <li>Two GE/FE line modules in any slot group</li> </ul> |

**Table 41: Combinations of Line Modules for Line Rate Performance—SRP-5G+ Module in an ERX-705 Router**

| Possible Combinations of Line Modules In Slot Groups                                                                                                                                                                                                                                                                                                                                     | Examples of Allowed Combinations                                                                                                                                                                                                                                                           | Examples of Forbidden Combinations                                                                                                                                                                                                                                                                                                                                |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>NOTE:</b> The total bandwidth of all line modules must not exceed 5 Gbps. To make optimal use of the available bandwidth, put line modules that require maximum bandwidth in slot 2, 3, or 4.</p>                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                   |
| <ul style="list-style-type: none"> <li>One supported line module and one empty slot in slot group 1<br/><b>NOTE:</b> The SRP-5G+ module supports all line modules listed in Table 38 on page 354.</li> <li>Two OCx/STMx ATM line modules in slot group 1</li> <li>One cOCx/STMx, COCX-F3, CT3/T3 FO, GE/FE, IPSec Service, or OCx/STMx line module in slot groups 2, 3, and 4</li> </ul> | <ul style="list-style-type: none"> <li>Two OCx/STMx ATM line modules (total 2.44 Gbps) in slot group 1, and a GE/FE line module (2.46 Gbps) in slot group 4</li> <li>Two OCx/STMx ATM line modules (total 2.44 Gbps) in slot group 1, and a COCX-F3 line module in slot group 2</li> </ul> | <ul style="list-style-type: none"> <li>Two OCx/STMx ATM line modules (total 2.44 Gbps) in slot group 1, a GE/FE line module (2.46 Gbps) in slot group 3, and an OCx/STMx POS line module (2.46 Gbps) in slot 4 (violates chassis limitation)</li> <li>Two OCx/STMx POS line modules (total 4.92 Gbps) in slot group 1 (violates slot group limitation)</li> </ul> |

## Specifying the Type of Performance

After you have installed a suitable combination of line modules, you can specify a different type of performance. To specify the type of performance:

1. Issue the **show bandwidth oversubscription** command.
2. If the setting is not the one you want, enable or disable bandwidth oversubscription.
3. Reboot the router.

### **bandwidth oversubscription**

- Use to enable bandwidth oversubscription for an ERX-7xx model or ERX-1410 router. Reboot the router after you have issued this command to change the bandwidth oversubscription status.
- By default, bandwidth oversubscription is enabled.
- Example

```
host1(config)#bandwidth oversubscription
```

- Use the **no** version to disable bandwidth oversubscription. Reboot the router after you have issued this command to change the bandwidth oversubscription status.
- See bandwidth oversubscription.

## Monitoring Bandwidth Oversubscription

Use the **show bandwidth oversubscription** and **show utilization** (see “Monitoring Modules” on page 404) commands to monitor the status of bandwidth oversubscription.

### **show bandwidth oversubscription**

- Use to display the bandwidth oversubscription status for an ERX-7xx model or ERX-1410 router.
- Example 1: This example shows the display when bandwidth oversubscription is enabled.

```
host1#show bandwidth oversubscription
Bandwidth oversubscription is currently in effect.
```

- Example 2: This example shows the display that appears after you issue the **no bandwidth oversubscription** command to disable bandwidth oversubscription.

```
host1#no bandwidth oversubscription
host1#show bandwidth oversubscription
Bandwidth oversubscription is currently in effect.
Bandwidth oversubscription will not be in effect the next time the system
reboots.
```

- Example 3: This example shows the display when bandwidth oversubscription is disabled.

```
host1#show bandwidth oversubscription
Bandwidth oversubscription is currently not in effect.
```

- Example 4: This example shows the display that appears after you issue the **bandwidth oversubscription** command to enable bandwidth oversubscription.

```
host1#bandwidth oversubscription
host1#show bandwidth oversubscription
Bandwidth oversubscription is currently not in effect.
Bandwidth oversubscription will be in effect the next time the system
reboots.
```

- See show bandwidth oversubscription.

## Troubleshooting Bandwidth Oversubscription

If you enter a forbidden combination of line modules or exceed the slot group bandwidth when you have not configured bandwidth oversubscription, you will see an error message.

For example, suppose you originally configure the router for bandwidth oversubscription and then want to change to full line rate performance. You forget to remove line modules or disable slots, and enter the **no bandwidth oversubscription** command. The following message appears:

```
host1(config)#no bandwidth oversubscription
% failed : bandwidth over subscribed at slot 0-2
```

To resolve the problem, remove the unwanted line modules, or disable the slots that contain those line modules.

## Line Module Redundancy

---

You can install an extra line module in a group of identical line modules to provide redundancy if one of the modules fails.

The process by which the router switches to the spare line module is called *switchover*. During switchover, the line, circuit, and IP interfaces on the I/O module or one or more IOAs appear to go down temporarily. The duration of the downtime depends on the number of interfaces and the size of the routing table, because the router must reload the interface configuration and the routing table from the SRP module.

If the line module software is not compatible with the running SRP module software release, a warning message appears on the console.

## Module Requirements

The requirements for line module redundancy depend on the type of router that you have.



**NOTE:** The information in this section does not apply to the ERX-310 router, which does not support line module redundancy.

---

### ERX-7xx Models and ERX-14xx Models

To use this feature on ERX-7xx models and ERX-14xx models, you must also install a redundancy midplane and a redundancy I/O module. For a detailed explanation of how the router provides redundancy for line modules and procedures for installing the modules, see the *ERX Hardware Guide*.

### E120 Router and E320 Router

To configure line module redundancy on the E120 router or the E320 router, you must also install an ES2-S1 Redund IOA in either slot 0 or slot 11. The ES2-S1 Redund IOA is a full-height IOA. For a detailed explanation of how the router provides redundancy for line modules and procedures for installing the modules, see the *E120 and E320 Hardware Guide*.

On E120 and E320 routers, each side of the chassis is treated as a redundancy group. The lowest numbered slot for each side acts as the spare line module, providing backup functionality when an ES2-S1 Redund IOA is located directly behind it. When the line module does not contain an ES2-S1 Redund IOA, it is considered a primary line module.

The spare line module only backs up a line module of the same type. For example, an ES2 4G LM spare line module backs up any ES2 4G LM, but does not back up an ES2 10G Uplink LM. The router accepts the following redundancy groups:

- ES2 4G LM and ES2 4G LM
- ES2 10G Uplink LM and ES2 10G Uplink LM
- ES2 10G LM and ES2 10G LM

Also, you cannot configure redundancy for the ES2-S1 Service IOA.

### ***IOA Behavior When the Router Reboots***

On E120 and E320 routers, switchover is based on the combined states of the line module and the IOAs that are installed in the affected slot.

When the router reboots and the formerly configured primary line module is not present, or is present and fails diagnostics, it switches to a spare line module and takes inventory of the IOAs. If the IOA is present and new, the router reverts back to the primary line module so that the spare line module can service other active primary line modules.

When the router reboots and there is a slot that contains a line module and one active and one inactive IOA, the inactive IOA remains in that state.

### ***Line Module Behavior When Disabling or Enabling IOAs***

On E120 and E320 routers, a line module reboots when you issue the **adapter disable** or **adapter enable** commands for an associated IOA.

When you issue the **adapter disable** or **adapter enable** commands, the line module (primary or spare) currently associated with that IOA reboots. If the IOA is protected by a line module redundancy group, an automatic line module redundancy switchover or revert can be triggered by the line module reboot. To prevent undesired line module redundancy actions, issue the **redundancy lockout** command for the primary line module slot before issuing the **adapter disable** or **adapter enable** commands.

## ***Automatic Switchover***

Provided you have not issued the **redundancy lockout** command for the primary line module, the router switches over to the spare line module automatically if it detects any of the following failures on the primary line module:

- Power-on self-test (POST) failure
- Software-detected unrecoverable error
- Software watchdog timer expiration
- Primary line module failure to respond to keepalive polling from the SRP module
- Removal, disabling, or reloading of the primary line module
- Missing or disabled primary line modules when the router reboots
- Resetting the primary line module using the concealed push button

## Limitations of Automatic Switchover

If automatic switchover is enabled on a slot (the default configuration) and a spare line module is available, issuing some CLI commands for the primary line module causes a switchover (see Table 42 on page 360).

You can also disable automatic switchover on individual slots. For more information, see “Configuring Line Module Redundancy” on page 360.

**Table 42: Commands That Can Cause Automatic Switchover**

| Command                                             | Reason for Automatic Switchover                                                      |
|-----------------------------------------------------|--------------------------------------------------------------------------------------|
| <b>slot disable</b> <i>primary-line-module-slot</i> | The command disables the primary line module but not the primary I/O module or IOAs. |
| <b>reload slot</b> <i>primary-line-module-slot</i>  | The command is equivalent to pushing the reset button on the primary line module.    |

## Reversion after Switchover

You can install only one spare line module in the group of slots covered by the redundancy midplane or redundancy group. If the router is using the spare line module, no redundancy is available. It is desirable to revert to the primary module as soon as possible. By default, the router does not automatically revert to the primary module after switchover; however, you can configure it to do so. (See “Configuring Line Module Redundancy” on page 360.) Before reversion can take place, the primary line module must complete the POST diagnostics.

## Configuring Line Module Redundancy

You can modify the default redundancy operations on the router as follows:

- Disable automatic switchover on a slot.
- Enable automatic reversion after switchover.

### redundancy lockout

- Use to prevent the router from switching automatically to a spare line module if the primary module in the specified slot fails.
- The **redundancy force-switchover** command overrides the **redundancy lockout** command.
- Example
 

```
host1(config)#redundancy lockout 5
```
- Use the **no** version to restart redundancy protection for the slot.
- See redundancy lockout.



**redundancy revertive**

- Use to enable the router to revert from all spare line modules to the associated primary line modules automatically.
- Reversion takes place when the primary line module is once again available unless you specify a time of day. In that case, reversion takes place only when the primary module is available and after the specified time.
- Example

```
host1(config)#redundancy revertive 23:00:00
```

- Use the **no** version to disable automatic reversion.
- See redundancy revertive.

**Managing Line Module Redundancy**

When the router is running and a redundancy group is installed, you can manage the redundancy situation as follows:

- Force switchover manually.
- Force reversion manually.

**redundancy force-switchover**

- Use to force the router to switch from the primary line module in the specified slot or the primary SRP module to the spare line module or SRP module.
- The command causes a single switchover. When you reboot, the router reverts to the configured setting for this slot.
- The **redundancy force-switchover** command overrides the **redundancy lockout** command.
- Example

```
host1#redundancy force-switchover 5
```

- There is no **no** version.
- See redundancy force-switchover.

**redundancy revert**

- Use to force the router to revert to the primary line module in the specified slot.
- The router acts on this command immediately unless you specify a time or a time and date that the action is to take place.
- The command causes a single reversion. When you reboot, the router uses the configured setting for this slot.
- Example

```
host1#redundancy revert 4 23:00:00 5 September 200X
```

- There is no **no** version.
- See redundancy revert.

## **SRP Module Redundancy**

This section covers general issues of SRP module redundancy. It does not cover NVS cards or the behavior on systems running high availability features such as hitless SRP switchover. For information about managing NVS in a router that contains two SRP modules, see “Managing Flash Cards on SRP Modules” on page 373. For information about managing high availability in a router, see “Managing Modules” on page 335.

The information in this section does not apply to the ERX-310 router, which does not support SRP module redundancy. For this reason, any references to synchronization that may appear in command output or system messages do not apply to the ERX-310 router.

## **SRP Module Behavior**

The SRP module uses a 1:1 redundancy scheme. When two SRP modules are installed in the router, one acts as a primary and the second as a redundant module. On ERX-7xx models, ERX-14xx models, and the ERX-310 router, both SRP modules share a single SRP I/O module located in the rear of the chassis. On the E120 router and the E320 router, both SRP modules share an SRP IOA located in the rear of the chassis.

After you install two SRP modules, the modules negotiate for the primary role. A number of factors determine which module becomes the primary; however, preference is given to the module in the lower slot. The SRP modules record their latest roles and retain them the next time you switch on the router.

With the default software settings, if the primary SRP module fails, the redundant SRP module assumes control without rebooting itself. For information about preventing the redundant SRP module from assuming control, see “Managing SRP Module Redundancy” on page 367.

On E120 and E320 routers, the switch fabric is distributed between the SFMs and the SRP modules. If the primary SRP module fails a diagnostic test on its resident slice of switch fabric, then it abdicates control to the redundant SRP module if both of the following are true:

- The standby SRP module does not indicate any error.
- The standby SRP module passes diagnostics on its attached fabric slice.

When the redundant SRP module assumes control, the following sequence of events occurs:

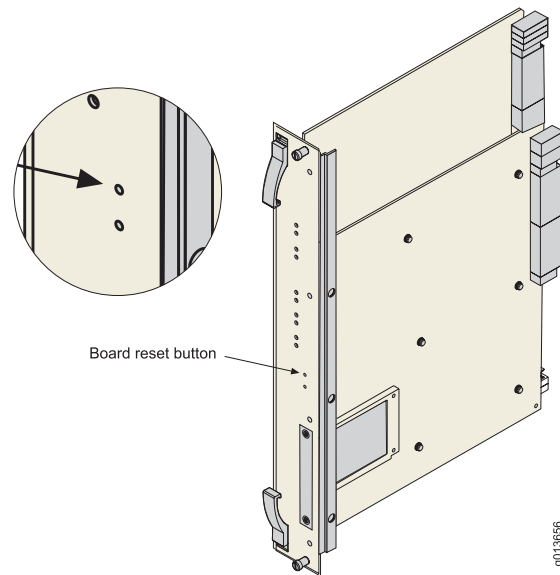
1. The original primary SRP module reboots and assumes the redundant role.
2. The redundant SRP module restarts and assumes the primary role without reloading new code. (When upgrading software, you must reload the software on the redundant SRP module. See “Installing JUNOS Software” on page 125.)

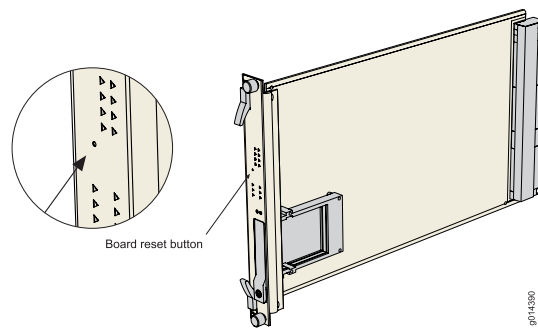
3. All line modules reboot.

The following actions activate the redundant SRP module:

- Failure of the primary SRP module (hardware or software)
- Pushing the recessed reset button on the primary SRP module (see Figure 25 on page 364 and Figure 26 on page 365)
- Issuing the **srp switch** command
- Issuing the **redundancy force-switchover** command

**Figure 25: SRP Module on ERX-7xx Models and ERX-14xx Models**



**Figure 26: SRP Module on the E120 Router and the E320 Router**

### Specifying the Configuration for Redundant SRP Modules

On a router with redundant SRP modules, you can specify the configuration that both the primary and redundant modules load in the event of a reload or switchover. A switchover can result from an error on the primary SRP module or from an **srp switch** command. The following behavior takes place only in the event of a cold restart; it does not take place in the event of a warm restart.

When you arm a configuration (.cnf) file by issuing the **boot config cnfFilename** command, a subsequent SRP switchover causes the redundant SRP module to assume the role of primary SRP module with the configuration specified by the .cnf file. The new primary SRP module does not use the running configuration.

If you want the redundant SRP module to instead use the running configuration when it assumes the primary role, then you must first arm a configuration file with the **boot config cnfFilename once** command. To exhaust the **once** option, you must then cause the redundant SRP module to reload for some reason, such as by issuing a **reload** command or by arming a new JUNOS release or a hotfix file.

When a switchover subsequently occurs, the redundant SRP module reloads with the running configuration and assumes the primary role. For more information about the **boot config** command, see “Booting the System” on page 579.

## Installing a Redundant SRP Module

You can install a redundant SRP module into a running router, provided that the redundant SRP module has a valid, armed software release on its NVS card. Access to a software release in NVS ensures that the redundant SRP module can boot; the release need not be the same as that on the primary SRP module. To install a redundant SRP module into a running router, follow these steps:



**WARNING:** Do not insert any metal object, such as a screwdriver, or place your hand into an open slot or the backplane when the router is on. Remove jewelry (including rings, necklaces, and watches) before working on equipment that is connected to power lines. These actions prevent electric shock and serious burns.

---



**CAUTION:** When handling modules, use an antistatic wrist strap connected to the router’s ESD grounding jack, and hold modules by their edges. Do not touch the components, pins, leads, or solder connections. These actions help to protect modules from damage by electrostatic discharge.

---

1. Install the redundant SRP module into the open SRP slot (slot 6 or 7 for ERX-14xx models, the E120 router, and the E320 router; slot 0 or 1 for ERX-7xx models).

For detailed information about installing the SRP module, see the *ERX Hardware Guide* or the *E120 and E320 Hardware Guide*.

2. Wait for the redundant SRP module to boot, initialize, and reach the standby state.

When the module is in standby state, the REDUNDANT LED is on and the ONLINE LED is off. If you issue the **show version** command, the state field for the slot that contains the redundant SRP module is standby.

3. Synchronize the NVS file system of the redundant SRP module to that of the primary SRP module.
- 



**NOTE:** The SRP module reboots after synchronization is complete.

---

### reload slot

- Use to reboot a selected slot on the router.
- If you specify a slot on the E120 router or the E320 router that contains an SRP module, you reboot the SC subsystem on that slot by default. You do not, however, reboot the fabric slice that resides on the slot.

- Use the **srp** keyword to reboot the portion of the SC subsystem that resides on a specified SRP module.
- Use the **fabric** keyword to reboot the fabric slice that resides on the specified SRP module.
- Example 1—Reboots the module in slot 7  
           **host1#reload slot 7**
- Example 2—Reboots the SC on the SRP module in slot 7 (applies only to E120 and E320 routers)  
           **host1#reload slot 7 srp**
- There is no **no** version.
- See reload slot.

### **synchronize**

- Use to force the file system of the redundant SRP module to synchronize with the NVS file system of the primary SRP module.
- If you synchronize the redundant SRP module with the primary SRP module and the redundant module is armed with a release different from the one it is currently running, the redundant SRP module is automatically rebooted to load the armed release.
- Optionally, you can use the **low-level-check** keyword to force the router to validate all files or only configuration files in NVS, and to synchronize all files that failed the checksum test during the **flash-disk-compare** command as well as any other files that are unsynchronized. See “Validating and Recovering Redundant SRP File Integrity” on page 379 for details.
- Examples  
           **host1#synchronize**  
           **host1#synchronize low-level-check all**  
           **host1#synchronize low-level-check configuration**
- There is no **no** version.
- See synchronize.

## **Managing SRP Module Redundancy**

You can prevent the redundant SRP module from taking over when:

- The primary SRP module experiences a software failure.
- You push the reset button on the primary SRP module.



**NOTE:** If you do not configure this option, when troubleshooting an SRP module, disconnect the other SRP module from the router. This action prevents the redundant SRP module from taking over if you push the reset button on the primary SRP module.

To configure this option:

1. Issue the **disable-switch-on-error** command.
2. Synchronize the NVS file system of the redundant SRP module to that of the primary SRP module.

Refer to the commands and guidelines in the previous section and below.

### **disable-switch-on-error**

- Use to prevent the redundant SRP module from taking over if the primary SRP module experiences a software failure or if you push the reset button on the primary SRP module.
- Issue the “synchronize” on page 367 command immediately before you issue this command.
- If you issue the **disable-switch-on-error** command, and later issue the **srp switch** command, the redundant SRP module waits about 30 seconds before it takes over from the primary SRP module.
- Example
 

```
host1(config)#disable-switch-on-error
```
- Use the **no** version to revert to the default situation, in which the redundant SRP module takes over if the primary SRP module experiences a software failure.
- See disable-switch-on-error.

### **synchronize**

- Use to force the NVS file system of the redundant SRP module to synchronize with the NVS file system of the primary SRP module.
- If you synchronize the redundant SRP module with the primary SRP module and the redundant module is armed with a release different from the one it is currently running, the redundant SRP module is automatically rebooted to load the armed release.
- Optionally, you can use the **low-level-check** keyword to force the router to validate all files or only configuration files in NVS, and to synchronize all files that failed the checksum test during the **flash-disk-compare** command as well as any other files that are unsynchronized. See “Validating and Recovering Redundant SRP File Integrity” on page 379 for details.
- Examples

```
host1#synchronize
host1#synchronize low-level-check all
host1#synchronize low-level-check configuration
```



- There is no **no** version.
- See synchronize.

## Switching to the Redundant SRP Module

To switch immediately from the primary SRP module to the redundant SRP module, issue the **redundancy force-switchover** command or the **srp switch** command. You can configure the router to prompt you if the modules are in a state that could lead to loss of configuration data or NVS corruption.

### **redundancy force-switchover**

- Use to force the router to switch from the primary line module in the specified slot or the primary SRP module to the spare line module or SRP module.
- The command causes a single switchover. When you reboot, the router reverts to the configured setting for this slot.
- With the **srp** option, the command is equivalent to the **srp switch** command.
- The **redundancy force-switchover** command overrides the **redundancy lockout** command.
- Example

```
host1#redundancy force-switchover 5
```

- There is no **no** version.
- See redundancy force-switchover.

### **srp switch**

- Use to switch from the primary SRP module to the redundant SRP module.
- When the high availability state is active, this command delays until all transaction data, up to when you issue the command, has been mirrored to the standby SRP module. This preserves legacy behavior requiring that SRP modules be synchronized before the switchover.
- If you specify the **force** keyword, the procedure fails if the SRP modules are in certain states, such as during a synchronization. In these cases, the router displays a message that indicates that the procedure cannot currently be performed and the reason why. However, if the SRP modules are in other states that could lead to a loss of configuration data or an NVS corruption, the router displays a message that explains the state of the SRP modules, and asks you to confirm (enter yes or no) whether you want to proceed.
- If you do not specify the **force** keyword, the procedure fails if the SRP modules are in any state that could lead to a loss of configuration data or an NVS corruption, and the router displays a message explaining the command failure.
- When you issue this command, the router prompts you for a confirmation before the command takes effect.
- If you issue the **disable-switch-on-error** command and later issue the **srp switch** command, the redundant SRP module waits about 30 seconds before it takes over from the primary SRP module.

- If the router does not contain a redundant SRP module, this command has no effect.
- Example
 

```
host1#srp switch
host1#srp switch force
```
- There is no **no** version.
- See `srp switch`.

### Upgrading Software on a Redundant SRP Module

For information about upgrading software on SRP modules on ERX-7xx models, ERX-14xx models, or the ERX-310 router, see “Installing JUNOS Software” on page 125.

### Monitoring the Status LEDs

You can determine the redundancy state of line modules and SRP modules by examining their status LEDs. See Table 43 on page 370 for a description of the LEDs functions. In addition, if you issue the **show version** command, the state field for the slot that contains the redundant SRP module should be standby.

**Table 43: Function of the Online and Redundant LEDs**

| Online LED | Redundant LED | State of the Module                                      |
|------------|---------------|----------------------------------------------------------|
| Off        | Off           | Module is booting or is an inactive primary line module. |
| On         | Off           | Module is active, but no redundant module is available.  |
| Off        | On            | Module is in standby state.                              |
| On         | On            | Module is active, and a redundant module is available.   |

### Monitoring Line Module and SRP Module Redundancy

You can use **show** commands to monitor the status of redundancy groups, line modules, and SRP modules.



**NOTE:** For more information about monitoring high availability, see “Managing Modules” on page 335.

#### **show environment**

- Use to display information about the hardware installed for redundancy.
- See “Managing the System” on page 235, for details and examples.

- See show environment.

### **show hardware**

- Use to display detailed information about the line modules and SRP modules.
- See “Monitoring Modules” on page 404 for details and examples.
- See show hardware.

### **show redundancy**

- Use to display the configuration for line module redundancy and SRP redundancy.
- Field descriptions
  - SRP
    - high-availability state—State of the high availability mode (disabled, active, or pending)
    - current redundancy mode—Redundancy mode currently being used by this router (high-availability or file-system-synchronization)
    - last activation type—Last type of activation that occurred on this router (that is, the method by which the SRP last booted [cold-start or warm-start])
  - Criteria Preventing High Availability from being Active—Criteria required for HA to be active.
  - slot—Slot in which the line module resides
  - hardware role—Function of the line module: primary or spare
  - lockout config—Status of redundancy on this line module
    - protected—Line module redundancy is enabled
    - locked out—Line module redundancy is disabled
  - backed up by slot—Slot that contains the line module that is a spare for this primary line module
  - sparing for slot—Slot that contains the primary line module for which this line module is a spare
  - revert at—Time at which you want the line module to revert
  - midplane type—Identifier for the type of midplane
  - midplane rev—Hardware revision number of the redundancy midplane
  - fabric slice redundancy—Status of the fabric slice on the SRP modules or SFMs on the E120 and E320 routers
    - slot—Slot in which the fabric slice resides
    - slice state—State of the fabric slice (online, not present)
    - type—Identifier for the type of hardware (SRP module or SFM)

### ■ Example 1

In the following example, the user issues a **show redundancy** command, and then a **redundancy force switchover** command. Finally, the user issues the **show redundancy line-card** command to display information specific to the line modules. The two displays show how the states of the primary and spare line modules change.

```
host1#show redundancy
```

```
SRP
```

```

```

```
high-availability state: disabled
current redundancy mode: file-system-synchronization
last activation type: cold-start
```

```
Criteria Preventing High Availability from being Active
```

```

 criterion met

High Availability mode configured? No
Mirroring Subsystem present? No
```

```
Line Card
```

```

```

```
automatic reverting is off
```

| slot | hardware<br>role | lockout<br>config | backed<br>up<br>by<br>slot | sparing<br>for<br>slot | revert<br>at |
|------|------------------|-------------------|----------------------------|------------------------|--------------|
| 0    | spare            | ---               | ---                        | ---                    | ---          |
| 2    | primary          | protected         | ---                        | ---                    | ---          |
| 12   | ---              | ---               | ---                        | ---                    | ---          |

| slots | midplane<br>type | midplane<br>rev |
|-------|------------------|-----------------|
| 0 - 5 | 6                | 0               |

```
host1#redundancy force-switchover 2
```

```
host1#show redundancy line-card
```

```
automatic reverting is off
```

| slot | hardware<br>role | lockout<br>config | backed<br>up<br>by<br>slot | sparing<br>for<br>slot | revert<br>at |
|------|------------------|-------------------|----------------------------|------------------------|--------------|
| 0    | spare            | ---               | ---                        | 2                      | ---          |
| 2    | primary          | protected         | 0                          | ---                    | ---          |
| 12   | ---              | ---               | ---                        | ---                    | ---          |

| slots | midplane<br>type | midplane<br>rev |
|-------|------------------|-----------------|
| 0 - 5 | 6                | 0               |

```

0 - 5 6 0

```

- Example 2—Displays the redundancy status on an E320 router

```
host1#show redundancy
```

```
SRP
```

```

```

```

high-availability state: active
current redundancy mode: high-availability
last activation type: cold-start

```

```
Line Card
```

```

```

```
automatic reverting is off
```

| slot | hardware<br>role | lockout<br>config | backed<br>up<br>by<br>slot | sparing<br>for<br>slot | revert<br>at |
|------|------------------|-------------------|----------------------------|------------------------|--------------|
| 0    | spare            | ---               | ---                        | ---                    | ---          |
| 2    | primary          | protected         | ---                        | ---                    | ---          |
| 4    | primary          | protected         | ---                        | ---                    | ---          |

```
fabric slice redundancy: none
```

| slot | state  | type    |
|------|--------|---------|
| 6    | online | SFM-100 |
| 7    | online | SFM-100 |
| 8    | ---    | ---     |
| 9    | ---    | ---     |
| 10   | ---    | ---     |

- See show redundancy.

### **show version**

- Use to display information about each module in the router.

See “Managing the System” on page 235, for details and examples.

- See show version.

## **Managing Flash Cards on SRP Modules**

Each SRP module contains a flash card that stores system files. On the E120 router and the E320 router, each SRP module can have an additional flash card; the second card is reserved for the storage of core dumps.

In this documentation, the flash card on the primary SRP module is referred to as the primary flash card; the flash card on the redundant SRP module is referred to as the redundant flash card.

If you have two SRP modules installed in a router, you can use flash cards of different capacities on the SRP modules. The effective capacity of the higher-capacity flash card equals that of the lower-capacity flash card.

## **Flash Features**

The software contains a number of features that optimize the way the router restores its configuration if it is shut down improperly:

- The router tracks improper shutdowns.
- After an improper shutdown, the router runs an investigation of the file allocation table (FAT) the next time it reboots.
- The router creates backups of critical files.
- When you install a new flash card or restart the router after shutting it down incorrectly, a utility scans the flash card to detect corrupt sectors. If the utility finds files or directories that contain corrupt sectors, it removes the files and directories, because they can no longer be used. The utility also fixes problems with unused sectors. If the utility cannot correct a corrupt sector, it marks the sectors so that they cannot be reused. Errors in the boot block, FAT, or root directory are fatal and cannot be corrected by the scan utility.
- In a router that contains two SRP modules, if the scanning utility detects corrupt sectors in flash on the primary SRP module during rebooting, the primary SRP module reboots again. Both SRP modules now have standby status and reboot. The first SRP module to complete rebooting becomes the primary. Because the former redundant module started to reboot first, it likely becomes the primary. When the former primary module has rebooted and the scan utility has fixed corrupt sectors in its flash card, the SRP modules will synchronize. Any files or directories removed by the scan utility are restored during the synchronization.
- If you reboot the router before it has completely written configuration updates to the flash card, the router starts with the last saved configuration. If you reboot the router after it has written the configuration updates to the flash card, but before it has applied those updates to actual configuration data, the configuration update process resumes immediately following the reboot and is completed before any application accesses its configuration data.

## **Flash Features on the E120 Router and the E320 Router**

The E120 router and the E320 router can have a second flash card installed with its SRP modules. Device names are reserved for the E120 and E320 router flash card slots: disk0, disk1, standby-disk0, and standby-disk1. For backward compatibility, you can use the name standby, which is equivalent to standby-disk0. You can use the second card (disk1 or standby-disk1) only for storage of core dump (.dmp) files. When the a card is installed and mounted as disk1 or standby-disk1, all .dmp files are automatically stored on this card. You must use the card mounted as disk0 or standby-disk0 for all other file types. Core dump files are stored on disk0 or standby-disk0 only when a second card is not installed.

The **copy**, **dir**, **delete**, and **rename** commands all recognize the device names, as in the following examples. Disk1 and standby-disk1 accept only dump files. This means that you can copy only .dmp files to the second disk, delete only .dmp files from the second disk, and rename only .dmp files on the second disk.

```
host1#copy reset05.dmp server2:reset05.dmp
host1#copy disk0:051802.dmp server2:reset05.dmp
host1#delete disk1:reset05.dmp
host1#delete standby:reset05.dmp
host1#delete standby-disk0:reset05.dmp
host1#delete standby-disk1:reset05.dmp
host1#rename standby-disk1:foo.dmp standby-disk1:bar.dmp
host1#rename foo.dmp /outgoing/bar.dmp
host1#dir
Please wait...
active/standby file systems are synchronized
unshared
```

| file                     | size      | size      | date (UTC)          | in<br>use |
|--------------------------|-----------|-----------|---------------------|-----------|
| -----                    | -----     | -----     | -----               | ---       |
| disk0:reboot.hty         | 654336    | 654336    | 03/01/2005 16:08:28 |           |
| disk0:system.log         | 3644      | 3644      | 11/30/2004 20:48:18 |           |
| disk0:special.rel        | 159256660 | 61695156  | 02/18/2005 10:31:48 |           |
| disk0:lm4_12.dmp         | 344200394 | 344200394 | 02/12/2005 12:12:12 |           |
| standby-disk0:lm4_13.dmp | 344200394 | 344200394 | 02/13/2005 13:13:13 |           |
| disk1:lm4_14.dmp         | 344200394 | 344200394 | 02/14/2005 14:14:14 |           |
| standby-disk1:lm4_15.dmp | 344200394 | 344200394 | 02/15/2005 15:15:15 |           |
| disk0:boston.scr         | 833       | 833       | 02/22/2005 17:46:18 |           |
| disk0:bulkstats.scr      | 170       | 170       | 02/13/2006 17:34:30 |           |
| ram:bulkstats1.sts       | 737       | 737       | 03/07/2006 09:07:52 |           |

```

Disk capacity

Device Capacity Free Reserved
 (bytes) (bytes) (bytes)

disk0: 1025482752 342066375 68157440
ram: 5767168 5734400 0

```

Because the device names are reserved, if you upgrade from a release where you previously used those names for remote hostnames, an error message appears when you try to use that remote hostname:

```
%ambiguous file name, reserved disk device name "disk1" must be removed from
host table
```

To prevent corruption of flash cards, always issue the **halt** command before you remove an SRP module. See “Removing an SRP Module” on page 343. Issue the **halt** command before you remove a flash card installed as disk 0 or standby disk 0. Flash cards installed and mounted as disk1 or standby disk1 can be safely removed by issuing the **no mount** command for the card and then ejecting the card. Always reboot the router using the rebooting procedure. See “Bootting the System” on page 579. Do not reboot the router by switching it off and on.

## Installing and Removing Flash Cards

For information about replacing flash cards, see *ERX Hardware Guide, Chapter 4, Installing Modules*, or *E120 and E320 Hardware Guide, Chapter 4, Installing Modules*.

Before you remove the second flash card (disk1) on the SRP 120 module or the SRP 320 module, you must first unmount the card with the **no mount** command. This command causes the file system to reject all subsequent requests for opening files on the flash card and closes all open files. When this is accomplished, the disk is marked as safely unmounted and a status message indicates that is safe to eject the disk. A status message is displayed when you issue the **mount** or **no mount** command:

- When you issue the **mount** command:
  - % Device is mounted
  - % Device is already mounted
  - % Device is not present
- When you issue the **no mount** command:
  - % Device is dismounted
  - % Device is already dismounted
  - % Device is not present
  - % Command failed, files are open on device



**CAUTION:** When you eject a mounted disk 0 while the router is in an operational state, the SRP module initiates a reload. When you eject a mounted disk 1, data on the disk can be corrupted, but the router does not reboot.

---

### **mount**

- Use to mount the disk. If the disk was not safely unmounted previously, then before mounting the file system and permitting user access the command initiates disk and file system integrity checks. These checks are the same ones that are automatically performed when a disk is installed and the SRP module is reloaded.
- This command applies only to the flash card installed in slot 1 on an SRP 320 module. The command is rejected if you specify disk0, because that card is required for system operation and cannot be unmounted.
- Example
 

```
host1#mount disk1
```
- The **no** version prepares the flash card for safe removal. The router subsequently behaves as if the second flash card is no longer present. To access the second card, you must either eject and re-insert the card, or issue the mount command for the card. You can use the **force** keyword to force the dismount even when files on the flash disk are open for modification.
- See mount.



## Synchronizing Flash Cards



**NOTE:** The information in this section does not apply to the ERX-310 router, which does not support SRP module redundancy.

When the router contains two SRP modules, the contents of the modules' flash cards need to be synchronized. Synchronization prevents the redundant flash card from overwriting saved files on the primary flash card if the primary SRP module fails and the redundant SRP module takes control.

By default, autosynchronization is enabled on the router. Autosynchronization runs as a background process every 5 minutes, tracking changes in image, configuration, and script files, and keeping the two SRP modules synchronized. You can also synchronize the SRP modules manually by issuing the **synchronize** command.

Before synchronization, the router does the following:

- Verifies that critical files on the primary SRP module are present. If files are missing, the router does not proceed with the synchronization.
- Verifies whether there is enough space on the redundant flash card to copy all the new or changed files from the primary flash card.

Depending on the outcome of the space verification, the router proceeds as follows:

- If the card has enough space, the router copies new or changed files from the primary flash card to the redundant flash card without deleting any files on the redundant flash card. If the router is interrupted while it is synchronizing with this method, the synchronization resumes when it has recovered from the interruption.
- If the card does not have enough space, the router deletes any files on the redundant flash card that do not appear on the primary flash card, then copies new or changed files from the primary flash card to the redundant flash card. If the router is interrupted while it is synchronizing with this method, it does not resume the synchronization when it has recovered from the interruption.

If an SRP synchronization is in progress or has failed and the router is recovering, the router prevents the redundant SRP module from taking the primary role while the primary is rebooting and for 30 seconds after the primary module has rebooted. These conditions prevent a redundant SRP module with corrupted or missing files from becoming the primary and overwriting files or directories on the primary module.

### **synchronize**

- Use to force the file system of the redundant SRP module to synchronize with the flash file system of the primary SRP module.
- If you synchronize the redundant SRP module with the primary SRP module and the redundant module is armed with a release different from the one it is currently running, the redundant SRP module is automatically rebooted to load the armed release.

- Optionally, you can use the **low-level-check** keyword to force the router to validate all files or only configuration files in NVS, and to synchronize all files that failed the checksum test during the **flash-disk-compare** command as well as any other files that are unsynchronized. See “Validating and Recovering Redundant SRP File Integrity” on page 379 for details.



**NOTE:** In most cases, use the **synchronize** command instead of the **synchronize low-level-check** command. The **synchronize low-level-check** command is provided for troubleshooting, and is intended to be used under direction from JTAC.

---

- Examples

```
host1#synchronize
host1#synchronize low-level-check all
host1#synchronize low-level-check configuration
```

- There is no **no** version.
- See **synchronize**.

### Synchronizing Flash Cards of Different Capacities

If the capacity of the primary flash card is equal to or smaller than that of the redundant flash card, the router copies all the files from the primary flash card to the redundant flash card. However, if the capacity of the primary flash card exceeds that of the redundant flash card, the router creates a hidden synchronization reserve file on the primary flash card, provided enough space is available for the file.

The purpose of the synchronization file is to prevent the creation of data that cannot fit on the redundant flash card. The file contains no useful data, and does not appear when you view the files in NVS. The size of the file is equal to the difference in capacities of the two flash cards. For example, if the primary flash card has a capacity of 224 MB, and the redundant flash card has a capacity of 220 MB, the size of the synchronization file is 4 MB, and only 220 MB of space is available on the primary flash card.

If the primary flash card does not have enough space to create the synchronization reserve file, the **synchronize** command fails, and you see a warning message on the console. To resolve this issue, either delete unwanted files from the primary flash card or replace the redundant flash card with a higher-capacity flash card.

### Disabling Autosynchronization

If autosynchronization is enabled while you are copying long scripts or installing new software releases, it detects a disparity between the modules during the middle of the process. This feature causes significant unnecessary synchronization, resulting in prolonged copy times.

If you have installed a redundant SRP module, perform the following steps before copying long scripts:

1. Turn off autosynchronization with the **disable-autosync** command.
2. Perform the installation or copy the script.
3. Reenable autosynchronization with the **no disable-autosync** command.
4. Manually synchronize the modules with the **synchronize** command.

Refer to the commands and guidelines in the previous section and in the sections that follow.

### **disable-autosync**

- Use to turn off automatic synchronization between the primary and redundant SRP modules.
- Example  
  

```
host1(config)#disable-autosync
```
- Use the **no** version to revert to the default situation, in which automatic synchronization runs as a background process every 5 minutes.
- See disable-autosync.

## **Validating and Recovering Redundant SRP File Integrity**



**NOTE:** The information in this section does not apply to the ERX-310 router, which does not support SRP module redundancy.

Even when flash cards on the primary and redundant SRP modules are synchronized, differences can exist in the content of files that reside on the primary flash card and the redundant flash card. You can use the **flash-disk compare** command to detect these differences so you can validate and, if necessary, recover the file integrity of the redundant SRP module.

The **flash-disk compare** command validates only those files that are synchronized between the primary and redundant SRP modules. It does not compare files that are normally excluded from the synchronization process, such as log files and core dump files. The command uses a simple checksum error detection algorithm to compare the contents of a file residing on the flash card of the primary SRP module with the contents of the same file residing on the flash card of the redundant SRP module.

To validate and recover redundant SRP file integrity:

1. Ensure that the file systems on the primary flash card and the redundant flash card are synchronized. (See “Synchronizing Flash Cards” on page 377 for details.)
2. Issue the **flash-disk compare** command, specifying whether to perform the checksum validation for all files in NVS or only for configuration files.

```
host1#flash-disk compare all
host1#flash-disk compare configuration
```

The **flash-disk compare configuration** command, which validates only configuration files, excludes larger files such as software releases and scripts from the validation process. As a result, this command takes less time to complete than the **flash-disk compare all** command, which validates all NVS files.

3. Review the **flash-disk compare** output to determine whether any files failed the checksum validation.

If the **flash-disk compare** command detects differences in the content of one or more files, the router reports a checksum test failure.

4. If one or more files failed the checksum validation, determine whether the corrupted files reside on the primary SRP module or on the redundant SRP module.
5. If the corrupted file resides on the primary SRP module, issue the **srp switch** command to force a switch from the primary SRP module to the redundant SRP module.

This action ensures that the error-free version of the file will be on the SRP module that takes control after the switch.

6. Issue the **synchronize** command with the **low-level-check** keyword to force the router to:
  - Validate all files in NVS (when you use the **all** keyword) or only configuration files in NVS (when you use the **configuration** keyword).
  - Synchronize all files that failed the checksum test during the **flash-disk compare** command, as well as any other unsynchronized files.

```
host1#synchronize low-level-check all
host1#synchronize low-level-check configuration
```

This action resolves any file discrepancies between the primary and redundant SRP modules and restore SRP file integrity.



**NOTE:** Both the **flash-disk compare** and **synchronize low-level-check** commands perform CPU-intensive processing that can take several minutes to complete. For best results, do not run these commands simultaneously on the same router. In addition, do not run multiple instances of the **flash-disk compare** command simultaneously on the same router.

---

### **flash-disk compare**

- Use to perform a checksum validation that compares the contents of the NVS file system on the primary SRP module with the contents of the NVS file system on the redundant SRP module.
- The command validates only those files that are synchronized between the primary and redundant SRP modules; it does not validate log files, core dump files, and other files that are excluded from the system synchronization process.
- Specify one of the following keywords:

- **all**—Compares all files in NVS; this option can take several minutes to complete.
- **configuration**—Compares only configuration files; this option takes less time to complete because it compares only a subset of the files in the NVS file system.
- If all files pass the validation test, the router reports that all checksums matched and displays the total number of files and total number of bytes of information compared.
- If one or more files fail the validation test, the router reports a checksum test failure and does not display the total number of files and bytes compared.
- If one or more of the following conditions exist, the command fails and the router displays a message that explains why it cannot perform the checksum test:
  - The file systems on the primary flash card and the redundant flash card are not synchronized.
  - The router does not contain a redundant SRP module.
  - The redundant SRP module is offline.
- Example 1—Shows output when all files passed the validation test

```

host1#flash-disk compare all
WARNING: This command may take several minutes to complete.
Proceed? [confirm]
WARNING: No changes should be made to the system while this command is in
progress.
Please wait.....
All file checksums matched.
Number of Files = 866
Number of Bytes = 61660650

```

- Example 2—Shows output when one or more configuration files failed the validation test

```

host1#flash-disk compare configuration
WARNING: This command may take several minutes to complete.
Proceed? [confirm]
WARNING: No changes should be made to the system while this command is in
progress.
Please wait.....
At least one configuration file failed checksum test.

```

- There is no **no** version.
- See flash-disk compare.

## **synchronize**

- Use to force the NVS file system of the redundant SRP module to synchronize with the NVS file system of the primary SRP module.
- If you synchronize the redundant SRP module with the primary SRP module and the redundant module is armed with a release different from the one it is currently running, the redundant SRP module is automatically rebooted to load the armed release.
- Optionally, you can use the **low-level-check** keyword to force the router to validate all files or only configuration files in NVS, and to synchronize all files that failed the checksum validation test during the **flash-disk-compare** command as well as any other files that are unsynchronized.
- When you use the **low-level-check** keyword, you must also specify one of the following keywords:
  - **all**—Validates all files in NVS, and synchronizes all files that failed the checksum test as well as any other unsynchronized files; this option can take several minutes to complete.
  - **configuration**—Validates all configuration files in NVS, and synchronizes all files that failed the checksum test as well as any other unsynchronized files; this option takes less time to complete because it validates only a subset of the files in the NVS file system.
- If one or more of the following conditions exist when you use the **low-level-check** keyword, the command fails and the router displays a message that explains why it cannot perform the synchronization:
  - The router does not contain a redundant SRP module.
  - The redundant SRP module is offline.
  - The armed releases are different on the primary SRP and redundant SRP.
- Examples
 

```
host1#synchronize
host1#synchronize low-level-check all
host1#synchronize low-level-check configuration
```
- There is no **no** version.
- See synchronize.

## Reformatting the Primary Flash Card

You can reformat the primary flash card. To do so:

1. Access Boot mode.
  - a. From Privileged Exec mode, enter the reload command. Information about the reloading process is displayed.
  - b. When the countdown begins, press the mb key sequence (case-insensitive).

The CLI enters Boot mode (:boot## prompt). If you do not press the mb key sequence, the reloading process continues and returns the CLI to the normal User Exec mode.

2. Issue the **flash-disk initialize** command.

### **flash-disk initialize**

- Use to reformat the flash card.
- You can perform a low-level format of the flash card.
- On the E120 and E320 routers only, you can use this command to format a second flash card installed as disk1. You can issue this command in Boot mode for either flash card. In Privileged Exec mode, you can use the **disk1** keyword to access the unmounted second flash card while the router is in an operational state.
- This command is available for disk1 in Privileged Exec mode only on SRP 320 modules. This command is not accepted for disk0 in Privileged Exec mode.
- Example 1

```
host1#halt primary-srp
host1#reload
WARNING: Execution of this command will cause the system to reboot.
Proceed with reload? [confirm]
Reload operation commencing, please wait...
[Press mb]
:boot##flash-disk initialize
```

- Example 2—On an SRP 320 module

```
host1#no mount disk1
% Device is dismounted
host1#flash-disk initialize disk1
WARNING: Execution of this command will cause the contents of disk1 to be
erased.
Proceed with Flash disk initialization? [confirm]
Please wait.....
```

- There is no **no** version.
- See flash-disk initialize.

## **Copying the Image on the Primary SRP Module**



**NOTE:** The information in this section does not apply to the ERX-310 router, which does not support SRP module redundancy.

You can copy the contents of NVS on the primary SRP module to a spare flash card. To do so:

1. Access Boot mode.

- a. From Privileged Exec mode, enter the reload command. Information about the reloading process is displayed.
- b. When the countdown begins, press the mb key sequence (case-insensitive).

This CLI enters Boot mode (:boot## prompt).

If you do not press the mb key sequence, the reloading process continues and returns the CLI to the normal User Exec mode.

2. Issue the **flash-disk duplicate** command.
3. Follow the instructions on the screen. When prompted, insert the original or spare flash card in the primary SRP module.

### **flash-disk duplicate**

- Use to copy the contents of the primary flash card to a spare flash card.
- The primary and spare flash cards must be from the same manufacturer and must have the same size.



**NOTE:** This command is available only in Boot mode.

---

- When you issue the **flash-disk duplicate** command, insert the original and spare flash cards when prompted. The router copies the flash card contents incrementally, so you may need to exchange the flash cards several times.
- Example

```
host1#halt primary-srp
host1#reload
WARNING: Execution of this command will cause the system to reboot.
Proceed with reload? [confirm]
Reload operation commencing, please wait...
[Press mb]
:boot##flash-disk duplicate
```

- There is no **no** version.
- See flash-disk duplicate.

## **Scanning Flash Cards**

You can find both structural errors in the data in NVS and physical errors in the flash card. You can also remove files with errors, and attempt to repair structural or physical errors.

### **check-disk**

- Use to find and repair structural inconsistencies and damage in the DOS file system in NVS on the primary SRP module.
- If the router contains primary and redundant modules, only NVS on the primary SRP module is scanned.



- On the E120 and E320 routers only, you can use this command to check and repair a second flash card installed as disk1. You can issue this command in Boot mode for either flash card. In Privileged Exec mode, you can use the **disk1** keyword to access the unmounted second flash card while the router is in an operational state.
- This command is available for disk1 in Privileged Exec mode only on SRP 320 modules. This command is not accepted for disk0 in Privileged Exec mode.
- Example

```
:boot## check-disk disk0
Copyright (c) 1993-1996 RST Software Industries Ltd. Israel. All rights
reserved
ver: 2.6 FCS
Disk Check In Progress ...
 total disk space (bytes) : 512,122,880
 bytes in each allocation unit : 8,192
 total allocation units on disk : 62,515
 bad allocation units : 1
 available bytes on disk : 120,651,776
 available clusters on disk : 14,728
 maximum available contiguous chain (bytes) : 120,651,776
 available space fragmentation (%) : 0
 clusters allocated : 47,786
Done Checking Disk.
```

- There is no **no** version.
- See check-disk.

### **flash-disk scan**

- Use to find and repair files with physical errors in NVS. These errors are created if the router is not powered down or reset correctly.
- If the router contains primary and redundant modules, only NVS on the primary SRP module is scanned.
- Use the **repair** keyword to fix nonfatal errors found on the disk. If the repair fails, the router no longer uses the corrupted areas.
- On the E120 and E320 routers only, you can use this command to find and repair files on a second flash card installed as disk1. You can issue this command in Boot mode for either flash card. In Privileged Exec mode, you can use the **disk1** keyword to access the unmounted second flash card while the router is in an operational state.
- This command is available for disk1 in Privileged Exec mode only on SRP 320 modules. This command is not accepted for disk0 in Privileged Exec mode.
- Example  
In this example, the user scans NVS and finds one file with an error. The user then issues the **flash-disk scan** with the **repair** keyword to remove the file. Finally, the user scans NVS again, and finds no files with errors.

```
:boot##flash-disk scan
Proceed with Flash disk scan? [confirm]
Srp PCMCIA Card Scan...
```

```

Boot Block OK
File Allocation Table OK
Root Directory OK
Checking File Space
Please Wait...
Checking Free Space
Please Wait...
PCMCIA Card Scan Detected Errors in:
\\images\ct1Diag\ct1Diag3c440e9e.cmp

```

PCMCIA Card Scan successful!

```

:boot##flash-disk scan repair
WARNING: Execution of this command may cause the contents of the Flash
disk to be modified.
Proceed with Flash disk scan? [confirm]
Srp PCMCIA Card Scan...
Boot Block OK
File Allocation Table OK
Root Directory OK
Checking File Space
Please Wait...
Checking Free Space
Please Wait...
PCMCIA Card Scan Removed:
\\images\ct1Diag\ct1Diag3c440e9e.cmp

```

PCMCIA Card Scan successful!

```

:boot##flash-disk scan
Proceed with Flash disk scan? [confirm]
Srp PCMCIA Card Scan...
Boot Block OK
File Allocation Table OK
Root Directory OK
Checking File Space
Please Wait...
Checking Free Space
Please Wait...
PCMCIA Card Scan successful!

```

- There is no **no** version.
- See flash-disk scan.

## Monitoring Flash Cards

Use the show nvs command to monitor the status of NVS on the primary SRP module.  
Use the show flash command to view information about the flash card.

### show flash

- Use to display information about the flash card.
- Field descriptions

- Active System Controller—Information for flash cards on the active SRP module
- disk0—Flash card installed in slot 0 of the SRP module
- disk1—Flash card installed in slot 1 of the SRP module; available only on SRP modules for the E120 and E320 routers
- Manufacturer—Name of manufacturer of the installed flash card
- Capacity—Total capacity of the flash card, in bytes
- Standby System Controller—Information for flash cards on the standby SRP module
- Example

host1#**show flash**

```

Active System Controller:

Device Manufacturer Capacity Status

disk0 SILICONSYSTEMS 1047126528 mounted
disk1 STI 1024966656 mounted

```

```

Standby System Controller:

Device Manufacturer Capacity Status

standby-disk0 SILICONSYSTEMS 1047674880 mounted
standby-disk1 SILICONSYSTEMS 1047674880 mounted

```

- See show flash.

### **show nvs**

- Use to monitor NVS status.
- Field descriptions
  - total nvs file sizes—Sum of sizes of all files in NVS, in bytes
  - total nvs file errors—Number of read and write errors in all files in NVS
  - nvs flash in use—NVS used, in bytes
  - available nvs flash—NVS available, in bytes
- Example

```

host1#show nvs
total nvs file sizes = 228864
total nvs file errors = 0
nvs flash in use = 1265152
available nvs flash = 35435008

```

- See show nvs.

## Updating the Router with JUNOS Hotfix Files

---

A JUNOS hotfix is a file or collection of files that you can apply to update an operational E-series router to address one or more specific, critical software issues. The hotfix can replace or add functionality to one or more software components. Hotfixes also enable the delivery of software updates without having to load an entire software release. Hotfixes can also deploy debugging code to collect data that facilitates troubleshooting of software issues.

Although most hotfixes can also be manually activated without reloading the router, some hotfixes cannot. You can configure any hotfix to be activated automatically when the router reloads.

A hotfix consists of a .hfx file and possibly other supporting files. The .hfx file manages the associated files in much the same way that a .rel file manages supporting files associated with a release image.

To use a hotfix, you must use the **copy** command to download the file from a network host to the router. You cannot copy the hotfix to an FTP file server. You can use file system commands such as **dir**, **rename**, and **delete** with the hotfix. After a hotfix is copied to the local flash card, it remains there until you explicitly delete it.

Hotfixes must be activated to take effect. A *startup* hotfix is automatically activated during system initialization. A *hot-patchable* hotfix does not require a reload to become active; it takes effect immediately if compatibilities and dependencies are correctly met. You can manually install hot-patchable hotfixes with the **hotfix activate** command. Hot-patchable hotfixes can also be configured to be activated as a startup hotfix.

Arming a hotfix prepares it for activation after a system reload. You can configure hotfixes in several ways with the **boot hotfix** and **hotfix activate** commands, as in the following examples:

- Activated immediately on an active router but not armed as a startup hotfix. In this case, the hotfix is activated only until the SRP module reloads. If the SRP module reloads, then you must manually activate the hotfix again (if desired) with the **hotfix activate** command.
- Activated immediately on an active router and armed as a startup hotfix. In this case the hotfix is automatically activated after every reload.
- Armed as a startup hotfix with the **boot hotfix** command but not immediately activated. In this case the hotfix is activated when the SRP module reloads.

When a system reloads with the backup settings specified by the **boot backup** command, no armed hotfixes are activated. The currently armed hotfix settings are retained in the event that the router reverts back to its normal boot settings.

### Hotfix Compatibility and Dependency

Hotfixes can have compatibility and dependency requirements. A given hotfix is compatible with one or more releases. It can be dependent on one or more other hotfixes being active. Compatibility and dependency requirements are stored as part of the hotfix. The requirements are enforced at the time of arming or activation. If

the software installed and active on the router does not match the requirements specified in the hotfix, then activation of the hotfix fails. Such a failure generates appropriate error and log messages.

The following restrictions can apply to a hotfix:

- **Dependency**—A hotfix that must be active or armed before another hotfix can be activated or armed.
- **Safe With**—A list of hotfixes with which another hotfix is compatible and can safely be concurrently armed or activated. This list applies only to hotfixes that have some patched functionality in common and are armed or activated concurrently.
- **Unsafe With**—A list of hotfixes with which another hotfix is not compatible and cannot safely be concurrently armed or activated. The CLI displays a warning message when you try to activate a hotfix that is unsafe with one or more active or armed hotfixes.
- **Manual Activate [Active / Standby] Srp**—The name of a binary flag that indicates whether manual activation of the hotfix is allowed on the active and standby SRP modules. When the flag is set to false, you cannot manually activate the hotfix; instead, the hotfix can only be activated as a startup hotfix. The CLI displays a warning message when you try to activate a hotfix that cannot be manually activated.
- **Manual Deactivate [Active / Standby] Srp**—The name of a binary flag that indicates whether manual deactivation of the hotfix is allowed on the active and standby SRP modules. When the flag is set to false, you cannot manually deactivate the hotfix. You must disarm the hotfix and reload the router. The CLI displays a warning message when you try to deactivate a hotfix that cannot be manually deactivated.
- **Line card requires reload**—The name of a binary flag that indicates whether line modules require a reload for the hotfix to become active on the module. The CLI displays a warning message if the line modules must be reloaded. If the warning is confirmed, the SRP module reloads each line module. The flag applies to all line modules targeted by the hotfix that are installed in the router.

Hotfixes remain armed only for compatible releases. If you change the armed release by issuing the **boot system** command, hotfixes that are not compatible with the new release are no longer armed. However, if you subsequently rearm a compatible release, the previously armed hotfixes for that release are automatically armed again.

## Removing Hotfixes

You can deactivate, disarm, and delete hotfixes from a router. When you deactivate a hotfix, any functionality that was added as part of the hotfix is automatically removed (even though the .hfx file remains on the router).

You cannot deactivate a hotfix that is a dependency for other hotfixes until you deactivate the dependent hotfixes. When a hotfix is no longer active, you can use the **delete** command to remove the hotfix file from the flash card.

## Hotfixes and Backup Settings

The **boot backup** command does not explicitly support hotfix files. When a system reloads with the backup settings specified by the **boot backup** command, no armed hotfixes are activated. However, the armed hotfix settings are retained in the event that the system reverts to its normal (nonbackup) boot settings. If that happens, these hotfixes are automatically rearmed and reactivated after a reload.

## Hotfixes and Standby SRP Modules

Hotfixes are supported in redundant SRP module configurations. Hotfix files are synchronized between the active and standby SRP modules by both automatic and manual synchronization. Hotfix activation restrictions are enforced identically on the active and standby SRP modules. A hotfix that is hot-patchable on the active module is hot-patchable on the standby module. A hotfix that requires startup activation on the active SRP module also requires startup activation on the standby SRP module.

Hotfixes are synchronized from the active SRP module to the standby SRP module. The standby SRP automatically activates the hotfixes that are armed as startup hotfixes. However, if the synchronization reveals that the set of active hotfixes on the standby SRP module is different from the set of armed hotfixes on the active SRP module, then the standby SRP module automatically reboots. This action causes the standby SRP module to activate the startup hotfixes. When you activate or arm a hotfix for startup activation, compatibility and dependency checks are performed independently on the active and standby SRP modules.

## Hotfixes and Line Modules

For line modules, a hotfix consists of one or more image fixes specific to a particular model of module or to a module type, depending on the fix. When a hotfix is activated, each image fix contained in the hotfix is activated on all applicable modules that are installed in the router. When existing line modules come online during startup and when new line modules are inserted in the chassis, image fixes for that particular line module are requested and activated during module startup.

Line module image hotfixes that have been armed as startup hotfixes are activated before application configuration occurs on the line module.

Only image fixes contained in hotfixes that are active on the primary SRP module can be activated on the line modules during startup. Hotfixes that are armed but not active on the primary SRP module are not activated on line modules.

A hotfix can contain a combination of image fixes. System controller (SC) and interface controller (IC) image fixes are cumulative and activated in the order in which they were armed. For forwarding controller (FC) image fixes, the last one armed is the only one applied.



**NOTE:** Because image fixes are activated in a particular order, we recommend that you create a list of any hotfixes that you are currently running or intend to run with a new FC image fix. JTAC can then provide you with the correct order of activation.

A hotfix cannot be partially activated on a router. If activation of any image hotfix fails on any corresponding module, the entire activation fails for all applicable line modules. Activation failure results in the generation of an appropriate log message. E-series routers do not support activation of a hotfix on a per-slot basis or a per-subsystem basis.

For example, suppose that a hotfix contains an image fix for the SRP module and the GE-2 line module. The SRP image fix is successfully activated on the SRP module, but the activation of the GE-2 image fix fails for some reason. In this case, the SRP module image fix is deactivated and no further attempts are made to activate the image fix on other GE-2 modules.

### **boot hotfix**

- Use to arm the specified hotfix as a startup hotfix that is automatically activated the next time the SRP module reboots.
- Arming fails if the specified hotfix depends on a hotfix that is not already armed. In this event, the CLI displays an error message similar to the following:

```
% The hotfix, 975, requires the following hotfixes to be armed:
990
```

- Arming fails if the hotfix is not compatible with the armed release. The CLI displays the following error message:
- When a router reverts to its backup boot settings, as specified by the **boot backup** command, no armed hotfixes are activated. The armed hotfix settings are retained in the event the router reverts back to its normal boot settings.
- Example

```
host1(config)#boot hotfix hf63037.hfx
```

- Use the **no** version to disarm a specified hotfix. You can disarm all hotfixes armed for all releases by specifying the **all-releases** keyword. If any startup hotfixes are armed, the CLI then prompts you to confirm the deletion,

If the hotfix being disarmed is a dependency for another armed hotfix, the command fails and the CLI displays an error message similar to the following:

```
The hotfix, 990, has the following armed dependents which must be disarmed
first:
975
```

```
% Disarming failed
```

When you disarm hotfixes that have dependencies, you must disarm them in the reverse sequence from which they were armed. However, if you have issued the **all-releases** keyword, the disarming automatically takes place in the correct order.

- See boot hotfix.

### **no boot hotfix all-releases**

- Use in Boot mode to disarm all armed hotfixes for all releases.
- Example

```
:boot##no boot hotfix all-releases
```

- There is no affirmative version of this command; there is only a **no** version.
- See no boot hotfix all-releases.

### **hotfix activate**

- Use to manually activate the specified hotfix.
- Each image fix contained in the hotfix is downloaded from the local flash card to the SRP module and any corresponding line module, and then activated on the modules.
- When a new line module is inserted in the router, all applicable image fixes are activated during initialization of the module. Activation is performed by the line module operational image before application configuration takes place on the module.
- An activation failure for any image fix on its corresponding line module causes the entire activation to fail. The image fix is then deactivated on any modules on which it was successfully activated.
- Activation fails if the specified hotfix is incompatible with the running release. In this event, an error message similar to the following is displayed:

```
% Hotfix is incompatible with running release.
```

- Activation fails if the specified hotfix depends on other hotfixes that have not been activated. The CLI displays an error message similar to the following:

```
The hotfix, 975, requires the following hotfixes to be activated:
990
```

```
% Activation failed
```

- Startup hotfixes cannot be manually activated. If you attempt to manually activate a startup hotfix, the operation fails and generates the following error message:

```
% Manual activation not allowed
```

- Example

```
host1#hotfix activate hf63037.hfx
```



- Use the **no** version to manually deactivate the specified hotfix. Deactivation restores the system to the state that existed before the hotfix was activated. You can specify the **all** keyword to deactivate all active hotfixes.

When you deactivate hotfixes that have dependencies, you must deactivate them in the reverse sequence from which they were armed. However, if you have issued the **all** keyword, the disarming automatically takes place in the correct order.

- See hotfix activate.

## Monitoring Hotfixes

Several commands provide information about hotfixes that have been loaded on the router. You can use the **show hotfix** command to discover the armed and activation status of all hotfixes or a specific hotfix. The output lists the hotfix by name and a unique ID number, which is useful if the filename has been changed. This command also displays dependencies for each hotfix; that is, other hotfixes that must be activated before that hotfix can be activated. For more usage details and sample output, see “show hotfix” on page 394.

The **dir** command displays all hotfixes present on the local flash card. The in use field indicates that the hotfix is either currently activated or armed to be activated as a startup hotfix for the currently armed release.

```
host1# dir
*** Active/standby file systems are not synchronized. ***
Active System Controller:
```

| file          | size      | unshared<br>size | date (UTC)          | in<br>use |
|---------------|-----------|------------------|---------------------|-----------|
| reboot.hty    | 596288    | 596288           | 03/07/2005 19:35:52 |           |
| system.log    | 6762      | 6762             | 03/07/2005 17:30:08 |           |
| haIpSetup.mac | 4874      | 4874             | 03/24/2004 10:02:08 |           |
| 6-0-1p0-5.rel | 148489185 | 148489185        | 02/28/2005 18:17:32 | !         |
| hf63035.hfx   | 30445     | 30445            | 03/07/2005 14:04:02 | !         |
| hf63030.hfx   | 28675     | 28675            | 03/05/2005 18:22:32 |           |
| ...           |           |                  |                     |           |

You can use the **show version** command to display a summary of each of the hotfixes currently activated on the system, including the hotfix name and hotfix ID.

```
host1#show version
Juniper Edge Routing Switch ERX-1400
Copyright (c) 1999-2005 Juniper Networks, Inc. All rights reserved.
System Release: 6-0-1p0-5.rel
 Version: 6.0.1 patch-0.5 (January 28, 2005 14:55)
 Active hotfixes:
 hf63036.hfx (Id: 1020)
 hf63037.hfx (Id: 1030)
System running for: 7 days, 3 hours, 55 minutes, 5 seconds
(since FRI FEB 04 2005 13:01:30 UTC)
```

The **show boot** command displays the current boot settings, including armed hotfixes that will be activated when the router reboots.

```
host1#show boot
```

```
System Release: 6-0-1p0-5.rel
 Armed Hotfixes: hf63035.hfx
 hf63036.hfx
 hf63037.hfx
System Configuration: running-configuration
```

The header of the **show configuration** command output includes the armed hotfix summary. You can issue the **show configuration system file-system** command to display the **boot hotfix** commands that restore the router to its current configuration when you issue the configuration script on a router configured with factory defaults.

Hotfixes that are active when you issue the **show configuration** command are not part of the command output or the resulting configuration script. Only armed hotfixes are part of the **show configuration** script.

```
host1#show configuration system file-system
! Configuration script being generated on TUE MAR 22 2005 16:43:41 UTC
! Juniper Edge Routing Switch ERX-1400
! Version: 6.0.1 patch-0.5 (January 28, 2005 14:55)
! Active hotfixes: hf63036.hfx (Id: 23453036)
! hf63037.hfx (Id: 34563037)
! Copyright (c) 1999-2005 Juniper Networks, Inc. All rights reserved.
!
! Commands displayed are limited to those available at privilege level 15
!
boot config running-configuration
boot system 6-0-1p0-5.rel
boot hotfix hf63036.hfx
boot hotfix hf63037.hfx
no boot backup
no boot subsystem
no boot backup subsystem
no boot force-backup
```

### **show hotfix**

- Use to display the name, ID, activation and arming status, and dependencies for all hotfixes or a specific hotfix available on the local file system.
- You can issue the **detail** keyword to additionally display a synopsis of the hotfix behavior. The detailed output for a specific hotfix also indicates compatible and incompatible hotfixes and lists modules affected by the hotfix.
- Field descriptions
  - name—Filename of the hotfix
  - id—Number uniquely identifying the hotfix; nonconfigurable so that you can identify the hotfix if the filename has been changed
  - active—Status of hotfix activation; X indicates that the hotfix is active
  - armed—Status of hotfix arming; X indicates that the hotfix is armed to be activated; only hotfixes armed for the currently armed release are displayed as armed

- requires—Hotfix ID number or numbers identifying hotfix dependencies, which are hotfixes that must be activated before this hotfix can be activated
- synopsis—Brief description of the functionality or behavior of the hotfix
- Description—More detailed description of the functionality or behavior of the hotfix
- Dependencies—Hotfix ID number or numbers identifying hotfix dependencies, which are hotfixes that must be activated before this hotfix can be activated
- Safe to repatch—Hotfix ID number or numbers of hotfixes that can be concurrently active with this hotfix; applies only to hotfixes that fix the same existing functionality
- Unsafe with—Hotfix ID number or numbers of hotfixes that are incompatible and cannot be activated at the same time as this hotfix
- Notes—Restrictions on manual activations or deactivations
- Example 1

host1#show hotfix

| name             | id   | active | armed | requires |
|------------------|------|--------|-------|----------|
| -----            | ---- | -----  | ----- | -----    |
| sleep.hfx        | 975  | X      | X     | 990      |
| clock.hfx        | 990  | X      | X     |          |
| showHotfix.hfx   | 2010 |        |       |          |
| incompatible.hfx | 410  |        |       |          |
| hfActivate.hfx   | 960  |        |       |          |

- Example 2—The **detail** keyword additionally displays a synopsis of the hotfix.

host1#show hotfix detail

| name             | id                                               | active | armed | requires |
|------------------|--------------------------------------------------|--------|-------|----------|
| -----            | ----                                             | -----  | ----- | -----    |
| sleep.hfx        | 975                                              | X      | X     | 990      |
| clock.hfx        | 990                                              | X      | X     |          |
| showHotfix.hfx   | 2010                                             |        |       |          |
| incompatible.hfx | 410                                              |        |       |          |
| hfActivate.hfx   | 960                                              |        |       |          |
| name             | synopsis                                         |        |       |          |
| -----            | -----                                            |        |       |          |
| sleep.hfx        | Modify the output of the sleep command.          |        |       |          |
| clock.hfx        | Modify the behavior of show clock.               |        |       |          |
| showHotfix.hfx   | Changes the output of show hotfix.               |        |       |          |
| incompatible.hfx | Changes the output of show hotfix.               |        |       |          |
| hfActivate.hfx   | Change log message severity for hotfix activate. |        |       |          |

- Example 3—The **detail** keyword for a particular hotfix displays the most detailed information.

```
host1#show hotfix clock.hfx detail
```

```
HotfixId: 990
```

```
Synopsis: Modify the behavior of show clock.
```

```
Active: Yes
```

```
Armed: Yes
```

```
Description: Changes the output of the show clock command.
```

```
Affected modules: SRP, GE, VTM
```

```
Dependencies:
```

```
Safe to repatch:
```

```
Unsafe with:
```

```
Notes:
```

```
1) This hotfix can only be activated when the active SRP reloads
```

```
2) Arming this hotfix will cause the standby SRP to reload
```

- See show hotfix.

## Example: Using and Monitoring Hotfixes

This example presents several aspects of hotfix use. In this example, 6-0-1p0-5.rel is the currently armed and active release. Hotfix hf63035.hfx is compatible with this release and is currently activated and armed as a startup hotfix.

```
host1# dir
```

```
Active System Controller:
```

| file          | size      | unshared<br>size | date (UTC)          | in<br>use |
|---------------|-----------|------------------|---------------------|-----------|
| reboot.hty    | 596288    | 596288           | 03/07/2005 19:35:52 |           |
| system.log    | 6762      | 6762             | 03/07/2005 17:30:08 |           |
| haIpSetup.mac | 4874      | 4874             | 03/24/2004 10:02:08 |           |
| 6-0-1p0-5.rel | 125987342 | 125987342        | 02/30/2005 18:17:32 | !         |
| 6-1-0.rel     | 148489185 | 148489185        | 02/28/2005 20:19:20 |           |
| hf63035.hfx   | 30445     | 30445            | 03/07/2005 14:04:02 | !         |
| hf63036.hfx   | 27445     | 27445            | 03/07/2005 16:12:05 |           |
| hf63037.hfx   | 28324     | 28324            | 03/07/2005 16:13:25 |           |

```
host1# show hotfix detail
```

| name        | id       | active | armed | requires |
|-------------|----------|--------|-------|----------|
| hf63035.hfx | 12343035 | X      | X     |          |
| hf63036.hfx | 23453036 |        |       |          |
| hf63037.hfx | 34563037 |        |       | 23453036 |

| name        | synopsis                                     |
|-------------|----------------------------------------------|
| hf63035.hfx | Fix for CQ63035, bgp crash, out of resources |
| hf63036.hfx | Fixed show version formatting issue          |

```
hf63037.hfx Increased max session limit on ERX310 to 32,000
```

```
host1(config)# boot hotfix hf63037.hfx
```

```
% The hotfix, 34563037, requires the following hotfix(es) to be armed:
23453036
```

The hf63036.hfx hotfix must be armed as a startup hotfix:

```
host1(config)# boot hotfix hf63036.hfx
```

This command succeeds because hf63036.hfx is compatible with the currently armed release, 6-1-0.rel, and has no dependencies on other hotfixes.

Now the attempt to arm hf63037.hfx succeeds because its dependency on hf63036.hfx has been met.

```
host1(config)# boot hotfix hf63037.hfx
```

Now suppose the user reloads the router:

```
host1# reload
```

As the router loads the armed release, 6-1-0.rel, the hotfix loader discovers three armed startup hotfixes, hf63035.hfx, hf63036.hfx, and hf63037.hfx. Only hf63036.hfx and hf63037.hfx are activated. Hotfix hf63035.hfx is disarmed because it is incompatible with the new running release. The router therefore becomes operational running 6-1-0.rel with hf63036.hfx and hf63037.hfx activated.

```
host1# dir
in
file size size date (UTC) use

reboot.hty 596288 596288 03/07/2005 19:35:52
system.log 6762 6762 03/07/2005 17:30:08
haIpSetup.mac 4874 4874 03/24/2004 10:02:08
6-0-1p0-5.rel 125987342 125987342 02/30/2005 18:17:32

6-1-0.rel 148489185 148489185 02/28/2005 20:19:20 !
hf63035.hfx 30445 30445 03/07/2005 14:04:02
hf63036.hfx 27445 27445 03/07/2005 16:12:05 !
hf63037.hfx 28324 28324 03/07/2005 16:13:25 !
host1#show hotfix
```

```
name active armed requires

hf63035.hfx
hf63036.hfx X X
hf63037.hfx X X 23453036
```

Now suppose the user attempts to deactivate hf63036.hfx:

```
host1#no hotfix activate hf63036.hfx
```

The hotfix, 23453036, has the following active dependents which must be deactivated

```

first:
34563037
% De-activation failed.

```

The command fails because hf63037.hfx is dependent on hf63036.hfx. Interdependent hotfixes must be deactivated and disarmed in the reverse order that they were activated.

When 6-0-1p0-5.rel is re-armed and the router reloaded, the hotfix loader determines that the startup hotfixes, hf63036.hfx and hf63037.hfx, are incompatible with the release. It disarms these hotfixes. The user decides to delete the now unnecessary hotfixes from the router.

```

host1# delete hf63036.hfx
host1# delete hf63037.hfx
host1# dir
Active System Controller:

```

| file          | size      | unshared<br>size | date (UTC)          | in<br>use |
|---------------|-----------|------------------|---------------------|-----------|
| reboot.hty    | 596288    | 596288           | 03/07/2005 19:35:52 | ---       |
| system.log    | 6762      | 6762             | 03/07/2005 17:30:08 |           |
| haIpSetup.mac | 4874      | 4874             | 03/24/2004 10:02:08 |           |
| 6-0-1p0-5.rel | 125987342 | 125987342        | 02/30/2005 18:17:32 | !         |
| 6-1-0.rel     | 148489185 | 148412851        | 02/28/2005 20:19:20 |           |
| hf63035.hfx   | 30445     | 30445            | 03/07/2005 14:04:02 | !         |

```

host1# show hotfix detail

```

| name        | active | armed | requires |
|-------------|--------|-------|----------|
| hf63035.hfx | X      | X     | ---      |

## Managing the Ethernet Port on the SRP Module

You can configure the Fast Ethernet management port to access the router from a Telnet session or SNMP.

On ERX-7xx models, ERX-14xx models, and ERX-310 routers, the Fast Ethernet port is located on the SRP I/O module. For more information about configuring the Fast Ethernet port on an SRP I/O module, see *ERX Hardware Guide, Chapter 7, Accessing ERX Routers*.

Use the Fast Ethernet port on the SRP I/O module only as a router management port. Do not use this port to route traffic for Fast Ethernet or higher-level protocols such as transport or routing protocols, because doing so affects the performance of the router.

On the E120 router and the E320 router, the Fast Ethernet port is located on the SRP IOA. For more information about configuring the Fast Ethernet port on an SRP IOA, see *E120 and E320 Hardware Guide, Chapter 7, Accessing E-Series Routers*.

### Interface fastEthernet

- Use to select a Fast Ethernet interface on a line module or an SRP module.
- On ERX-7xx models, ERX-14xx models, and the ERX-310 router, specify the Fast Ethernet interface management port by using the *slot/port* format.
- On the E120 and E320 routers, you can specify the Fast Ethernet port on the SRP IOA by using the *slot/adaptor/port* format. The port on the SRP IOA is always identified as 0.
- Example 1—Selects a Fast Ethernet management port on ERX-7xx models, ERX-14xx models, or the ERX-310 router

```
host1(config)#interface fastEthernet 0/0
```

- Example 2—Selects a Fast Ethernet management port on the E320 router

```
host1(config)#interface fastEthernet 6/0/0
```

- Use the **no** version to remove IP from an interface or subinterface.
- See interface fastEthernet.

## Monitoring Statistics

You can set a baseline and view statistics on the Fast Ethernet port of the SRP module in the same way that you would for other Ethernet interfaces. See *JUNOS Physical Layer Configuration Guide*.

## Monitoring the Ethernet Configuration for the SRP Module

Slots 0 and 1 are reserved for SRP modules on ERX-7xx models; slots 6 and 7 are reserved for SRP modules on ERX-14xx models, the E120 router, and the E320 router. When you configure the Fast Ethernet interface on an SRP module, the output of the **show configuration** command always indicates that the interface is configured in the lower of the two slots (slot 0 or slot 6). This indication is true if you configure the interface on a redundant SRP module in the higher slot or even if you have only one SRP module and it is installed in the higher slot, as shown in the following example:

```
host1#show version
Juniper Edge Routing Switch ERX-700
Copyright (c) 1999-2005 Juniper Networks, Inc. All rights reserved.
System Release: erx_7-1-0.rel Partial
Version: 7.1.0 [BuildId 4518] (December 21, 2005 11:23)
System running for: 25 days, 3 hours, 31 minutes, 5 seconds
(since THU DEC 22 2005 11:36:41 UTC)
```

| slot | state   | type       | admin   | spare | running release | slot uptime    |
|------|---------|------------|---------|-------|-----------------|----------------|
| 0    | standby | SRP-10Ge   | enabled | ---   | erx_7-1-0.rel   | ---            |
| 1    | online  | SRP-10Ge   | enabled | ---   | erx_7-1-0.rel   | 25d03h:28m:49s |
| 2    | ---     | ---        | ---     | ---   | ---             | ---            |
| 3    | ---     | ---        | ---     | ---   | ---             | ---            |
| 4    | online  | CT3-12     | enabled | ---   | erx_7-1-0.rel   | 25d03h:24m:46s |
| 5    | online  | OC3-4A-APS | enabled | ---   | erx_7-1-0.rel   | 25d03h:24m:22s |
| 6    | online  | GE         | enabled | ---   | erx_7-1-0.rel   | 25d03h:24m:44s |

```

host1#configure terminal
Enter configuration commands, one per line. End with ^Z.
host1(config)#interface fastethernet 0/0
host1(config-if)#ip address 10.6.130.83 255.255.128.0
host1(config-if)#exit
host1(config)#ip route 0.0.0.0 0.0.0.0 10.6.128.1
host1(config)#exit
host1#show config
! Configuration script being generated on TUE SEP 14 2004 13:22:06 UTC
! Juniper Edge Routing Switch ERX-700
! Version: 6.0.0 beta-1.8 [BuildId 2538] (September 7, 2004 12:46)
! Copyright (c) 1999-2004 Juniper Networks, Inc. All rights reserved.
!
! Commands displayed are limited to those available at privilege level 10
!
boot config running-configuration
boot system erx_6-0-0b1-8.rel
no boot backup
no boot subsystem
no boot backup subsystem
no boot force-backup
!
! Note: The following commands are here to ensure that all virtual routers and
! vrfs are created before other commands that may need to reference them.
! These commands will be repeated further on as each virtual router and vrf
! has its configuration presented.
!
virtual-router default
virtual-router vr8
!
!
hostname "host1"
exception protocol ftp anonymous null
!
controller t3 2/0
[...]
!
interface fastEthernet 0/0
ip address 10.6.130.83 255.255.128.0
!
ip route 0.0.0.0 0.0.0.0 10.6.128.1
! Trap Source: <not configured>
! Note: SNMP server not running.
!

```

## Enabling Warm Restart Diagnostics on Modules

---

You can enable the system to perform diagnostic tests on SRP modules and line modules when the specified module is warm restarted. The system performs all the diagnostic tests that normally run when the module is cold started.

SRP modules on all E-series routers support warm restart diagnostics. Table 44 on page 401 lists the line modules that support warm restart diagnostics.



**Table 44: Supported Line Modules**

| Line Module       |
|-------------------|
| cOCx FO           |
| CT3/T3-F0         |
| OCx/STMx ATM      |
| GE/FE             |
| GE-2              |
| GE-HDE            |
| OC3/STM1 GE/FE    |
| OC48              |
| ES2 4G LM         |
| ES2 10G Uplink LM |

The number of diagnostic tests that the system performs on line modules depends on whether you have configured line module redundancy. If you enable warm restart diagnostics on the spare line module when all other line modules are active, the system performs diagnostic tests on the spare line module including the spare I/O module.

Enabling warm restart diagnostics on a primary line module forces the line module to switch over to the spare line module.

To ensure complete diagnostic test coverage, we recommend that you disable line module redundancy using the **redundancy lockout** command before enabling warm restart diagnostics.

### Enabling Warm Restart Diagnostics

Use the **diag** command to enable warm restart diagnostics on a module.

#### **diag**

- Use to restart the specified SRP module or line module and enable the system to perform diagnostic tests on the module.
- Use the **force** keyword to enable the system to manually confirm conflicting conditions when the slot of the active SRP module is specified.
- If you specify a slot on the E120 router and the E320 router that contains an SRP module, you can use the *subsystem* variable to perform diagnostic tests on a subsystem on the SRP module. We recommend that you perform diagnostic tests on one subsystem at a time to avoid interrupting network traffic transmitting through the fabric modules.

- Use the **srp** keyword to perform diagnostic tests on the SC subsystem that resides on a specified SRP module.
- Use the **fabric** keyword to run diagnostic tests on the fabric slice that resides on the specified SRP module.
- Example 1—Enables warm restart diagnostics on a line module  

```
host1#diag 3 force
```
- Example 2—Enables warm restart diagnostics on the fabric subsystem of an active SRP module on the E320 router  

```
host1#diag 6 fabric
```
- There is no **no** version.
- See diag.

## Enabling Diagnostics

Use the **diag** command to enable warm restart diagnostics on a module. Use the **diag-level** command to set the diagnostics level on a module.

### diag-level

- Use to set the diagnostics level on the active or standby SRP module to reduce the boot time during a cold and a warm boot.
- Use the **normal** keyword (default) to execute full diagnostics on the boot of the line card.
- Use the **bypass** keyword to skip diagnostic tests on the boot of the line card.
- Example —Bypasses diagnostic tests  

```
host1#diag—level bypass
```
- There is no **no** version.
- See .

## Ignoring Diagnostic Test Failures

You can ignore diagnostic test failures on the line module or SRP. This enables you to categorize diagnostic failures and determine the impact on functional behavior.

To ignore diagnostic test failure on the line module or SRP:

1. Select the slot number of the slot that you want to ignore diagnostic test failure. This information is stored on the SRP and is independent of the hardware in the slot. You can reload a particular slot to boot the module to the operational image.

```
host1#slot ignore-diagnostic-failure 0
```

2. Issue the **show environment** command to check which line modules are configured to ignore diagnostics test failure.

```

host1#show environment
chassis: 14 slot (id 0x5, rev. 0x1)
fabric: 40 Gbps (rev. 0)
fans: fanSubsystem0k
nvs: ok (488MB flash disk, 43% full), matches running config
power: A ok, B not present
srp redundancy: mode is high-availability, state initializing
 auto-sync enabled, switch-on-error enabled
 sync in progress
slots: ok
 online: 0 6 12
 standby: 7
 empty: 1 2 3 4 5 8 9 10 11 13
 diagnostic failure is ignored on slot: 0
line redundancy: none
temperature: ok
timing: primary
 primary: internal SC oscillator (ok)
 secondary: internal SC oscillator (ok)
 tertiary: internal SC oscillator (ok)
 auto-upgrade enabled
system operational: yes

```

3. Issue the **no** version of the command to return to the default setting for the slot:

```

host1(config)# no slot ignore-diagnostic-failure 12

```

4. Issue the **show environment** command to check that the slot no longer ignores diagnostic test failures :

```

host1#show environment
chassis: 14 slot (id 0x5, rev. 0x1)
fabric: 40 Gbps (rev. 0)
fans: fanSubsystem0k
nvs: ok (488MB flash disk, 43% full), matches running config
power: A ok, B not present
srp redundancy: mode is high-availability, state initializing
 auto-sync enabled, switch-on-error enabled
 sync in progress
slots: ok
 online: 0 6 12
 standby: 7
 empty: 1 2 3 4 5 8 9 10 11 13
 diagnostic failure is ignored on slot: 0,6,7
line redundancy: none
temperature: ok
timing: primary
 primary: internal SC oscillator (ok)
 secondary: internal SC oscillator (ok)
 tertiary: internal SC oscillator (ok)
 auto-upgrade enabled
system operational: yes

```

If an SRP failure occurs when the router boots from the factory defaults or when your configuration is lost, you can ignore test failures from the boot menu:

1. From the boot prompt, issue the option **ignore-srp-diagnostic-results** command.

```
:boot##option ignore-srp-diagnostic-results
```

2. Verify that the setting is correct:

```
:boot##show options
no option auto-boot-disable
option countdown
no option debug-startup
no option halt-on-failure
no option bypass-diagnostics
no option stay-in-diagnostics
option ignore-srp-diagnostic-results
no option instruction-cache-disable
no option watchdog-disable
no option redirect-serial
no option diagnostics-burn-in
no option start-wdb
no option start-standby-wdb
no option assertions-in
no option memory-debug
no option disable-backpress
no option stl-debug
```

- Related Topics**
- slot ignore-diagnostic-failure command
  - show environment command

## Monitoring Modules

---

Use the following commands to view information about all router modules.

### **show hardware**

- Use to display information about SRP modules, line modules, and I/O modules in ERX-7xx models, ERX-14xx models, and the ERX-310 router.
- Use to display information about the chassis, SRP modules, SFMs, line modules, IOAs, and the fan tray in the E120 router and the E320 router.
- Field descriptions
  - slot—Physical slot that contains the module
  - type—Kind of module or chassis and fan tray in the E120 and E320 routers; an “e” at the end of an SRP module type (for example, SRP-5Ge) indicates that the module includes error-checking code (ECC) memory.
  - serial number—Serial number of the module, chassis, or fan tray
  - assembly number—Part number of the module, chassis, or fan tray
  - assembly rev.—Hardware revision of the module, chassis, or fan tray
  - ram (MB)—Memory capacity of the host processor

- number of MAC addresses—Total number of Ethernet addresses on an I/O module or an IOA
  - base MAC address—Lowest Ethernet address on an I/O module or an IOA
  - Tray—Number of the fan tray in the E120 and E320 routers; 0 indicates the primary fan
  - Major/Minor rev—Revision number of the module on the E120 and E320 routers
- Example 1—Displays the status of hardware on an ERX-7xx model

```

host1#show hardware

```

| slot | type             | serial<br>number | assembly<br>number | assembly<br>rev. | ram<br>(MB) |
|------|------------------|------------------|--------------------|------------------|-------------|
| 0    | SRP-10Ge         | 4305358981       | 3500005472         | A06              | 2048        |
| 1    | SRP-10Ge         | 4305359020       | 3500005472         | A06              | 2048        |
| 2    | ---              | ---              | ---                | ---              | ---         |
| 3    | ---              | ---              | ---                | ---              | ---         |
| 4    | CT3-12           | 4305337201       | 3500010901         | A07              | 128         |
| 5    | OC3/OC12/DS3-ATM | 4605300290       | 3500103958         | A06              | 256         |
| 6    | GE/FE            | 4605340294       | 3500104554         | A08              | 256         |

| slot | type          | serial<br>number | assembly<br>number | assembly<br>rev. | number<br>of<br>MAC<br>addresses |
|------|---------------|------------------|--------------------|------------------|----------------------------------|
| 0    | ---           | ---              | ---                | ---              | ---                              |
| 1    | SRP-10Ge I/O  | 4605250426       | 3500003302         | A02              | 1                                |
| 2    | ---           | ---              | ---                | ---              | ---                              |
| 3    | ---           | ---              | ---                | ---              | ---                              |
| 4    | CT3/T3-12 I/O | 4305316605       | 3500010801         | A02              |                                  |
| 5    | OC3(8)-MM I/O | 4304443600       | 4500001501         | A03              | 4                                |
| 6    | GE-SFP I/O    | 4605310064       | 4500002001         | A05              | 1                                |

| slot | base<br>MAC address |
|------|---------------------|
| 0    | ---                 |
| 1    | 0090.1aa0.577a      |
| 2    | ---                 |
| 3    | ---                 |
| 4    |                     |
| 5    | 0090.1a41.7c68      |
| 6    | 0090.1aa0.6216      |

- Example 2—Displays the status of hardware on the E320 router

```

host1#show hardware

```

| Chassis |                  |                    |                  |                    |
|---------|------------------|--------------------|------------------|--------------------|
| type    | serial<br>number | assembly<br>number | assembly<br>rev. | Major/Minor<br>rev |
| Chassis | 5504200687       | 4400006402         | 01               | 0.101              |

| Modules |         |               |                 |               |          |               |
|---------|---------|---------------|-----------------|---------------|----------|---------------|
| slot    | type    | serial number | assembly number | assembly rev. | ram (MB) | Major/Min rev |
| 0       | ---     | ---           | ---             | ---           | ---      | ---           |
| 1       | ---     | ---           | ---             | ---           | ---      | ---           |
| 2       | LM-4    | 4303470363    | 4500006301      | 01            | 256      | 1.101         |
| 3       | ---     | ---           | ---             | ---           | ---      | ---           |
| 4       | ---     | ---           | ---             | ---           | ---      | ---           |
| 5       | ---     | ---           | ---             | ---           | ---      | ---           |
| 6       | ---     | ---           | ---             | ---           | ---      | ---           |
| 6       | ---     | ---           | ---             | ---           | ---      | ---           |
| 7       | SRP-100 | 4304218323    | 4500006601      | 03            | 1024     | 1.103         |
| 7       | SFM-100 | 4304218323    | 4500006601      | 03            | ---      | 1.103         |
| 8       | SFM-100 | 4304206756    | 4500006701      | 04            | ---      | 1.104         |
| 9       | SFM-100 | 4304206762    | 4500006701      | 04            | ---      | 1.104         |
| 10      | SFM-100 | 4304206737    | 4500006701      | 04            | ---      | 1.104         |
| 11      | ---     | ---           | ---             | ---           | ---      | ---           |
| 12      | ---     | ---           | ---             | ---           | ---      | ---           |
| 13      | ---     | ---           | ---             | ---           | ---      | ---           |
| 14      | ---     | ---           | ---             | ---           | ---      | ---           |
| 15      | ---     | ---           | ---             | ---           | ---      | ---           |
| 16      | ---     | ---           | ---             | ---           | ---      | ---           |

| Adapters |                  |                 |                 |               |                         |
|----------|------------------|-----------------|-----------------|---------------|-------------------------|
| slot     | type             | serial number   | assembly number | assembly rev. | number of MAC addresses |
| 0/0      | ---              | ---             | ---             | ---           | ---                     |
| 0/1      | ---              | ---             | ---             | ---           | ---                     |
| 1/0      | ---              | ---             | ---             | ---           | ---                     |
| 1/1      | ---              | ---             | ---             | ---           | ---                     |
| 2/0      | GE-4 IOA         | 4304020462      | 4500006800      | 11            | 4                       |
| 2/1      | ---              | ---             | ---             | ---           | ---                     |
| 3/0      | ---              | ---             | ---             | ---           | ---                     |
| 3/1      | ---              | ---             | ---             | ---           | ---                     |
| 4/0      | ---              | ---             | ---             | ---           | ---                     |
| 4/1      | ---              | ---             | ---             | ---           | ---                     |
| 5/0      | ---              | ---             | ---             | ---           | ---                     |
| 5/1      | ---              | ---             | ---             | ---           | ---                     |
| 7/0      | SRP IOA          | 4303470366      | 4500006500      | 02            | 2                       |
| 11/0     | ---              | ---             | ---             | ---           | ---                     |
| 11/1     | ---              | ---             | ---             | ---           | ---                     |
| 12/0     | ---              | ---             | ---             | ---           | ---                     |
| 12/1     | ---              | ---             | ---             | ---           | ---                     |
| 13/0     | ---              | ---             | ---             | ---           | ---                     |
| 13/1     | ---              | ---             | ---             | ---           | ---                     |
| 14/0     | ---              | ---             | ---             | ---           | ---                     |
| 14/1     | ---              | ---             | ---             | ---           | ---                     |
| 15/0     | ---              | ---             | ---             | ---           | ---                     |
| 15/1     | ---              | ---             | ---             | ---           | ---                     |
| 16/0     | ---              | ---             | ---             | ---           | ---                     |
| 16/1     | ---              | ---             | ---             | ---           | ---                     |
| slot     | base MAC address | Major/Minor rev |                 |               |                         |
| 0/0      | ---              | ---             |                 |               |                         |

```

0/1 --- ---
1/0 --- ---
1/1 --- ---
2/0 0090.1a00.17ec 1.111
2/1 --- ---
3/0 --- ---
3/1 --- ---
4/0 --- ---
4/1 --- ---
5/0 --- ---
5/1 --- ---
7/0 0090.1a00.17ae 1.102
11/0 --- ---
11/1 --- ---
12/0 --- ---
12/1 --- ---
13/0 --- ---
13/1 --- ---
14/0 --- ---
14/1 --- ---
15/0 --- ---
15/1 --- ---
16/0 --- ---
16/1 --- ---

```

```

 Fan(s)

Tray type serial assembly assembly Major/Minor
----- --- number number rev. rev
0 Primary FAN 4303370009 4400007000 01 1.101

```

- Example 3—Displays the status of hardware on the E120 router

```
host1#show hardware
```

```

 Chassis

type serial assembly assembly Major/Minor
----- number number rev. rev
Chassis 4307018011 4580002602 01 0.101

 Modules

slot type serial assembly assembly ram Major/Minor
----- --- number number rev. (MB) rev
0 --- --- --- --- --- ---
1 LM-10 4306493492 4500009501 08 1024 1.108
2 LM-10 4306493502 4500009501 08 1024 1.108
3 --- --- --- --- --- ---
4 --- --- --- --- --- ---
5 --- --- --- --- --- ---
6 SRP-120 4306483377 4501008401 02 4096 1.102
6 SFM-120 4306483377 4501008401 02 --- 1.102
7 SRP-120 4306483378 4501008401 02 4096 1.102
7 SFM-120 4306483378 4501008401 02 --- 1.102
8 SFM-120 4306493692 4501008501 02 --- 1.102

```

|    |         |            |            |    |     |       |
|----|---------|------------|------------|----|-----|-------|
| 9  | SFM-120 | 4306493725 | 4501008501 | 02 | --- | 1.102 |
| 10 | SFM-120 | 4306493734 | 4501008501 | 02 | --- | 1.102 |

## Adapters

| slot | type     | serial number | assembly number | assembly rev. | number of MAC addresses |
|------|----------|---------------|-----------------|---------------|-------------------------|
| 0/0  | ---      | ---           | ---             | ---           | ---                     |
| 0/1  | ---      | ---           | ---             | ---           | ---                     |
| 1/0  | ---      | ---           | ---             | ---           | ---                     |
| 1/1  | GE-8 IOA | 4306472048    | 4500009102      | A04           | 8                       |
| 2/0  | ---      | ---           | ---             | ---           | ---                     |
| 2/1  | GE-8 IOA | 4306362247    | 4500009102      | A03           | 8                       |
| 3/0  | ---      | ---           | ---             | ---           | ---                     |
| 3/1  | ---      | ---           | ---             | ---           | ---                     |
| 4/0  | ---      | ---           | ---             | ---           | ---                     |
| 4/1  | ---      | ---           | ---             | ---           | ---                     |
| 5/0  | ---      | ---           | ---             | ---           | ---                     |
| 5/1  | ---      | ---           | ---             | ---           | ---                     |
| 6/0  | SRP IOA  | 4306483232    | 4501006502      | A00           | 2                       |

| slot | base MAC address | Major/Minor rev |
|------|------------------|-----------------|
| 0/0  | ---              | ---             |
| 0/1  | ---              | ---             |
| 1/0  | ---              | ---             |
| 1/1  | 0090.1a42.7327   | 2.4             |
| 2/0  | ---              | ---             |
| 2/1  | 0090.1a42.5223   | 2.3             |
| 3/0  | ---              | ---             |
| 3/1  | ---              | ---             |
| 4/0  | ---              | ---             |
| 4/1  | ---              | ---             |
| 5/0  | ---              | ---             |
| 5/1  | ---              | ---             |
| 6/0  | 0090.1a42.76c4   | 2.0             |

## Fan(s)

| Tray | type        | serial number | assembly number | assembly rev. | Major/Minor rev |
|------|-------------|---------------|-----------------|---------------|-----------------|
| 0    | Primary FAN | 4306505285    | 4400010001      | 01            | 1.101           |

- See show hardware.

**show utilization**

- Use to display information about the resources that modules consume.
- When you issue this command, the router releases available memory on the SRP module immediately; however, the display appears a few seconds later.
- To display detailed information about the average CPU utilization percentage calculated over 5-second, 1-minute, and 5-minute intervals for each module installed in the router, use the **detail** keyword.
- Field descriptions



- slot—Slot in which the module resides
- type—Type of module
- heap (%)—Percentage of the RAM that is currently in use by software running on the module
- cpu (%)—Percentage of the module CPU capacity currently used; this field appears only when the **detail** keyword is omitted
- bw exceed—Status of bandwidth oversubscription for this slot; this field appears only when bandwidth oversubscription is configured
  - Y indicates that this slot is in an oversubscribed slot group
  - --- indicates that no module is installed or slot has no bandwidth oversubscription
- The following additional fields appear when the **detail** keyword is used:
  - last available cpu (%)—Average CPU utilization percentage for each installed module during the last 5-second interval for which data was available. If the current CPU utilization data for a module is *not* available at any point, the last available cpu (%) field displays the last available 5-second CPU utilization percentage, which is the same value that appears in the cpu (%) field when the **detail** keyword is omitted. If the current 5-second CPU utilization data is available, the last available cpu (%) field and the 5 sec cpu (%) field display the same value.
  - 5 sec cpu (%)—Average CPU utilization percentage for each installed module during the most recent 5-second interval
  - 1 min cpu (%)—Average CPU utilization percentage for each installed module during the most recent 1-minute interval
  - 5 min cpu (%)—Average CPU utilization percentage for each installed module during the most recent 5-minute interval
- Depending on the output of the **show utilization** command when you use the **detail** keyword, some or all of the following symbols and explanatory notes might appear:
  - --- indicates an empty slot on ERX-7xx models, ERX-14xx models, or the ERX-310 router. For the E120 and E320 routers, this symbol indicates either an empty slot, or a fabric slice that resides on an SRP module or on a switch fabric module (SFM).
  - ??? indicates that the current CPU utilization data is unavailable for the specified interval. Data might be unavailable for one or more of the following reasons:
    - A slot is in an inactive state.
    - A line module is very busy (that is, using 100 percent of its CPU capacity) and is unable to send its CPU utilization data to the SRP module.
    - A line module is experiencing communication problems that prevent it from sending its CPU utilization data to the SRP module.

- \*\*\* indicates that a module installed in the slot is running an incompatible version of JUNOS software.
- Example 1—Displays basic information about the resources consumed on the router

```

host1#show utilization
Please wait....
 System Resource Utilization

slot type heap cpu bw

0 --- --- --- ---
1 OC12Atm(P2) 59 44 Y
2 OC3/OC12-ATM 67 53 Y
3 --- --- --- ---
4 --- --- --- ---
5 OC3d 79 0 ---
6 SRP-10G 27 1 ---
7 --- --- --- ---
8 --- --- --- ---
9 --- --- --- ---
10 --- --- --- ---
11 --- --- --- ---
12 --- --- --- ---
13 --- --- --- ---

```

- Example 2—Displays detailed information about the average CPU utilization percentage calculated over 5-second, 1-minute, and 5-minute intervals for each module installed in an ERX-7xx model, ERX-14xx model, or ERX-310 router

In this example, slot 12 is empty (as indicated by the --- symbol), the CPU utilization for the FE-8 module installed in slot 10 is unavailable (as indicated by the ??? symbol), and the SRP module installed in slot 7 is running an incompatible version of JUNOS software (as indicated by the \*\*\* symbol).

```

host1#show utilization detail
Please wait...
 System Resource Utilization

slot type heap last bw 5 1 5

slot type (%) available exceed sec min min
 cpu (%)
0 OC3-4A 63 76 --- 76 70 71
1 COC3/COC12 11 2 --- 2 4 3
2 COC3-4 39 11 --- 11 17 20
3 OC3-4A 58 61 --- ??? ??? 68
4 OC3-4A 88 100 --- 100 96 92
5 OC3-4A 94 100 --- 100 93 87
6 SRP-40G+ 11 84 --- 84 85 73
7 SRP-40G+ 18 29 --- *** *** ***
8 OC3-4P 25 20 --- 20 17 22
9 FE-8 61 48 --- 48 53 47
10 FE-8 ??? ??? --- ??? ??? ???
11 CT3-12 11 2 --- 2 4 10

```

```

12 --- --- --- --- --- ---
13 CT3-12 32 16 --- 16 12 16

```

Note: '---' indicates empty slots.  
 '???' indicates data not available.  
 '\*\*\*' indicates board running incompatible version of software.

- Example 3—Displays detailed information about the average CPU utilization percentage calculated over 5-second, 1-minute, and 5-minute intervals for each module installed in an E320 router.

In this example, slots 3, 5, 12, 14, and 16 are empty (as indicated by the --- symbol), fabric slices are present on the SFM-100 modules in slots 8, 9, and 10 (also indicated by the --- symbol), the CPU utilization for the LM-4 module installed in slot 1 is unavailable (as indicated by the ??? symbol), and the SRP-100 module installed in slot 7 is running an incompatible version of JUNOS software (as indicated by the \*\*\* symbol).

```
host1#show utilization detail
```

```
Please wait...
```

```

 System Resource Utilization

 last
 available
 cpu (%)

slot type heap bw 5 1 5
 (%) exceed sec min min
 (%) (%) (%) (%) (%)

0 LM-4 9 1 --- 1 1 1
1 LM-4 ??? ??? --- ??? ??? ???
2 LM-4 23 3 --- ??? 4 8
3 --- --- --- --- --- --- ---
4 LM-4 60 1 --- 1 1 1
5 --- --- --- --- --- --- ---
6 SRP-100 15 3 --- 3 2 3
7 SRP-100 10 1 --- *** *** ***
8 SFM-100 --- --- --- --- --- ---
9 SFM-100 --- --- --- --- --- ---
10 SFM-100 --- --- --- --- --- ---
11 LM-4 60 1 --- 1 1 1
12 --- --- --- --- --- --- ---
13 LM-4 68 3 --- 3 3 3
14 --- --- --- --- --- --- ---
15 LM-4 66 1 --- 1 1 1
16 --- --- --- --- --- --- ---

```

Note: '---' indicates empty slots or fabric Slices.  
 '???' indicates data not available.  
 '\*\*\*' indicates board running incompatible version of software.

- See show utilization.



## Chapter 7

# Managing High Availability

This chapter describes how to manage Juniper Networks high availability (HA) software features for the E-series router. Use this chapter with “Managing Modules” on page 335 to fully manage the SRP and high availability features.

This chapter contains the following sections:

- Understanding High Availability on page 413
- Platform Considerations on page 414
- Redundancy Modes of Operation on page 414
- Understanding SRP State Behavior on page 416
- Application Support on page 419
- Before Activating High Availability on page 426
- Activating High Availability on page 426
- Deactivating High Availability on page 427
- Upgrading Software on page 428
- Monitoring High Availability on page 429

## Understanding High Availability

---

High availability is the idea of reducing or eliminating single points of failure. When applied to the E-series router, high availability provides both hardware-specific and software-specific methods to ensure minimal downtime and ultimately improve the performance of your network.

For hardware components, Juniper Networks provides redundancy solutions to ensure that the router continues to operate in the event of a hardware fault. This redundancy can exist on various router models in the form of multiple power supplies, cooling fans, switching planes, routing engines and, in some cases, interfaces. Redundancy also allows for hot-swapping various components within your Juniper Networks router.



**NOTE:** For information about E-series hardware redundancy features, see the *ERX Hardware Guide* or the *E120 and E320 Hardware Guide*.

---

## Platform Considerations

High availability is supported on all E-series routers except for the ERX-310 router.

For information about the modules supported on E-series routers:

- See the *ERX Module Guide* for modules supported on ERX-7xx models and ERX-14xx models.
- See the *E120 and E320 Module Guide* for modules supported on the E120 router and the E320 router.

## Module Requirements

The following table lists which SRPs support or do not support the high availability mode (stateful SRP switchover) feature.

| SRP Model    | Supported |
|--------------|-----------|
| SRP-5G       | No        |
| SRP-5G +     | Yes       |
| SRP-10G      | Yes       |
| SRP-40G      | No        |
| SRP-40G PLUS | Yes       |
| SRP-100      | Yes       |



**NOTE:** High availability requires two SRP modules with 1 GB of memory or more.

## Redundancy Modes of Operation

The switch route processor (SRP) modules can operate in one of two redundancy modes—file system synchronization and high availability.

### File System Synchronization Mode

File system synchronization is the default behavior mode for E-series routers that contain redundant SRPs. Available only to SRP modules, this mode has been available since the 2.x release. In this mode:

- Files and data (for example, configuration files and releases) in nonvolatile storage (NVS) remain synchronized between the primary and standby SRP modules.
- SRP modules will reload all line modules and restart from saved configuration files.

- If the active SRP module switches over to the standby SRP, the router cold-restarts as follows:
  - All line modules are reloaded.
  - User connections are lost, and forwarding through the chassis stops until the router SRP module recovers.
  - The standby SRP module boots from the last known good configuration from NVS.

For additional information about the default SRP functionality, see “Managing Modules” on page 335.

## High Availability Mode

Currently applicable to the SRP module, the Juniper Networks high availability mode uses an initial bulk file transfer and subsequent, transaction-based mirroring to ensure rapid SRP module recovery after a switchover. This process is referred to in this chapter as *stateful SRP switchover*.

In addition to keeping the contents of NVS, high availability mode keeps state and dynamic configuration data from the SRP memory synchronized between the primary and standby SRP modules.

When stateful SRP switchover is enabled, an SRP switchover keeps line modules up and forwarding data, and the newly active SRP module continues from the point of switchover.

By using transaction-based mirroring instead of file synchronization, high availability mode keeps the standby SRP module synchronized with the active SRP module. Mirroring occurs from memory on the active SRP module to memory on the standby SRP module by way of transactions. When a transaction is committed on the active SRP module, the data associated with the transaction is sent to the standby SRP module.

In high availability mode:

- The contents of the NVS in the primary and standby SRP modules remain synchronized.



**NOTE:** Configuration files are always synchronized. Nonconfiguration files are synchronized when the **disable-autosync** command has not been configured; this is the default case. When the **disable-autosync** command has been configured, nonconfiguration files are not synchronized.

---

- If a switchover occurs:
  - The standby SRP module warm-restarts using the mirrored data to restore itself to the state of the system before the switchover.
  - During the warm restart:

- User connections remain active, and forwarding continues through the chassis.
- New user connection attempts during switchover are denied until switchover is complete.
- New configuration changes are prevented until switchover is complete (or after 5 minutes).

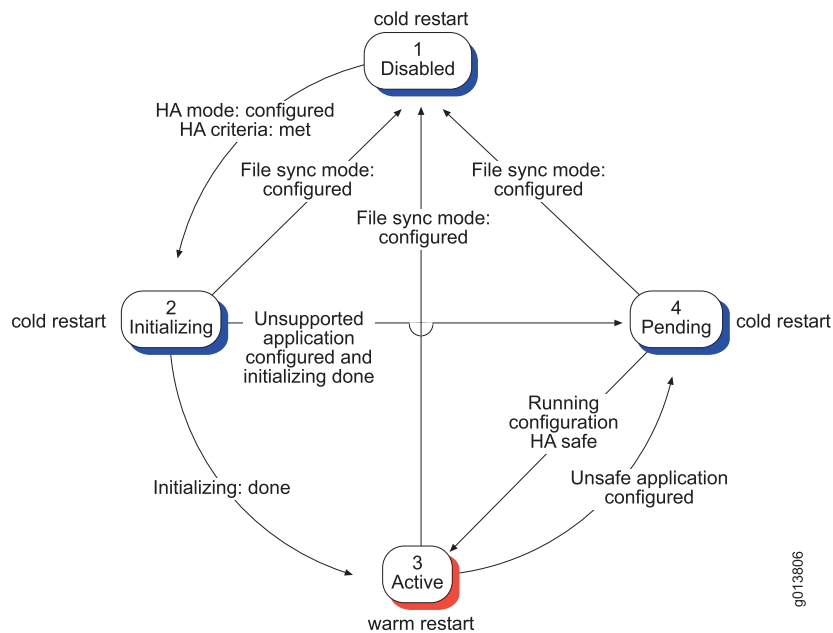


**NOTE:** If the switchover does not finish within 5 minutes, the SRP module cancels the operation and reenables CLI configuration.

## Understanding SRP State Behavior

The SRP progresses through various high availability states. These states are illustrated in Figure 27 on page 416.

**Figure 27: High Availability States**



### Disabled State

The initial, default state for high availability mode is disabled. While in this state, the router continues to use file system synchronization. If a switchover occurs while the router is in this state, the standby SRP module performs a cold restart.

The router enters this state when you power up the router or when the router warm-restarts from an SRP switchover.



Once you enable high availability, the system must meet the following criteria before it can enter the initializing state:

- High availability mode is configured.
- Active SRP hardware supports high availability.
- Network core dump feature is disabled.
- Running configuration will allow high availability to operate (that is, no unsupported applications are configured).
- Standby SRP hardware supports high availability.
- Standby SRP module is online and capable of mirroring.
- Standby SRP module is running the same release.

During the disabled state:

- If any one criterion is not met, the system remains in the disabled state, until the criterion is met.
- If a switchover occurs while the system is in the disabled state, the system cold-restarts.

While in the disabled state, the system operates as if it were configured for file system synchronization (for example, NVS is synchronized every 5 minutes, if autosynchronization is enabled).

If all criteria are met, high availability mode transitions to the initialization state.

## Initializing State

After the SRP module transitions into the initializing state, bulk synchronization of the memory and NVS occurs. This includes the following:

- File synchronization of the primary NVS with the standby NVS
- Mirroring of appropriate state and dynamic configuration information from the active SRP (memory) to the standby SRP (memory)



**NOTE:** Depending on the size of the configuration, this process can take several minutes.

---

During the initializing state:

- If an unsupported application is configured during initialization, the system completes initializing and enters the pending state.
- If any other criterion becomes false (or is no longer met), the system enters the disabled state.
- If a switchover occurs while the system is in this state, the system cold-restarts.

Once initialization is completed, the system enters the active state.

## Active State

During the active state, the data that was synchronized from the active SRP module to the standby SRP module during initialization remains synchronized through mirroring updates.

Mirroring updates occur as follows:

1. When making changes or updates, applications create individual transactions, perform the updates on the active SRP module, and post the transactions.
2. Following the updates, the active SRP module sends the changes to the standby SRP module.
3. The standby SRP module replays the updates (in the order in which they were committed on the active SRP module) and makes the appropriate changes for each changed application.
4. Updates that need to be stored in NVS (that is, for static configurations) are updated in NVS.



**NOTE:** While in the active and pending states, the CLI **synchronize** command does not update configuration files; these files are updated by the mirroring process.

---

During the active state:

- If a switchover occurs while the router is in the active state, the standby SRP module performs a warm restart (that is, stateful SRP switchover is in effect); the standby SRP module uses the configuration located in NVS.
- If an unsupported application is configured, the system transitions to the pending state.
- If any other criterion changes (is no longer met), the system transitions to the disabled state.



**NOTE:** Changes made in manual commit mode are maintained, uncommitted, in the standby SRP memory until a trigger to commit occurs; if a switchover occurs while in this mode, the standby SRP module uses the configuration in memory.

---

## Pending State

The system transitions to the pending state if an unsupported application is configured. When a transition to the pending state occurs, the system generates SNMP traps and log messages.

How the router behaves depends on which HA state the application is in when it shifts to a pending state:

- From disabled state—The router remains in the disabled state.
- From initializing state—The router completes the initializing state and transitions to the pending state after initialization is complete.
- Active State—The router transitions to the pending state.

The system remains in the pending state until the configuration of the unsupported application is removed. However, even though it is in the pending state, the system continues mirroring updates from the primary SRP module to the standby SRP module.



**NOTE:** You can use the **show redundancy srp** command to display the name of any unsupported applications that are configured.

If a switchover occurs while the system is in the pending state, the system cold-restarts.

## Application Support

Applications are either supported or unsupported by high availability.

- Supported—You can configure supported applications without having any adverse impact to high availability. When a switchover occurs, supported applications can react to switchovers in one of two different ways:
  - Gracefully recover using mirrored static and dynamic information (for example, IP, PPP, and PPPoE)
  - Recover using static configuration only; that is, no runtime state is restored after a switchover. Dynamic configuration and state information are lost. (For example, CLI sessions are restarted, telnet sessions are dropped, multicast routes must be rebuilt, and so on.)
- Unsupported—We recommend that you not configure unsupported applications on a chassis running in high availability mode. Although configured unsupported applications suspend high availability or prevent high availability from becoming active, they do not cause any problems with the function of the router.

Table 45 on page 419 indicates which applications support or do not support stateful SRP switchover.

**Table 45: Application Support for Stateful SRP Switchover**

| Application                     | Supported | Unsupported | Notes |
|---------------------------------|-----------|-------------|-------|
| <b>Physical Layer Protocols</b> |           |             |       |
| DS1                             | ✓         | –           | –     |
| DS3                             | ✓         | –           | –     |

**Table 45: Application Support for Stateful SRP Switchover** (continued)

| Application                                       | Supported | Unsupported | Notes                                                                                                                                                                                                                                                               |
|---------------------------------------------------|-----------|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| HDLC                                              | ✓         | –           | –                                                                                                                                                                                                                                                                   |
| SONET/SDH                                         | ✓         | –           | –                                                                                                                                                                                                                                                                   |
| SONET/SDH VT                                      | ✓         | –           | –                                                                                                                                                                                                                                                                   |
| <b>Link-Layer Protocols</b>                       |           |             |                                                                                                                                                                                                                                                                     |
| ATM                                               | ✓         | –           | Static and dynamic interfaces, with the exception of ATM subscribers, are supported.<br><br>In this case, <i>ATM subscribers</i> refers to a technology on the E-series router where the ATM layer does authentication (that is, not PPP or IP subscriber manager). |
| ATM 1483 bulk configuration of dynamic interfaces | ✓         | –           | –                                                                                                                                                                                                                                                                   |
| Bridged Ethernet                                  | ✓         | –           | –                                                                                                                                                                                                                                                                   |
| Cisco HDLC                                        | ✓         | –           | –                                                                                                                                                                                                                                                                   |
| Ethernet (with and without VLANs)                 | ✓         | –           | –                                                                                                                                                                                                                                                                   |
| Frame Relay                                       | ✓         | –           | –                                                                                                                                                                                                                                                                   |
| PPP                                               | ✓         | –           | –                                                                                                                                                                                                                                                                   |
| PPPoE                                             | ✓         | –           | –                                                                                                                                                                                                                                                                   |
| Transparent bridging                              | ✓         | –           | –                                                                                                                                                                                                                                                                   |
| <b>Unicast Routing</b>                            |           |             |                                                                                                                                                                                                                                                                     |
| Access Routes                                     | ✓         | –           | –                                                                                                                                                                                                                                                                   |
| BGP                                               | ✓         | –           | Supported for IPv4 only when the graceful restart extension is enabled. Does not support graceful restart for IPv6 address families.                                                                                                                                |
| FTP                                               | ✓         | –           | Static recovery support only.                                                                                                                                                                                                                                       |
| IP                                                | ✓         | –           | –                                                                                                                                                                                                                                                                   |
| IPv6                                              | ✓         | –           | –                                                                                                                                                                                                                                                                   |

**Table 45: Application Support for Stateful SRP Switchover** *(continued)*

| Application                   | Supported | Unsupported | Notes                                                                                                                                                                                                                                                                                                                                                   |
|-------------------------------|-----------|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| IPv6 neighbor discovery       | ✓         | –           | IPv6 neighbor discovery characteristics are replayed during switchover. Line modules do not flush neighbor discovery information during the switchover.                                                                                                                                                                                                 |
| IPSec Transport               | –         | ✓           | –                                                                                                                                                                                                                                                                                                                                                       |
| IPSec Tunnels                 | ✓         | –           | Completed IKE phase 1 and phase 2 negotiations supported only.                                                                                                                                                                                                                                                                                          |
| IS-IS                         | ✓         | –           | Supported only when the graceful restart extension is enabled.                                                                                                                                                                                                                                                                                          |
| IS-ISv6                       | ✓         | –           | Supported only when the graceful restart extension is enabled.                                                                                                                                                                                                                                                                                          |
| OSPFv2                        |           | –           | Supported only when the graceful restart extension is enabled.                                                                                                                                                                                                                                                                                          |
| OSPFv3                        | ✓         | –           | Supported only when the graceful restart extension is enabled.                                                                                                                                                                                                                                                                                          |
| RIP                           | ✓         | –           | Static recovery support only.                                                                                                                                                                                                                                                                                                                           |
| Static Routes (IP and IPv6)   | ✓         | –           | After all high-priority interfaces have been replayed from NVS and mirrored storage, static routes are replayed from NVS, followed by replay of low-priority interfaces from NVS and mirrored storage. This behavior enables static routes that are dependent on high-priority interfaces to be resolved quickly and installed in the IP routing table. |
| Telnet                        | ✓         | –           | Static recovery support only.                                                                                                                                                                                                                                                                                                                           |
| <b>IPv4 Multicast Routing</b> |           |             |                                                                                                                                                                                                                                                                                                                                                         |
| Multicast Routing             | ✓         | –           | Static recovery support only. During switchover, the system mirrors the multicast queue so that IP can use the same queue without needing to recreate a different connection.                                                                                                                                                                           |
| DVMRP                         | ✓         | –           | Static recovery support only. DVMRP gives the restart complete indication to the IP routing table after getting a peer update (60-second time-out).                                                                                                                                                                                                     |

**Table 45: Application Support for Stateful SRP Switchover** *(continued)*

| Application | Supported | Unsupported | Notes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-------------|-----------|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| IGMP        | ✓         | –           | <p>IC IGMP deletes its interface and membership state on SRP failover (controller down). As part of SRP warm start, IGMP interfaces are reconfigured from NVS and dynamic IGMP interfaces are reconfigured from mirrored storage. IGMP hosts are queried as IP interfaces come back up, the join state is re-established, and SC IGMP state is created.</p> <p>After the maximum query response time (across all interfaces) expires to allow hosts to re-establish join state, IGMP notifies MGMTM that graceful restart is complete.</p>                                                                                                                                                                                                                                                                                                                                         |
| MGTM        | ✓         | –           | <p>On SRP failover, old mroutes are retained on the line module to preserve multicast forwarding; cache-misses to the SRP are disabled. When MGMTM warm starts on the SRP, it reads the NVS configuration and enables multicast routing. When IGMP, DVMRP, and PIM have completed graceful restart and the IP route table multicast-view has completed graceful restart, old mroutes are deleted from the line module and cache-misses to the SRP are enabled. This triggers re-creation of mroutes and establishes the current multicast forwarding state.</p> <p>Although cache-misses to the SRP module are disabled, forwarding is preserved for old multicast joins to downstream routers and hosts. However, forwarding for new multicast joins requested by downstream routers and hosts after SRP module switchover is not provided until cache-misses are re-enabled.</p> |
| PIM         | ✓         | –           | <p>Static recovery support only. For warm start, PIM interfaces are reconfigured from NVS. A Hello message with a new Generation ID is issued as IP interfaces come up. A neighbor that receives this Hello determines that the upstream neighbor has lost state and needs to be refreshed. A VR-global configurable graceful restart timer is required for PIM to time out the re-establishment of the join state for sparse-mode interfaces. After this timer expires, PIM notifies MGMTM that graceful restart is complete.</p>                                                                                                                                                                                                                                                                                                                                                 |

**Table 45: Application Support for Stateful SRP Switchover** *(continued)*

| Application                          | Supported | Unsupported | Notes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|--------------------------------------|-----------|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>IPv6 Multicast Routing</b>        |           |             | No multicast routing state information remains following a switchover. Incremental support for multicast routing is planned for future releases.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Multicast Routing                    | –         | ✓           | –                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| MGTM                                 | –         | ✓           | –                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| MLD                                  | –         | ✓           | –                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| PIM                                  | –         | ✓           | –                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Multiprotocol Label Switching</b> |           |             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| MPLS                                 | ✓         | –           | <p>MPLS is HA-unsafe during a graceful restart. It is HA-unsafe until all the configured MPLS signaling protocols have completed their graceful restart procedures and any stale forwarding elements have been flushed from the line modules.</p> <p>If you force an SRP switchover while MPLS is HA-unsafe, the SRP module switches but the SRP module and the line modules undergo a cold restart.</p> <p>If the primary SRP module resets while MPLS is HA-unsafe, the router undergoes a cold restart.</p> <p>In addition, MPLS over IPv6 does not support HA. If it is configured, no warning or error is displayed during a warm start. MPLS is subsequently configured from NVS as it would be after a cold reboot.</p> |
| BGP signaling                        | ✓         | –           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| LDP signaling                        | ✓         | –           | <p>To provide uninterrupted service during an SRP switchover in a scaled configuration, such as one with 32,000 Martini circuits, set the LDP graceful restart reconnect time to the maximum 300 seconds and set the LDP graceful restart recovery timer to the maximum 600 seconds. This requirement is true for all SRP switchovers, including those in the context of a unified in-service software upgrade.</p> <p>LDP signaling does not support HA for IPv6.</p>                                                                                                                                                                                                                                                         |

**Table 45: Application Support for Stateful SRP Switchover** *(continued)*

| Application                                                | Supported | Unsupported | Notes                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|------------------------------------------------------------|-----------|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| RSVP signaling                                             | ✓         | –           |                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Local cross-connects between layer 2 interfaces using MPLS | ✓         | –           | –                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Policies and QoS</b>                                    |           |             |                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Policies                                                   | ✓         | –           | –                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| QoS                                                        | ✓         | –           | Static recovery support only.                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Remote Access</b>                                       |           |             |                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| AAA                                                        | ✓         | –           | –                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| DHCP External Server and Packet Trigger                    | ✓         | –           | Following a switchover, the DHCP lease (that is, time remaining) is recalculated based on when the lease started. When the release timer for a client expires, the client is deleted and the access route is removed, along with the dynamic subscriber interface if it was created. If the client requests a new lease, DHCP external server resynchronizes with the new lease time.                                                         |
| DHCP Packet Capture                                        | ✓         | –           | –                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| DHCP Proxy Client                                          | –         | ✓           | –                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| DHCP Relay Proxy                                           | –         | –           | –                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| DHCP Relay Server                                          | ✓         | –           | Before HA support, clients identified by the DHCP relay server were maintained on a switchover (their state was stored to NVS); DHCP relay server always had some level of HA support.<br><br>Currently, following a switchover, the DHCP lease (that is, time remaining) is reset. When the release timer for a client expires, the client requests a new lease. The E-series router DHCP relay server then synchronizes with the new state. |
| DHCPv4 Local Server                                        | ✓         | –           | –                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| DHCPv6 Local Server                                        | –         | ✓           |                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| L2TP                                                       | ✓         | –           |                                                                                                                                                                                                                                                                                                                                                                                                                                               |



**Table 45: Application Support for Stateful SRP Switchover** *(continued)*

| Application                   | Supported | Unsupported | Notes                                                                                                                                                                                                                      |
|-------------------------------|-----------|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| L2TP Dialout                  | –         | ✓           | –                                                                                                                                                                                                                          |
| Local Address Pools           | ✓         | –           | The internal local address server state supports only static recovery. However, the AAA application reallocates active addresses on a switchover. The resulting effect is the local address server having full HA support. |
| RADIUS Client                 | ✓         | –           | Similar to local address server, AAA recovers disrupted RADIUS communication on a switchover. The resulting effect is the RADIUS client having full HA support.                                                            |
| RADIUS Dynamic-Request Server | ✓         | –           | Static recovery support only.                                                                                                                                                                                              |
| RADIUS Initiated Disconnect   | ✓         |             | –                                                                                                                                                                                                                          |
| RADIUS Relay Server           | ✓         | –           | –                                                                                                                                                                                                                          |
| RADIUS Route-Download Server  | ✓         | –           | –                                                                                                                                                                                                                          |
| SRC Client                    | ✓         | –           | –                                                                                                                                                                                                                          |
| TACACS +                      | ✓         | –           | Static recovery support only.                                                                                                                                                                                              |
| <b>Miscellaneous</b>          |           |             |                                                                                                                                                                                                                            |
| DNS                           | ✓         | –           |                                                                                                                                                                                                                            |
| DNSv6                         | –         | ✓           | If DNSv6 is configured, no warning or error is displayed during a warm start. DNSv6 is subsequently configured from NVS as it would be after a cold reboot.                                                                |
| J-Flow (IP flow statistics)   | ✓         | –           | –                                                                                                                                                                                                                          |
| Line Module Redundancy        | ✓         | –           | –                                                                                                                                                                                                                          |
| Network Address Translation   | ✓         | –           | –                                                                                                                                                                                                                          |
| NTP                           | ✓         | –           | –                                                                                                                                                                                                                          |
| Resource Threshold Monitor    | ✓         | –           | –                                                                                                                                                                                                                          |

**Table 45: Application Support for Stateful SRP Switchover** *(continued)*

| Application             | Supported | Unsupported | Notes                                                       |
|-------------------------|-----------|-------------|-------------------------------------------------------------|
| Response Time Reporter  | ✓         | –           | –                                                           |
| Route Policy            | ✓         | –           | Static recovery support only.                               |
| Subscriber Interfaces   | ✓         | –           | IPv4 only. Subscriber interfaces are not applicable to IPv6 |
| Tunnels (GRE and DVMRP) | ✓         | –           | –                                                           |
| VRRP                    | ✓         | –           | Static recovery support only.                               |



**CAUTION:** When IP tunnels are configured on an HA-enabled router and the Service Module (SM) carrying these tunnels is reloaded, HA transitions to the pending state. HA remains in the pending state for 5 minutes after the successful reloading of the SM. This amount of time allows for IP tunnel relocation and for the tunnels to become operational again on the SM. If an SRP switchover occurs while HA is in the pending state, the router performs a cold restart.

## Before Activating High Availability

Before you activate high availability on the SRP modules, review “Managing Modules” on page 335 and any high availability–related changes to SRP management commands.

## Activating High Availability

You activate high availability (stateful SRP switchover) by launching Redundancy Configuration mode and issuing the **mode high-availability** command.

When activating high availability, keep the following in mind:

- In an E-series router that supports stateful SRP switchover, both SRP modules must be running the same software release version in order to activate high availability mode.
- If high availability mode cannot become active because of different releases on the active and standby SRP modules, the system reverts to its default mode (file system synchronization).
- When active or pending, the router configuration files are mirrored from the active SRP module to the standby SRP module. All other files shared between the active and standby SRP modules are automatically synchronized using legacy synchronization methods.

To enable high availability, enter the following:

```
host1(config)#redundancy
host1(config-redundancy)#mode high-availability
```

### **mode**

- Use the redundancy **mode** command to enable high availability.
- The **high-availability** keyword enables high availability mode for stateful SRP switchover. In this mode, the router uses mirroring to keep the configuration and state of the standby SRP module coordinated with the configuration and state of the active SRP module.



**NOTE:** High availability mode is currently available only on ERX-1440, ERX-1400, and ERX-700 routers that support dual SRPs.

---

- The **file-system-synchronization** keyword reverts the redundancy mode to its default. In this mode, the router uses file synchronization to keep the configuration of the standby SRP module coordinated with the configuration of the active SRP module.

- Example

```
host1(config-redundancy)#mode high-availability
```

- Use the **no** version to return high availability mode operation to its default (file system synchronization).
- See mode.

### **redundancy**

- Use to enter Redundancy Configuration mode.
- Example

```
host1(config)#redundancy
host1(config-redundancy)#
```

- There is no **no** version.
- See redundancy.

## **Deactivating High Availability**

---

To deactivate high availability support, enter the following:

```
host1(config)#redundancy
host1(config-redundancy)#mode file-system-synchronization
or
host1(config)#redundancy
host1(config-redundancy)#no mode
```

## Setting the IP Interface Priority

During the warm restart after an SRP switchover, IP and IPv6 interfaces are replayed from NVS and from mirrored storage. High-priority IP and IPv6 interfaces are replayed first, followed by static routes, and then by low-priority IP and IPv6 interfaces. This scheme enables static routes that are dependent on high-priority interfaces to be resolved and routing protocols to exchange information with peers over high-priority interfaces before the low-priority interfaces are replayed.

You can designate an IP or IPv6 interface as high priority either implicitly or explicitly:

- Implicit designation—Configure an IGP or PIM protocol on the interface.
- Explicit designation—Issue the **ip initial-sequence-preference 1** command on the IP subinterface, or the **ipv6 initial-sequence-preference 1** command on the IPv6 subinterface.

An IP or IPv6 interface can be designated as high priority by more than one protocol, the CLI command, or both. You can change an IP or IPv6 interface from high priority to low priority only by one of the following methods:

- Delete the IP or IPv6 interface.
- Remove all high-priority configuration from the IP or IPv6 interface, then reload the router.

### **ip initial-sequence-preference**

### **ipv6 initial-sequence-preference**

- Use to set the initial sequence preference value on an IP or IPv6 interface at the subinterface level.
- Specify a value of 1 to configure the interface as high-priority. Specify a value of 0 to configure the interface as low-priority.
- Example for IP
 

```
host1(config-subif)#ip initial-sequence-preference 1
```
- Example for IPv6
 

```
host1(config-subif)#ipv6 initial-sequence-preference 0
```
- There is no **no** version.
- See `ip initial-sequence-preference` and `ipv6 initial-sequence-preference`.

## Upgrading Software

---

As already mentioned, you cannot activate high availability when a different release of software is running on the standby SRP module. The router determines whether a release is the same by viewing the build date, the release file name, and the internal version number for the software on each SRP module.

The most efficient way to upgrade the software is to ensure that the standby SRP module is armed with the new release and then reload the standby SRP module. This reload occurs automatically after you download and arm a new release onto the active SRP module and the active SRP module subsequently synchronizes with the standby SRP module.

After reloading, and even though high availability mode is configured, the active SRP module reverts to using the file-system-synchronization operational mode for synchronizing updates. To complete the upgrade and place the system back in high-availability operational mode, you must execute the **srp switch** command to force the standby SRP module to take over as the active SRP module.



**NOTE:** Executing the **srp switch** command results in a cold restart of the router.

Once the switchover is initiated, the formerly active SRP module reloads the software and starts running the same release as the newly active SRP module. When the formerly active SRP module becomes operational as the standby SRP module, the newly active SRP module detects that the release it is running is the same as that on the standby SRP module and allows the originally active SRP module to resume the high-availability operational mode.

If a fault occurs when the active SRP module is in file-system-synchronization operational mode, the standby SRP module detects the fault and takes over, and the router cold-restarts. For this reason, it is important that you arm the new release only when you can accept the resulting window of vulnerability where high availability is disabled (that is, until the active and standby SRP modules are again running the same release).

## Monitoring High Availability

This section shows how to use the **show** commands to view your high availability configuration and how to clear the high availability switchover history for the router.

### High Availability show Commands

You can monitor various aspects of high availability using **show** commands. These aspects include redundancy modes and status, redundancy clients, historical information about redundancy on the router, and specific redundancy information for line modules and SRPs.

#### **show ip interface** **show ipv6 interface**

- Use to display the initial sequence preference values as well as other information relating to the current state of all IP or IPv6 interfaces or the IP or IPv6 interfaces you specify.
- Field descriptions relating to redundancy. These fields are displayed when the **brief** keyword is not issued.
  - Operational initial sequence preference—Actual initial sequence preference as determined by the combination of the protocol configured on the interface

and the CLI configuration on the interface; the value is 0 (low priority) or 1 (high priority)

- Administrative—Configured initial sequence preference specified with the **ip initial-sequence-preference** command or the **iipv6 initial-sequence-preference** command; the value is 0 (low priority) or 1 (high priority)
- Example 1—Displays a summary of the redundancy status of an ERX-14xx model

```
host1#show ip interface atm 2/0.1
```

```
ATM2/0.10 line protocol Atm1483 is up, ip is up
...
Warm-restart initial-sequence-preference: Operational = 1 Administrative
= 1
...
```

- There is no **no** version.

### **show redundancy**

- Use to display the supported redundancy modes and other status relating to high availability. In particular, the output indicates any conditions that are preventing high availability from operating.
- Field descriptions
  - SRP
    - high-availability state—State of the high availability mode (disabled, active, or pending)
    - current redundancy mode—Redundancy mode currently being used by this router (high-availability or file-system-synchronization)
    - last activation type—Last type of activation that occurred on this router (that is, the method by which the SRP last booted [cold-start or warm-start])
  - Criteria Required for High Availability to be Active—criteria required for high availability to be active.



**NOTE:** All criteria must be “yes” for high availability to be active.

---

- Line Card
  - automatic reverting—State of automatic reverting (on or off)
  - slot(s)—Slots in which the line modules reside
  - hardware role—Function of the line module: primary or spare



```

8 - 13 6 0
```

- Example 2—Displays the redundancy status of an ERX-14xx model in detail

```
host1#show redundancy detail

SRP

high-availability state: disabled
current redundancy mode: file-system-synchronization
last activation type: cold-start

Criteria Required for High Availability to be Active

 criterion met

Active SRP hardware supports High Availability? Yes
High Availability mode configured? No
Mirroring Subsystem present? Yes
Mirroring activity levels within limits? Yes
Network Core Dumps disabled? Yes
Running configuration is safe for High Availability? Yes
Standby SRP hardware supports High Availability? Yes
Standby SRP is online and capable of mirroring? Yes
Standby SRP is running the same release? Yes

Line Card

automatic reverting is off

 backed
 up
 by
slot hardware lockout slot sparing revert

3 --- --- --- --- ---
8 spare --- --- --- ---
12 primary protected --- --- ---

 midplane midplane
 type rev

8 - 13 6 0
```

- See show redundancy.

**show redundancy clients**

- Use to display high availability clients and their various levels of high availability support.
- Specify an optional client type that you want to view (all, supported, unsafe, unsupported)





**NOTE:** Issuing this command without the optional client type results in showing only unsupported high availability clients (the default).

- Field descriptions
  - client—High availability client
  - mode—Whether the client is supported or unsupported for high availability
- configuration—Safety level of the configuration based on whether or not the client is supported or unsupported and, in the case of those unsupported, whether or not the client has been configured (for example, if an unsupported client is configured on a router with high availability enabled, the configuration would read “unsafe” )
- Example 1

```
host1#show redundancy clients
```

```
Unsupported High Availability Clients
```

| client                | configuration |
|-----------------------|---------------|
| DHCP Proxy Client     | safe          |
| Global Ipv6           | safe          |
| IPsec Transport (ITM) | safe          |
| l2tpDialoutGenerator  | safe          |
| DHCPv6 Local Server   | safe          |
| Radius Relay Server   | safe          |

- Example 2

```
host1#show redundancy clients all
```

```
High Availability Client Information
```

| client               | mode        | configuration |
|----------------------|-------------|---------------|
| atm1483DataService   | supported   | safe          |
| AA83                 | supported   | safe          |
| aaaServer            | supported   | safe          |
| atmAa15              | supported   | safe          |
| AAQS                 | supported   | safe          |
| atm                  | supported   | safe          |
| Bridged Ethernet     | supported   | safe          |
| Transparent Bridging | supported   | safe          |
| dcm                  | supported   | safe          |
| dhcpExternal         | supported   | safe          |
| DHCP Proxy Client    | unsupported | safe          |
| DS1                  | supported   | safe          |
| DS3                  | supported   | safe          |
| ethernet             | supported   | safe          |
| Flow Inspection      | supported   | safe          |
| frameRelay           | supported   | safe          |
| FT1                  | supported   | safe          |
| Global Ipv6          | unsupported | safe          |
| Global Ip            | supported   | safe          |

|                       |             |      |
|-----------------------|-------------|------|
| HDLC                  | supported   | safe |
| IKEP                  | supported   | safe |
| ipflowstats           | supported   | safe |
| IpSubscriberManager   | supported   | safe |
| IPTU                  | supported   | safe |
| IPVR                  | supported   | safe |
| IPsec Transport (ITM) | unsupported | safe |
| l2tpDialoutGenerator  | unsupported | safe |
| l2tp                  | supported   | safe |
| LMGR                  | supported   | safe |
| DHCPv4 Local Server   | supported   | safe |
| DHCPv6 Local Server   | unsupported | safe |
| MPLS                  | supported   | safe |
| PMGR                  | supported   | safe |
| pppoe                 | supported   | safe |
| ppp                   | supported   | safe |
| qos                   | supported   | safe |
| Radius Relay Server   | unsupported | safe |
| RSVP                  | supported   | safe |
| SCM                   | supported   | safe |
| slotHelper            | supported   | safe |
| Cisco HDLC            | supported   | safe |
| ServiceManager        | supported   | safe |
| Sonet                 | supported   | safe |
| SonetPath             | supported   | safe |
| SonetVT               | supported   | safe |
| IPsec Tunnel (ST)     | supported   | safe |

- See show redundancy clients.

### **show redundancy history**

- Use to display information about dates, times, and the number of occurrences for starts and switchovers.
- Use the **srp** keyword to view SRP module-specific information.
- Use the **detail** keyword to view additional history information.
- Field descriptions
  - system up time—Amount of time elapsed since the last cold boot
  - last cold start—Date and time the router experienced the last cold start
  - last cold switchover—Date and time the router experienced the last cold switchover
  - last warm switchover—Date and time the router experienced the last warm switchover
  - cold starts—Total number of cold starts the router has experienced
  - switchovers—Number of cold, warm, and consecutive warm switchovers the router has experienced
- Example 1

```
host1#show redundancy history
```

```

system up time: 0 00:08:01
last cold start: 2004-07-26 10:44:25
last cold switchover: 2004-07-25 18:51:56
last warm switchover: 2004-07-25 20:58:57

```

```

activation statistics:
 cold starts: 92
 switchovers:
 cold: 21
 warm: 147
 consecutive warm: 0

```

#### ■ Example 2

```
host1#show redundancy history detail
```

```

system up time: 0 00:08:01
last cold start: 2004-07-26 10:44:25
last cold switchover: 2004-07-25 18:51:56
last warm switchover: 2004-07-25 20:58:57

```

```

activation statistics:
 cold starts: 92
 switchovers:
 cold: 21
 warm: 147
 consecutive warm: 0

```

| SRP activation time | type       | slot | system uptime | running release   |
|---------------------|------------|------|---------------|-------------------|
| 2004-09-08 15:10:40 | cold-start | 00   | ---           | erx_6-0-0b1-8.rel |
| 2004-09-08 14:39:10 | cold-start | 00   | ---           | erx_6-0-0b1-1.rel |

#### ■ See show redundancy history.

### **show redundancy line-card**

- Use to display line-module-specific redundancy information.
- Field descriptions
  - automatic reverting—State of automatic reverting (on or off)
  - slot(s)—Slots in which the line modules reside
  - hardware role—Function of the line module: primary or spare
  - lockout config—Status of redundancy on this line module (protected—Line module redundancy is enabled; locked out—Line module redundancy is disabled)
  - backed up by slot—Slot that contains the line module that is a spare for this primary line module
  - sparing for slot—Slot that contains the primary line module for which this line module is a spare

- revert at—Time at which you want line module to revert
- midplane type—Identifier for the type of midplane
- midplane rev—Hardware revision number of the redundancy midplane
- Example

```
host1#show redundancy line-card
```

```
automatic reverting is off
```

| slot | hardware<br>role | lockout<br>config | backed<br>up<br>by<br>slot | sparing<br>for<br>slot | revert<br>at |
|------|------------------|-------------------|----------------------------|------------------------|--------------|
| 3    | ---              | ---               | ---                        | ---                    | ---          |
| 8    | spare            | ---               | ---                        | ---                    | ---          |
| 12   | primary          | protected         | ---                        | ---                    | ---          |

| slots  | midplane<br>type | midplane<br>rev |
|--------|------------------|-----------------|
| 8 - 13 | 6                | 0               |

- See show redundancy line-card.

### **show redundancy srp**

- Use to display SRP-module-specific redundancy information.
- Use the brief keyword to display summary information about SRP redundancy.
- Field descriptions
  - SRP
    - high-availability state—State of the high availability mode (disabled, active, or pending)
    - current redundancy mode—Redundancy mode currently being used by this router (high-availability or file-system-synchronization)
    - last activation type—Last type of activation that occurred on this router (that is, the method by which the SRP last booted [cold start or warm start])
  - Criteria Required for High Availability to be Active—Criteria required for high availability to be active.



**NOTE:** All criteria must be “yes” for high availability to be active.

- Example 1

```
host1#show redundancy srp
```

```

high-availability state: active
current redundancy mode: high-availability
last activation type: warm-switch

```

■ Example 2

```
host1#show redundancy srp detail
```

```

high-availability state: disabled
current redundancy mode: file-system-synchronization
last activation type: cold-start

```

Criteria Required for High Availability to be Active

| -----<br>criterion<br>-----                          | met<br>--- |
|------------------------------------------------------|------------|
| Active SRP hardware supports High Availability?      | Yes        |
| High Availability mode configured?                   | No         |
| Mirroring Subsystem present?                         | Yes        |
| Mirroring activity levels within limits?             | Yes        |
| Network Core Dumps disabled?                         | Yes        |
| Running configuration is safe for High Availability? | Yes        |
| Standby SRP hardware supports High Availability?     | Yes        |
| Standby SRP is online and capable of mirroring?      | Yes        |
| Standby SRP is running the same release?             | Yes        |

■ See show redundancy srp.

**show redundancy switchover-history**

- Use to display the high availability switchover history for the chassis.
- Field descriptions
  - SRP activation time—Amount of time the SRP module has been active
  - type—Type of switchover
  - slot—Slot in which the SRP module resides
  - system uptime—Amount of time the chassis has been operational
  - running release—Release running on the SRP module at the time of the switchover

■ Example

```
host1# show redundancy switchover-history
```

| SRP activation time<br>----- | type<br>----- | slot<br>--- | system<br>uptime<br>----- | running release<br>----- |
|------------------------------|---------------|-------------|---------------------------|--------------------------|
| 2004-07-26 10:44:25          | cold-start    | 07          | ---                       | L-07-25-60b1mrg-e.rel    |
| 2004-07-25 20:58:57          | warm-switch   | 06          | 0 00:15:08                | L-07-25-60b1mrg-e.rel    |
| 2004-07-25 20:53:41          | warm-switch   | 07          | 0 00:09:51                | L-07-25-60b1mrg-e.rel    |
| 2004-07-25 20:44:43          | cold-start    | 06          | ---                       | L-07-25-60b1mrg-e.rel    |
| 2004-07-25 19:32:01          | cold-start    | 06          | ---                       | L-07-25-60b1mrg-d.rel    |
| 2004-07-25 18:58:01          | warm-switch   | 06          | 0 00:12:01                | L-07-25-60b1mrg-c.rel    |
| 2004-07-25 18:51:56          | cold-switch   | 07          | 0 00:05:56                | L-07-25-60b1mrg-c.rel    |
| 2004-07-25 18:46:54          | cold-start    | 06          | ---                       | L-07-25-60b1mrg-c.rel    |

```

2004-07-25 17:44:48 warm-switch 06 0 00:14:32 L-07-25-60b1mrg-b.rel
2004-07-25 17:31:07 cold-start 07 --- L-07-25-60b1mrg-b.rel
2004-07-25 16:05:08 cold-start 07 --- L-07-25-60b1mrg-a.rel
2004-07-24 23:25:09 warm-switch 07 0 16:27:03 L-07-24-60b1mrg-b.rel
2004-07-24 23:18:23 cold-switch 06 0 16:20:17 L-07-24-60b1mrg-b.rel

```

- See show redundancy switchover-history.

## Clearing the Redundancy History

You can use the **clear redundancy history** command to clear the high availability switchover history for the router.

### clear redundancy history

- Use to clear the detailed high availability switchover history for the router.
- Example

```

host1# show redundancy history detail
system up time: 0 00:08:01
last cold start: 2004-07-26 10:44:25
last cold switchover: 2004-07-25 18:51:56
last warm switchover: 2004-07-25 20:58:57
activation statistics:
 cold starts: 92
 switchovers:
 cold: 21
 warm: 147
 consecutive warm: 0

SRP activation time type slot system running
release

2004-07-26 10:44:25 cold-start 07 ---
L-07-25-60b1mrg-e.rel
2004-07-25 20:58:57 warm-switch 06 0 00:15:08
L-07-25-60b1mrg-e.rel
2004-07-25 20:53:41 warm-switch 07 0 00:09:51
L-07-25-60b1mrg-e.rel
2004-07-25 20:44:43 cold-start 06 ---
L-07-25-60b1mrg-e.rel
2004-07-25 19:32:01 cold-start 06 ---
L-07-25-60b1mrg-d.rel
2004-07-25 18:58:01 warm-switch 06 0 00:12:01
L-07-25-60b1mrg-c.rel
2004-07-25 18:51:56 cold-switch 07 0 00:05:56
L-07-25-60b1mrg-c.rel
host1# clear redundancy history
host1# show redundancy history
system up time: 0 00:08:01
last cold start: 2004-07-26 10:44:25
last cold switchover: 2004-07-25 18:51:56
last warm switchover: 2004-07-25 20:58:57
activation statistics:
 cold starts: 92
 switchovers:

```

```

cold: 21
warm: 147
consecutive warm: 0

SRP activation time type slot system
release ----- ----- uptime


```

- There is no **no** version.
- See clear redundancy history.





## Chapter 8

# Configuring a Unified In-Service Software Upgrade

This chapter describes how to prepare for and perform a unified in-service software upgrade (unified ISSU) of JUNOS software on E120 and E320 routers. A unified in-service software upgrade provides a way to upgrade to a higher-numbered release while minimizing the effect of the upgrade on traffic forwarded through the router.

- Unified ISSU Overview on page 441
- Unified ISSU Platform Considerations on page 443
- Unified ISSU Terms That Describe SRP and Line Module Behavior on page 443
- Unified ISSU References on page 444
- Unified ISSU Phases Overview on page 444
- Application Support for Unified ISSU on page 452
- Unexpected Application-Specific Behavior During Unified ISSU on page 459
- Before You Begin a Unified In-Service Software Upgrade on page 472
- Upgrading Router Software with Unified ISSU on page 474
- Halting the Unified ISSU Process and Restoring the Original State of the Router on page 478
- Monitoring a Unified In-Service Software Upgrade on page 480

## Unified ISSU Overview

---

In software releases numbered lower than Release 6.0, all line modules are reloaded when an SRP switchover occurs. This reload disconnects user sessions and disrupts forwarding through the chassis. Stateful SRP switchover was introduced in JUNOS Release 6.0 to minimize the impact to the router of a stateful switchover from the active SRP module to the standby SRP module. Stateful SRP switchover (high availability) maintains user sessions during the switchover and data forwarding through the router continues to flow with little impact, thus improving the overall availability of the router.

The unified in-service software upgrade (unified ISSU) feature further extends router availability. Unified ISSU enables you to upgrade the router to a higher-numbered software release without disconnecting user sessions or disrupting forwarding through the chassis.

A conventional software upgrade—one that does not use the unified ISSU process—causes a router-wide outage for all users. Only static configurations (stored on the flash card) are maintained across the upgrade; all dynamic configurations are lost. A conventional upgrade takes 30-40 minutes to complete, with additional time required to bring all users back online.

When you perform a unified in-service software upgrade on a router that has one or more modules that do not support unified ISSU, these modules alone are upgraded by means of the legacy, conventional upgrade process. The unsupported modules undergo a cold reboot at the beginning of the unified ISSU process, and are held down until the in-service software upgrade is completed. Connections that pass through the unsupported modules are lost. The interfaces on these modules pass into a down state, which causes the physical layer and link layer to go down during the in-service software upgrade for those modules.

Applications that do not support unified ISSU applications cannot maintain state and configuration with minimal traffic loss across the upgrade to a higher-numbered release. When you attempt a unified in-service software upgrade on a router on which an ISSU-challenged application is configured, the in-service software upgrade cannot proceed. You must unconfigure the ISSU-challenged application to successfully perform the unified ISSU.

### ***Router Behavior During a Unified In-Service Software Upgrade***

The following behaviors are characteristic of a unified in-service software upgrade.

- Connections that were established before you begin the in-service software upgrade are maintained across the upgrade. Any such connection that was forwarding data continues to do so during and after the upgrade.
- New connections are denied until the upgrade is completed.
- Packet loss during the upgrade is limited. Bandwidth through the modules is reduced, but the impact is minimal.
- Graceful restart protocols do not time out during the in-service software upgrade.
- The unified in-service software upgrade has a minimal effect on the control and data planes. During the SRP module upgrade phase, forwarding through the fabric is interrupted for about 1 second on the E120 and E320 routers and about 4 seconds on the ERX-1440 router. During the line module upgrade phase, forwarding through the chassis is interrupted for about 15 seconds on the E120 and E320 routers and for about 50 seconds on the ERX-1440 router.
- Diagnostic software is not run on any modules during a unified in-service software upgrade.
- The router will undergo a cold restart if you attempt to upgrade the software to a lower-numbered version with unified ISSU. The in-service software upgrade must be to a higher-numbered release than the running release.
- Additional memory is consumed during a unified in-service software upgrade. Available memory on a line module might not be sufficient due to the module's configuration. Unified ISSU can detect this limitation during the upgrade procedure and exit the process.

## Unified ISSU Platform Considerations

Unified ISSU is supported on E120 and E320 routers. Unified ISSU is also supported on the ERX-1440 router with the SRP-40G PLUS with 2GB of memory. Unified ISSU on the ERX-1440 requires a license key.

For information about modules supported on E120 and E320 routers:

- See *E120 and E320 Module Guide, Table 1, Modules and IOAs* for detailed module specifications.
- See *E120 and E320 Module Guide, Appendix A, IOA Protocol Support* for information about the modules that support unified ISSU.

For information about modules supported on ERX-1440 router:

- See *ERX Module Guide, Table 1, ERX Module Combinations* for detailed module specifications.
- See *ERX Module Guide, Appendix A, Module Protocol Support* for information about the modules that support unified ISSU.

Redundant SRP modules are required for unified ISSU support.

Unified ISSU is not supported on the ERX-7xx models, ERX-14xx models, and the ERX-310 router.

## Unified ISSU Terms That Describe SRP and Line Module Behavior

Table 46 on page 443 defines terms relevant to module behavior during a unified in-service software upgrade.

**Table 46: Unified ISSU-Related Terms**

| Term         | Meaning                                                                                                                                                                                                                                                                                                                              |
|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Cold boot    | The SRP module or line module loads diagnostics from the flash file system and runs them. When the diagnostics successfully complete, the operational image is loaded from the flash file system and then cold started.                                                                                                              |
| Cold start   | The SRP module or line module is initialized from the loaded operational image. The line modules are reloaded and the configuration is read from flash memory. When the line modules are operational, their configuration data is bulk downloaded and their interfaces become operational.                                           |
| Cold restart | If the active SRP module fails, the standby SRP module assumes the role of active SRP module. When high availability is not configured, the cold restart is similar to the cold start, except that the applications are already loaded into memory on the standby SRP module and ready to be started. The line modules are reloaded. |

**Table 46: Unified ISSU-Related Terms** (continued)

| Term         | Meaning                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|--------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Warm restart | If the active SRP module fails, the standby SRP module takes the role of active SRP module. Mirrored configuration data as well as any mirrored volatile data are already resident in memory. The line modules continue to forward data (with a small loss of packets when the fabric is switched from the formerly active SRP module to the newly active SRP module). The protocols and other applications re-initialize from the mirrored data and resynchronize communications with the line modules. When resynchronization is completed, the router resumes normal operations, including updates of any routing tables that result from changes that occurred during the warm restart. |

## Unified ISSU References

For more information about stateful SRP switchovers see “Managing High Availability” on page 413.

For more information about SRP module redundancy, see “Managing Modules” on page 335.

## Unified ISSU Phases Overview

The JUNOS software includes software modules that operate the following hardware components:

- SRP module
- Line module control plane
- Line module forwarding plane

A unified in-service software upgrade replaces the currently operating software on each of these components with a higher-numbered release. The unified ISSU also upgrades or re-creates the state and configuration data of the configured applications.

Before you begin the in-service software upgrade, you must first prepare the router for the upgrade. See “Before You Begin a Unified In-Service Software Upgrade” on page 472 for more information.

The in-service software upgrade takes place in three phases:

1. Initialization Phase—When you issue the **issu initialize** command, unified ISSU verifies whether all prerequisites for the upgrade have been met. The router is prepared for the upgrade. The configuration that has been mirrored to the standby SRP module is upgraded according to the upgrade release. This phase can last from a few minutes up to 40 minutes depending on the number of software releases across which the router is being upgraded.
2. Upgrade Phase—When you issue the **issu start** command, unified ISSU again verifies whether all prerequisites for the upgrade have been met. During this

phase the line module control plane and forwarding plane are upgraded and all three hardware components are resynchronized. how long does this take

3. Service Restoration Phase—This phase automatically begins without user intervention when the upgrade phase has completed. During this final phase, the router is returned to a normal, runtime state.

The following sections describe these phases in more detail.

## Unified ISSU Initialization Phase Overview

When you issue the **issu initialize** command, unified ISSU first verifies whether all requirements for the upgrade are met. The verification process examines the running release, the SRP modules, the line modules, line module redundancy, and the router configuration.

The **issu initialize** command does not interrupt or disrupt any of the runtime operations of the router. The command has no effect on changes of authorization, forwarding, or subscribers (except that the rate of logins might be affected). You cannot manually change the file system redundancy mode from high availability to file synchronization until the unified in-service software upgrade is completed.



**NOTE:** We recommend that you make no configuration changes after you have issued the **issu initialization** command. As a best practice, ensure that your configuration is complete before you start the software upgrade.

---

During the initialization phase, you can halt the in-service software upgrade at any time and revert either to a normal SRP module switchover or to the previous state of the router. To stop the unified ISSU process, you must issue the **issu stop** command. If instead you simply exit the CLI session, the unified ISSU initialization phase continues.

The action taken when a requirement is not met depends on the requirement. For some failed verifications, the CLI warns you of the issue and prompts you to proceed or quit the upgrade process. More serious failures cause the CLI to exit the command and provide a message describing the issue.



**NOTE:** We recommend that you issue the **show issu** command before beginning the in-service software upgrade. The output of the command lists any necessary conditions that are not currently met on the router. You can therefore correct these failures before entering into the upgrade. You can issue the **show issu** command at any time.

---



**NOTE:** On E120 and E320 routers, you can hot swap an IOA during the initialization phase without affecting the in-service software upgrade. However, we strongly recommend that you perform any necessary hot swaps before you issue the **issu initialize** command.

---

If the standby SRP module reloads during the initialization phase, unified ISSU is halted. You must begin again by issuing the **issu initialize** command.

### Application Data Upgrade on the Standby SRP Module

Synchronized modules can become unsynchronized because you can change the router configuration at any time until you issue the **issu start** command. When the verification process is completed, unified ISSU starts up the stateful SRP switchover process to maintain synchronization between the active SRP module and the standby SRP module during the SRP module upgrade phase.



**NOTE:** An SRP switchover from the active SRP module to the standby SRP module at this point in the in-service software upgrade causes a cold restart of the router because the SRP modules are running two different releases. The current release is on the active SRP module and the upgrade release is on the standby SRP module.

---

The application and configuration data that has been mirrored to the standby SRP module is upgraded as required by the new software release. The CLI displays the progress of the SRP module upgrade.

While data on the standby SRP module is upgraded, any new changes that are mirrored from the primary SRP module to the standby SRP module are also upgraded to the version required by the armed release.



**NOTE:** This process consumes significant CPU resources on the redundant SRP module and can take a considerable amount of time to complete. Performance of the active SRP module might be affected during the SRP module upgrade.

---

When the upgrade release has been synchronized to the standby SRP module, stateful SRP switchover is disabled until the in-service software upgrade is completed.

If you configure an application that does not support unified ISSU during the initialization phase, the initialization phase completes, but the **issu start** command subsequently fails.

### SNMP Traps

When you issue the **issu initialization** command, the SNMP agent generates a `juniSystemIssuStateChange` trap with `juniSystemIssuState` set to `initializing`. When the unified ISSU initialization is completed, the SNMP agent generates a `juniSystemIssuStateChange` trap with `juniSystemIssuState` set to `initialized`.

## Unified ISSU Upgrade Phase Overview

During the upgrade phase, the CLI supports only a reduced set of administrative commands. You cannot interrupt the upgrade phase. The upgrade phase cannot commence if any CLI commands outside of this set are executing when you issue the **issu start** command.



**NOTE:** Although you can use any CLI session to issue the **issu start** command, we recommend that you issue the command from a session to the management console port. When the standby SRP module switchover takes place, all management network connections through the Ethernet management port are dropped, and you can access the router only through a console port until the service restoration phase is completed.

When you issue the **issu start** command, unified ISSU performs the following operations:

1. Verifies that the unified ISSU requirements on the router are still met.
2. Verifies that the active and standby SRP modules are synchronized. If they are not synchronized, forces a synchronization to ensure that all configuration and file system changes are propagated to the standby SRP module before proceeding with the upgrade.
3. Copies the NVS configuration from a backup memory area to the flash card on the standby SRP module. During the initialization phase, this configuration data was mirrored from NVS on the active SRP module and upgraded as required by the armed release.
4. Upgrades the control plane on each line module at the same time.
5. Switches control from the primary SRP module (running the current release) to the standby SRP module (running the armed upgrade release).
6. Upgrades the forwarding plane on each line module at the same time. The fabric is switched and upgraded.

You can view the status of the router and the progress of the upgrade at any time by issuing the **show issu** command from another terminal session to the router.



**NOTE:** While a unified ISSU operation is in progress, do not remove the SRP modules or attempt to reset them. Removing the SRP modules anytime during unified ISSU has an adverse impact.

After the unified ISSU operation is completed, issue the **show version** command. The output should indicate the following:

- The formerly active SRP module has rebooted and come up as the new standby SRP module.
- The newly active SRP module indicates that the formerly active SRP has rebooted and has come up as standby SRP module

You can then remove an SRP module after issuing the **halt** command.

## Exceptions During the Upgrade Phase

Table 47 on page 448 describes the behavior of the router during the upgrade phase when certain exceptional events take place outside the context of the in-service software upgrade.

**Table 47: Router Response to Undesirable Events During the Upgrade Phase**

| Event                                                            | Router Action                                                                                                                                                                                                                                                                                                                       |
|------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| The router reloads.                                              | <ul style="list-style-type: none"> <li>■ The unified ISSU operation halts.</li> <li>■ The router undergoes a cold restart.</li> <li>■ The router boots with the armed upgrade release.</li> <li>■ The line modules reboot.</li> </ul>                                                                                               |
| The primary SRP module switches over to the standby SRP module.  | <ul style="list-style-type: none"> <li>■ The unified ISSU operation halts.</li> <li>■ The router undergoes a cold restart.</li> <li>■ The router boots with the armed upgrade release.</li> <li>■ The line modules reboot.</li> </ul>                                                                                               |
| The standby SRP module reloads.                                  | <ul style="list-style-type: none"> <li>■ The unified ISSU operation halts.</li> <li>■ The router undergoes a cold restart.</li> <li>■ The router boots with the armed upgrade release.</li> <li>■ The line modules reboot.</li> </ul>                                                                                               |
| A line module reloads.                                           | <ul style="list-style-type: none"> <li>■ The line module is held down and prevented from rebooting until the service restoration phase is completed. The line module then undergoes a cold reboot to the running (pre-upgrade) release.</li> </ul>                                                                                  |
| An IOA is hotswapped.                                            | <ul style="list-style-type: none"> <li>■ Hot swapping is disabled during the upgrade phase. The line module undergoes a cold reboot and hot swapping is reenabled when the service restoration phase is completed.</li> </ul>                                                                                                       |
| An application that does not support unified ISSU is configured. | <ul style="list-style-type: none"> <li>■ This event can take place only before the <b>issu start</b> command is issued, because that command disables CLI configuration commands. When you issue the <b>issu start</b> command, after configuring such an application, the command exits and generates an error message.</li> </ul> |

## Verification of Requirements

Because some time may have passed since unified ISSU verified the requirements for the upgrade during the initialization phase, unified ISSU re verifies all the same conditions.

Unified ISSU also verifies that no CLI configuration sessions are open, that no scripts or macros are running, and that any SNMP requests or CLI commands in progress complete within 5 seconds.

If any of the required conditions are not met, the CLI either exits the command with an error message or provides an informative message and prompts you to proceed or halt.



When all the conditions are met, the CLI prompts you to proceed. If you continue, then you can subsequently halt the upgrade only by reloading the router. If you exit the command, the router remains in the unified ISSU initialized state.

## Upgrade Setup

At this stage all the preconditions have been met. The unified ISSU process shuts down all management interfaces to the router in order to prevent changes in the configuration.

Final preparation for the upgrade phase includes the following actions:

- **SNMP**—The SNMP agent generates a `juniSystemIssuStateChange` trap with `juniSystemIssuState` set to `upgrading` to indicate that the final phase of the operation has begun. When the trap is issued with this state value, the SNMP agent stops accepting any new SNMP gets or sets and does not issue any further traps.
- **CLI**—Most CLI commands are disabled. Only **reload**, **show issu**, and **show version** commands are available to you until the service restoration phase completes. These commands are available on the console and are not available to Telnet sessions.
- **External events**—Externally created events from sources other than the CLI are ignored. These events typically come from user connections, RADIUS servers, SRC software and SDX software, and SNMP, and include login requests, COA requests, multicast join requests, packet mirroring requests, and so on. Logout requests are cached and processed at a later stage.
- **Routing protocols**—The unified ISSU process prompts you to consider raising the link costs for each routing protocol that is configured on the router. Raising the link cost for routes through the upgrading router enables neighbors to recompute better routes to those destinations. If you choose to raise the link cost, the higher costs can take some time to propagate through the network. Because the router is unable to determine when this has completed, it waits for 2 minutes before proceeding to the next step in the upgrade.

The reason for raising the link cost is that once the upgrade of the line module control plane begins, routing protocol updates cannot be installed in the line modules until that upgrade completes. That period can be in the range 2–15 minutes. During the control plane upgrade, the routing protocols can still accept new routes and communicate with their neighbors but cannot install the routes.

- **Routing protocols**—The unified ISSU process prompts you to consider raising the link costs for each routing protocol that is configured on the router.

Once the upgrade of the line module control plane begins, routing protocol updates cannot be installed in the line modules until that upgrade completes. That period can be in the range 2–15 minutes. During the control plane upgrade, the routing protocols can still accept new routes and communicate with their neighbors but cannot install the routes.

Raising the link cost for routes through the upgrading router enables neighbors to recompute better routes to those destinations that do not pass through the upgrading router. If you choose to raise the link cost, the higher costs can take some time to propagate through the network. Because the router is unable to

determine when this has completed, it waits for 2 minutes before proceeding to the next step in the upgrade.

- **Unsupported line modules**—Any unsupported line modules that are present are held down after the start of this phase when you can no longer gracefully exit from the unified ISSU process. The modules are held down for the duration of the in-service software upgrade and are then undergo a cold boot to the original running release.
- **IGMP requests**—The router cannot handle IGMP requests for channel changing for IPTV implementations.

### ***Line Module Arming***

When the upgrade of the application data on the standby SRP upgrade is completed, unified ISSU temporarily arms the line modules with the upgrade release in a backup region of the memory.

### ***Line Module Control Plane Upgrade***

At this point, the upgrade release is preserved on each line module in some backup region. When signaled by the active SRP module, all supported line modules simultaneously reload and restart with the new release. Forwarding through the forwarding subsystem on the line modules—through the fabric of the system—is not be affected by the reload.

The line modules then simultaneously recover any application data preserved in memory on the line module and upgrade that data into a format that is understood by the applications running on the new release. This operation can take in the range of 1–10 minutes depending on the size of the data and the upgrade path of the data. Each line module restores its operational state, running the new release with all data upgraded to a version acceptable to the new software.

If the upgrade process fails for any line module, that module undergoes a cold restart, but none of the other line modules is affected.

### ***SRP Module Switchover***

At this stage the primary SRP module is running the current release, the redundant SRP module is running the armed release, and the control plane on each supported line module is running the armed release.

When the primary SRP module has verified that all line modules are up, the redundant SRP module takes over control of the router by becoming the active SRP module. The primary, and formerly active, SRP module reboots to the armed release and serves as the standby SRP module.

All applications on the newly active SRP module are restarted. Each application reconstructs itself from the mirrored data, restoring its state and configuration as it was before the switchover. Forwarding through the fabric is interrupted for about 1 second on the E120 and E320 routers and about 4 seconds on the ERX-1440 router.

The SRP switchover restarts the routing protocols and triggers a graceful restart because the routes need to be recomputed. This recalculation can take up to 90 seconds. Data continues to be forwarded through routes that were learned before the upgrade of the line module control planes.

### ***Line Module Forwarding Plane Upgrade***

While the applications on the SRP module and the line modules reconstruct themselves, they also begin to build up the new state for the forwarding subsystem. All applications on the line module signal the system when they are ready to start the forwarding upgrade.

Because upgrading the forwarding plane affects forwarding through the chassis for up to 30 seconds on the E120 and E320 routers and about 50 seconds on the ERX-1440 router, unified ISSU does not proceed until the routing protocols have signaled that route reconvergence has completed. Unified ISSU then informs all line modules to simultaneously upgrade their forwarding subsystems.

The line modules then perform the following steps:

1. Halt forwarding through the line modules. Although any links to external devices remain up, incoming data is dropped.
2. Update any changed programmable hardware devices.
3. Update the forwarding subsystem with the new release and upgraded configuration data.
4. Update the routing tables with the reconverged routes.
5. Resume forwarding.

## ***Unified ISSU Service Restoration Phase Overview***

This is the final unified ISSU phase. At this point, all three major components of the router—the SRP modules, the line module control planes, and the line module forwarding planes—have been upgraded and forwarding has resumed through the chassis. The following actions take place during this phase:

- The CLI is re-enabled. All commands are made available to users.
- The SNMP agent is restarted and bulk statistics are collected and available for review. (The first interval of bulk statistics collection starts when unified ISSU is still in process. Therefore, the system performs bulk statistics collection after the first interval.)
- New login requests and logout requests are processed. The router begins to accept externally created events from sources other than the CLI and SNMP. These events typically come from user connections, RADIUS servers, and SRC software and SDX software, and include login requests, COA requests, multicast join requests, and so on.
- Logout requests that were cached at the start of the in-service software upgrade are processed.
- After the flash memory on the newly active SRP module is updated, stateful SRP switchover is available to the router.

At this point the in-service software upgrade is completed, and the router is restored to normal operation. Any line modules that reloaded during the upgrade phase and were therefore held down are now rebooted to the original running release.

## Application Support for Unified ISSU

When an application supports unified ISSU, you can configure the application on the router and proceed with the unified in-service software upgrade with no adverse impact to the upgrade.

Applications that do not support unified ISSU cannot maintain state and configuration with minimal traffic loss across the upgrade. When you attempt the unified in-service software upgrade on a router that is configured with an ISSU-challenged application, the unified in-service software upgrade is halted and cannot proceed unless you remove the configuration. An application that does not support high availability cannot support unified ISSU.

Table 48 on page 452 indicates which applications support or do not support a unified in-service software upgrade, as well as limitations on their behavior.

**Table 48: Application Support for Unified In-Service Software Upgrades**

| Application                     | Supported | Unsupported | Notes                                                                                                                                                                                                              |
|---------------------------------|-----------|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Physical Layer Protocols</b> |           |             |                                                                                                                                                                                                                    |
| DS1<br>(E120 and E320)          | ✓         | –           | –                                                                                                                                                                                                                  |
| DS1<br>(ERX-1440)               | –         | –           | –                                                                                                                                                                                                                  |
| DS3                             | ✓         | –           | –                                                                                                                                                                                                                  |
| HDLC                            | ✓         | –           | –                                                                                                                                                                                                                  |
| SONET/SDH                       | ✓         | –           | E120 and E320 routers do not support APS.                                                                                                                                                                          |
| SONET/SDH VT                    | –         | ✓           | –                                                                                                                                                                                                                  |
| <b>Link-Layer Protocols</b>     |           |             |                                                                                                                                                                                                                    |
| ARP                             | ✓         | –           | ARP entries in the ARP cache do not time out because no ARP aging occurs during unified ISSU. When the unified ISSU is completed, the ARP cache contains the same entries as it had before the unified ISSU began. |

**Table 48: Application Support for Unified In-Service Software Upgrades** (continued)

| Application                                       | Supported      | Unsupported    | Notes                                             |
|---------------------------------------------------|----------------|----------------|---------------------------------------------------|
| ATM                                               | ✓              | –              | –                                                 |
| ATM 1483 bulk configuration of dynamic interfaces | ✓              | –              | –                                                 |
| ATM bulk configuration of static interfaces       | ✓              | –              | –                                                 |
| Bridged Ethernet                                  | ✓              | –              | –                                                 |
| Cisco HDLC                                        | ✓              | –              | –                                                 |
| Ethernet (with and without VLANs)                 | ✓              | –              | –                                                 |
| Frame Relay                                       | –              | –              | –                                                 |
| PPP                                               | ✓              | –              | –                                                 |
| PPPoE                                             | ✓              | –              | –                                                 |
| Transparent bridging                              | ✓              | –              | –                                                 |
| <b>Unicast Routing</b>                            |                |                |                                                   |
| Access Routes                                     | ✓              | –              | –                                                 |
| BGP                                               | ✓              | –              | –                                                 |
| FTP                                               | –              | ✓              | –                                                 |
| IP                                                | ✓              | –              | –                                                 |
| IPv6                                              | –              | ✓              | Unified ISSU does not support IPv6.               |
| IPSec Transport (E120 and E320)                   | Not applicable | Not applicable | E120 and E320 routers do not support IPSec.       |
| IPSec Transport (ERX-1440)                        | –              | –              | –                                                 |
| IPSec Tunnels (E120 and E320)                     | Not applicable | Not applicable | E120 and E320 routers do not support IPSec.       |
| IPSec Tunnels (ERX-1440)                          | –              | –              | –                                                 |
| IS-IS                                             | ✓              | –              | Support only when graceful restart is configured. |

**Table 48: Application Support for Unified In-Service Software Upgrades** *(continued)*

| Application                   | Supported | Unsupported | Notes                                                                                                                                                                                                                                                                     |
|-------------------------------|-----------|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| OSPF                          | ✓         | –           | Support only when graceful restart is configured.                                                                                                                                                                                                                         |
| RIP                           | ✓         | –           | –                                                                                                                                                                                                                                                                         |
| Static Routes                 | ✓         | –           | –                                                                                                                                                                                                                                                                         |
| Telnet                        | ✓         | –           | Authentication and command authorizations on Telnet sessions fail during the upgrade phase and Telnet sessions are dropped.                                                                                                                                               |
| <b>IPv4 Multicast Routing</b> |           |             |                                                                                                                                                                                                                                                                           |
| Multicast Routing             | ✓         | –           | –                                                                                                                                                                                                                                                                         |
| ANCP (L2C)                    | ✓         | –           | Unified ISSU can proceed if ANCP is configured. However, ANCP has no graceful restart extensions and therefore it cannot maintain its dynamic state across the upgrade. Consequently, all ANCP sessions are brought down and then restored when the upgrade is completed. |
| DVMRP (E120 and E320)         | ✓         | –           | –                                                                                                                                                                                                                                                                         |
| DVMRP (ERX-1440)              | –         | –           | –                                                                                                                                                                                                                                                                         |
| IGMP                          | ✓         | –           | –                                                                                                                                                                                                                                                                         |
| PIM                           | ✓         | –           | –                                                                                                                                                                                                                                                                         |
| <b>IPv6 Multicast Routing</b> |           |             |                                                                                                                                                                                                                                                                           |
| Multicast Routing             | –         | ✓           | Unified ISSU does not support IPv6.                                                                                                                                                                                                                                       |
| MLD                           | –         | ✓           | Unified ISSU does not support IPv6.                                                                                                                                                                                                                                       |

**Table 48: Application Support for Unified In-Service Software Upgrades** *(continued)*

| Application                                                | Supported | Unsupported | Notes                                                                                                                                                                                                                                                                                      |
|------------------------------------------------------------|-----------|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PIM                                                        | –         | ✓           | Unified ISSU does not support IPv6.                                                                                                                                                                                                                                                        |
| <b>Multiprotocol Label Switching</b>                       |           |             |                                                                                                                                                                                                                                                                                            |
| MPLS                                                       | ✓         | –           | –                                                                                                                                                                                                                                                                                          |
| BGP signaling                                              | ✓         | –           | –                                                                                                                                                                                                                                                                                          |
| LDP signaling                                              | ✓         | –           | –                                                                                                                                                                                                                                                                                          |
| RSVP-TE signaling                                          | ✓         | –           | –                                                                                                                                                                                                                                                                                          |
| Local cross-connects between layer 2 interfaces using MPLS | ✓         | –           | –                                                                                                                                                                                                                                                                                          |
| <b>Policies and QoS</b>                                    |           |             |                                                                                                                                                                                                                                                                                            |
| Policies                                                   | ✓         | –           | –                                                                                                                                                                                                                                                                                          |
| QoS                                                        | ✓         | –           | –                                                                                                                                                                                                                                                                                          |
| <b>Remote Access</b>                                       |           |             |                                                                                                                                                                                                                                                                                            |
| AAA                                                        | ✓         | –           | The following configuration is not supported: The subscriber username and password are on an ATM circuit in Bridged Ethernet over ATM or IP over ATM configurations.                                                                                                                       |
| DHCP External Server and Packet Trigger                    | –         | ✓           | –                                                                                                                                                                                                                                                                                          |
| DHCP Packet Capture                                        | ✓         | –           | Configuration of DHCP packet capture does not prevent unified ISSU from proceeding. However, the capturing of packets on the line modules is halted when the unified ISSU upgrade phase commences. Packet capture resumes automatically during the unified ISSU service restoration phase. |

**Table 48: Application Support for Unified In-Service Software Upgrades** *(continued)*

| Application                 | Supported | Unsupported | Notes                                                                                                                                                                                                                                                                                       |
|-----------------------------|-----------|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DHCP Proxy Client           | –         | ü           | –                                                                                                                                                                                                                                                                                           |
| DHCP Relay Proxy            | –         | ✓           | DHCP relay proxy continues processing of DHCP release requests during the unified ISSU to maintain server-client synchronization. State is preserved across the upgrade; statistics are not preserved.                                                                                      |
| DHCP Relay Server           | ✓         | –           | –                                                                                                                                                                                                                                                                                           |
| DHCPv4 Local Server         | ✓         | –           | Forwarding outages that take place during a unified ISSU can affect DHCP lease renewal. Before you begin unified ISSU, we recommend that you configure the DHCP local server address pools with a minimum lease time of 120 minutes to ensure that leases do not expire during the upgrade. |
| DHCPv6 Local Server         | –         | ✓           | Unified ISSU does not support IPv6.                                                                                                                                                                                                                                                         |
| L2TP                        | ✓         | –           | Unified ISSU forces an L2TP failover for all established tunnels. L2TP failover resynchronization is required for successful recovery of a tunnel and its sessions following the upgrade.                                                                                                   |
| L2TP Dialout                | –         | ✓           | –                                                                                                                                                                                                                                                                                           |
| Local Address Pools         | ✓         | –           | –                                                                                                                                                                                                                                                                                           |
| Local Authentication Server | ✓         | –           | –                                                                                                                                                                                                                                                                                           |
| RADIUS Client               | ✓         | –           | –                                                                                                                                                                                                                                                                                           |



**Table 48: Application Support for Unified In-Service Software Upgrades** *(continued)*

| Application                        | Supported | Unsupported | Notes |
|------------------------------------|-----------|-------------|-------|
| RADIUS Dynamic-Request Server      | ✓         | –           |       |
| RADIUS Initiated Disconnect        | ✓         | –           | –     |
| RADIUS Relay Server                | –         | ✓           | –     |
| RADIUS Route-Download Server       | ✓         | –           | –     |
| SRC Client                         | ✓         | –           | –     |
| Service Manager                    | –         | ✓           | –     |
| Subscriber Manager                 | ✓         | –           | –     |
| TACACS +                           | ✓         | –           | –     |
| <b>Miscellaneous</b>               |           |             |       |
| Bulk statistics                    | ✓         | –           | –     |
| Denial of Service (DoS) protection | ✓         | –           | –     |
| HTTP server                        | ✓         | –           | –     |
| IOA hot swap                       | –         | ✓           | –     |
| J-Flow (IP flow statistics)        | ✓         | –           | –     |

**Table 48: Application Support for Unified In-Service Software Upgrades** (continued)

| Application                       | Supported | Unsupported | Notes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-----------------------------------|-----------|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Line Module Redundancy            | ✓         | –           | <p>When you issue the <b>issu initialization</b> command, line module redundancy is made inactive until the upgrade is completed.</p> <p>If a line module in the redundancy group fails during this period of inactivity, unified ISSU holds that module down. The redundant line module cannot take over for the failed line module until the unified ISSU is completed.</p> <p>The primary line modules in the redundancy group must be active for the unified ISSU to proceed. If instead the redundant module is active, validation fails and unified ISSU is halted. You must revert to the primary module in the redundancy group to proceed with the upgrade.</p> |
| Mobile IP Home Agent              | –         | ✓           | –                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Network Address Translation (NAT) | ✓         | –           | You must remove the NAT license configuration as well as the NAT configuration from the router.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| NTP                               | ✓         | –           | –                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Resource Threshold Monitor        | ✓         | –           | –                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Response Time Reporter            | ✓         | –           | –                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Route Policy                      | ✓         | –           | –                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

**Table 48: Application Support for Unified In-Service Software Upgrades** *(continued)*

| Application             | Supported | Unsupported | Notes |
|-------------------------|-----------|-------------|-------|
| SNMP                    | ✓         | –           | –     |
| Subscriber Interfaces   | ✓         | –           | –     |
| Tunnels (GRE and DVMRP) | ✓         | –           | –     |
| VRRP                    | ✓         | –           | –     |

## Unexpected Application-Specific Behavior During Unified ISSU

This section describes the behavior of applications that vary from the expected behavior during a unified in-service software upgrade.

- “AAA Authentication and Authorization Disabled” on page 459
- “ATM Affected Behaviors” on page 460
- “DHCP Affected Behaviors” on page 461
- “DoS Protection State Freeze” on page 461
- “Ethernet Affected Behaviors” on page 462
- “FTP Server File Transfers Halted” on page 462
- “IS-IS Effects on Graceful Restart and Network Stability” on page 463
- “L2TP Failover of Established Tunnels” on page 464
- “OSPF Effects on Graceful Restart, Timeouts, and Network Stability” on page 465
- PIM Suspended During Unified ISSU on page 467
- “Subscriber Logins and Logouts Suspended During Unified ISSU” on page 467
- “SONET/SDH Behavior During Unified ISSU” on page 468
- T3 on page 468
- “TACACS+ Services Not Available” on page 468
- “Interruption in Traffic Forwarding for Layer 3 Routing and Signaling Protocols” on page 469
- “Recommended Routing Protocol Timer Settings” on page 471

### AAA Authentication and Authorization Disabled

Authentication and command authorization are temporarily disabled on the serial console connection during the upgrade phase. You can connect to the serial console and issue the **reload**, **show issu**, and **show version** commands without the action of authentication and authorization servers, such as RADIUS or TACACS+.

## **ATM Affected Behaviors**

The following aspects of ATM behavior during unified ISSU are different than the behavior during normal router operations.

### **ILMI Sessions Not Maintained**

The router does not maintain ILMI sessions during a unified in-service software upgrade. The router terminates all ILMI sessions and restarts them during the upgrade. If the ILMI protocol is enabled on any port, you are warned during the initialization phase when unified ISSU is verifying the prerequisites for the upgrade. You can choose to continue the upgrade—and bring down the sessions—or to halt the in-service software upgrade.

### **OAM CC Effects on VCC**

When an ATM VC is configured as an OAM CC source, periodic OAM cells are generated for about 15 seconds. The device configured as the OAM CC sink is likely to declare the VCC down during this time. Unified ISSU generates a warning when it detects an OAM CC source configuration during the initialization phase while unified ISSU is verifying the prerequisites for the upgrade. You can choose to continue or halt the in-service software upgrade.

When an ATM VC is configured as OAM CC sink, it cannot receive OAM CC cells generated by the source for about 15 seconds. The OAM CC does not time out and the VCC is not declared down. OAM CC cell generation resumes when the unified ISSU operation is completed.

### **OAM VC Integrity Verification Cessation**

During the unified ISSU operation, verification of OAM VC integrity stops. This verification resumes when the unified ISSU operation is completed.

ATM does not respond to incoming OAM loopback cells during the upgrade for a period of less than 30 seconds. The lack of response might cause ATM peers to declare VCC (VPC) down.

### **Port Data Rate Monitoring Cessation**

The monitoring of ATM port data rates is halted during a unified in-service software upgrade. Monitoring resumes immediately after the unified ISSU operation is completed. The data rates reported by the **show atm interface** command are inaccurate for the period of one configured load interval after unified ISSU is completed.

### **VC and VP Statistics Monitoring Halts Unified ISSU Progress**

A unified in-service software upgrade cannot proceed if VC or VP statistics monitoring is in progress.

## DHCP Affected Behaviors

### DHCP Common Component Information Suspended

The common DHCP component supports unified ISSU. This component configures option 60 vendor-option strings when you issue the **set dhcp vendor-option** command. The DHCP common component ceases all CLI and SNMP operations when you issue **issu start** command. You can therefore obtain no information about the common DHCP infrastructure until the in-service software upgrade is completed.

### DHCP External Server Prevents Unified ISSU Operation

The DHCP external server application does not support unified ISSU. You must completely unconfigure this application from all virtual routers to perform a unified in-service software upgrade.

### DHCP Relay and DHCP Relay Proxy Prevent Unified ISSU

The DHCP relay and DHCP relay proxy applications do not support unified ISSU. You must completely unconfigure these applications from all virtual routers to perform a unified in-service software upgrade.

### DHCP Packet Capture Halted on Line Modules

The DHCP packet capture application supports unified ISSU in that its configuration does not halt a unified in-service software upgrade. However, packet capture on line modules is halted during the upgrade phase. Packets are not captured and buffered for later forwarding to the SRP module during this phase. Capture resumes automatically during the service restoration phase.

## DoS Protection State Freeze

The denial-of-service (DoS) protection application freezes its state when the in-service software upgrade is initiated. Any suspicious control flow, protocol, or priority remains suspicious until unified ISSU completes.

Freezing the DoS protection state prevents any active control flows from interfering with the system while the unified ISSU is in progress. However, no new control flows, protocols, or priorities are monitored for suspicious activity, and no suspicious activity can be detected until the upgrade is completed.



**NOTE:** Because of this limitation on DoS functionality, we recommend that you do not initiate unified ISSU until all suspicious control flows, protocols, and priorities have been resolved.

---

When the in-service software upgrade is completed, the DoS protection application resumes attending to all dynamic state that was frozen at the beginning of the unified ISSU process.

Some suspicious control flows might remain in a suspicious list based on your configuration, if the upgrade software version has DoS protection classification algorithms that are better or different than in the previous version. Because flows are discovered and monitored at 1-second intervals, the new conditions might cause these flows to be removed. You do not need to explicitly clear the flows when unified ISSU is completed.

## ***Ethernet Affected Behaviors***

The following aspects of Ethernet behavior during a unified in-service software upgrade are different than during normal router operations.

### **ARP Packets Briefly Not Sent or Received**

There is a brief period at the end of the upgrade phase when ARP packets are not sent or received. This event can affect ARP entries on attached devices that were in the process of being aged out.

### **Link Aggregation interruption**

During the in-service software upgrade, LACP PDUs are not generated or received for about 15 seconds on Ethernet ports configured with LACP,

This interruption has no effect on the local side of the link because JUNOS software generates LAC PDU packets every 30 seconds. The link is not declared down unless packets are missed three times. LACP packet generation continues when the unified ISSU operation is completed.

If a device on the other end of the link is configured with the short timeout of one second, then the device is likely to declare the link to be down and remove the link from the LAG bundle.

### **Port Data Rate Monitoring Halted**

The monitoring of Ethernet port data rate is halted during a unified in-service software upgrade. Monitoring resumes immediately after the unified ISSU operation is completed. The data rates reported by the **show interface** command are inaccurate for the period of one configured load interval after unified ISSU is completed.

### **VLAN Statistics Monitoring Halts Unified ISSU Progress**

A unified in-service software upgrade cannot proceed if VLAN statistics monitoring is in progress.

## ***FTP Server File Transfers Halted***

During a unified in-service software upgrade, file transfers that involve the FTP server are halted because of the SRP module switchover during the upgrade.

For this reason, the FTP server does not support unified ISSU. You can continue with the in-service software upgrade only when the FTP server is not enabled. You must disable the FTP server to perform the upgrade.

## ***IS-IS Effects on Graceful Restart and Network Stability***

IS-IS has the following issues to consider before you begin a unified in-service software upgrade:

- Graceful restart—Required
- Routing around the upgrading router—Optional

### **Configuring Graceful Restart Before Unified ISSU Begins**

You must configure IS-IS graceful restart on the router and on all IS-IS neighbors before you begin the in-service software upgrade. When the unified ISSU process verifies the upgrade requirements during the initialization phase, it detects whether graceful restart is configured. If it is not configured, the CLI displays a warning message and prompts you to proceed or halt. You can stop at this point to configure graceful restart.

If instead you proceed, the in-service software upgrade can complete successfully, but the IS-IS neighbors are likely to break the adjacencies with the upgrading router and consider that routes formerly reached through this router are now unreachable. When the in-service software upgrade completes and the routing protocols restart, the IS-IS neighbors can relearn the routes through the router.

When you issue the **issu start** command, IS-IS lengthens its hello timer values and sends LSPs with the new values. The upgrade proceeds when the IS-IS neighbors have acknowledged the new values.

### **Configuring Graceful Restart When BGP And LDP Are Configured**

When BGP, IS-IS, and LDP are all configured on a router on which you will perform a unified in-service software upgrade, ensure that the IS-IS graceful restart timeout is longer than the LDP graceful restart timeout. The IS-IS graceful restart does not complete when the LDP graceful restart timeout is longer than the IS-IS graceful restart timeout. Configure IS-IS graceful timeout with the **nsf t3** command. Configure LDP graceful restart timeout with the **mpls ldp graceful-restart timers max-recovery** command.

### **Routing Around the Restarting Router to Minimize Network Instability**



**NOTE:** The situation described in this section is very uncommon. This rare circumstance arises when you have redundant uplinks to the core and network topology changes cause routes to go through the upgrading router. In a typical network design, this is not an issue and you do not need to route peers around the upgrading router,

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During the unified ISSU upgrade phase, network instability can result if the restarting router goes into an unstable state after the unified ISSU process fails. Some IS-IS traffic loss occurs during the resulting line module resets. For those reasons, you might want IS-IS peers to route around the router that is being upgraded.

You can use the **overload advertise-high-metric issu** command to cause the router to advertise a high metric to its neighbors so that they route around the upgrading router. When you issue the **issu start** command, the router raises the metric to the maximum link cost on all interfaces running IS-IS. The maximum value depends on the metric type. IS-IS neighbors then choose a path with lower metrics to reach any destination that was previously reached through the upgrading router. When unified ISSU is completed, IS-IS reverts the metrics back to the values that were configured before the in-service software upgrade.

When traffic engineering has been configured, the traffic engineering metrics are also increased. New tunnels are not established through the upgrading router and any tunnels undergoing re-optimization in other routers go around the upgrading router.

IS-IS support for unified ISSU does not depend on this configuration. If you do not issue the **overload advertise-high-metric issu** command, the in-service software upgrade can still proceed to successful completion without disrupting IS-IS functionality.

#### **overload advertise-high-metric issu**

- Use to cause IS-IS to advertise the maximum link metric on all interfaces to IS-IS neighbors when a unified in-service software upgrade is started.
- Example

```
host1(config-router)#overload advertise-high-metric issu
```

- Use the **no** version to send the configured link costs to neighbors during the in-service software upgrade.
- See `overload advertise-high-metric issu`.

### **L2TP Failover of Established Tunnels**

L2TP never declares itself as unified ISSU unsafe. However, unified ISSU forces an L2TP failover for all established tunnels. Successful recovery of a tunnel and its sessions following the in-service software upgrade requires a successful L2TP failover resynchronization, either by the L2TP silent failover method or the L2TP failover protocol.

When the L2TP silent failover method is configured on ERX-1440 routers, use the **l2tp retransmission** command to set the retransmission retry count to 8 for the remote peers. A value of more than 7 helps ensure that the remote peers keep retransmitting control messages for the duration of the unified ISSU warm restart and the tunnels are not disconnected.



When the unified ISSU operation attempts to verify the upgrade prerequisites, a warning message is generated if any tunnels are present for which failover resynchronization is disabled.

You can use the **show l2tp tunnel failover-resync disable** command to identify the tunnels referred to by the warning message. The command enables filtering based upon the effective failover resynchronization mechanism:

```
host1#show l2tp tunnel failover-resync disable
L2TP tunnel 2/1 is Up with 1 active session
1 L2TP tunnel found
```

If a successful failover resynchronization cannot be performed for a tunnel following the upgrade, then the tunnel and all of its sessions are subject to disconnection.

L2TP automatically detects a peer L2TP disconnect after the in-service software upgrade is completed by detecting a control channel failure.

When peer LNSs are not configured with PPP keepalives or inactivity timeouts, you must configure an inactivity timeout for L2TP on the LAC. This timeout enables the router to detect a PPP disconnect when signaling has been dropped during the unified ISSU forwarding interruption. In the absence of this configuration, the connection at the LAC and LNS is left as logged in for an extended period of time following the upgrade.

## ***OSPF Effects on Graceful Restart, Timeouts, and Network Stability***

OSPF has the following issues to consider before you begin a unified in-service software upgrade:

- Graceful restart—Required
- Dead interval—Required
- Routing around the upgrading router—Optional

### **Configuring Graceful Restart Before Unified ISSU Begins**

You must configure OSPF graceful restart before you begin the in-service software upgrade. When the unified ISSU process verifies the upgrade requirements during the initialization phase, it detects whether graceful restart is configured. If it is not configured, the CLI displays a warning message and prompts you to proceed or halt. You can stop at this point to configure graceful restart.

If instead you proceed, the in-service software upgrade can complete successfully, but the OSPF neighbors are likely to break the adjacencies with the upgrading router and consider that routes formerly reached through this router are now unreachable. When the in-service software upgrade completes and the routing protocols restart, the IS-IS neighbors can relearn the routes through the router.

You must also ensure that the OSPF neighbors have been configured as graceful restart helper routers. During the unified ISSU initialization phase, OSPF graceful restart on the upgrading router cannot verify whether its neighbors are helper routers, and reports that fact by means of the CLI.

## Configuring Graceful Restart When BGP And LDP Are Configured

When BGP, LDP, and OSPF are all configured on a router on which you will perform a unified in-service software upgrade, ensure that the OSPF graceful restart timeout is longer than the LDP graceful restart timeout. The OSPF graceful restart does not complete when the LDP graceful restart timeout is longer than the OSPF graceful restart timeout. Configure OSPF graceful restart timeout with the **graceful-restart restart-time** command. Configure LDP graceful restart timeout with the **mpls ldp graceful-restart timers max-recovery** command.

## Configuring a Longer Dead Interval Than Normal

To prevent OSPF from timing out to the OSPF neighbors, you must configure a dead interval that is longer than the period required for the in-service software upgrade to complete. You must use the value provided by unified ISSU in a warning message displayed during the initialization phase.

## Routing Around the Restarting Router to Minimize Network Instability



**NOTE:** The situation described in this section is very uncommon. This rare circumstance arises when you have redundant uplinks to the core and network topology changes cause routes to go through the upgrading router. In a typical network design, this is not an issue and you do not need to route peers around the upgrading router,

During the unified ISSU upgrade phase, network instability can result if the restarting router goes into an unstable state after the unified ISSU process fails. Some OSPF traffic loss occurs during the resulting line module resets. For those reasons, you might want OSPF peers to route around the router that is being upgraded.

You can use the **overload advertise-high-metric issu** command to cause the router to advertise a high link cost to its neighbors so that they route around the upgrading router. When you issue the **issu start** command, the router raises the link cost to the maximum link cost on all interfaces running OSPF. The higher cost is advertised in the OSPF LSAs. OSPF neighbors then choose a path with lower metrics to reach any destination that was previously reached through the upgrading router. When unified ISSU is completed, OSPF reverts the link costs back to the values that were configured before the in-service software upgrade.

When traffic engineering has been configured, the traffic engineering metrics are also increased. New tunnels are not established through the upgrading router and any tunnels undergoing re-optimization in other routers go around the upgrading router.

OSPF support for unified ISSU does not depend on this configuration. If you do not issue the **overload advertise-high-metric issu** command, the in-service software upgrade can still proceed to successful completion without disrupting OSPF functionality.

***overload advertise-high-metric issu***

- Use to cause OSPF to advertise the maximum link cost on all interfaces to OSPF neighbors when a unified in-service software upgrade is started.

- Example

```
host1(config-router)#overload advertise-high-metric issu
```

- Use the **no** version to send the configured link costs to neighbors during the in-service software upgrade.
- See `overload advertise-high-metric issu`.

### ***PIM Suspended During Unified ISSU***

You can minimize PIM traffic loss during the in-service software upgrade by issuing the **ip pim dr-priority** command to set a priority so that PIM neighbors do not forward traffic through the upgrading router. By default, a PIM interface has a priority of one. If you set the priority to one, the lowest possible priority, then the upgrading router is not selected to be a designated router in the PIM network if an interface on another router in that network has a higher priority.

#### ***ip pim dr-priority***

- Use to set a priority by which a router is likely to be selected as the designated router.
- Example

```
host1(config-if)#ip pim dr-priority 1
```

- Use the **no** version to restore the default value, 1.
- See `ip pim dr-priority`.

### ***Subscriber Logins and Logouts Suspended During Unified ISSU***

All new subscriber logins are ignored during the upgrade phase. New subscriber logouts are cached and processed after the unified ISSU operation is completed.

#### **Subscriber Statistics Accumulation or Deletion**

All subscriber statistics present in the line modules are cleared when the line module forwarding planes are upgraded. For this reason, the router has to read the statistics from the forwarding plane before it is upgraded.

However, forwarding through the line modules continues after that point, until the line module forwarding plane is upgraded. Some statistics can therefore accumulate in the forwarding plane in the interval between these two events. These statistics are not preserved across the upgrade.

Statistics for subscribers that log out during the forwarding plane upgrade are collected and reported before the forwarding plane is reloaded. Statistics are not collected for

any subscribers who are connected before you issue the **issu start** command but who log out before the forwarding plane upgrade is completed.

The following subscriber statistics are preserved across the upgrade:

- All policy statistics
- Accounting statistics reported by IP: in bytes, out bytes, in packets, out packets
- Accounting statistics reported by L2TP: in octets, out octets, in packets, out packets
- Accounting statistics reported by PPP: in octets, out octets, in packets, out packets

All other statistics are set to zero, including all statistics belonging to the SNMP generic interface MIB for every interface layer.

### ***SONET/SDH Behavior During Unified ISSU***

During a unified in-service software upgrade, several aspects of SONET behavior differ from normal operation.

- SONET APS is not supported.
- During a conventional software upgrade, a SONET loss-of-signal defect lasts more than 2.5 seconds, causing the router to declare an LOS failure. Devices on the remote end of SONET links detect the failure and bring down the link and the dynamic interface stacks built on the link.

During a unified in-service software upgrade, the LOS does not last more than 2.5 seconds. The remote device detect a momentary LOS but does not perceive this short LOS as a link failure and does not bring the link down,

### ***T3***

Local T3 (DS3) devices are reprogrammed during a unified in-service software upgrade, generating a defect. The router completes the reprogramming within 2.5 seconds. Because JUNOS DS3 applications declare an alarm and bring down the link only if the defect persists for more than 2.5 seconds, unified ISSU does not cause the links to be brought down. However, the remote T3 devices must also wait 2.5 seconds before declaring an alarm. If the equipment on the far end of the T3 connection generates an alarm immediately rather than waiting, the link goes down, causing the higher layers to also go down for the remote equipment.

### ***TACACS+ Services Not Available***

During the upgrade phase of unified ISSU, TACACS+ services are unavailable. If you have configured AAA authentication for Telnet (with the **aaa new-model command**) this lack of availability affects CLI authentication, authorization, and accounting activities.

CLI login and privilege authentication cannot succeed during a unified ISSU unless you configure at least one of the alternate authentication methods with the **aaa authentication login** command: **enable**, **line**, or **none**.

Similarly, CLI exec and command authorization cannot succeed during a unified ISSU unless you configure one of the alternate authorization methods with the **aaa authorization** command: **if-authenticated** or **none**.

Because there is no alternate method of accounting other than TACACS, CLI exec and command accounting does not work during this phase.

### ***Interruption in Traffic Forwarding for Layer 3 Routing and Signaling Protocols***

The routing protocols are affected by two interruptions in traffic forwarding caused by the in-service software upgrade during the upgrade phase.

- **Switchover from active to standby SRP module**—When the active SRP module running the current release switches over to the standby SRP module running the upgrade release, the routing protocols and all other applications restart. A control plane outage of 30–40 seconds prevents the protocols from sending hellos or keepalive messages.

The protocols must gracefully restart to come back online, recover their routing state on the newly active SRP module, and respond to their peers. Therefore, you must enable graceful restart for all protocols before you begin the in-service software upgrade. All neighbors of the routing protocols must also be configured to support graceful restart.

A data plane outage of about 1 second for the E120 and E320 routers and about 4 seconds for the ERX-1440 router also takes place during the switchover of the fabric from the active primary SRP module to the standby SRP module.

- **Upgrade of the forwarding plane for each line module**—After the routing protocols reconverge with their peers and rebuild their routing tables, unified ISSU upgrades the forwarding plane on all line modules simultaneously. This upgrade halts forwarding through the chassis. This forwarding outage lasts about 15 seconds for the E120 and E320 routers and about 50 seconds for the ERX-1440 router.

If capable, routing protocols temporarily lengthen their timers to survive the outages. During the initialization phase, unified ISSU checks for timers that are set too short and whether the protocol enables timer renegotiation. If these checks fail, unified ISSU generates a warning and enables you to reconfigure the protocols before you issue the **issu start** command.

We recommend that you configure timers to be longer than usual for the routing protocols that cannot renegotiate timers. You can use bidirectional forwarding detection (BFD) to quickly detect forwarding interruptions.

Table 49 on page 470 describes how individual routing protocols behave during a unified in-service software upgrade.

**Table 49: Behavior of Routing Protocols During a Unified In-Service Software Upgrade**

| Protocol | Behavior                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| BFD      | BFD renegotiates its timers as needed. Typically, the timers are lengthened until the SRP module switchover takes place, then shortened for the forwarding plane upgrade, and finally shortened to the original configured values.                                                                                                                                                                                                                                                                                                                                                                                        |
| BGP      | <p>The configured BGP timers are typically long enough to survive the forwarding outages. If not, unified ISSU generates a warning message.</p> <p>BGP sends out keepalive messages immediately before and immediately after both the SRP module switchover and the forwarding plane restart, independent of the interval since it last sent them.</p>                                                                                                                                                                                                                                                                    |
| IS-IS    | If necessary, temporarily lengthens the hello timers.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| LDP      | <p>Unified ISSU warns you if the hello timers or the keepalive timers are not long enough to survive the forwarding plane upgrade.</p> <p>LDP sends out hello messages and keepalive messages immediately before and immediately after both the SRP module switchover and the forwarding plane restart, independent of the interval since it last sent them.</p>                                                                                                                                                                                                                                                          |
| OSPF     | <p>OSPF timers are not negotiable between peers. Unified ISSU generates a warning if the hello timers or the keepalive timers are not long enough to survive the forwarding plane upgrade.</p> <p>OSPF begins a graceful restart before the SRP module switchover. When you configure graceful restart before the in-service software upgrade, you must ensure that the graceful restart times are long enough to allow recovery.</p> <p>OSPF sends out hello messages and keepalive messages immediately before and immediately after forwarding plane restart, independent of the interval since it last sent them.</p> |
| PIM      | <p>If necessary, temporarily lengthens the hold times in hello messages. PIM guarantees that at least one hello message with a lengthened hold time is sent to each neighbor.</p> <p>If necessary, increases the join-prune hold time. PIM guarantees that at least one join-prune message with a lengthened hold time is sent to each neighbor.</p>                                                                                                                                                                                                                                                                      |
| RIP      | RIP timers do not affect unified ISSU.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| RSVP-TE  | <p>If necessary, temporarily lengthens the graceful restart timers to survive the SRP module switchover.</p> <p>If necessary, lengthens the hello timers to survive the forwarding plane upgrade.</p>                                                                                                                                                                                                                                                                                                                                                                                                                     |

You might want some or all traffic to be routed around the upgrading router rather than accept a forwarding loss during the forwarding interruption. To do so, you must configure your routing protocols appropriately. For example, you might raise the link

cost in IS-IS and OSPF, causing their neighbors to seek alternate routes that have lower link costs. In PIM, you can set the priority for the router interface to zero to ensure that the upgrading router is not selected as a designated router.

## Recommended Routing Protocol Timer Settings

You can use the default values for many of the routing protocol timers with no adverse effect on a unified in-service software upgrade. For other timers, we recommend particular values, as described in Table 50 on page 471.

**Table 50: Recommended Routing Protocol Timer Settings**

| Protocol | Timers                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| BFD      | Use the default timers.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| BGP      | Use the default timers, including graceful restart default timers.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| DVMRP    | Use the default timers.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| IGMP     | Use the default timers.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| IS-IS    | Use the default timers, including graceful restart default timers.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| LDP      | <p>Use the default timers, including graceful restart default timers, except for the following:</p> <ul style="list-style-type: none"> <li>■ Set the hello hold time to at least 901 seconds for a helper or a restarter configuration for a link-level adjacency or for LDP targeted sessions.</li> </ul>                                                                                                                                                                                                                                                                            |
| OSPF     | Use the default timers, including graceful restart default timers, except for the dead interval. Set the OSPF dead interval to at least 301 seconds.                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| PIM      | <p>Set the query interval to at least 210 seconds.</p> <p>ISSU generates a warning for any of the following conditions, but you can ignore the warning without causing a higher FC outage:</p> <ul style="list-style-type: none"> <li>■ The current router is a DR.</li> <li>■ The current router is configured as an Auto RP mapping agent and is chosen as the RP for any group.</li> <li>■ The current router is an elected or candidate BSR, or if BSR candidate RPs are configured.</li> <li>■ The graceful restart timer is less than the default value, 30 seconds.</li> </ul> |
| RIP      | <p>Use the default timers; graceful restart is not supported. For scaled configurations, such as for 2000 RIP interfaces, use the following values:</p> <ul style="list-style-type: none"> <li>■ Flush interval: 600 seconds</li> <li>■ Holddown time: 260 seconds</li> <li>■ Invalid interval: 260 seconds</li> <li>■ Update interval: 60 seconds</li> </ul>                                                                                                                                                                                                                         |

**Table 50: Recommended Routing Protocol Timer Settings** *(continued)*

| Protocol | Timers                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| RSVP-TE  | <p>Use the default timers, including graceful restart default timers, except for the following:</p> <ul style="list-style-type: none"> <li>■ For graceful restart, the hello timeout interval is the product of hello misses multiplied by the hello refresh interval. Determine which period is longer, the IC upgrade time or the forwarding upgrade time. Configure the hello refresh and hello miss values so that the hello timeout is greater than the longer of those two periods.</li> <li>■ For node hellos, the product of the refresh misses multiplied by the hello refresh interval must be great than the FC outage time. For an outage time of less than 30 seconds, for example, configure the following values: <ul style="list-style-type: none"> <li>■ Set the node hello refresh interval to 8000.</li> <li>■ Set the node hello refresh misses to 4.</li> </ul> </li> </ul> |

## Before You Begin a Unified In-Service Software Upgrade

The following hardware and software prerequisites must be met for the successful completion of unified ISSU. You can issue the **show issu** command to determine whether the routers meets these requirements.

### Hardware Requirements for Unified ISSU

- The router must support unified ISSU. Therefore the router must be an E120, E320, or ERX-1440 router.
- Two SRP modules must be installed in the router.
- All installed combinations of line modules and IOAs must support unified ISSU. Unsupported modules that are online are reloaded during the unified ISSU, with consequent loss of connections and traffic forwarding.

Do not install IOAs in the chassis while the unified ISSU operation is in process.

- The redundant SRP module must have at least 300 MB of free memory. Depending on their configuration, line modules require up to 75 MB of free memory.

For information about modules supported on E120 and E320 routers:

- See *E120 and E320 Module Guide, Table 1, Modules and IOAs* for detailed module specifications.
- See *E120 and E320 Module Guide, Appendix A, IOA Protocol Support* for information about the modules that support unified ISSU.
- On the ERX-1440, certain hardware updates might require a module to be cold restarted. Unified ISSU cannot be successfully accomplished with such modules. In this case, the behavior is the same as for unsupported line modules. The



unified ISSU process reboots these modules and holds them down until the supported modules on the router complete the unified ISSU process.

When hardware updates are required for modules that you have installed in an ERX-1440 router, contact your Juniper Networks representative to determine whether the update affects unified ISSU.

## **Software Requirements for Unified ISSU**

- The running JUNOS software release must support unified ISSU.

You can upgrade to a software version that supports unified ISSU from a software version that does not support unified ISSU only by means of a conventional upgrade. During the conventional upgrade, all line modules are reloaded, all subscribers are dropped, and traffic forwarding is interrupted until the upgrade is completed.

- The armed (upgrade) release must be capable of being upgraded to from the currently running release; it must be higher-numbered than the running release.
- All applications that are configured on the router must support unified ISSU and stateful SRP switchover.

If one or more unified ISSU-challenged applications are configured and you proceed with a unified in-service software upgrade, the unified ISSU process forces a conventional upgrade on the router. All line modules are reloaded, all subscribers are dropped, and traffic forwarding is interrupted until the upgrade is completed.

You can avoid this circumstance by removing the configuration for the unified ISSU-challenged applications from the router before you begin the in-service software upgrade.

See “Application Support for Unified ISSU” on page 452 for information about whether an application supports unified ISSU.

- Stateful SRP switchover must be configured on the router. Use the following commands to configure high availability:

```
host1(config)#redundancy
host1(config-redundancy)#mode high-availability
```

See “Managing Modules” on page 335 for information about high availability.

The following requirements must be met for traffic forwarding to continue. However, failing to meet these requirements does not halt the unified ISSU operation. The unified ISSU process offers the option to override or ignore these forwarding requirements.

- Graceful restart must be enabled for all configured routing protocols. The unified ISSU operation relies on graceful restart to keep the routing protocols alive through the various stages of the upgrade.
- All connected peers must be configured with graceful restart. Because some protocols cannot themselves confirm peer configuration for graceful restart, you must ensure that the peers are properly configured.
- For applications that exchange keepalive messages with peers, you must ensure that the poll times are adequate to maintain the peering session across any forwarding interruption caused by the unified ISSU operation.
- On the ERX-1440, you must enter the key provided with your license in order to make the unified ISSU CLI commands available. Unified ISSU is licensed on only the ERX-1440 router; no license is required or available on the E120 and E320 routers.

The license issu command is available only on the ERX-1440 CLI.

## Upgrading Router Software with Unified ISSU

To upgrade your router software by means of unified ISSU, perform the following steps.

1. Disable autosynchronization.

```
host1(config)#disable-autosync
```

2. Copy the new release to the router.



**NOTE:** Be sure to specify the correct software release (.rel) filename for the router you are using, as described in the section “Identifying the Software Release File” on page 126 in “Installing JUNOS Software” on page 125.

```
host1#copy /incoming/releases/ftpserver/quebec2.rel R2.rel
```

3. Save the current configuration.

```
host1#copy running-configuration system2.cnf
```

4. Determine whether the router hardware and the software release meet the criteria required for unified ISSU to operate successfully by using one of the following commands:

```
host1#show issu
host1#show issu brief
host1#show issu detail
```

5. Arm the primary SRP module with the upgrade release.

```
host1#boot system R2.rel
```



**NOTE:** You must arm any hotfixes that need to be loaded with the new release after you have armed the new release. The hotfixes are supplied when the modules to which they apply are rebooted.

6. Synchronize the NVS file system of the redundant SRP module with that of the primary SRP module.

```
host1#synchronize
```

Because the redundant SRP module is running a different release than the armed release, the module automatically reboots and runs the armed (upgrade) release, R2.rel.

Wait for the redundant SRP module to boot, initialize, and reach the standby state. At this point, the REDUNDANT LED on the module is illuminated and the ONLINE LED is off. The State field in the show version display indicates that the redundant module is in the standby state.

7. Synchronize the file system of the primary module with that of the redundant module.

The NVS file systems of the two SRP modules are unsynchronized because the redundant SRP module rebooted.

```
host1#synchronize
```

8. Reenable autosynchronization.

```
host1(config)#no disable-autosync
```

9. (ERX-1440 only) Configure the ERX-1440 license key.

```
host(config)#license issu xyz123abc
```

License for ISSU configured.

10. Determine whether unified ISSU is in the Idle state and whether all upgrade requirements have been met.

```
host1#show issu
```



**NOTE:** If the results indicate that some requirements are not met, you must correct this situation before proceeding.

11. Ensure that stateful SRP switchover is configured on the router.

```
host1#show redundancy srp
```

If it is not already configured, do so now.

```
host1(config)#redundancy
```

```
host1(config-redundancy)#mode high-availability
```

12. For each configured protocol on the router and its neighbors, ensure that graceful restart is configured. See the relevant protocol configuration chapters in the JUNOS document set for information about configuring graceful restart.
13. Begin the initialization phase of the in-service software upgrade.

```
host1#issu initialize
```

The CLI displays the status of the initialization as it proceeds.

14. (Optional) From a different CLI session, display the progress of the initialization.

```
host1#show issu
```

Unified ISSU must be in the Initialized state before you proceed to the next step. The time required for initialization varies with the system load and the complexity of the router configuration.

15. Start the upgrade phase.

```
host1#issu start
```

The router switches to the redundant SRP module running the upgrade release, R2.rel. Significant upgrade milestones are displayed as they occur.

16. When the console indicates that the upgrade is completed, you can verify that the router is back in the idle state and running the upgrade release, R2.rel.

```
host1#show issu
```

You can also verify the status of the SRP modules and line modules, as well as the running and armed releases.

```
host1#show version
```

### ***issu initialize***

- Use to start the initialization phase of the unified ISSU process.
- This command displays the percentage completion for the process as it takes place.
- Example

```
host1#issu initialize
Verifying the ISSU criteria... verified
Starting the ISSU initializing phase
Upgrading the standby SRP- This phase can take a long time
10% completed...
```

- There is no **no** version.
- See `issu initialize`.

**issu start**

- Use to start the upgrade phase of the unified ISSU process after the initialization phase has completed.

- Example

```
host1#issu start
Verifying the ISSU criteria... verified
The system will now enter the upgrading phase. This phase cannot be aborted.
Do you wish to continue?
Yes
Starting the ISSU upgrade phase
... Upgrading the line card – Control plane
... Upgrading completed
Switching from primary SRP to the standby SRP
The system will resume on the SRP in slot 7 in a few minutes.
```

- There is no **no** version.
- See **issu start**.

**issu stop**

- Use to gracefully stop a unified in-service software upgrade and place the process in an idle state.
- You can issue this command only when unified ISSU is in the initialized state. You cannot issue this command after you have issued the **issu start** command to begin the upgrade phase of unified ISSU.
- Example

```
host1#issu stop
The command will abort the ISSU operation. Do you wish to continue?
Yes
Stopping the ISSU upgrade process
...reloading standby SRP
```

- There is no **no** version.
- See **issu stop**.

**license issu**

- Use to specify the unified ISSU license key for an ERX-1440 router.
- Purchase a unified ISSU license to allow a unified ISSU upgrade on an E-series router.



**NOTE:** Acquire the ERX-1440 unified ISSU license from Juniper Networks Customer Service or your Juniper Networks sales representative.

---

- The **issu initialization**, **issu start**, **issu stop**, and **show issu** commands are not visible on an ERX-1440 router until you specify the license.

- This command is not visible on an E120 or E320 router. A license is not required or available for the E120 and E320 routers.
- Example 1—the correct key is entered
 

```
host1#license issu xyz123abc
License for ISSU configured.
```
- Example 2—an incorrect key is entered
 

```
host1#license issu abc123def456
%Unable to configure ISSU license (Invalid License)
```
- Use the **no** version to disable the license on the ERX-1440 router.
- See `license issu`

## Halting the Unified ISSU Process and Restoring the Original State of the Router

The options that are available to halt the in-service software upgrade depend on the phase that the upgrade is in when you attempt to halt it. The phase also affects the state of the router after the upgrade is halted.

### Halting Unified ISSU During Initialization Phase

During the initialization phase, you can halt the unified ISSU process by issuing the **issu stop** command. This action reloads the redundant SRP module with the armed upgrade release. As a result, unified ISSU is placed in the idle state and the following releases are present on the router:

- Primary SRP module—Running (original) release
- Redundant SRP module—Upgrade release
- Line modules—Running (original) release

After you stop unified ISSU, you can return the router to the state it was in when you began the in-service software upgrade. To roll the router back to its beginning state with the redundant SRP module running the original release, you must perform the following steps to arm the redundant SRP module with the running release:

1. Turn off auto synchronization.

```
host1(config)#disable-autosync
```

2. Specify that the router use the running release when it reboots.

```
host1(config)#boot system erx_x-y-z.rel
```

3. Synchronize the NVS file system of the redundant module with that of the primary module.

```
host1#synchronize
```

The redundant SRP module automatically reboots because the armed release (the original release) now differs from the software release it is currently running (the upgrade release).

4. Verify that stateful SRP switchover is enabled.

```
host1#show redundancy
```

## Halting Unified ISSU During Upgrade Phase

During the upgrade phase—before the line module and control plane software is upgraded—the unified ISSU process provides an opportunity to cancel the upgrade. If you choose to cancel, the router remains in the unified ISSU initialized state. The CLI command set becomes fully accessible.

If you do not cancel at this point, then the process continues and any line modules that do not support unified ISSU are reloaded. Application sessions are brought down and traffic forwarding is interrupted for the unsupported modules.

If you do cancel in response to the CLI prompt, unified ISSU returns to the initialized state, and the following releases are present on the router:

- Primary SRP module—Running (original) release
- Redundant SRP module—Upgrade release; the module is in the unified ISSU initialized state
- Line modules—Running (original) release

To roll back from the unified ISSU initialized state, you must issue the **issu stop** command. The command reloads the redundant SRP module with the armed release and places unified ISSU in the idle state. As a result, the following releases are present on the router:

- Primary SRP module—Running (original) release
- Redundant SRP—Upgrade release
- Line modules—Running (original) release

After you stop unified ISSU, you can return the router to the state it was in when you began the in-service software upgrade. To roll the router back to its beginning state with the redundant SRP module running the original release, you must perform the following steps to arm the redundant SRP module with the running release:

1. Turn off auto synchronization.

```
host1(config)#disable-autosync
```

2. Specify that the router use the running release when it reboots. For

```
host1(config)#boot system erx_x-y-z.rel
```

3. Synchronize the NVS file system of the redundant module with that of the primary module.

```
host1#synchronize
```

The redundant SRP module automatically reboots because the software release that it is configured to run now differs from the software release it is running.

## Monitoring a Unified In-Service Software Upgrade

You can use the **show issu** command to monitor the status of the router with regard to a unified in-service software upgrade.

### **show issu**

- Use to display information about the current status of the router relative to a unified in-service software upgrade and of the upgrade itself.
- Field descriptions
  - ISSU state—State of the upgrade process, idle, initializing, initialized, or upgrading
  - ISSU description—State of the upgrade, including percent complete
  - criteria met—Whether prerequisites for the upgrade have been met and, generally, what errors occurred
  - running release—Filename of JUNOS software release that is currently running on the SRP modules
  - armed release—Filename of JUNOS software release that is armed to become the next running release when the router reboots
- Example 1—Displays the current unified ISSU state and identifies the active and armed releases

```
host1#show issu brief
```

```
ISSU state: initializing
ISSU description: ISSU initialize is in-progress, 5% complete
criteria met: No, upgrade error(s) found
running release: release1.rel
armed release: release2.rel
```

- Example 2—To the information displayed by **show issu brief**, adds a summary table of unified ISSU verification criteria

```
host1# show issu
show issuISSU state: idle
ISSU description: ISSU is currently idle
criteria met: No, upgrade error(s) found
running release: release1.rel
armed release: release2.rel
ISSU Activation Criteria Summary
Met
-- -----
1 In-Service Software Upgrade ready? Yes
```



|             |                                         |     |
|-------------|-----------------------------------------|-----|
| 2           | High-Availability ready?                | No  |
| 3           | Line modules ready?                     |     |
| Conditional |                                         |     |
| 4           | Configuration conversion support ready? | Yes |
| 5           | CLI sessions ready?                     | Yes |
| 6           | Routing applications ready?             | Yes |
| 7           | Protocol timers ready?                  | Yes |

- Example 3—To the information displayed by **show issu**, adds a detailed table of unified ISSU verification criteria that lists mandatory and conditional criteria that have not been met, the impact of this status, and the remedy as reported by router applications and system components that participate in the in-service software upgrade

```

host1# show issu detail
ISSU state: idle
ISSU description: ISSU is currently idle
criteria met: No, upgrade error(s) found
running release: release1.rel
armed release: release2.rel
ISSU Activation Criteria Summary
Met
-- -----

1 In-Service Software Upgrade ready? Yes
2 High-Availability ready? No
3 Line modules ready?
Conditional
4 Configuration conversion support ready? Yes
5 CLI sessions ready? Yes
6 Routing applications ready? Yes
7 Protocol timers ready? Yes

ISSU Criterion Detail
Met
-- -----

1 In-Service Software Upgrade ready? Yes
2 High-Availability ready? No
-> Problem: The standby SRP must not be running the same release
 e
 Reporting Slot: 6
 Impact: ISSU cannot be performed

```

Remedy: boot a release compatible with ISSU on the standby S  
RP

3 Line modules ready?  
Conditional  
-> Problem: Card does not support required memory configuration  
Conditional  
: Slot 1, OC3/OC12/DS3-ATM, requires at least 256 MB

Reporting Slot: 6

Impact: If you continue, the card will immediately be reset  
and then cold started when ISSU Upgrade completes

Remedy: data unavailable

-> Problem: Card does not support required memory configuration  
Conditional  
: Slot 8, CT3-12, requires at least 256 MB

Reporting Slot: 6

Impact: If you continue, the card will immediately be reset  
and then cold started when ISSU Upgrade completes

Remedy: data unavailable

-> Problem: Card does not support required memory configuration  
Conditional  
: Slot 9, CT3-12, requires at least 256 MB

Reporting Slot: 6

Impact: If you continue, the card will immediately be reset  
and then cold started when ISSU Upgrade completes

Remedy: data unavailable

-> Problem: Card does not support required memory configuration  
Conditional  
: Slot 10, CT3-12, requires at least 256 MB

Reporting Slot: 6

Impact: If you continue, the card will immediately be reset  
and then cold started when ISSU Upgrade completes

Remedy: data unavailable

-> Problem: Card not disabled or not online: Slot 1, OC3/OC12/D  
Conditional  
S3-ATM, 0/0

Reporting Slot: 6

Impact: If you continue, the card will immediately be reset and then cold started when ISSU Upgrade completes

Remedy: If not standby, Wait for card to come online before proceeding

-> Problem: Card not disabled or not online: Slot 8, CT3-12, 0/Conditional  
0

Reporting Slot: 6

Impact: If you continue, the card will immediately be reset and then cold started when ISSU Upgrade completes

Remedy: If not standby, Wait for card to come online before proceeding

|   |                                         |     |
|---|-----------------------------------------|-----|
| 4 | Configuration conversion support ready? | Yes |
| 5 | CLI sessions ready?                     | Yes |
| 6 | Routing applications ready?             | Yes |
| 7 | Protocol timers ready?                  | Yes |

- See show issu.



## Chapter 9

# Passwords and Security

Passwords and security are of utmost importance for the security of your router. This chapter provides the information you need to configure your E-series router to be secure for all levels of users.

This chapter contains the following sections:

- Overview on page 485
- Platform Considerations on page 485
- Setting Basic Password Parameters on page 486
- Setting and Erasing Passwords on page 489
- Vty Line Authentication and Authorization on page 495
- Virtual Terminal Access Lists on page 503
- Secure System Administration with SSH on page 503
- Restricting User Access on page 514
- Denial of Service (DoS) Protection on page 518

## Overview

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One of your major management responsibilities is to secure your router. To do this, assign passwords or secrets to the router. In Global Configuration mode, you can set passwords or secrets to prevent unauthorized users from accessing the router in Privileged Exec mode.

Passwords and secrets have the same degree of security on your router, and they are used interchangeably. You can define either a password or a secret for your router, but not both.

## Platform Considerations

---

Passwords and security are supported on all E-series routers.

For information about the modules supported on E-series routers:

- See the *ERX Module Guide* for modules supported on ERX-7xx models, ERX-14xx models, and the ERX-310 router.
- See the *E120 and E320 Module Guide* for modules supported on the E120 router and the E320 router.

## Setting Basic Password Parameters

This section shows how to set up basic passwords and secrets on your router. You cannot create your own encrypted passwords and secrets. You must use encrypted passwords and secrets that the router generates.



**NOTE:** See “Setting and Erasing Passwords” on page 489 for additional commands for erasing and monitoring passwords.

### Creating Encrypted Passwords

This example encrypts password *t1meout1* and creates a password for privilege level 10.

1. Enable and configure the password. The **0** keyword specifies that you are entering an unencrypted password.

```
host1(config)#enable password level 10 0 t1meout1
```

2. Display the encrypted password.

```
host1(config)#exit
host1#show secret
```

Current Password Settings

| level | encryption<br>type | encrypted<br>password/secret | mode       |
|-------|--------------------|------------------------------|------------|
| 0     |                    |                              |            |
| 1     |                    |                              |            |
| 2     |                    |                              |            |
| 3     |                    |                              |            |
| 4     |                    |                              |            |
| 5     |                    |                              |            |
| 6     |                    |                              |            |
| 7     |                    |                              |            |
| 8     |                    |                              |            |
| 9     |                    |                              |            |
| 10    | 7 (password)       | dq]XG`,%N"SS7d}o)_?Y         | configured |
| 11    | 7 (password)       | dq]XG`,%N"SS7d}o)_?Y         | inherited  |
| 12    | 7 (password)       | dq]XG`,%N"SS7d}o)_?Y         | inherited  |
| 13    | 7 (password)       | dq]XG`,%N"SS7d}o)_?Y         | inherited  |
| 14    | 7 (password)       | dq]XG`,%N"SS7d}o)_?Y         | inherited  |
| 15    | 7 (password)       | dq]XG`,%N"SS7d}o)_?Y         | inherited  |

You or users with high privilege levels can now use the encrypted password, *dq]XG`,%N"SS7d}o)\_?Y*, with the **password** command.

### Creating Secrets

This example generates a secret for the password *rocket*, and creates a secret for privilege level 15.

1. Enable and configure the secret. The **0** keyword specifies that you are entering an unencrypted secret.

```
host1(config)#enable secret level 15 0 rocket
```

2. Display the secret.

```
host1(config)#exit
host1#show secret
```

| Current Password Settings |                 |                           |            |
|---------------------------|-----------------|---------------------------|------------|
| level                     | encryption type | encrypted password/secret | mode       |
| 0                         |                 |                           |            |
| 1                         |                 |                           |            |
| 2                         |                 |                           |            |
| 3                         |                 |                           |            |
| 4                         |                 |                           |            |
| 5                         |                 |                           |            |
| 6                         |                 |                           |            |
| 7                         |                 |                           |            |
| 8                         |                 |                           |            |
| 9                         |                 |                           |            |
| 10                        |                 |                           |            |
| 11                        |                 |                           |            |
| 12                        |                 |                           |            |
| 13                        |                 |                           |            |
| 14                        |                 |                           |            |
| 15                        | 5 (secret)      | bcA";+1aeJD8)/[1ZDP6      | configured |

You or users with high privilege levels can now use the encrypted password, *bcA";+1aeJD8)/[1ZDP6*, with the **password** command.

## Encrypting Passwords in Configuration File

You can also direct the system software to encrypt passwords saved in the configuration file by using the **service password-encryption** command. This command is useful to keep unauthorized individuals from viewing your password in your configuration file. It is important to remember that this command uses a simple cipher and is not intended to protect against serious analysis. You can tell if a string is encrypted if it is preceded by an 8.

## Commands and Guidelines

Use the following commands and guidelines to set passwords or secrets for the privilege levels.

### **enable password**

- Use to set a password, which controls access to Privileged Exec mode and some configuration modes.
- Enter the password in plain text (unencrypted) or cipher text (encrypted). In either case, the system stores the password as encrypted.

- The first time you define a password, you must enter it in plain text. To view its encrypted form, use the **show config** display. To redefine the password at a later date, you can enter the password in its encrypted form.
- You can use the following keywords:
  - 0 (zero)—Specifies an unencrypted password
  - 7—Specifies an encrypted password
- Example 1 (unencrypted password)
 

```
host1(config)#enable password 0 mypassword
```
- Example 2 (encrypted password)
 

```
host1(config)#enable password 7 x13_2
```
- Use the **no** version to remove the password.
- See enable password.

### **enable secret**

- Use to set a secret, which controls access to the Privileged Exec mode and some configuration modes.
- Enter the secret in plain text (its unencrypted form) or cipher text (its encrypted form). In either case, the system stores the secret as encrypted.
- The first time you define a secret, you must enter it in plain text. To view its encrypted form, use the **show config** display. To redefine the secret at a later date, you can enter the secret in its encrypted form.
- You can use the following keywords:
  - 0 (zero)—Specifies an unencrypted secret
  - 5—Specifies an encrypted secret
- Example 1 (unencrypted secret)
 

```
host1(config)#enable secret 0 yalta45
```
- Example 2 (encrypted secret)
 

```
host1(config)#enable secret 5 y13_x
```
- Use the **no** version to remove the secret.
- See enable secret.

### **service password-encryption**

- Use to encrypt passwords that are saved in the system's configuration file. The command converts plain text to cipher text. The default is no encryption.
- Use of this command prevents casual observers from viewing passwords, for example, in data obtained from **show config** displays. The command is not intended to provide protection from serious analysis.



- This command does not apply to passwords set with **enable secret**, **enable password**, or **password** (Line Configuration mode).
- This command does apply to authentication key passwords and BGP neighbor passwords.
- Example
 

```
host1(config)#service password-encryption
```
- Use the no version to remove the encryption assignment.
- See service password-encryption.

## Setting and Erasing Passwords

You can set the following passwords:

- Enable passwords that control access to different groups of commands.
- A console password that controls access to the console.
- Passwords for individual vty lines or groups of vty lines.

## Privilege Levels

Different groups of commands are associated with privilege levels (Table 51 on page 489). You can set enable passwords to allow users to access commands at different privilege levels.

**Table 51: Commands Available at Different Privilege Levels**

| Privilege Level | Commands Available                                                                          |
|-----------------|---------------------------------------------------------------------------------------------|
| 0               | <b>help</b> , <b>exit</b> , <b>enable</b> , and <b>disable</b> commands                     |
| 1               | User Exec commands plus commands at level 0                                                 |
| 5               | Privileged Exec <b>show</b> commands plus commands at levels 0 and 1                        |
| 10              | All commands except support commands                                                        |
| 15              | Support commands that Juniper Networks Technical Support may provide and all other commands |

To maximize security and usability, set different passwords for levels 1, 5, 10, and 15. By default, no **enable** passwords exist.

## Accessing Privilege Levels

If users have access to the console, they automatically have access to privilege level 0. To access higher levels of privilege, they must enter the **enable** *privilege-level*

command. When users specify a privilege level, the system determines whether there is a password at that level. If there is not, the system prompts the user for the password for the lower level closest to the requested level.

## Setting Enable Passwords

To set up **enable** passwords, use the commands described in “Setting Basic Password Parameters” on page 486.

## Erasing Enable Passwords

If you forget an **enable** password or secret, you can erase all enable passwords and secrets.

Two commands allow you to erase passwords and secrets: **erase secrets** and **service unattended-password-recovery**. It is important to fully understand the purpose of these commands and how they work with each other.

The **erase secrets** command can be used to delete all existing passwords. To use this command, you must be physically present at the router to complete the operation. After the command has been executed, you have a finite number of seconds to press the software reset button on the SRP module. You can execute this command from the console or any vty.

The **service unattended-password-recovery** command provides you with a way to delete existing passwords and secrets without physically being present at the router. You must have the proper privilege level to execute the command, and you can execute it from either the console or any vty.

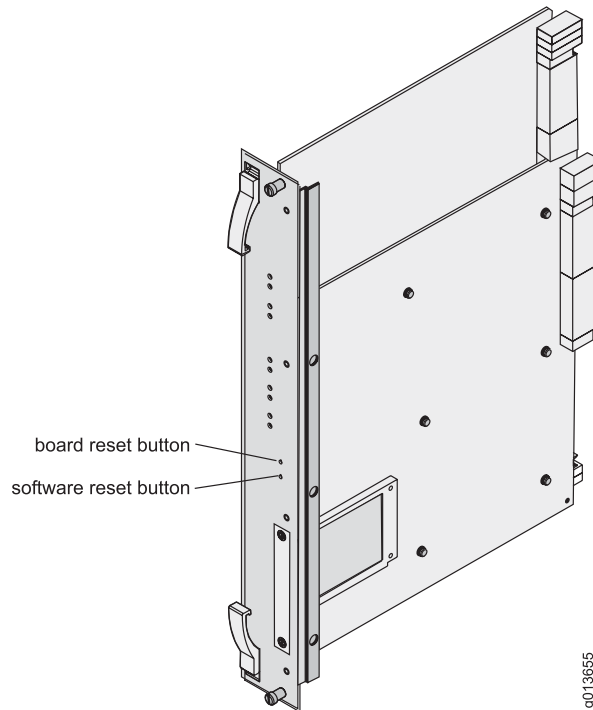
When you execute **service unattended-password-recovery**, you change the behavior of **erase secrets**. You can now delete passwords and secrets from the console by executing **erase secrets** without a time restraint or having to be physically present at the router. When you use the **no** version of **service unattended-password-recovery**, you revert the functionality of erase secrets to the factory default setting.

To erase all **enable** passwords or secrets:

1. Log in to the router.
2. Erase the existing **enable** password or secret. Specify the number of seconds to allow for the erase operation.

```
host1>erase secrets 60
```

3. Within the time limit that you specified for the **erase secrets** command, press the recessed software reset button on the primary SRP module (see Figure 28 on page 491).

**Figure 28: Location of the Software Reset Button**

**NOTE:** If you do not press the software reset button within the time limit, the system will not erase the password, and you will need to repeat the process.

### **erase secrets**

- Use to delete all CLI passwords and secrets.
- After you issue this command, press the software reset button (see Figure 28 on page 491) within the time you specify for this command.
- Allows you to set the number of seconds (1–60) for this procedure to be accomplished.
- Allows you to set a new password when you have forgotten your password.
- Can be used with the **service unattended-password-recovery** command.
- Example

```
host1>erase secrets 60
```

- There is no **no** version.
- See erase secrets.

### **service unattended-password-recovery**

- Use to allow you to delete all passwords and secrets from the console without being physically present at the router.
- When executed, this command changes the behavior of the **erase secrets** command, which will not take any parameters and will not be available through a vty session.
- Example
 

```
host1(config)#service unattended-password-recovery
```
- Use the **no** version to revert erase secrets to factory default settings.
- See service unattended-password-recovery.

## Setting a Console Password

By default, there is no console password. To set a console password:

1. Make sure that you know the enable password for the system.

If you need to reset the enable password, see “Privilege Levels” on page 489.

2. Access Privileged Exec mode, and enter the enable password if prompted.
3. Access Global Configuration mode.
4. Access Line Configuration mode.

```
host1(config)#line console 0
```

5. Enable password checking at login.

```
host1(config-line)#login
```

6. Specify a password.

```
host1(config-line)#password 7 dq]XG`,%N"SS7d}o)_?Y
```

## line

- Use to specify the vty lines or the console.
- Example

```
host1(config)#line vty 1 4
```

- Use the **no** version to remove a vty line or a range of lines from your configuration; users will not be able to run Telnet, SSH, or FTP to lines that you remove. When you remove a vty line, the system removes all lines above that line. For example, **no line vty 6** causes the system to remove lines 6 through 29. You cannot remove lines 0 through 4.
- See line.

## login

- Use to enable password checking at login.
- The default setting is to enable a password.
- Example

```
host1(config)#line vty 1 4
host1(config-line)#login
```

- Use the no version to disable password checking and allow access without a password.
- See login.

### **password**

- Use to specify a password on the console, a line, or a range of lines.
- If you enable password checking, but do not configure a password, the system will not allow you to access virtual terminals.
- Use the following keywords to specify the type of password you will enter:
  - 0 (zero)—Unencrypted password
  - 5—Secret
  - 7—Encrypted password



**NOTE:** To use an encrypted password or a secret, you must follow the procedure in “Setting Basic Password Parameters” on page 486 to obtain the encrypted password or secret. You cannot create your own encrypted password or secret; you must use a system-generated password or secret.

- Example 1 (unencrypted password)

```
host1(config-line)#password 0 mypassword
```

- Example 2 (secret)

```
host1(config-line)#password 5 bcA";+1aeJD8)/[1ZDP6
```

- Example 3 (encrypted password)

```
host1(config-line)#password 7 dq]XG`,%N"SS7d}o)_?Y
```

- Use the no version to remove the password. By default, no password is specified.
- See password.

## Erasing the Console Password

If you forget the console password, you can erase the existing value and configure a new one. This action deletes all authentication for the console line. To erase existing passwords:

1. Reboot the router by pressing the recessed software reset button on the primary SRP module (see Figure 28 on page 491) and then pressing the mb key sequence during the countdown.
2. Disable authentication at the console level.

```
:boot##disable console authentication
```

If you remember the password at this point, you can override this action by entering:

```
:boot##no disable console authentication
```

3. Reload the operating system.

```
:boot##reload
```

When the operating system reloads, you can access the console without a password.



**NOTE:** You will be able to log in to the console without a password until you set a new password.

## Monitoring Passwords

You can use the show secrets command to view all current passwords and secrets.

### show secrets

- Use to display all passwords and secrets.
- Passwords and secrets appear in their encrypted form.
- In the mode column, *inherited* indicates whether a secret was inherited from a lower password level. The **show secrets** command displays only secrets configured by the user; it does not display inherited secrets.
- Example

```
host1#show secrets
Current Password Settings

level encryption encrypted
 type password/secret mode

0
1
2
3
```

```

4
5 7 (password) zRFj_6>^]10kZR@e!|S$ configured
6 7 (password) zRFj_6>^]10kZR@e!|S$ inherited
7 7 (password) zRFj_6>^]10kZR@e!|S$ inherited
8 7 (password) zRFj_6>^]10kZR@e!|S$ inherited
9 7 (password) zRFj_6>^]10kZR@e!|S$ inherited
10 7 (password) zRFj_6>^]10kZR@e!|S$ inherited
11 7 (password) zRFj_6>^]10kZR@e!|S$ inherited
12 7 (password) zRFj_6>^]10kZR@e!|S$ inherited
13 7 (password) zRFj_6>^]10kZR@e!|S$ inherited
14 7 (password) zRFj_6>^]10kZR@e!|S$ inherited

```

- See show secrets.

## Vty Line Authentication and Authorization

---

The router supports 30 virtual tty (vty) lines for Telnet, Secure Shell Server (SSH) and FTP services. Each Telnet, SSH, or FTP session requires one vty line. You can add security to your router by configuring the software to validate login requests. There are two modes of authentication for a vty line:

- Simple authentication—Password-only authentication through the local configuration
- AAA authentication—Username and password authentication through a set of authentication servers

You can enable AAA authorization, which allows you to limit the services available to a user. Based on information retrieved from a user's profile, the user is either granted or denied access to the requested server.

### Configuring Simple Authentication

To configure simple authentication:

1. Specify a vty line or a range of vty lines on which you want to enable the password.

```

host1(config)#line vty 8 13
host1(config-line)#

```

2. Specify the password for the vty lines.

```

host1(config-line)#password 0 mypassword

```

3. Enable login authentication on the lines.

```

host1(config-line)#login

```

4. Display your vty line configuration.

```

host1#show line vty 8

```

```
no access-class in
data-character-bits 8
exec-timeout never
exec-banner enabled
motd-banner enabled
login-timeout 30 seconds
```

### **line**

- Use to specify the vty line(s) on which you want to enable the password.
- You can set a single line or a range of lines. The range is 0–29.
- Example

```
host1(config)#line vty 8 13
```

- Use the **no** version to remove a vty line or a range of lines from your configuration; users will not be able to run Telnet, SSH, or FTP to lines that you remove. When you remove a vty line, the system removes all lines above that line. For example, **no line vty 6** causes the system to remove lines 6 through 29. You cannot remove lines 0 through 4.
- See line.

### **login**

- Use to enable password checking at login.
- The default setting is to enable a password.
- Example

```
host1(config-line)#login
```

- Use the **no** version to disable password checking and allow access without a password.
- See login.

### **password**

- Use to specify a password on a single line or a range of lines.
- If you enable password checking but do not configure a password, the system will not allow you to access virtual terminals.
- Specify a password in plain text (unencrypted) or cipher text (encrypted). In either case, the system stores the password as encrypted.
- Use the following keywords to specify the type of password you will enter:
  - 0 (zero)—Unencrypted password
  - 5—Secret
  - 7—Encrypted password





**NOTE:** To use an encrypted password or a secret, you must follow the procedure in “Setting Basic Password Parameters” on page 486 to obtain the encrypted password or secret. You cannot create your own encrypted password or secret; you must use a system-generated password or secret.

- Example 1 (unencrypted password)

```
host1(config-line)#password 0 mypassword
```

- Example 2 (secret)

```
host1(config-line)#password 5 bcA";+1aeJD8)/[1ZDP6
```

- Example 3 (encrypted password)

```
host1(config-line)#password 7 dq]XG`,%N"SS7d}o)_?Y
```

- Use the **no**version to remove the password. By default, **no password** is specified.
- See password.

### **show line vty**

- Use to display the configuration of a vty line.
- Field descriptions
  - access-class—Access-class associated with the vty line
  - data-character-bits—Number of bits per character
    - 7—Setting for the standard ASCII set
    - 8—Setting for the international character set
  - exec-timeout—Time interval that the terminal waits for expected user input
    - Never—Indicates that there is no time limit
  - exec-banner—Status for the exec banner: enabled or disabled. This banner is displayed by the CLI after user authentication (if any) and before the first prompt of a CLI session.
  - motd-banner—Status for the message of the day (MOTD) banner: enabled or disabled. This banner is displayed by the CLI when a connection is initiated.
  - login-timeout—Time interval during which the user must log in.
    - Never—Indicates that there is no time limit
- Example

```
host1#show line vty 0
no access-class in
data-character-bits 8
```

```
exec-timeout 3w 3d 7h 20m 0s
exec-banner enabled
motd-banner enabled
login-timeout 30 seconds
```

- See show line vty.

## Configuring AAA Authentication and AAA Authorization

Before you configure AAA authentication and AAA authorization, you need to configure a RADIUS and/or TACACS+ authentication server. Note that several of the steps in the configuration procedure are optional.

To configure AAA new model authentication and authorization for inbound sessions to vty lines on your router:

1. Specify AAA new model authentication.

```
host1(config)#aaa new-model
```

2. Create an authentication list that specifies the type(s) of authentication methods allowed.

```
host1(config)#aaa authentication login my_auth_list tacacs+ line enable
```

3. (Optional) Specify the privilege level by defining a method list for authentication.

```
host1(config)aaa authentication enable default tacacs+ radius enable
```

4. (Optional) Enable authorization, and create an authorization method list.

```
host1(config)aaa authorization commands 15 boston if-authenticated tacacs+
```

5. (Optional) Disable authorization for all Global Configuration commands.

```
host1(config)#no aaa authorization config-commands
```

6. Specify the range of vty lines.

```
host1(config)#line vty 6 10
host1(config-line)#
```

7. (Optional) Apply an authorization list to a vty line or a range of vty lines.

```
host1(config-line)#authorization commands 15 boston
```

8. Specify the password for the vty lines.

```
host1(config-line)#password xyz
```

9. Apply the authentication list to the vty lines you specified on your router.

```
host1(config-line)#login authentication my_auth_list
```

### **aaa authentication enable default**

- Use to allow privilege determination to be authenticated through the TACACS + or RADIUS server. This command specifies a list of authentication methods that are used to determine whether a user is granted access to the privilege command level.
- The authentication methods that you can use in a list include these options: **radius**, **line**, **tacacs +**, **none**, and **enable**.
- To specify that the authentication should succeed even if all methods return an error, specify **none** as the final method in the command line.
- Requests sent to a TACACS + or RADIUS server include the username that is entered for login authentication.
- If the authentication method list is empty, the local **enable** password is used.
- Example

```
host1(config)#aaa authentication enable default tacacs+ radius
```

- Use the **no** version to empty the list.
- See aaa authentication enable default.

### **aaa authentication login**

- Use to set AAA authentication at login. This command creates a list that specifies the methods of authentication.
- After you have specified **aaa new-model** as the authentication method for vty lines, an authentication list called “ default ” is automatically assigned to the vty lines. To allow users to access the vty lines, you must create an authentication list and either:
  - Name the list “ default.”
  - Assign a different name to the authentication list, and assign the new list to the vty line using the **login authentication** command.
- The authentication methods that you can use in a list include these options: **radius**, **line**, **tacacs +**, **none**, and **enable**.
- The system traverses the list of authentication methods to determine whether a user is allowed to start a Telnet session. If a specific method is available but the user information is not valid (such as an incorrect password), the system does not continue to traverse the list and denies the user a session.
- If a specific method is unavailable, the system continues to traverse the list. For example, if **tacacs +** is the first authentication type element on the list and the TACACS + server is unreachable, the system attempts to authenticate with the next authentication type on the list, such as **radius**.
- The system assumes an implicit denial of service if it reaches the end of the authentication list without finding an available method.
- Example

```
host1(config)#aaa authentication login my_auth_list tacacs+ radius line none
```

- Use the **no** version to remove the authentication list from your configuration.
- See aaa authentication login.

### aaa authorization

- Use to set the parameters that restrict access to a network.
- Use the keyword **exec** to determine if the user is allowed to run Exec mode commands. The commands that you can execute from Exec mode provide only user-level access.
- Use the keyword **commands** to run authorization for all commands at the specified privilege level (0–15). See Table 51 on page 489 for a description of privilege levels.
- You can enter up to three authorization types to use in an authorization method list. Options include: **if-authenticated**, **none**, and **tacacs +**.



**NOTE:** For information about TACACS +, see *JUNOS Broadband Access Configuration Guide*.

---

- Authorization method lists define the way authorization is performed and the sequence in which the methods are performed. You can designate one or more security protocols in the method list to be used for authorization. If the initial method fails, the next method in the list is used. The process continues until either there is successful communication with a listed authorization method or all methods defined are exhausted.
- Example

```
host1(config)#aaa authorization exec
```

- Use the **no** version to delete the method list.
- See aaa authorization.

### aaa authorization config-commands

- Use to reestablish the default created when the **aaa authorization commands** command was issued.
- After the **aaa authorization commands** command has been issued, **aaa authorization config-commands** is enabled by default, which means that all configuration commands are authorized.
- Example

```
host1(config)#aaa new-model
host1(config)#aaa authorization command 15 parks tacacs+ none
host1(config)#no aaa authorization config-commands
```

- Use the **no** version to disable AAA configuration command authorization.
- See aaa authorization config-commands.

### **aaa new-model**

- Use to specify AAA new model as the authentication method for the vty lines on your router.
- If you specify AAA new model and you do not create an authentication list, users will not be able to access the router through a vty line.
- Example

```
host1(config)#aaa new-model
```

- Use the **no** version to restore simple authentication.
- See aaa new-model.

### **authorization**

- Use to apply AAA authorization to a specific vty line or group of lines.
- Use the **exec** keyword to apply this authorization to CLI access in general.
- Use the **commands** keyword to apply this authorization to user commands of the privilege level you specify.
- You can specify the name of an authorization method list; if no method list is specified, the default is used.
- After you enable the **aaa authorization** command and define a named authorization method list (or use the default method list) for a particular type of authorization, you must apply the defined list to the appropriate lines for authorization to take place.
- Example

```
host1(config)#line vty 6
host1(line-config)#authorization commands 15 sonny
```

- Use the **no** version to disable authorization.
- See authorization.

### **line**

- Use to specify the virtual terminal lines.
- You can set a single line or a range of lines. The range is 0–29.
- Example

```
host1(config)#line vty 6 10
```

- Use the **no** version to remove a vty line or a range of lines from your configuration; users will not be able to run Telnet, SSH, or FTP to lines that you remove. When you remove a vty line, the system removes all lines above that

line. For example, **no line vty 6** causes the system to remove lines 6 through 29. You cannot remove lines 0 through 4.

- See line.

### **login authentication**

- Use to apply an authentication list to the vty lines you specified on your router.
- Example

```
host1(config-line)#login authentication my_auth_list
```

- Use the **no** version to specify that the system should use the default authentication list.
- See login authentication.

### **password**

- Use to specify a password on a line or a range of lines if you specified the line option with the “aaa authentication login” on page 499 command.
- If you enable password checking but do not configure a password, the system will not allow you to access virtual terminals.
- Use the following keywords to specify the type of password you will enter:
  - 0 (zero)—Unencrypted password
  - 5—Secret
  - 7—Encrypted password



**NOTE:** To use an encrypted password or a secret, you must follow the procedure in “Setting Basic Password Parameters” on page 486 to obtain the encrypted password or secret. You cannot create your own encrypted password or secret; you must use a system-generated password or secret.

---

- Example 1 (unencrypted password)

```
host1(config-line)#password 0 mypassword
```

- Example 2 (secret)

```
host1(config-line)#password 5 bcA";+1aeJD8)/[1ZDP6
```

- Example 3 (encrypted password)

```
host1(config-line)#password 7 dqjXG`,%N"SS7d}o)_?Y
```

- Use the **no** version to remove the password. By default, **no password** is specified.
- See password.

## Virtual Terminal Access Lists

---

You can provide additional security for your router by using access lists to restrict access to vty lines.

When the router attempts to authenticate a user, it always selects the first vty line that has an access class that permits that user's host. The vty line's configuration must authenticate the user to allow access. Otherwise, the user can never gain access. Consequently, we recommend that you use identical authentication configurations for all vtys that have the same access class list.

To set up access lists:

- Associate the access list with inbound Telnet sessions.

```
host1(config)#line vty 12 15
host1(config-line)#access-class Management in
```

- Configure an access list.

```
host1(config)#access-list Management permit ip 192.168.11.16 0.0.0.15 any
host1(config)#access-list Management permit ip 192.168.4.0 0.0.0.255
host1(config)#access-list Management deny ip any any
```

### ***access-class in***

- Use to associate the access list with vty lines.
- Example—This example sets the virtual terminal lines to which you want to restrict access and specifies an access class to grant access to incoming requests.

```
host1(config)#line vty 12 15
host1(config-line)#access-class Management in
```

- Use the **no** version to remove access restrictions.
- See access-class in.

### ***access-list***

- Use to configure an access list.
- Example

```
host1(config)#access-list Management permit ip 192.168.11.16 0.0.0.15 any
```

- Use the **no** version to remove the access list.
- See access-list.

## Secure System Administration with SSH

---

The system supports the SSH protocol version 2 as a secure alternative to Telnet for system administration.



**NOTE:** Versions earlier than 2.0.12 of the SSH protocol client are not supported. The SSH server embedded within the router recognizes SSH clients that report an SSH protocol version of 1.99, with the expectation that such clients are compatible with SSH protocol version 2.0. Clients that report an SSH protocol version of 1.99 apparently do so to determine the protocol version supported by the server.

SSH provides the following major features:

- Server authentication through a Diffie-Hellman key exchange—Protects against hackers interjecting mimics to obtain your password. You can be confident that you are connected to your own router.
- User authentication—Ensures that the router is allowing connection from a permitted host and remote user.



**NOTE:** Digital Signature Standard (DSS) public key user authentication for SSH is not supported. RADIUS password authentication is the only method of user authentication currently supported. It is enabled by default. If RADIUS authentication is disabled, then all SSH clients that pass protocol negotiation are accepted.

- Data encryption and key-protected hashing—Provides a secure, trustable session to the upper-layer user interface. Encryption provides confidentiality by preventing unauthorized persons from listening in on management traffic. Encryption and hashing ensure data integrity to obstruct man-in-the-middle attacks, in which unauthorized persons access messages and modify them without detection.

## Transport

The SSH transport layer handles algorithm negotiation between the server and client over TCP/IP. Negotiation begins when the SSH client and server send each other textual information that identifies their SSH version. If they both agree that the versions are compatible, the client and server exchange lists that specify the algorithms that they support for key exchange, encryption, data integrity through a message authentication code (MAC), and compression. Each party sends two lists. One list has the algorithms supported for transmission; the other has the algorithms supported for receipt. The algorithms are specified in order of preference in each list. The client and server use the algorithm for each process that matches the client's highest preference and is supported by the server. If no intersection is found, the negotiation attempt fails and the connection is terminated.

If algorithm negotiation is successful, the server sends its public host key to the client for authentication so the client can be certain that it is connected to the intended host rather than to an imposter. The client compares the key to its host key database. The client authenticates the server if the key is found in the database. If the key is not present, then the client can accept or reject this new, unknown key depending on how you have configured the client. For more information, see “Host Key Management” on page 505.



When the client authenticates the server's host key, it begins the transport key exchange process by sending the key data required by the negotiated set of algorithms. The server responds by sending its own key data set. If both sides agree that the keys are consistent and authentic, the keys are applied so that all subsequent messages between client and server are encrypted, authenticated, and compressed according to the negotiated algorithms.

## **User Authentication**

User authentication begins after the transport keys are applied. The client typically asks the server which authentication methods it supports. The server responds with a list of supported methods with no preference.

The client specifies a user authentication method. If the chosen method is supported by the server, the client then challenges the user—that is, the client prompts the user for a password or public-key pass phrase. The client sends the challenge response from the user and the username to the server. The server authenticates the user based on this response.

The system software currently supports only RADIUS password authentication, which is enabled by default. The RADIUS server validates the username and password from its database. If user authentication is disabled, then all SSH clients that pass protocol negotiation are accepted.

## **Connection**

The SSH connection layer creates the user session when the user is authenticated. The server waits for a connection request. The router currently supports only shell requests, which the server interprets as a request for entry into a CLI session. The server ignores any other requests, such as X11 or TCP/IP tunneling.

## **Key Management**

The E-series router implementation of SSH provides for management of user keys and host keys.

### **User Key Management**

Key administration is still under development for the server environment.

### **Host Key Management**

You create a host key for the SSH server with the **crypto key generate dss** command. If a host key already exists, this command replaces it with a new key and terminates all ongoing SSH sessions. Any SSH clients that previously accepted the old host key reject the new key the next time the client and server connect. The client then typically instructs the end user to delete the locally cached host key and to try to connect again.



---

**CAUTION:** Use caution issuing the **crypto key generate dss** command from an SSH client. Issuing this command will terminate that SSH session; it will be the last command you send from that session.

---

The public half of the host key is sent from the server to the client as part of the transport layer negotiation. The client attempts to find a match for this key with one stored locally and assigned to the server. If the client does not find a match, it can accept or reject the key sent from the server. Refer to your client documentation for detailed information. You typically configure the client to do one of the following:

- Never accept an unknown key.
- Always accept an unknown key.
- Query the administrator before accepting an unknown key.

If you do not want the client ever to trust the server when it sends an unknown key, you must manually copy—using the **copy** command—the host key from each server to each intended client. This is the only way to be certain that each client has a local copy of the necessary keys for matching during negotiation.

If you configure the client to accept unknown keys—either automatically or with administrator approval—this acceptance policy applies only to the first time the client receives a key from a particular server. When the SSH client accepts a host key, it stores the key locally and uses it for all future comparisons with keys received from that host. If the client subsequently receives a different key—a new unknown—from that server, it is rejected.

You cannot configure an SSH client to accept a new key after it has accepted a key from an SSH server. You must delete the old key before a new key can be accepted.

## Performance

Generating a host key is computationally intensive and can take up to several minutes depending on the load of the system. The system cannot accept any CLI inputs from that session while it is generating the key.

Encryption, data integrity validation, and compression are all computationally intensive. These features can affect router performance in the following ways:

- Reduce the effective baud rate compared with Telnet or the local CLI. Users are unlikely to notice this performance degradation because user interaction is inherently slow compared with other system operations.
- Increase the general load on the system CPU.

## Security Concerns

You might be concerned about security with the current support of SSH for the following reasons:

- Only RADIUS user authentication is supported. If you disable user authentication, all users are accepted if the client and server successfully complete negotiation.
- Because the load on the system CPU increases with use of SSH, you might be concerned about denial-of-service attacks. However, the forwarding engine takes care of this issue, because it limits the rate at which it sends packets to the system controller. A flood of packets from a packet generator does not cause problems regardless of whether SSH is enabled.

## **Before You Configure SSH**

You must obtain and install a commercial SSH client on the host from which you want to administer the system. Versions earlier than 2.0.12 of the SSH client are not supported.

Determine your Telnet policy before you configure SSH on your system. Effective use of SSH implies that you should severely limit Telnet access to the system. To limit Telnet access, create access control lists that prevent almost all Telnet usage, permitting only trusted administrators to access the system through Telnet. For example, you might limit access to administrators who need to Telnet to the system from a remote host that does not have the SSH client installed.

You must install and configure a RADIUS server on a host machine before you configure SSH on your router. Refer to your RADIUS server documentation for information about choosing a host machine and installing the server software. You must also configure the RADIUS client on your router. See *JUNOS Broadband Access Configuration Guide* for more information.

## **SSH Configuration Tasks**

You configure SSH on individual virtual routers, rather than on the global system. To configure SSH:

1. Access the context of the virtual router.
2. Configure encryption.(Optional)
3. Configure user authentication, including connection parameters.
4. Configure message authentication.(Optional)
5. Enable SSH.
6. Display SSH to verify configuration.

### **Configuring Encryption**

The embedded SSH server and external SSH client maintain separate lists of the encryption algorithms that each supports. Lists are kept for inbound and outbound algorithms. For the server:

- Inbound means the algorithms that the server supports for information coming in from a client.

- Outbound means the algorithms that the server supports for information it sends out to a client.

You must configure each list separately. By default, all of the supported encryption algorithms are available. You need to configure encryption only if you need to specifically remove or add any supported algorithm from the list. Refer to your SSH client documentation for details on configuring encryption on your client. The system supports the following SSH algorithms for encryption:

- 3des-cbc—A triple DES block cipher with 8-byte blocks and 24 bytes of key data. The first 8 bytes of the key data are used for the first encryption, the next 8 bytes for the decryption, and the following 8 bytes for the final encryption.
- blowfish-cbc—A block cipher with 8-byte blocks and 128-bit keys that provides strong encryption and is faster than DES.
- twofish-cbc—A block cipher with 16-byte blocks and 256-bit keys that is stronger and faster than Blowfish encryption.

Although it is not recommended, you can also specify **none**. In this case, the system does not perform encryption.

### **ip ssh crypto**

- Use to add an encryption algorithm to the specified support list for the SSH server.

Example 1—This example adds the blowfish-cbc algorithm to the list of supported inbound algorithms.

```
host1(config)#ip ssh crypto client-to-server blowfish-cbc
```

Example 2—This example removes the 3des-cbc algorithm from the list of supported outbound algorithms.

```
host1(config)#ip ssh crypto server-to-client no 3des-cbc
```

- The **default** version restores the specified list to the factory default, which includes all supported algorithms (3des-cbc, twofish-cbc, and blowfish-cbc). The default list does not include the none option.

Example

```
host1(config)#ip ssh crypto server-to-client default 3des-cbc
```

- If you do not specify a direction (client-to-server or server-to-client), the command applies the algorithm to both inbound and outbound lists.
- Use the **no** version to remove or exclude an algorithm from the specified list.
- See `ip ssh crypto`.

## Configuring User Authentication

The router supports RADIUS for user authentication. RADIUS authentication is enabled by default. You must have previously configured a RADIUS server on a host machine and the RADIUS client on your system.

You can specify timeout and retry limits to control the SSH connection process. The limits apply only from the time the user first tries to connect until the user has been successfully authenticated. The timeout limits are independent of any limits configured for virtual terminals (vty). The following limits are supported:

- SSH timeout—Maximum time allowed for a user to be authenticated, starting from the receipt of the first SSH protocol packet.
- Authentication retry—Number of times a user can try to correct incorrect information—such as a bad password—in a given connection attempt.
- Sleep—Prevents a user that has exceeded the authentication retry limit from connecting from the same host within the specified period.

### ***ip ssh authentication-retries***

- Use to set the number of times that a user can retry a failed authentication, such as trying to correct a wrong password. The SSH server terminates the connection when the limit is exceeded.
- Specify an integer from 0–20.
- Example

```
host1(config)#ip ssh authentication-retries 3
```

- Use the **no** version to restore the default value, 20 retry attempts.
- See `ip ssh authentication-retries`.

### ***ip ssh disable-user-authentication***

- Use to disable RADIUS password authentication. If you disable RADIUS authentication, all SSH clients that pass protocol negotiation are accepted.
- RADIUS authentication is enabled by default.
- Example

```
host1(config)#ip ssh disable-user-authentication
```

- Use the **no** version to restore RADIUS authentication.
- See `ip ssh disable-user-authentication`.

### ***ip ssh sleep***

- Use to set a sleep period in seconds for users that have exceeded the authentication retry limit. Connection attempts from the user at the same host are denied until this period expires.
- Specify any nonnegative integer.
- Example

```
host1(config)#ip ssh sleep 300
```

- Use the **no** version to restore the default value, 600 seconds.
- See `ip ssh sleep`.

### ***ip ssh timeout***

- Use to set a timeout period in seconds. The SSH server terminates the connection if protocol negotiation—including user authentication—is not completed within this timeout.
- Specify an integer from 10–600.
- Example

```
host1(config)#ip ssh timeout 480
```

- Use the **no** version to restore the default value, 600 seconds.
- See `ip ssh timeout`.

## **Configuring Message Authentication**

The SSH server and SSH client maintain separate lists of the message authentication algorithms that each supports. Lists are kept for *inbound* and *outbound* algorithms. For the server, *inbound* means the algorithms that the server supports for information coming in from a client. For the server, *outbound* means the algorithms that the server supports for information it sends out to a client. You must configure each list separately. By default, all of the supported encryption algorithms are available. You need to configure encryption only if you need to specifically remove or add any supported algorithm from the list. The system supports the following SSH algorithms for hash function-based message authentication:

- `hmac-sha1`—Uses Secure Hash Algorithm 1 (SHA-1) to create a 160-bit message digest from which it generates the MAC.
- `hmac-sha1-96`—Uses the first 96 bits of the SHA-1 message digest to generate the MAC.
- `hmac-md5`—Uses MD5 hashing to create a 128-bit message digest from which it generates the MAC.

Although it is not recommended, you can also specify **none**. In this case, the system does not verify the integrity of the data.

### ***ip ssh mac***

- Use to add a message authentication algorithm to the specified support list for the SSH server.

Example 1—This example adds the `hmac-md5` algorithm to the list of supported outbound algorithms.

```
host1(config)#ip ssh mac server-to-client hmac-md5
```

- If you do not specify a direction (client-to-server or server-to-client), the command applies the algorithm to both inbound and outbound lists.
- The **default** version restores the specified list to the factory default, which includes all supported algorithms (hmac-md5, hmac-sha1, and hmac-sha1-96). The default list does not include the *none* option.
- Example 2—This example restores the hmac-sha1 algorithm to the list of supported inbound algorithms.

```
host1(config)#ip ssh mac client-to-server default hmac-sha1
```

- Use the **no** version to remove or exclude an algorithm from the specified list.

Example 3—This example removes the hmac-sha1 algorithm from the list of supported inbound algorithms.

```
host1(config)#ip ssh mac client-to-server no hmac-sha1
```

- See ip ssh mac.

## Enabling and Disabling SSH

The SSH server daemon starts only if the server host key exists when the router boots. The host key resides in NVS and is persistent across system reboots. After it has started, the daemon listens for traffic on TCP port 22. The server daemon is disabled by default.

### crypto key dss

- Use the **generate** keyword to create the SSH server host key and enable the daemon.
- Example

```
host1(config)#crypto key generate dss
```

- Use the **zeroize** keyword to remove the SSH server host key and stop the SSH daemon if it is running. Issuing this command terminates any active client sessions. The next time the router boots after this command is issued, the SSH server daemon is not started.
- The command is not displayed by the **show configuration** command.



**NOTE:** SSH can be enabled or disabled regardless of the state of the Telnet daemon. If SSH is enabled, use access control lists to limit access through Telnet. See “Virtual Terminal Access Lists” on page 503 for information about using access control lists.

---

- Example

```
host1(config)#crypto key zeroize dss
```

- There is no **no** version.
- See `crypto key dss`.

## Displaying SSH Status

You can monitor the current state of the SSH server with the **show ip ssh** command.

### **show ip ssh**

- Use to display the current state of the SSH server.
- Use the **detail** keyword to display the encryption and MAC algorithm lists for the client and server. For each active session, **detail** shows the version of SSH running on the client and the algorithms in use for encryption and message authentication.
- Field descriptions
  - daemon status—Indicates whether the SSH server is enabled; if so, how long it has been up
  - supported encryption, inbound—Encryption algorithms supported inbound from the client
  - supported encryption, outbound—Encryption algorithms supported outbound to the client
  - supported MAC, inbound—Message authentication code algorithms supported inbound from the client
  - supported MAC outbound—Message authentication code algorithms supported outbound to the client
  - connections since last system reset—Number of connections made through SSH since the last time the system was reset
  - connections since daemon startup—Number of connections made since the SSH server was enabled
  - active sessions—Number of SSH sessions currently active
    - id—Session ID number
    - username—Username for the remote user that initiated the session
    - host—IP address of the remote client
    - uptime (d:h:m:s)—Duration of the session
    - client version—Version of the SSH software run by the remote client
    - ciphers inbound/outbound—Encryption algorithms used by the client and the system for this session
    - MAC inbound/outbound—Message authentication code algorithms used by the client and the system for this session
- Example



```
host1#show ip ssh detail
```

```
SSH Server version: SSH-2.0-2.0.12
```

```
daemon status: enabled, up since MON NOV 08 1999 14:38:19 UTC
```

```
supported encryption, inbound: 3des-cbc,blowfish-cbc,twofish-cbc
supported encryption, outbound: 3des-cbc,blowfish-cbc,twofish-cbc
supported MAC, inbound: hmac-sha1,hmac-sha1-96,hmac-md5
supported MAC, outbound: hmac-sha1,hmac-sha1-96,hmac-md5
```

```
connections since last system reset: 4 out of 4 attempts
connections since daemon startup: 4 out of 4 attempts
```

```
active sessions: 1
```

| id | username | host       | uptime<br>(d:h:m:s) | client version                 | ciphers<br>inbound/outbound | MAC<br>inbound/outbound |
|----|----------|------------|---------------------|--------------------------------|-----------------------------|-------------------------|
| 3  | mcarr    | 10.0.0.145 | 0:00:00:19          | SSH-2.0-2.0.12<br>F-SECURE SSH | 3des-cbc/3des-cbc           | hmac-md5/hmac-md5       |

- To view failed connection attempts and other protocol errors logged at the error severity level, use the **show log data** command:

```
host1#show log data category ssh severity error
```

- See show ip ssh.

## Terminating an SSH Session

You can use the session identifier to terminate an SSH session.

### **disconnect ssh**

- Use to terminate an active SSH session.
- Use the **show ip ssh** command to determine the session identifier for the session to terminate.
- Example

```
host1(config)#disconnect ssh 12
```



**NOTE:** You can also use the **clear line vty** terminal command to terminate SSH sessions. In that case, use the **show users** command to determine the virtual terminal number to specify with the **clear line vty** terminal command.

- There is no **no** version.
- See disconnect ssh.

## Restricting User Access

Users who are authenticated through RADIUS or TACACS+ can be restricted to certain sets of commands and virtual routers (VRs). The levels of access are shown in Table 52 on page 514. For information about TACACS+, see *JUNOS Broadband Access Configuration Guide*.

**Table 52: CLI User Access Levels**

| Access Level | Commands Available                                                                  |
|--------------|-------------------------------------------------------------------------------------|
| 0            | disable, enable, exit, and help commands                                            |
| 1            | Level 0 commands and all other commands available in User Exec mode                 |
| 5            | Level 1 commands and all Privileged <b>show</b> commands                            |
| 10           | All commands except support and privilege change commands                           |
| 15           | Commands that Juniper Networks Technical Support may provide and all other commands |

### Restricting Access to Commands with RADIUS

You can use RADIUS authentication to specify a level of commands that a user is allowed. If you do not configure RADIUS authentication for the console or virtual terminals, all users who successfully log in are automatically granted Level 1 access.

The vendor-specific attribute (VSA) Admin-Auth-Level supports the levels of access shown in Table 52 on page 514. In addition to VSA access level support, the software provides access to levels 1 and 10 through the Initial-Auth-Level in the standard RADIUS Service-Type attribute. If the RADIUS Service-Type attribute is included in the RADIUS Access-Accept message, the standard attribute overrides any VSA setting.

If you are using the RADIUS Service-Type attribute to assign access levels, the system sets the Initial-Auth-Level as follows:

- If the Service-Type attribute is set to “administrative,” then the Initial-Auth-Level is set to 10.
- If the Service-Type attribute is set to “nas prompt” or “login,” the Initial-Auth-Level is set to 1.

### Per-User Enable Authentication

After a user has been authenticated through RADIUS, the RADIUS server provides the E-series router with the names of the privilege levels (for example, “10”) that the user has **enable** access to. When the user attempts to access a privilege level through the **enable** command, the system either denies or approves the user’s request.

The decision to deny or approve the user's request is based on the list the system received through RADIUS. See Table 53 on page 515.

**Table 53: Juniper Networks–Specific CLI Access VSA Descriptions**

| VSA                      | Description                                            | Type | Length | Subtype | Subtype Length | Value                                            |
|--------------------------|--------------------------------------------------------|------|--------|---------|----------------|--------------------------------------------------|
| Initial-CLI-Access-Level | Specifies the initial level of access to CLI commands. | 26   | len    | 18      | sublen         | Single attribute; enter only: 0, 1, 5, 10, or 15 |
| Alt-CLI-Access-Level     | Specifies level of access to CLI commands.             | 26   | len    | 20      | sublen         | Single attribute; enter only: 0, 1, 5, 10, or 15 |



**NOTE:** All levels to which a user can have access must explicitly be specified in the Admin-Auth-Set VSA.

The user is not prompted for a password, because the system knows whether or not the user should have access to the requested level. If the user is not authenticated through RADIUS, the router uses the system-wide **enable** passwords instead.

## Restricting Access to Virtual Routers

You can use RADIUS authentication to specify whether users can access all virtual routers (VRs), one specific VR, or a set of specific VRs.



**NOTE:** This classification is independent of the command access levels configurable through the Initial-CLI-Access-Level VSA.

The VSA Allow-All-VR-Access controls access; the VSA Virtual-Router controls the VR to which the user logs in, and the VSA Alt-CLI-Virtual-Router-Name specifies which VRs other than the VR specified by the VSA virtual-router are accessible to restricted users. See Table 54 on page 515.

**Table 54: Juniper Networks–Specific Virtual Router Access VSA Descriptions**

| VSA                 | Description                                   | Type | Length | Subtype | Subtype Length | Value                                  |
|---------------------|-----------------------------------------------|------|--------|---------|----------------|----------------------------------------|
| Allow-All-VR-Access | Specifies user access to all virtual routers. | 26   | len    | 19      | sublen         | Integer:<br>0 – disable,<br>1 – enable |

**Table 54: Juniper Networks–Specific Virtual Router Access VSA Descriptions**  
(continued)

| VSA                         | Description                                                                                                                                                                                    | Type | Length | Subtype | Subtype Length | Value                                 |
|-----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|--------|---------|----------------|---------------------------------------|
| Virtual-Router              | Specifies the VR to which the user logs in or the only VR to which a user has access. The default setting is the default VR.                                                                   | 26   | len    | 1       | sublen         | String:<br><i>virtual-router-name</i> |
| Alt-CLI-Virtual-Router-Name | Specifies a VR, other than the VR specified by the Virtual-Router VSA, to which the user has access. You can define this VSA multiple times to define a set of VRs to which a user has access. | 26   | len    | 21      | sublen         | String:<br><i>virtual-router-name</i> |

### VSA Configuration Examples

Consider a router on which five VRs have been configured. The VRs are called Boston, Chicago, Detroit, Los Angeles, and San Francisco. The following examples illustrate how to use the VSAs to control a user's access to these VRs.

**Example 1** In this example, you want the user to have access to all VRs and to log in to the default VR. Accept the default setting or set the following VSA:

- Allow-All-VR-Access—1

**Example 2** In this example, you want the user to have access to all VRs and to log in to the VR Boston. Set the VSAs as follows:

- Allow-All-VR-Access—1
- Virtual-Router—Boston

**Example 3** In this example, you want the user to have access only to the VR Boston. Set the VSAs as follows:

- Allow-All-VR-Access—0
- Virtual-Router—Boston

**Example 4** In this example, you want the user to log in to VR Boston, and to have access to VRs Chicago, Los Angeles, and San Francisco. Set the VSAs as follows:

- Allow-All-VR-Access—0
- Virtual-Router—Boston
- Alt-CLI-Virtual-Router-Name—Chicago
- Alt-CLI-Virtual-Router-Name—Los Angeles
- Alt-CLI-Virtual-Router-Name—San Francisco

### Commands Available to Users

If you do not configure RADIUS authentication for the console or virtual terminals, there are no restrictions on VR access for any user who successfully logs in to the router. For example, nonrestricted users can:

- Issue the **virtual-router** command in Privileged Exec mode, to switch to another previously created virtual router.
- Issue the **virtual-router** command in Global Configuration mode to create a new virtual router and switch to its context.
- Access Global Configuration mode to configure the router and virtual routers.
- View all settings for the router and all virtual routers.

User restricted to one or a set of specific VRs can see and use only a limited set of commands to monitor the status of those VRs and view some configuration settings on those VRs. More specifically, such users:

- Can issue the virtual-router command in Privileged Exec mode to switch to another previously configured VR to which they have access.
- Cannot create new VRs or access VRs other than those to which they have access.
- Cannot access Global Configuration mode and cannot configure VRs to which they have access.
- Cannot see or use any commands associated with the file system, boot settings, or system configuration.

The following table lists some, but not all, commands accessed from Exec mode that are available only to users with no VR restriction:

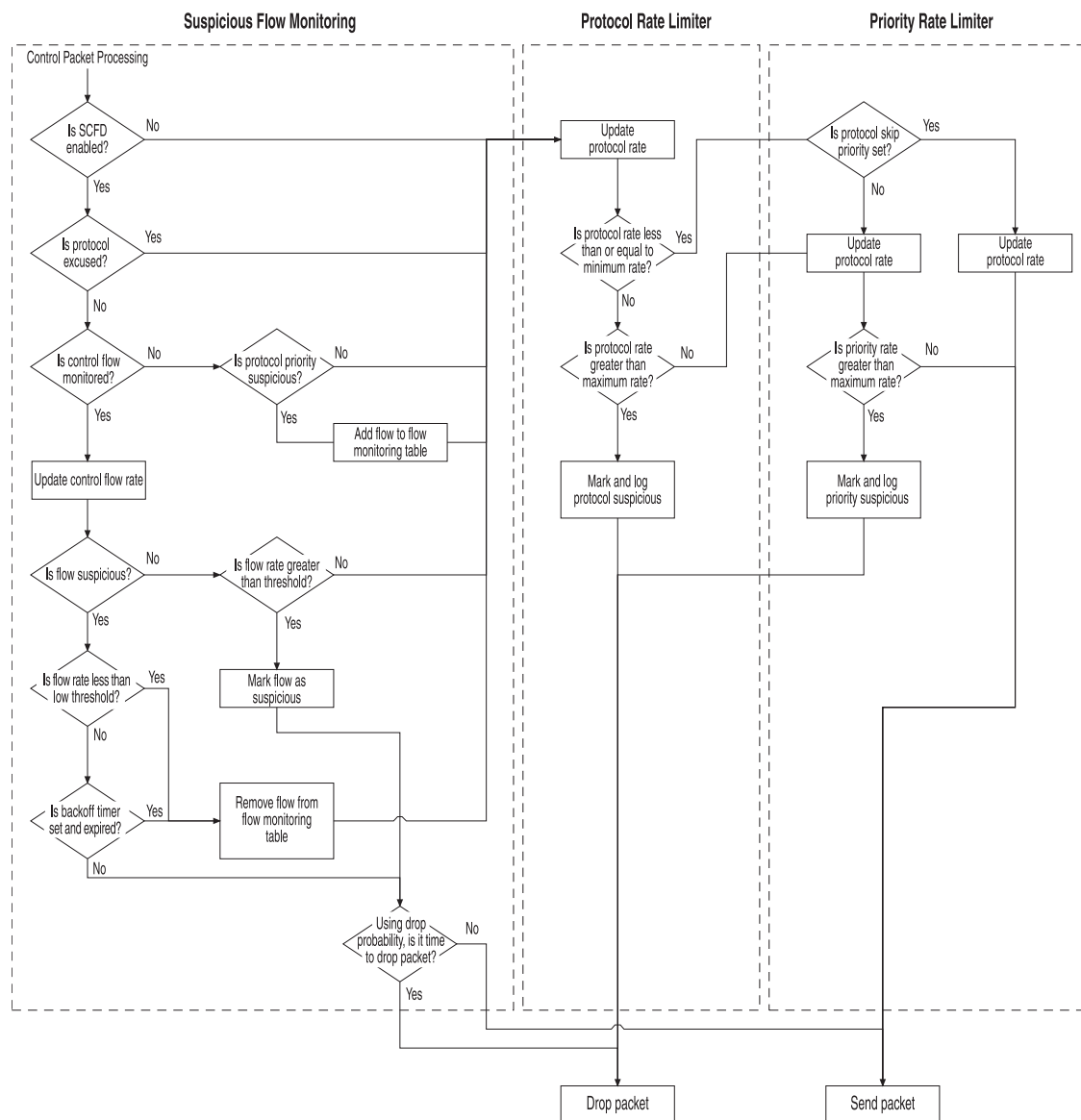
|                            |                             |                 |
|----------------------------|-----------------------------|-----------------|
| clear line                 | reload                      | show redundancy |
| clock set                  | reload slot                 | show secrets    |
| copy                       | rename                      | show subsystems |
| copy running-configuration | redundancy force-switchover | show timing     |
| delete                     | redundancy revert           | show users      |

|                |                     |                  |
|----------------|---------------------|------------------|
| dir            | show boot           | show utilization |
| disconnect ssh | show config         | srp switch       |
| configure      | show exception dump | synchronize      |
| erase secrets  | show ip ssh         | –                |
| halt           | show line           | –                |

## Denial of Service (DoS) Protection

A denial-of-service (DoS) attack is any attempt to deny valid users access to network or server resources by using up all the resources of the network element or server. Denial of service protection provides reactive prevention from attack and determines whether the source of traffic is valid or invalid. DoS protection includes diagnostic tools and configuration options. DoS protection groups provide a simple policy that can be applied to interfaces, which can specify a set of parameters to tune behavior.

Figure 29 on page 519 shows an example of the state of a flow with DoS protection using suspicious control flow detection (SCFD).

**Figure 29: Typical Control Packet Processing**

### Suspicious Control Flow Detection

To reduce the chance of a successful denial of service (DoS) attack and to provide diagnostic abilities while undergoing an attack, the system can detect suspicious control flows and keep state on those flows. A flow is a specific control protocol on a specific interface from a particular source. When the system determines that a control flow is suspicious, it can take corrective action on that control flow.

Keeping full state on each control flow can use a large number of resources. Instead, the system detects which flows have suspicious traffic. If a control flow is marked as suspicious, every packet associated with the flow is considered suspicious. When

a packet is marked as suspicious, it is dropped based on drop probability before being delivered to the control processor.

When a distributed DoS attack occurs on a line module, suspicious flow control resources can be exhausted. To provide further counter measures, you can enable the group feature, where flows are grouped together and treated as a whole. If you do not use the group feature, suspicious flows can fill up the suspicious flow table and prevent detection of additional attacking flows.

## ***Suspicious Control Flow Monitoring***

Each protocol has a per-protocol rate limit. The rate limiter is used to limit the rate of packets that proceed to the control processor for the specific protocol. Per-protocol rate limiting is also used to begin the process by which flows of the specific protocol are monitored.

Each priority has a per-priority rate limit. The rate limiter limits the rate of packets that proceed to the control processor for the specific priority. It also begins the process by which flows of the specific priority are monitored.

All protocols on each line module have a rate limit. Each protocol is associated with a given priority, which is also provided with a rate limit. When a slot comes under attack, the first lines of defense are the protocol and priority rate limiters. If the line module determines that a specific protocol or priority is under attack (because the rate has been exceeded), it proceeds to monitor all flows from the problem protocol or priority. Initially, a control flow is marked as nonsuspicious.

After a control flow is placed in the suspicious flow table, the system inspects all packets that belong to the flow. The interface controller (IC) and forwarding controller (FC) monitor the table to determine whether the suspicious flow has a packet rate above the suspicious level. If the packet rate is above this level, the flow is marked as suspicious. Marking a control flow as suspicious affects only a particular protocol on a particular interface. When a flow is marked as suspicious, all packets belonging to that flow are marked as suspicious and trapped at the forwarding controller.

Suspicious control flows are continually monitored. The flow can be restored if the flow goes below the low threshold level. The flow can also be restored based on a backoff timer. The flow is removed from the suspicious flow table if the related interface is removed.

Approximately 2000 flows can be monitored as suspicious at any time for each line module. When the suspicious flow table on a particular line module reaches its maximum and the system is not set to group flows, flows that should be marked as suspicious proceed as nonsuspicious. When you return a suspicious flow to a nonsuspicious state or delete it, the flows that did not fit into the table are added to the table.

By default, the system groups flows when the suspicious flow table size is exceeded on a line module. When the flow table is full, instead of marking a specific flow in that group as suspicious and providing information on each flow on that line module, the system groups flows based on group membership and provides information on the group instead of each flow. This flow information is useful under severe distributed



DoS attacks. Group membership is based on physical port and control protocol; all flows in that group are considered suspicious.

## **Configurable Options**

You can configure the following options for suspicious flow detection:

- Global on or off. When the option is set to off, flows or packets are not marked as suspicious. The default is on.
- Actions a line module takes when the suspicious flow table on the line module overflows:
  - Overflow—Stop recognizing new suspicious flows
  - Group—Group flows into logical groupings where some individual flows are monitored as a group
- Suspicious threshold for each protocol. The threshold is the rate in packets per second at which a flow becomes suspicious. A zero setting disables suspicious flow detection for the protocol. Flows are subject to protocol and priority rate limits, but not to suspicious flow detection.
- Low threshold for each protocol. The threshold rate determines whether an interface transitions from suspicious back to nonsuspicious. A zero setting means that the flow does not transition back to nonsuspicious based on packet rate.
- Backoff time in seconds for each protocol. After this period expires, the flow transitions to nonsuspicious regardless of the current rate. When set to zero, an interface does not return to the nonsuspicious state using a time mechanism.

You can also clear the following:

- All suspicious flows from the suspicious flow table for a specific slot.
- Suspicious flows from the suspicious flow table for the entire system.
- A single suspicious flow; returns the flow to the nonsuspicious state.

## **Display Options**

For monitoring purposes, you can:

- Display all suspicious control flows when the system has recognized an attack.
- Display the current state and the number of transitions into suspicious state for the protocol and priority.
- Display historical counts about the number of flows made suspicious.
- View a trap or log generated when a control flow is considered suspicious.
- View a trap or log generated when a control flow is no longer suspicious.

## **Traps and Logs**

The system generates a trap and a log message under the following conditions:

- A control flow transitions into a suspicious state; another trap and log message is generated on removal from a suspicious state.
- A protocol transitions to or from the suspicious state.
- A priority transitions to or from the suspicious state.
- The suspicious flow control system is overflowing or grouping flows on a line module.

You can control trap and log messages using CLI or SNMP commands.

## **Suspicious Control Flow Commands**

Use the commands described in this section to regulate suspicious control flows.

### ***baseline suspicious-control-flow-detection counts***

- Use to set a baseline for statistics for suspicious control flow detection.
- Example

```
host1#baseline suspicious-control-flow-detection counts
```

- There is no **no** version.
- See baseline suspicious-control-flow-detection counts.

### ***clear suspicious-control-flow-detection***

- Use to clear the active state for suspicious control detection.
- If you do not specify a slot or interface, clears all suspicious flows.
- If you specify a slot, clears all specified suspicious flows on that slot.
- If you specify an interface and protocol, and source mac-address. clears that specific flow.
- Example

```
host1#clear suspicious-control-flow-detection interface atm 1/0.1 ppp Control
address 0000.0001.0002
```

- There is no **no** version.
- See clear suspicious-control-flow-detection.

### ***suspicious-control-flow-detection grouping-off***

- Use to turn off overflow protection for suspicious control flow detection, enabling flows to be grouped into larger entities when the line module flow table overflows.
- Example

```
host1(config)#suspicious-control-flow-detection grouping-off
```

- Use the **no** version to turn on overflow protection.
- See suspicious-control-flow-detection grouping-off.

**suspicious-control-flow-detection off**

- Use to turn off the suspicious control flow detection.
- Example

```
host1(config)#suspicious-control-flow-detection off
```

- Use the **no** version to turn on suspicious control flow detection, which is the default.
- See suspicious-control-flow-detection off.

**suspicious-control-flow-detection protocol backoff-time**

- Use to set the backoff time in seconds for a specific protocol that triggers the suspicious flow to return to a nonsuspicious state.
- When set to zero, a suspicious control flow for a protocol does not return to a nonsuspicious state using a time mechanism.
- Example

```
host1(config)#suspicious-control-flow-detection protocol iposi backoff-time 300
```

- Use the **no** version to restore the defaults for the protocol, 300 seconds.
- See suspicious-control-flow-detection protocol backoff-time.

**suspicious-control-flow-detection protocol low-threshold**

- Use to set a threshold for a specific protocol; if the flow rate falls below this rate, a suspicious flow changes to the nonsuspicious state.
- Low threshold is the rate in packets per second at which a suspicious flow becomes no longer suspicious.
- When set to zero, a suspicious flow cannot change to the nonsuspicious state by means of a low threshold rate. To clear this flow, you must use the **clear suspicious-control-flow-detection** command.
- Example

```
host1(config)#suspicious-control-flow-detection protocol iposi low-threshold 512
```

- Use the **no** version to restore the defaults for the protocol.
- See suspicious-control-flow-detection protocol low-threshold.

**suspicious-control-flow-detection protocol threshold**

- Use to set the threshold in packets per second for a specific protocol, which triggers the flow to become a suspicious flow.
- When set to zero, a suspicious flow cannot change to the nonsuspicious state via a threshold rate.
- Example

```
host1(config)#suspicious-control-flow-detection protocol iposi threshold 1024
```

- Use the **no** version to restore the defaults for the protocol.
- See suspicious-control-flow-detection protocol threshold.

## Monitoring Suspicious Control Flow

Use the commands described in this section to monitor suspicious control flows.

### **show suspicious-control-flow-detection counts**

- Use to display statistics for suspicious control flow detection. When a slot is specified, displays only information for the specific slot. If no slot is specified, displays information for all slots.
- The **delta** keyword displays statistics for the current baseline.
- Field descriptions
  - Number of suspicious flows total—Total number of suspicious flows, current and past
  - Number of suspicious flows current—Number of suspicious flows currently detected and monitored
  - Number of groups total—Total number of groups, current and past
  - Number of groups current—Number of groups currently detected and monitored
  - Number of false negatives total—Total number of flows monitored that have not become suspicious (exceeded their threshold)
  - Number of false negatives current—Current number of flows monitored that have not become suspicious (exceeded their threshold)
  - Number of table overflows—Number of times a flow table overflows
- Example

```
host1(config)#show suspicious-control-flow-detection counts
Suspicious Flow Detection System Counts
 Number of suspicious flows total: 0
 Number of suspicious flows current: 0
 Number of groups total: 0
 Number of groups current: 0
 Number of false negatives total: 0
 Number of false negatives current: 0
 Number of table overflows: 0
```

- See show suspicious-control-flow-detection counts.

### **show suspicious-control-flow-detection flows**

- Use to display suspicious flows.
- Field descriptions

- Interface—Interface for the flow
- Protocol—Control protocol of the flow
- MAC address—Source MAC address of the flow
- InSlot—For certain flows detected on egress, the possible ingress slot of the flow
- Rate (pps)—Rate of the flow
- Peak Rate (pps)—Peak rate of the flow
- Time Since Created—Time since the flow was determined to be suspicious, in hh:mm:sec format
- Example

```
host1(config)# show suspicious-control-flow-detection flows
Suspicious Flow Detection System Flows
```

| Interface             | Protocol        | MAC address    | In Slot | Peak Rate (pps) | Rate (pps) | Time since Create |
|-----------------------|-----------------|----------------|---------|-----------------|------------|-------------------|
| -----                 | -----           | -----          | -----   | ---             | ---        | -----             |
| GigabitEthernet 1/0/7 | Ethernet ARP    | 0000.0100.0002 | ---     | 1000030         | 1000050    | 00:00:32          |
| *group 3 slot 1       | EthernetArpMiss | 0000.0100.0003 | ---     | 1000            | 3000       | 00:10:10          |

- See show suspicious-control-flow-detection flows.

#### **show suspicious-control-flow-detection info**

- Use to display information about suspicious flows.
- You can specify the following keywords:
  - **delta**—Displays statistics for the current baseline
  - **brief**—Displays only suspicious information
  - **slot**—Displays information for the specific slot
- Field descriptions
  - Protocol Information
    - Protocol—Control protocol of the flow
    - State
      - OK—Protocol is currently not receiving an excess amount of traffic.
      - Suspicious—Protocol detected as receiving an excess amount of traffic within the last backoff time in number of seconds.
  - Transitions—Number of times this protocol or priority has transitioned to the suspicious state
  - Priority Information
    - Priority—Priorities map to a specific queue and color; priority groups are Hi-Green, Hi-Yellow, Lo-Green and Lo-Yellow.

- State:
  - OK—Protocol is currently not receiving an excess amount of traffic
  - Suspicious—Protocol detected as receiving an excess amount of traffic within the last backoff time in number of seconds.
- Transitions—Number of times this protocol or priority has transitioned to the suspicious state

■ Example

```
host1(config)#show suspicious-control-flow-detection info slot 2
```

```
Suspicious Flow Detection System Information
```

```
Suspicious Flow Detection System is enabled
```

Using Groups

The suspicious control flow system is not in overflow state or using groups

Protocol Information

| Protocol                                       | State | Transitions |
|------------------------------------------------|-------|-------------|
| -----                                          |       |             |
| Ppp Echo Request                               | OK    | 0           |
| Ppp Echo Reply                                 | OK    | 0           |
| Ppp Echo Reply Fastpath                        | OK    | 0           |
| Ppp Control                                    | OK    | 0           |
| Atm Control (ILMI)                             | OK    | 0           |
| Atm OAM                                        | OK    | 0           |
| Atm Dynamic Interface Column Creation          | OK    | 0           |
| Atm Inverse ARP                                | OK    | 0           |
| Frame Relay LMI Control                        | OK    | 0           |
| Frame Relay Inverse Arp                        | OK    | 0           |
| Pppoe Control                                  | OK    | 0           |
| Pppoe Config Dynamic Interface Column Creation | OK    | 0           |
| Ethernet ARP Miss                              | OK    | 0           |
| Ethernet ARP                                   | OK    | 0           |
| Ethernet LACP packet                           | OK    | 0           |
| Ethernet Dynamic Interface Column Creation     | OK    | 0           |
| Slep SLARP                                     | OK    | 0           |
| MPLS TTL Exceeded On Receive                   | OK    | 0           |
| MPLS TTL Exceeded On Transmit                  | OK    | 0           |
| MPLS MTU Exceeded                              | OK    | 0           |
| Ipssec Transport Mode L2tp Control             | OK    | 0           |
| NAT/Firewall Payload                           | OK    | 0           |
| NAT/Firewall Update Table                      | OK    | 0           |
| DHCP External                                  | OK    | 0           |
| IP OSI                                         | OK    | 0           |
| IP TTL Expired                                 | OK    | 0           |
| IP Options Other                               | OK    | 0           |
| IP Options Router Alert                        | OK    | 0           |
| IP Multicast/Broadcast Other                   | OK    | 0           |
| IP Multicast DHCP (SC)                         | OK    | 0           |
| IP Multicast Control (SC)                      | OK    | 0           |
| IP Multicast Control (IC)                      | OK    | 0           |
| IP Multicast VRRP                              | OK    | 0           |
| IP Multicast Cache Miss                        | OK    | 0           |
| IP Multicast Cache Miss Auto Reply             | OK    | 0           |
| IP Multicast Wrong Interface                   | OK    | 0           |

|                                         |    |   |
|-----------------------------------------|----|---|
| IP Local DHCP (SC)                      | OK | 0 |
| IP Local Dhcp (IC)                      | OK | 0 |
| IP Local Icmp Echo                      | OK | 0 |
| IP Local Icmp Other                     | OK | 0 |
| IP Local LDP                            | OK | 0 |
| IP Local BGP                            | OK | 0 |
| IP Local OSPF                           | OK | 0 |
| IP Local RSVP                           | OK | 0 |
| IP Local PIM                            | OK | 0 |
| IP Local COPS                           | OK | 0 |
| IP Local L2tp Control (SC)              | OK | 0 |
| IP Local L2tp Control (IC)              | OK | 0 |
| IP Local Other                          | OK | 0 |
| IP Local Subscriber Interface Miss      | OK | 0 |
| IP Route To SRP Ethernet                | OK | 0 |
| IP Route No Route Exists                | OK | 0 |
| IP Normal Path MTU                      | OK | 0 |
| IP Neighbor Discovery                   | OK | 0 |
| IP Neighbor Discovery Miss              | OK | 0 |
| IP Search Error                         | OK | 0 |
| IP MLD                                  | OK | 0 |
| IP Local PIM Assert                     | OK | 0 |
| IP Local BFD                            | OK | 0 |
| IP IKE                                  | OK | 0 |
| IP Reassembly                           | OK | 0 |
| IP Local Icmp Frag                      | OK | 0 |
| IP Local Frag                           | OK | 0 |
| IP Application Classifier HTTP Redirect | OK | 0 |

#### Priority Information

| Priority     | State | Transitions |
|--------------|-------|-------------|
| -----        |       |             |
| Hi-Green-IC  | OK    | 0           |
| Hi-Yellow-IC | OK    | 0           |
| Lo-Green-IC  | OK    | 0           |
| Lo-Yellow-IC | OK    | 1           |
| Hi-Green-SC  | OK    | 0           |
| Hi-Yellow-SC | OK    | 0           |
| Lo-Green-SC  | OK    | 0           |
| Lo-Yellow-SC | OK    | 0           |

- See show suspicious-control-flow-detection info.

#### ***show suspicious-control-flow-detection protocol***

- Use to display protocol information for suspicious control flows.
- Field descriptions
  - Protocol—Control protocol
  - Threshold—Threshold in packets per second
  - Lo-Threshold—Low threshold in packets per second
  - Backoff-Time—Backoff time in seconds
- Example

| host1(config)#show suspicious-control-flow-detection protocol |           |              |              |
|---------------------------------------------------------------|-----------|--------------|--------------|
| Protocol                                                      | Threshold | Lo-Threshold | Backoff-Time |
| -----                                                         |           |              |              |
| Ppp Echo Request                                              | 10        | 5            | 300          |
| Ppp Echo Reply                                                | 10        | 5            | 300          |
| Ppp Echo Reply Fastpath                                       | 10        | 5            | 300          |
| Ppp Control                                                   | 10        | 5            | 300          |
| Atm Control (ILMI)                                            | 10        | 5            | 300          |
| Atm OAM                                                       | 10        | 5            | 300          |
| Atm Dynamic Interface Column Creation                         | 10        | 5            | 300          |
| Atm Inverse ARP                                               | 10        | 5            | 300          |
| Frame Relay LMI Control                                       | 10        | 5            | 300          |
| Frame Relay Inverse Arp                                       | 10        | 5            | 300          |
| Pppoe Control                                                 | 512       | 256          | 300          |
| Pppoe Config Dynamic Interface Column Creation                | 10        | 5            | 300          |
| Ethernet ARP Miss                                             | 128       | 64           | 300          |
| Ethernet ARP                                                  | 128       | 64           | 300          |
| Ethernet LACP packet                                          | 10        | 5            | 300          |
| Ethernet Dynamic Interface Column Creation                    | 512       | 256          | 300          |
| SLep SLARP                                                    | 128       | 64           | 300          |
| MPLS TTL Exceeded On Receive                                  | 10        | 5            | 300          |
| MPLS TTL Exceeded On Transmit                                 | 10        | 5            | 300          |
| MPLS MTU Exceeded                                             | 10        | 5            | 300          |
| Ipssec Transport Mode L2tp Control                            | 2048      | 1024         | 300          |
| NAT/Firewall Payload                                          | 512       | 256          | 300          |
| NAT/Firewall Update Table                                     | 512       | 256          | 300          |
| DHCP External                                                 | 1024      | 512          | 300          |
| IP OSI                                                        | 2048      | 1024         | 300          |
| IP TTL Expired                                                | 10        | 5            | 300          |
| IP Options Other                                              | 512       | 256          | 300          |
| IP Options Router Alert                                       | 2048      | 1024         | 300          |
| IP Multicast/Broadcast Other                                  | 512       | 256          | 300          |
| IP Multicast DHCP (SC)                                        | 512       | 256          | 300          |
| IP Multicast Control (SC)                                     | 2048      | 1024         | 300          |
| IP Multicast Control (IC)                                     | 512       | 256          | 300          |
| IP Multicast VRRP                                             | 512       | 256          | 300          |
| IP Multicast Cache Miss                                       | 128       | 64           | 300          |
| IP Multicast Cache Miss Auto Reply                            | 128       | 64           | 300          |
| IP Multicast Wrong Interface                                  | 10        | 5            | 300          |
| IP Local DHCP (SC)                                            | 512       | 256          | 300          |
| IP Local Dhcp (IC)                                            | 512       | 256          | 300          |
| IP Local Icmp Echo                                            | 512       | 256          | 300          |
| IP Local Icmp Other                                           | 128       | 64           | 300          |
| IP Local LDP                                                  | 2048      | 1024         | 300          |
| IP Local BGP                                                  | 2048      | 1024         | 300          |
| IP Local OSPF                                                 | 64        | 32           | 300          |
| IP Local RSVP                                                 | 2048      | 1024         | 300          |
| IP Local PIM                                                  | 2048      | 1024         | 300          |
| IP Local COPS                                                 | 2048      | 1024         | 300          |
| IP Local L2tp Control (SC)                                    | 2048      | 1024         | 300          |
| IP Local L2tp Control (IC)                                    | 512       | 256          | 300          |
| IP Local Other                                                | 512       | 256          | 300          |
| IP Local Subscriber Interface Miss                            | 512       | 256          | 300          |
| IP Route To SRP Ethernet                                      | 512       | 256          | 300          |
| IP Route No Route Exists                                      | 10        | 5            | 300          |
| IP Normal Path MTU                                            | 10        | 5            | 300          |



|                                         |      |      |     |
|-----------------------------------------|------|------|-----|
| IP Neighbor Discovery                   | 128  | 64   | 300 |
| IP Neighbor Discovery Miss              | 128  | 64   | 300 |
| IP Search Error                         | 10   | 5    | 300 |
| IP MLD                                  | 512  | 256  | 300 |
| IP Local PIM Assert                     | 512  | 256  | 300 |
| IP Local BFD                            | 1024 | 512  | 300 |
| IP IKE                                  | 512  | 256  | 300 |
| IP Reassembly                           | 2048 | 1024 | 300 |
| IP Local Icmp Frag                      | 512  | 256  | 300 |
| IP Local Frag                           | 512  | 256  | 300 |
| IP Application Classifier HTTP Redirect | 128  | 64   | 300 |

- See show suspicious-control-flow-detection protocol.

### **show snmp interfaces**

- Use to display a list of interface types that are compressed in the interface tables and the interface numbering method configured on the router.
- Field descriptions
  - Compressed(Removed) Interface Types—List of interface types that are removed from the ifTable and ifStackTable
  - Armed Interface Numbering Mode—Interface numbering method configured on the router: RFC1213, RFC2863
  - maxIfIndex—Maximum value that the system will allocate to the ifIndex field
  - maxIfNumber—Maximum number of interfaces allowed in the ifTable
  - Interface Description Setting—Method used to encode the ifDescr and ifName objects: common, legacy, proprietary
- Example

```
host1#show snmp interfaces
Compressed(Removed) Interface Types:
HDLC, FT1, ATM, ATM1483
Armed Interface Numbering Mode:
RFC1213, maxIfIndex=65535, maxIfNumber=65535
Interface Description Setting: proprietary
```

- See show snmp interfaces.

## **Denial-of-Service Protection Groups**

A DoS protection group provides a simple policy that can be applied to interfaces. This policy can specify a complete set of parameters to tune the behavior of the DoS protection groups. The system uses these parameters to determine the priority and rates for various control protocols. The rate of traffic for a particular protocol is unlikely to be the same on all ports in the system. A configuration can have several types of interfaces, such as DHCP access clients, PPPoE access clients, and uplink interfaces. Each of these interfaces requires a different DoS configuration. All

interfaces are associated with a default DoS protection group, which has standard system defaults. The maximum rates are per line module, and the drop probability is 100 percent (all suspicious packets are dropped).

## Group Parameters

DoS protection groups support the following set of parameters:

- Protocol-to-priority mapping enables you to map a protocol to one of four priorities.
- Protocol burst enables you to configure the burst level for the protocol. The burst is configurable in packets, and defaults to a value in packets that is one half of the maximum rate.
- Protocol maximum rate limit (per line module) enables you to map a protocol to a maximum rate limit. This rate limit applies to all packets for a particular protocol for interfaces belonging to this particular DoS protection group on a line module. By having a DoS protection group on a single line module, the total maximum rate for a protocol can be up to the sum of the four rates configured, depending on the DoS group attached to an interface. You can set a maximum rate of zero for protocols that are not used. The actual rate never exceeds the maximum rate, but the actual rate allowed can be less than the configured maximum rate because of the weighting of protocols within a DoS protection group and the use of multiple DoS protection groups.
- Protocol weight with respect to other protocols in the DoS protection group enables you to balance the priority of the protocols. For each priority grouping, weight determines the effective minimum rate that each protocol receives. Within each priority, the sum of the minimum rates for all protocols using that priority is equal to or less than the priority rate times the over-subscription value. Each priority has a separate rate for each DoS protection group.
- Protocol drop probability for suspicious packets enables you to map a protocol to a specific drop probability. The drop probability is the percentage probability that a suspicious packet is dropped.
- Protocol skip priority rate limiter enables you to configure the system so that the specified protocol is not subject to the priority rate limiter for the priority and DoS protection group selected. The default is off—the protocol is subject to priority rate limiting.
- Priority rate sets the rate of the priority in packets per second for the line module. If this rate is exceeded, it triggers DoS suspicious control flow detection.
- Priority burst enables you to set the number of packets allowed to exceed the maximum rate before packets are dropped and DoS suspicious control flow detection is triggered.
- Priority oversubscription enables you to set an oversubscription factor for the priority rate limiter. In addition to the priority rate, it calculates the minimum rate limits for protocols with a priority grouping and allows for oversubscription of the priority rate. The value indicates a percentage that the priority rate limiter is allowed to be oversubscribed, in the range 100–1000.

## Attaching Groups

By default, each interface belongs to the default DoS protection group. The name is the only non-configurable aspect of the default DoS protection group.

The DoS protection group is a configurable parameter for all Layer 2 and IP interfaces. Similar to other configurable interface parameters, the DoS protection group can be set using profiles.

Because all newly created interfaces default to using the default DoS protection group, they do not inherit any DoS protection group association from a higher or lower interface binding.

The DoS group applies to all types of control flows for the specific interface. For example, an IP interface supports a variety of control protocols, each of which can be separately mapped to a priority and drop probability, but to a single DoS protection group.

## Protocol Mapping

Table 55 on page 531 and Table 56 on page 532 list the protocols mapped within DoS protection groups.

**Table 55: Layer 2-Related Protocols**

| CLI Name               | Description of Flow                                       |
|------------------------|-----------------------------------------------------------|
| atmControl             | ATM ILMI packets                                          |
| atmOAM                 | ATM OAM packets                                           |
| atmDynamicIf           | ATM dynamic interface column creation                     |
| atmInverseArp          | ATM inverse ARP packets                                   |
| dhcPExternal           | DHCP external packets                                     |
| ethernetArpMiss        | Ethernet/Bridged Ethernet request to send ARP             |
| ethernetArp            | Ethernet/Bridged Ethernet reception of ARP packet         |
| ethernetLacp           | Ethernet LACP packet                                      |
| ethernetDynamicIf      | Ethernet/Bridged Ethernet dynamic VLAN interface creation |
| flisInPayload          | Firewall/NAT payload                                      |
| flisInPayloadUpdateTbl | Firewall/NAT payload and update table                     |

**Table 55: Layer 2-Related Protocols** *(continued)*

| CLI Name          | Description of Flow                                              |
|-------------------|------------------------------------------------------------------|
| frameRelayControl | Frame Relay LMI packets                                          |
| frameRelayArp     | Frame Relay inverse ARP packets                                  |
| itmL2tpControl    | IPSec transport mode L2TP control packets                        |
| mplsTtlOnRx       | MPLS TTL expired on ingress                                      |
| mplsTtlOnTx       | MPLS TTL expired on egress                                       |
| mplsMtu           | MPLS MTU exceeded                                                |
| pppEchoRequest    | PPP echo request packets destined for the IC                     |
| pppEchoReply      | PPP echo reply packets destined for the IC                       |
| pppEchoReplyFast  | PPP echo request packets generating an FC-based reply            |
| pppControl        | other PPP control packets                                        |
| pppoeControl      | PPPoE PADx packets                                               |
| pppoePppConfig    | PPPoE handling of PPP LCP packets for dynamic interface creation |
| slepSlarp         | Serial Line Interface SLARP packets                              |

**Table 56: IP-Related Protocols**

| CLI Name                    | Description of Flow                               |
|-----------------------------|---------------------------------------------------|
| ipAppClassifierHttpRedirect | IP Application Classifier (HTTP redirect) packets |
| ipIke                       | IP IKE packet                                     |
| ipLocalBfd                  | IP BFD packets                                    |
| ipLocalBgp                  | IP BGP packets                                    |
| ipLocalCops                 | IP COPS packets                                   |

**Table 56: IP-Related Protocols** *(continued)*

| CLI Name                   | Description of Flow                                                                |
|----------------------------|------------------------------------------------------------------------------------|
| ipLocalDemuxMiss           | IP Subscriber Interface Miss packets                                               |
| ipLocalDhcpIc              | IP DHCP packets destined for the IC (not broadcast)                                |
| ipLocalDhcpSc              | IP DHCP packets destined for the SC (broadcast and IC not enabled)                 |
| ipLocalFrag                | IP fragments not classifiable                                                      |
| ipLocalIcmpEcho            | IP ICMP echo request and reply                                                     |
| ipLocalIcmpFrag            | IP ICMP packets that are not further classifiable (most likely large ping packets) |
| ipLocalIcmpOther           | IP ICMP except echo request and reply                                              |
| ipLocalL2tpControlIc       | IP L2TP control packets for IC                                                     |
| ipLocalL2tpControlSc       | IP L2TP control packets for SC                                                     |
| ipLocalLDP                 | IP LDP packets                                                                     |
| ipLocalOspf                | IP OSPF packets                                                                    |
| ipLocalOther               | IP Local packets not otherwise classified                                          |
| ipLocalPim                 | IP PIM packets (except typeAssert)                                                 |
| ipLocalPimAssert           | IP PIM assert type packets                                                         |
| ipLocalRsvp                | IP RSVP packets                                                                    |
| ipMld                      | IP Multicast listener packet                                                       |
| ipMulticastBroadcastOther  | Ip Multicast/Broadcast not otherwise classified                                    |
| ipMulticastCacheMiss       | IP Multicast route table misses                                                    |
| ipMulticastCacheMissAutoRp | IP Multicast route table Auto-RP misses                                            |
| ipMulticastControlIc       | IP IGMP packets for the IC                                                         |
| ipMulticastControlSc       | IP Multicast control packet not otherwise classified                               |
| ipMulticastDhcpSc          | IP Multicast DHCP destined for SC                                                  |
| ipMulticastVrrp            | IP VRRP packets                                                                    |
| ipMulticastWrongIf         | IP Multicast on wrong interface                                                    |
| ipNeighborDiscovery        | IPv6 Neighbor Discovery                                                            |
| ipNeighborDiscoveryMiss    | IPv6 Neighbor Discovery miss                                                       |

**Table 56: IP-Related Protocols** (continued)

| CLI Name             | Description of Flow                                    |
|----------------------|--------------------------------------------------------|
| ipNormalPathMtu      | IP Path MTU request                                    |
| ipOptionsOther       | IP options not otherwise classified                    |
| ipOptionsRouterAlert | IP Router Alert                                        |
| ipOsi                | OSI packets                                            |
| ipReassembly         | IP packets that have been reassembled on a server card |
| ipRouteNoRoute       | IP packets with no route indication                    |
| ipRouteToSrpEthernet | Packets routed to the SRP Ethernet                     |
| ipTtlExpired         | IP TTL expired                                         |

## DoS Protection Group Configuration Example



**NOTE:** To configure a DoS protection group for an interface, you must configure the settings under the default group, which is the only group that is currently supported.

To configure a DoS protection group for an interface:

```
host1(config)#dos-protection-group default
host1(config-dos-protection)#protocol AtmOam rate 512
host1(config-dos-protection)#protocol PppoeControl rate 512
host1(config-dos-protection)#protocol IpLocalOther rate 512
```

To display the configuration:

```
host1#show dos-protection-group default
```

default (canned-group: defaultCanned) \*modified -- no references

| Protocol                              | Dest | Mod | Rate | Burst | Weight | DropProb | Priority  | Skip |
|---------------------------------------|------|-----|------|-------|--------|----------|-----------|------|
| Ppp Echo Request                      | IC   | -   | 2048 | 1024  | 100    | 100      | HI green  | Y    |
| Ppp Echo Reply                        | IC   | -   | 2048 | 1024  | 100    | 100      | HI green  | Y    |
| Ppp Echo Reply Fastpath               | FC   | -   | 0    | 0     | 100    | 100      | Data path | Y    |
| Ppp Control                           | IC   | -   | 2048 | 1024  | 100    | 100      | HI green  | N    |
| Atm Control (ILMI)                    | IC   | -   | 2048 | 1024  | 100    | 100      | HI green  | Y    |
| Atm OAM                               | IC   | *   | 512  | 512   | 100    | 100      | LO green  | N    |
| Atm Dynamic Interface Column Creation | IC   | -   | 1024 | 512   | 100    | 100      | HI yellow | N    |
| Atm Inverse ARP                       | IC   | -   | 256  | 128   | 100    | 100      | LO yellow | N    |
| Frame Relay Control (LMI)             | IC   | -   | 2048 | 1024  | 100    | 100      | HI green  | Y    |
| Frame Relay Inverse                   | IC   | -   | 256  | 128   | 100    | 100      | LO yellow | N    |

|                      |    |   |      |     |     |     |    |        |   |  |
|----------------------|----|---|------|-----|-----|-----|----|--------|---|--|
| Arp                  |    |   |      |     |     |     |    |        |   |  |
| Pppoe Control        | IC | * | 512  | 512 | 100 | 100 | HI | yellow | N |  |
| Pppoe Ppp Config Dyn | IC | - | 1024 | 512 | 100 | 100 | HI | yellow | N |  |
| amic Interface Colum |    |   |      |     |     |     |    |        |   |  |
| n Creation           |    |   |      |     |     |     |    |        |   |  |
| Ethernet ARP Miss    | IC | - | 256  | 128 | 100 | 100 | LO | yellow | N |  |
| Ethernet ARP         | IC | - | 256  | 128 | 100 | 100 | LO | yellow | N |  |

## DoS Protection Group Commands

Use the commands described in this section to create DoS protection groups and attach them to different types of interfaces.

- Use to attach an ATM DoS protection group to an interface.
- Example

```
host1(config-if)#atm dos-protection-group group1
```

- Use the **no** version to remove the attachment of the DoS protection group from the interface.

### **bridge1483 dos-protection-group**

- Use to attach a bridge 1483 DoS protection group to an interface.
- Example

```
host1(config-if)#bridge1483 dos-protection-group group1
```

- Use the **no** version to remove the attachment of the DoS protection group from the interface.
- See bridge1483 dos-protection-group.

### **dos-protection-group**

- Use to create a DoS protection group and enter DoS Protection Group Configuration mode.
- A group named default always exists.
- Example

```
host1(coonfig)#dos-protection-group default
```

- Use the **no** version to remove the DoS protection group.
- See dos-protection-group.

### **ethernet dos-protection-group**

- Use to attach an Ethernet DoS protection group to an interface.
- Example

```
host1(config-if)#ethernet dos-protection-group group1
```

- Use the **no** version to remove the attachment of the DoS protection group from the interface.
- See ethernet dos-protection-group.

### ***frame-relay dos-protection-group***

- Use to attach a Frame Relay DoS protection group to an interface.
- Example

```
host1(config-if)#frame-relay dos-protection-group group1
```

- Use the **no** version to remove the attachment of the DoS protection group from the interface.
- See frame-relay dos-protection-group.

### ***hdlc dos-protection-group***

- Use to attach an HDLC DoS protection group to an interface.
- Example

```
host1(config-if)#hdlc dos-protection-group group1
```

- Use the **no** version to remove the attachment of the DoS protection group from the interface.
- See hdlc dos-protection-group.

### ***ip dos-protection-group***

- Use to attach an IP DoS protection group to an interface.
- Example 1

```
host1(config-if)#ip dos-protection-group group1
```

- Example 2

```
host1(config)#dos-protection-group default
host1(config-dos-protection)#protocol AtmOam rate 512
host1(config-dos-protection)#protocol PppoeControl rate 512
host1(config-dos-protection)#protocol IpLocalOther rate 512
```

- Use the **no** version to remove the attachment of the DoS protection group from the interface.
- See ip dos-protection-group.

### ***ipv6 dos-protection-group***

- Use to attach an IPv6 DoS protection group to an interface.
- Example

```
host1(config-if)#ipv6 dos-protection-group group1
```



- Use the **no** version to remove the attachment of the DoS protection group from the interface.
- See `ipv6 dos-protection-group`.

### ***lag dos-protection-group***

- Use to attach a LAG DoS protection group to an interface.
- Example

```
host1(config-if)#lag dos-protection-group group1
```

- Use the **no** version to remove the attachment of the DoS protection group from the interface.
- See `lag dos-protection-group`.

### ***ppp dos-protection-group***

- Use to attach a PPP DoS protection group to an interface.
- Example

```
host1(config-if)#ppp dos-protection-group group1
```

- Use the **no** version to remove the attachment of the DoS protection group from the interface.
- See `ppp dos-protection-group`.

### ***pppoe dos-protection-group***

- Use to attach a PPPoE DoS protection group to an interface.
- Example

```
host1(config-if)#pppoe dos-protection-group group1
```

- Use the **no** version to remove the attachment of the DoS protection group from the interface.
- See `pppoe dos-protection-group`.

### ***priority burst***

- Use to set the burst size in packets for the priority.
- Example

```
host1(config-dos-protection)#priority Hi-Green-IC burst 32
```

- Use the **no** version to return to the default value.
- See `priority burst`.

### ***priority over-subscription-factor***

- Use to set the oversubscription value for the priority rate limiter.
- The oversubscription value and the priority rate are used to calculate the minimum rate limits for port compression.
- Allows an oversubscription of the priority rate because all protocols within a priority are not generally used simultaneously.
- Example

```
host1(config-dos-protection)#priority Hi-Green-IC over-subscription-factor 100
```

- Use the **no** version to return no oversubscription value.
- See priority over-subscription-factor.

### ***priority rate***

- Use to set the rate in packets-per-second for the priority.
- Example

```
host1(config-dos-protection)#priority Hi-Green-IC rate 6000
```

- Use the **no** version to return to the default value of 0.
- See priority rate.

### ***protocol burst***

- Use to set the burst size in packets-per-second for the protocol.
- The default value is one half the maximum rate in packets.
- Example

```
host1(config-dos-protection)#protocol IpLocalDhcpIc burst 65535
```

- Use the **no** version to set the default value, which is equal to half of the configured maximum rate.
- See protocol burst.

### ***protocol drop-probability***

- Use to map a protocol to a specific drop probability, which is the percentage probability of an exceeded packet being dropped.
- Example

```
host1(config-dos-protection)#protocol IpLocalDhcpIc drop-probability 100
```

- Use the **no** version to set the drop probability to the value specified in the associated default group.
- See protocol drop-probability.

### ***protocol priority***

- Use to set the priority for the protocol.
- Example

```
host1(config-dos-protection)#protocol IpLocalDhcplc priority hiGreen
```

- Use the **no** version to set the priority to the value specified in the associated default group.
- See protocol priority.

### ***protocol rate***

- Use to map a protocol to a maximum rate limit.
- The rate limit applies to all packets of the protocol for interfaces belonging to the DoS protection group.
- A particular protocol can be up to the sum of the four rates configured, depending on the DoS group attached to an interface.
- Use a maximum rate of 0 for protocols that are not used.
- The actual rate never exceeds the maximum rate, but can be less than the configured maximum rate due to the weighting of the protocols within a DoS protection group and the use of multiple DoS protection groups.
- Example

```
host1(config-dos-protection)#protocol IpLocalDhcplc rate 100
```

- Use the **no** version to set the value to the value specified in the associated default group.
- See protocol rate.

### ***protocol skip-priority-rate-limiter***

- Use to set the skip priority rate limiter for the protocol.
- The specified protocol is not subject to the priority rate limiter for the priority and DoS protection group selected.
- The default sets the protocol such that it is subject to priority rate limiting.
- Example

```
host1(config-dos-protection)#protocol IpLocalDhcplc skip-priority-rate-limiter
```

- Use the **no** version to set the value to the default, which is not to use skip-priority-rate-limiter.
- See protocol skip-priority-rate-limiter.

### ***protocol weight***

- Use to set the weight for the protocol.
- For each port compression, weight determines the effective minimum rate that each protocol receives.

- Within each port compression, the sum of the minimum rates for all protocols is equal to or less than the priority rate.
- For each priority, there is a separate rate for each DoS protection group.
- Example

```
host1(config-dos-protection)#protocol IpLocalDhcplc weight 100
```

- Use the **no** version to set the weight to the value specified in the associated default group.
- See protocol weight.

#### ***use canned-group***

- Use to create a DoS protection group that uses a pre-programmed set of parameters.
- Use the **revert** keyword to return the values to the canned group values
- Example

```
host1#use canned-group group1
```

- Use the **no** version to associate the group with the default canned group settings.
- See use canned-group.

#### ***vlan dos-protection-group***

- Use to attach a VLAN DoS protection group to an interface.
- Example

```
host1(config-if)#vlan dos-protection-group
```

- Use the **no** version to remove the attachment of the DoS protection group from the interface.
- See vlan dos-protection-group.

### ***Monitoring DoS Protection Groups***

Use the commands described in this section to monitor DoS protection groups.

#### ***show dos-protection-group***

- Use to display DoS protection groups.
- If you do not specify a group, displays the names of the currently configured DoS protection groups.
- If you specify a group, displays information about the specified group.
- If you do not specify the **brief** keyword, displays a list of references (interfaces and templates) to the DoS protection group,

- When *\*modified\** appears next to the name of the DoS protection group, the group or protocol within the group has changed from the preprogrammed value of the associated group.
- Example

```
host1(config)#show dos-protection-group
DOS Protection Groups:
Default (canned-group: " default") *modified*
Uplink (canned-group: " link")
ATM (canned-group: " ppoe") *modified*
VLAN (canned-group: " mixed-access")
```

- See show dos-protection-group.



## Chapter 10

# Writing CLI Macros

An E-series router has an embedded macro language that enables you to define and run macros that can generate and execute CLI commands. Macro files—identified by the *.mac* extension—can be used to store more than one macro. Depending on your needs, you might want to store all of your macros in one file, group macros by function, or store only one macro per file.

This chapter contains the following sections:

- Platform Considerations on page 543
- Writing Macros on page 543
- Detecting and Recording Macro Errors on page 561
- Running Macros on page 566
- Scheduling Macros on page 569
- Practical Examples on page 573

### Platform Considerations

---

Macros are supported on all E-series routers.

For information about the modules supported on E-series routers:

- See the *ERX Module Guide* for modules supported on ERX-7xx models, ERX-14xx models, and the ERX-310 router.
- See the *E120 and E320 Module Guide* for modules supported on the E120 router and the E320 router.

### Writing Macros

---

You must write macros on your computer, not on the E-series router. The macros can contain loops, variables, string and numeric values, and conditional statements. Macros can invoke other macros (as long as they are contained within the same macro file), including themselves, but infinite recursion is not permitted. Macros are case-insensitive.

Macros consist of *control expressions* and *noncontrol expressions*. Control expressions are enclosed by *control brackets*, which are angle-bracket and number sign pairs, like this: `< # controlExpression # >`. Examples of control expressions include the macro

name and macro end statements, and *while* loops. A control expression can include multiple operation statements if you separate the statements with semicolons (;). For example:

```
<# i:=0; while i++ < 3 #>
```

All macros must have names consisting only of letters, numbers, and the underline character (\_). The first character of a macro name cannot be a number. If you include more than one macro within a macro file, each macro must have a unique name. The first line of a macro defines the macro's name:

```
<# macroName #>
```

Noncontrol expressions are not enclosed by control brackets and simply become part of the generated CLI command text.

You must end all macros with the following control expression:

```
<# endtmp1 #>
```

You can add comments to your control expressions to clarify the code by prefacing the comment with forward slashes (//) inside the control brackets:

```
<# endtmp1 //A comment in the macro end expression #>
```

Text after the // is ignored when the macro is run and is not displayed by the CLI.

You can also add comments outside the control expressions by prefacing the comment with an exclamation point (!). The CLI displays these comments if you use the **test** or **verbose** keywords with the **macro** command; the CLI never interprets these comments as commands.

```
!This is a comment outside any control expression
```

You can improve the readability of a macro by using tabs to indent expressions. Leading and trailing tabs have no effect on the macro output, because they are removed when the macro is run.

**Example** The following is a simple macro that you can use to configure the IP interface on the Fast Ethernet port of the SRP module after you have restored the factory defaults:

```
<# ipInit #>
<# ipAddress := env.getline (" IP Address of System?") #>
ena
conf t
int f0/0
ip addr <# ipAddress; '\n' #>
ip route 10.0.0.0 255.0.0.0 192.168.1.1
host pk 10.10.0.166 ftp
<# endtmp1 #>
```



## Environment Commands

Macros use environment commands to write data to the macro output, to determine a value, or to call other commands. Table 57 on page 545 describes the environment commands that are currently supported.

**Table 57: Environment Commands**

| Command                                                     | Description                                                                                                                                                                                                                                                                                  |
|-------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>env.delay(int <i>delay</i>)</code>                    | Causes the macro to delay further execution for the number of seconds specified by <i>delay</i>                                                                                                                                                                                              |
| <code>env.getLine</code>                                    | Prompts the user with a question mark (?) and waits for a response                                                                                                                                                                                                                           |
| <code>env.getLine(string <i>prompt-string</i>)</code>       | Prompts the user with the value of <i>prompt-string</i> and waits for a response                                                                                                                                                                                                             |
| <code>env.getLineMasked</code>                              | Prompts the user with a question mark (?), waits for a response, and echoes the response with an asterisk (*) for each character entered by the user                                                                                                                                         |
| <code>env.getLineMasked(string <i>prompt-string</i>)</code> | Prompts the user with the value of <i>prompt-string</i> , waits for a response, and echoes the response with an asterisk (*) for each character entered by the user                                                                                                                          |
| <code>env.argc</code>                                       | Returns the number of arguments passed to the macro                                                                                                                                                                                                                                          |
| <code>env.argv(n)</code>                                    | Returns the value of the nth argument, such that $1 \leq n \leq \text{env.argc}$<br><br>The returned value is a string, not a number; if you want to use this value for a subsequent numeric operation, you must first convert it to a number with the <code>env.atoi(string)</code> command |
| <code>env.argv(0)</code>                                    | Returns the name of the macro                                                                                                                                                                                                                                                                |
| <code>env.atoi(string)</code>                               | Converts the specified string to a numeric value                                                                                                                                                                                                                                             |
| <code>env.atoi(env.argv(n))</code>                          | Converts input values to integers                                                                                                                                                                                                                                                            |
| <code>env.setResult</code>                                  | Sets parameters within a macro for display through the macroData log at the NOTICE severity level following the completion of the macro                                                                                                                                                      |
| <code>env.getErrorCommand</code>                            | Returns the command string that triggered a macro error                                                                                                                                                                                                                                      |
| <code>env.getErrorStatus</code>                             | Returns the reason for a triggered error                                                                                                                                                                                                                                                     |
| <code>env.startCommandResults</code>                        | Starts the capture of command output                                                                                                                                                                                                                                                         |
| <code>env.stopCommandResults</code>                         | Stops the capture of command output                                                                                                                                                                                                                                                          |
| <code>env.getResults</code>                                 | Returns one line of output from the capture buffer                                                                                                                                                                                                                                           |
| <code>env.regexMatch(string)</code>                         | Checks a string against a regular expression                                                                                                                                                                                                                                                 |

**Table 57: Environment Commands** *(continued)*

| Command                                 | Description                            |
|-----------------------------------------|----------------------------------------|
| <code>env.getRegexpMatch(string)</code> | Extracts a string from a larger string |

## Capturing Output of Commands

Macro language commands can start and stop the capture of JUNOS command output and save the results.

The `env.startCommandResults` command starts JUNOS output capture and flushes any existing capture buffer. The capture stops when directed by a **stop** command or when the buffer maximum of 5,242,880 (5MB) characters is reached. The command output in the buffer is stored as normally seen on the terminal output. A `< CR >` ends a line of buffer data.

The `env.stopCommandResults` command stops JUNOS output captures. The `env.getResults` command obtains one line of output from the capture buffer.

The `env.startCommandResults`, `env.stopCommandResults`, and `env.getResults` commands apply to one CLI session. There is no effect on CLI sessions other than the CLI session running the macro.

The `env.getResults` command gets the next line of the capture buffer. Each call gets the next line of the capture buffer. The command returns the first line the first time it is called after a capture start (`env.startCommandResults`). It resets the next line it returns by passing a line number argument. An argument of 0 or 1 returns the first line.

For example:

```
<# env.startCommandResults #>
show version
<# env.stopCommandResults #>
! possibly other JUNOS commands
<# while something is true #>
<# outputLine := env.getResults #>
...
<# endwhile #>
```

## Adding Regular Expression Matching to Macros

Use the following syntax to check a string against a regular expression:

```
env.regexpMatch(stringToMatch, someRegularExpression)
```

For example, the string `outputLine` is checked to determine whether it starts with the value `System`:

```
<# if env.regexpMatch(outputLine, "^System") #>
...
<# endif #>
```

In this example, the string interface is checked to determine whether it has the correct syntax:

```
<# interface := env.argv(1) #>
<# if env.regexpMatch(interface, "^[0-9]+/[0-9]+$") #>
...
<# endif #>
```

### ***Extracting a Substring Based on Regular Expression Matching***

A string can be extracted from a larger string using the following syntax:

```
env.getRegexpMatch(stringToMatch, someRegularExpression, occurrence)
```

This example gets the third occurrence of a sequence of numbers followed by a space, followed by a sequence of letters within string outputLine:

```
<# value := env.getRegexpMatch(outputLine, "[0-9]+ [a-zA-Z]+", 3) #>
```

This example gets the interface value from an interface string:

```
<# interface := env.getRegexpMatch(interface, "[0-9]+/[0-9]+", 1) #>
```

### ***Adding Global Variables for Availability to the onError Macro***

Global variables can be set in any macro and retrieved without being explicitly passed in another macro. The global variable is set with the following syntax:

```
env.setVar(name, value)
```

The name is a quoted string and the value can be a character string or number.

The global variable is retrieved with the following syntax:

```
value := env.getVar(name).
```

The name is a quoted string and the value is the value stored by an earlier env.setVar.

A macro can contain one onError macro. The onError macro is like any other macro file template. There can only be one macro with the name onError in the macro file.

In this example, the macro sets a global variable before using it in a configuration command:

```
<# badInt #>
<# interface := "9/0" #>
<# env.setVar("interface",interface) #>
config t
interface fast <# interface; '\n' #>
ip add 7.6.5.4 255.255.255.0
<#endtmpl#>

<# onError #>
<# c := env.getVar("interface") #>
```

```

<# setoutput console #>
<# "begin output\n" #>
<# "The interface value: ";c; "\n" #>
<# endsetoutput #>
end
<#endtmpl#>

```

When the macro runs, the global variable interface is set and the interface command contains an invalid interface value. The CLI reports a syntax error and the macro onError is called. Within the onError macro, the global variable interface is retrieved.

```

ERX-40-4a-cc#macro b.mac badInt
Macro 'badInt' in file 'b.mac' starting execution (Id: 18)
Enter configuration commands, one per line. End with ^Z.
The interface command contains a bad interface value.
ERX-40-4a-cc(config)#interface fast 9/0
 ^
% interface not found

```

The CLI reports a syntax error and the macro onError is called. Within the onError macro, the global variable interface is retrieved.

```

The interface value: 9/0
The macro terminates.
Macro 'badInt' in file 'b.mac' ending execution (Id: 18)

```

## Unique IDs for Macros

Each macro that is started has an associated macro ID. The ID is displayed when the macro is started and when the macro ends. Log messages for macroScheduler also display the unique ID.

For example, macro c in file bench.mac is started on a Telnet session and the unique ID is 25. The following start and end messages are output to the CLI session:

```

Macro 'c' in file 'bench.mac' starting execution (Id: 25)
...
Macro 'c' in file 'bench.mac' ending execution (Id: 25)

```

## Accurate Use of Error Status When Accessed Outside of onError Macro

When the status is requested from a macro other than the onError macro, the error status reported is unavailable and the error string is empty.

For example, the following macro gets the command error and status. The macro is not an onError macro so the status is reported as unavailable.

```

<# errorStatusTest #>

<# setoutput console #>
<# "error: " $ env.getErrorCommand $ "\n" #>
<# "status: " $ env.getErrorStatus $ "\n\n" #>
<# endsetoutput #>

```

```
<#endtmpl#>
```

When you run the macro, the error command is blank and the error status is Status is not available:

```
ERX-40-4a-cc#macro b.mac errorStatusTest
Macro 'errorStatusTest' in file 'b.mac' starting execution (Id: 17)
error:
status: "Macro is not onError. Status is not available"

Macro 'errorStatusTest' in file 'b.mac' ending execution (Id: 17)
```

## Variables

A local variable enables you to store a value used by the macro while it executes. The macro can modify the value during execution. Local variables can be integers, real numbers, or strings. The initial value of local variables is zero.

Like macros, local variables must have a name consisting only of letters, numbers, or the underline character (\_). The variable name must not begin with a number. You must not use a reserved keyword as a variable name. A line that ends with a variable needs a new line character at the end of the line.

## Literals

A literal is an exact representation of numeric or string values. Every number is a literal. Place single or double quotation marks around a string to identify it as a string literal. You can specify special characters within a literal string by prefacing them with a backslash as follows:

|                       |    |
|-----------------------|----|
| quotation mark        | \' |
| double quotation mark | \" |
| tab                   | \t |
| carriage return       | \r |
| new line              | \n |
| string end            | \0 |
| backslash             | \\ |

```
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 'string literal'
 " count"
 "\t this string starts with a tab and ends with a tab \t"
```

## Operators

You can use operators to perform specific actions on local variables or literals, resulting in some string or numeric value. Table 58 on page 550 lists the available macro operators in order of precedence by operation type. Operators within a given row are equal in precedence.

**Table 58: Macro Operators**

| Operation Type | Operators |        |         |            |   |    |    |
|----------------|-----------|--------|---------|------------|---|----|----|
| Extraction     | substr()  | rand() | round() | truncate() |   |    |    |
| String         | \$        |        |         |            |   |    |    |
| Multiplicative | *         | /      | %       |            |   |    |    |
| Arithmetic     | +         | -      | ++      | --         |   |    |    |
| Relational     | <         | >      | <=      | >=         | = | != |    |
| Logical        |           | &&     | !       |            |   |    |    |
| Assignment     | :=        |        |         |            |   |    |    |
| Miscellaneous  | [ ]       | ,      | ()      | .          | ; | <# | #> |

Table 59 on page 550 briefly describes the action performed by each operator.

**Table 59: Operator Actions**

| Operation           | Operator | Action                                                                                                                                                                           |
|---------------------|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Arithmetic (binary) | +        | Adds the right and left sides together                                                                                                                                           |
| Arithmetic (binary) | -        | Subtracts the element to the right of the operator from the element to the left of the operator                                                                                  |
| Assignment          | :=       | Evaluates the elements to the right of the operator, then assigns that value to the local variable to the left of the operator                                                   |
| Combine             | \$       | Creates a new string by joining the values of the right and left sides; converts any numeric values to strings before joining                                                    |
| Less than           | <        | Evaluates as true (returns a 1) if the element to the left of the operator is <i>less than</i> the expression to the right of the operator; otherwise the result is false (0)    |
| Greater than        | >        | Evaluates as true (returns a 1) if the element to the left of the operator is <i>greater than</i> the expression to the right of the operator; otherwise the result is false (0) |

**Table 59: Operator Actions** (continued)

| Operation                  | Operator | Action                                                                                                                                                                                                                                                                      |
|----------------------------|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Less than or equal to      | < =      | Evaluates as true (returns a 1) if the element to the left of the operator is <i>less than or equal to</i> the expression to the right of the operator; otherwise the result is false (0)                                                                                   |
| Greater than or equal to   | > =      | Evaluates as true (returns a 1) if the element to the left of the operator is <i>greater than or equal to</i> the expression to the right of the operator; otherwise the result is false (0)                                                                                |
| Equal to                   | =        | Evaluates as true (returns a 1) if the element to the left of the operator is equivalent to the expression to the right of the operator; otherwise the result is false (0)                                                                                                  |
| Not equal to (logical NOT) | !=       | Evaluates as true (returns a 1) if the element to the left of the operator is not equal to the expression to the right of the operator; otherwise the result is false (0)                                                                                                   |
| Logical OR                 |          | Evaluates as true (returns a 1) if the values of either the left or right sides is nonzero; evaluation halts at the first true (1) expression                                                                                                                               |
| Logical AND                | &&       | Evaluates as true (returns a 1) if the values of the left and right sides are both nonzero; evaluation halts at the first false (0) expression                                                                                                                              |
| Miscellaneous              | [ ]      | See “Invoking Other Macros” on page 559 for usage.                                                                                                                                                                                                                          |
| Miscellaneous              | ,        | See “While Constructs” on page 557 for usage.                                                                                                                                                                                                                               |
| Miscellaneous              | ( )      | Groups operands and operators to achieve results different from simple precedence; effectively has the highest precedence                                                                                                                                                   |
| Miscellaneous              | .        | Provides access to environment commands; see Table 57 on page 545. Provides access to macros; see “Invoking Other Macros” on page 559                                                                                                                                       |
| Miscellaneous              | ;        | Separates operation statements within a control expression                                                                                                                                                                                                                  |
| Miscellaneous              | < # # >  | Encloses control expressions                                                                                                                                                                                                                                                |
| Multiplication             | *        | Multiplies the expression to the left of the operator by the expression to the right                                                                                                                                                                                        |
| Division                   | /        | Divides the expression to the left of the operator by the expression to the right                                                                                                                                                                                           |
| Modulo                     | %        | Divides the expression to the left of the operator by the expression to the right and returns the integer remainder. If the expression to the left of the operator is less than the expression to the right, then the result is the expression to the left of the operator. |
| Postincrement              | + +      | Increments the variable after the expression is evaluated                                                                                                                                                                                                                   |

**Table 59: Operator Actions** *(continued)*

| Operation          | Operator   | Action                                                                                                                           |
|--------------------|------------|----------------------------------------------------------------------------------------------------------------------------------|
| Postdecrement      | --         | Decrements the variable after the expression is evaluated                                                                        |
| Preincrement       | ++         | Increments the variable before the expression is evaluated                                                                       |
| Predecrement       | --         | Decrements the variable before the expression is evaluated                                                                       |
| Negation           | !          | Reverses the logical state of its operand. 0 is returned for nonzero operands. 1 is returned for operands that evaluate to zero. |
| Arithmetic (unary) | +          | Provides the absolute value of the value                                                                                         |
| Arithmetic (unary) | -          | Provides the inverse of the value                                                                                                |
| Substring          | substr()   | Extracts a portion of a string                                                                                                   |
| Randomize          | rand()     | Generates a random integer between the provided endpoints, inclusive                                                             |
| Round              | round()    | Rounds the value to the nearest integer                                                                                          |
| Truncate           | truncate() | Truncates a noninteger value to the value left of the decimal point                                                              |

## Assignment

Use the assignment operator (`:=`) to set the value of a local variable. The expression to the right of the operator is evaluated, and then the result is assigned to the local variable to the left of the operator. The expression to the right of the operator can include the local variable if you want to modify its current value.

**Example**

```
<# i := i + 1 #>
<# count := count - 2 #>
```

## Increment and Decrement

You can use the increment operator (`++`) to increase the value of a local variable by one. You specify when the value is incremented by the placement of the operator. Incrementing occurs after the expression is evaluated if you place the operator to the right of the operand. Incrementing occurs before the expression is evaluated if you place the operator to the left of the operand.

**Example 1**

```
<# i := 0; j := 10 #>
<# j := j - i++ #>
```

In Example 1, the result is that *i* equals 1 and *j* equals 10, because the expression is evaluated ( $10 - 0 = 10$ ) before *i* is incremented.



**Example 2** `<# i := 0; j := 10 #>`  
`<# j := j - ++i #>`

In Example 2, the result is still that *i* equals 1, but now *j* equals 9, because *i* is incremented to 1 before the expression is evaluated ( $10 - 1 = 9$ ).

Similarly, you can use the decrement operator (`--`) to decrement local variables. Placement of the operator has the same effect as for the increment operator.

When a local variable with a string value is used with the increment or decrement operators, the value is permanently converted to an integer equal to the length in characters of the string value.

## String Operations

The combine operator (`$`) concatenates two strings into one longer string. Numeric expressions are converted to strings before the operation proceeds. The variable *local* evaluates to “want a big”:

**Example** `\<# local := “ want a ” $ “ big” #>`

## Extraction Operations

The extraction operations are substring (`substr`), randomize (`rand`), round, and truncate. These operators are equal in precedence, and all take precedence over the string operator.

You can use the substring operator (`substr`) to extract a shorter string from a longer string. To use the substring operator, you must specify the source string, an offset value, and a count value. You can specify the string directly, or you can specify a local variable that contains the string. The offset value indicates the place of the first character of the substring to be extracted; “0” indicates the first character in the source string. The count value indicates the length of the substring. If the source string has fewer characters than the sum of the offset and count values, then the resulting substring has fewer characters than indicated by the count value.

**Example** `<# local := “ want a ” $ “ big” $ “ string” #>`  
`<# substr(local, 5, 12) #>The result is “ a big string”`  
`<# substr(local, 0, 10) #>The result is “ want a big”`  
`<# substr(“ ready” , 0, 4) #>The result is “ read”`

The random operator produces a random integer value from the specified inclusive range; in the following example, the result is between 1 and 10:

`<# number:= rand(1,10) #>`

The round operator rounds off the number to the nearest integer:

`<# decimal:= 4.7 #>`  
`<# round(decimal) #>The result is decimal is now 5`

The truncate operator truncates noninteger numbers to the value left of the decimal point:

```
<# decimal:= 4.7 #>
<# truncate(decimal) #>The result is decimal is now 4
```

## Arithmetic Operations

The arithmetic operations are multiply (\*), divide (/), modulo (%), add (+), and subtract (-). Multiply, divide, and modulo are equal in precedence, but each has a higher precedence relative to add and subtract. Add and subtract are equal in precedence.

**Example** `<# 4 % 3 + 12 - 6 #>`The result is 7

When a local variable with a string value is used with arithmetic operators, the value is temporarily converted to an integer equal to the length in characters of the string value. You can use the `env.atoi` commands to avoid this situation.

## Relational Operations

The relational operations compare the value of the expression to the left of the operator with the value of the expression to the right. The result of the comparison is 1 if the comparison is true and 0 if the comparison is false.

If the expressions on both sides of the operator are strings, they are compared alphabetically. If only one expression is a string, the numeric value is used for comparison. Arithmetic operators have a higher precedence.

**Example** `<# i := 9; i++ < 10 #>`The result is 1  
`<# i := 9; ++i < 10 #>`The result is 0

## Logical Operations

You can use the logical operators AND (&&), OR (||), and NOT (!) to evaluate expressions. The result of the operation is a 1 if the operation is true and 0 if the operation is false.

For the logical AND, the result of the operation is true (1) if the values of the expressions to the left and right of the operator are both nonzero. The result of the operation is false (0) if either value is zero. The evaluation halts when an expression is evaluated as zero.

For the logical OR, the result of the operation is true (1) if the values of the expression on either the left or right of the operator is nonzero. The result of the operation is false (0) if both values are zero. The evaluation halts when an expression is evaluated as nonzero.

The NOT operator must precede the operand. The operation inverts the value of the operand; that is, a nonzero expression becomes 0, and a zero expression becomes

1. For the logical NOT, the result of the operation is true (1) if it evaluates to zero, or false if it evaluates to nonzero.

**Example**

```
<# i := 6; i >= 3 && i <= 10 #>The result is 1
<# i := 1; i >= 3 && i <= 10 #>The result is 0
<# i := 6; i >= 3 || i <= 10 #>The result is 1
<# i := 1; i >= 3 && i <= 10 #>The result is 0
<# i := 5; !i #> The result is 0
<# i := 5; j := 0; !i && !j #>The result is 0
<# i := 5; j := 0; !i || !j #>The result is 1
```

Relational operators have a higher precedence than logical AND and OR. The NOT operator is equal in precedence to the increment and decrement operators.

### Miscellaneous Operations

The positive (+) and negative (-) operations must precede the operand. The result of a positive operation is the absolute value of the operand. The result of a negative operation is the negative value of the operand; that is, a +(-5) becomes 5 and a -(-2) becomes 2. These operators have the same precedence as the increment and decrement operators. If there is an operand on both sides of these operators, they are interpreted as the add and subtract operators.

**Example**

```
<# local_abs := +local #>
<# local_neg := -local #>
```

All operations are performed in the order implied by the precedence of the operators. However, you can modify this order by using parentheses (( )) to group operands and operators. Operations within parentheses are performed first. The result is that of the operations within the parentheses.

**Example**

```
<# 4 % (3 + 12) - 6 #>The result is -6
<# 5 && 2 > 1 #>The result is 1
<# (5 && 2) > 1 #>The result is 0
```

Results of control expressions are written to the output stream when the expression consists of the following:

- A single local variable
- A single literal element
- An operation whose result is not used by one of the following operations:

|            |              |               |       |
|------------|--------------|---------------|-------|
| assignment | predecrement | postdecrement | while |
| if         | preincrement | postincrement |       |

**Example**

```
<# localvar #>value of localvar is written
<# " any string" #>" any string" written
```

```

<# 4 % 3 + 12 - 6 #>" 7" is written
<# 4 % (3 + 12) - 6 #>" -6" is written
<# i := i + 1 #>nothing is written
<# count := (count - 2) #>nothing is written

```

## Conditional Execution

You can use *if* or *while* constructs in macros to enable conditional execution of commands.

### If Constructs

*If* constructs provide a means to execute portions of the macro based on conditions that you specify. An *if* construct consists of the following components:

- An opening *if* expression
- A group of any number of additional expressions
- (Optional) Any number of *elseif* expressions and groups of associated expressions
- (Optional) An *else* expression and any associated group of expressions
- An *endif* expression to indicate the end of the *if* structure

The *if* expression and any optional *elseif* expressions must include a lone environment value command, a local variable, a literal, or some operation using one or more operators.

Only one of the groups of expressions within the *if* construct is executed, according to the following scheme:

1. The *if* expression is evaluated. If the result is true (nonzero), the associated expression group is executed.
2. If the result is false (zero), then the first *elseif* expression, if present, is evaluated. If the result is true (nonzero), the associated expression group is executed.
3. If the result of evaluating the first *elseif* expression is false (zero), the next *elseif* expression is evaluated, if present. If the result is true (nonzero), the associated expression group is executed.

If all *elseif* expressions evaluate to false (zero) or if no *elseif* expressions are present, then the *else* expression group—if present—is executed.

4. This evaluation process continues until an expression evaluates to nonzero. If there is no nonzero evaluation, then no expression group is executed.

You can write an empty expression group so that no action is performed if this group is selected for execution. You can nest *if* structures within other *if* structures or *while* structures.

The following sample macro demonstrates various *if* structures:

```

<# if_examples #>
<# //----- #>

```

```

<# if 1 #>
! This is always output because any nonzero value is " true."
<# endif #>
<# if 0 #>
! This is never output because a value of zero is " false."
<# endif #>
<# // Here's an example with elseif and else. #>
<# color := env.getline("What is your favorite color? ") #>
<# if color = "red" #>
! Red is my favorite color, too.
<# elseif color = "pink" #>
! Pink is a lot like red.
<# elseif color = "black" #>
! Black is just a very, very, very dark shade of red.
<# else #>
! Oh. That's nice.
<# endif #>
<# // Here's a nested if example. #>
<# sure := env.getline("Are you sure that " $ color $ " is your favorite color?"
") #>
<# if substr(sure, 0, 1) = 'y' || substr(sure, 0, 1) = 'Y' #>
<# if color != "black" && color != "white";
shade := env.getline("Do you prefer dark " $ color $
" or light " $ color $ "? ") #>
<# if shade = "dark" #>
! I like dark colors, too.
<# elseif shade = "light" #>
! I prefer dark colors myself.
<# else #>
! Hmmm, that's neither dark nor light.
<# endif #>
<# else #>
! Oh. That's nice.
<# endif #>
<# else #>
! I didn't think so!
<# endif #>
<# endtmpl #>

```

## While Constructs

*While* constructs provide a means to repeatedly execute one or more portions of the macro based on a condition that changes during the execution. A *while* construct consists of the following components:

- An opening *while* expression
- A group of any number of additional expressions
- An *endwhile* expression to indicate the end of the *while* structure

The *while* expression must include a lone environment value command, a local variable, a literal, or some operation using one or more operators. Each time that this expression evaluates to nonzero, the associated expression group is executed.

You can place an iteration expression after the *while* expression. This optional expression is evaluated after each execution of the *while* expression group.

You can include *if* structures within a *while* structure. You can also include special control expressions indicated by the *break* or *continue* expressions. The *break* expression breaks out of the *while* structure by halting execution of the expression group and executing the first expression after the *endwhile* statement. The *continue* expression skips over the rest of the expression group, evaluates any iteration expression, then continues with the execution of the *while* structure. The *while* structure is limited to 100,000 repetitions by default. You can nest up to 10 *while* structures.

**Example** The following sample macro demonstrates various *while* structures:

```
<# while_examples #>
<# //----- #>
<# // Remember that variables are automatically initialized to 0. #>
! Table of squares of the first 10 integers:
<# while ++i <= 10 #>
!<#i;" ";i*i;"\n"#>
<# endwhile #>
<# // Remember that the value of a string used as an integer is the number. #>
<# // of characters in the string. #>
<# stars := "" #>
<# while stars < 10, stars := stars $ ""#>
!<# stars;"\n" #>
<# endwhile #>
<# while stars > 0, stars := substr(stars, 0, stars-1)#>
!<# stars;"\n" #>
<# endwhile #>
<# // An example of the continue and break statements. #>
<# // Also note that many statements can be grouped. #>
! All the positive even numbers less than 11
<# i:=0; while ++i < 100 #>
<#if i%2; continue; endif; if i > 10; break; endif; "!" $ i $ "\n"; #>
<# endwhile #>
<# // While constructs will NOT iterate forever. #>
<# while 100 > 0 // This is always true, but the macro will eventually stop #>
<# ++iterations; endwhile #>
! The while loop iterated <#iterations#> times.
<# endtmpl #>
```

## Passing Parameters in Macros

You can pass parameters to an entry macro. The system translates these parameters to the correct data type.



**NOTE:** The `env.argv` array is separate from this feature and still functions as designed. In other words, the `env.argv` array continues to pass parameters as text strings. To use `env.argv` array values for subsequent numeric operations, you must first convert the values to a number by using the `env.atoi(string)` command.

**Example** The following macro (saved as *m.mac*) uses values specified in a CLI command to compute the final result:

```
<# m(left,right,third) #>
<# multi := left * right #>
<# multiFinal := multi * third #>
```

```

<# setoutput console #>
<# " The result is: multiFinal; " \n" #>
<# endsetoutput #>
<# endtmpl #>

```

The following example provides the output from using this macro:

```

host1#macro m.mac m 5 6 7
host1#The result is: 210

```

## Generating Macro Output

You may want a macro to provide output while it is operating. In simple cases, you can use the **verbose** keyword to echo commands to the display and display comments as the macro executes. For more information about the **verbose** keyword, see “Example 2” on page 553 in “Invoking Other Macros” on page 559.

When running more complex macros or macros that contain a lot of commands or comments, you may want to output only certain information (that is, not all commands and comments). In this case, you can use `<# setoutput console #>` to send the information directly to the console display when it executes.

**Example 1** The following example shows how you can send output directly to the console:

```

<# setoutput console #>
This message appears in the console window (whether or not you use verbose mode).
<#endsetoutput #>

```

**Example 2** The following example shows how you can send a single argument to the console:

```

<# puts (msg) #>
!=====
!=====
! output "msg" to console
!=====
!=====
<# setoutput console #>
<# msg; "\n"#>
<#endsetoutput #>
<# endtmpl #>
!=====
!=====
<# tmp1.puts(" Hello World")

```

## Invoking Other Macros

Macros can invoke other macros within the same macro file; a macro can also invoke a macro from another macro file if the invocation takes place in literal text, that is, not within a control expression. A macro can invoke itself directly or indirectly (an invoked macro can invoke the macro that invoked it); the number of nested invocations is limited to 10 to prevent infinite recursion.

Within each macro, you can specify parameters that *must* be passed to the macro when it is invoked by another. You must specify named variables enclosed in parentheses after the macro name in the first line of the macro, as shown in this example:

```
<# macroName (count, total) #>
```

Additional parameters can be passed as well. Parameters can be local variables, environmental variables, literals, or operations. The invoking macro passes local variables by reference to the invoked macro. Passing parameters has no effect on the invoking macro unless the parameter is a local variable that is changed by the invoked macro. When the invoked macro completes execution, the local variable assumes the new value for the invoking macro.

The invoked macro can use the **param[ *n* ]** expression to access parameters passed to it, where *n* is the number of the parameter passed. This is useful if optional parameters can be passed to a macro or if the same iterative algorithm needs to process the parameters.

Use the expression **param[0]** to return the total number of parameters passed to the macro. Use the **return** keyword to halt execution of the invoked macro and resume execution of the invoking macro. Use the **exit** keyword to halt execution of all macros.

**Example 1** The following sample macro demonstrates macro invocation:

```
<# invoking_examples #>
<# //----- #>
<# name := env.getline("What is your first name? ") #>
! First, <#name#>, we will invoke the if_examples and
! the while_examples macros...
<# tmp1.if_examples; tmp1.while_examples #>
! Hey <#name#>, have you noticed that your name backwards is:
!<# eman:= ""; tmp1.reversestring(name, eman); eman; "\n"#>
<# tmp1.argumentlist("a", "b", "c")#>
<# endtmp1 #>
<# argumentlist #>
<# if param[0] = 0; return; endif #>
! argumentList() was called with the following arguments:
<# while ++i <= param[0]#>
! <#param[i];"\n"#>
<# endwhile #>
<# endtmp1 #>
<# reversestring (string, gnirts) #>
<# i := 0 + string; // i is now equal to the number of characters in string. #>
<# while --i >= 0; gnirts := gnirts $ substr(string, i, 1); endwhile #>
<# endtmp1 #>
```

**Example 2** The following macro in file macro1.mac invokes a macro from within another file, macro2.mac:

```
<# callAnotherMacro #>
<# localVar := 5 #>
macro macro2.mac macroName2 <# localVar #> string1
<# endtmp1 #>
```

This macro passes the value of localVar to macroName2. The value of localVar remains at 5 for callAnotherMacro, regardless of any operations upon that variable in the



second macro. In other words, an invoked macro in another file cannot return any values to the invoking macro.

The output of `callAnotherMacro` looks like this:

```
host1# macro verbose macro1.mac callAnotherMacro
host1#!Macro 'callAnotherMacro' in the file 'macro1.mac' starting execution (Id: 55)
macro macro2.mac macroName2 5 string1
!Macro 'macroName2' in the file 'macro2.mac' starting execution
!Macro 'macroName2' in the file 'macro2.mac' ending execution
host1#!Macro 'callAnotherMacro' in the file 'macro1.mac' ending execution (Id: 55)
```

The invoked macro cannot invoke a third macro from another file. Only a single level of invocation is supported.

## Detecting and Recording Macro Errors

---

You can control how a macro responds when an error occurs during execution. By creating and adding an `onError` macro to your macro file, you can specify that, on the occurrence of an error, macro execution within the current macro stops and the `onError` macro is invoked. An `onError` macro can call other macros. If another error occurs after the `onError` macro is invoked, macro execution stops again and the `onError` macro is invoked again. This process continues either until the `onError` macro completes or until reaching the recursion limit of 10.

### Detectable Macro Errors

CLI macros detect various errors when a macro is executed. Some of these errors are detected without the use of an `onError` macro; they include the following:

- Macro file not found
- Macro not found
- Macro compilation error
- Macro does not complete error due to excessive looping or recursion

The following errors are detected only when a CLI macro file contains an `onError` macro:

- Syntactic error in executed CLI command
- Runtime error in executed CLI command

In addition to these detectable errors, you can use the following environment commands to return textual error information to the `macroData` log file:

- `env.getErrorCommand`
- `env.getErrorStatus`




---

**CAUTION:** Though you can use the **env.getErrorCommand** and **env.getErrorStatus** commands in any macro, the only appropriate place from which to execute these commands is from an **onError** macro.

---

## Logging Macro Results

You can use the **env.setResult** command to set parameters within a macro to display information through the macroData log file. When defined, parameter information appears in the macroData log file at the NOTICE severity level following the completion of the macro.

The following example defines several results (1 through 5):

```
<# numberMacro #>
<# env.setResult("A", " " $1) #>
<# env.setResult("A", " " $2) #>
<# env.setResult("A", " " $3) #>
<# env.setResult("A", " " $4) #>
<# env.setResult("A", " " $5) #>
<#endtmpl#>
```

Each value is sent to the macroData log file, starting with 1 and ending with 5. Each successive value overwrites the previous value in the log file. In other words, if the macro ends after setting the third result (that is, 3) the log file displays the following:

A is 3

If the macro finishes completely, the log file displays the following:

A is 5

## Viewing Macro Errors

You can view macro error information in the macroData log file using the **show log data** command and specifying the **macroData** keyword for the category.




---

**NOTE:** Each execution of a macro, by any user and by any name, obtains a unique ID. This ID appears in the starting and ending message of the macro output and for each log message in the macroData log.

---

### **show log data**

- Use to display log event data using the **category** keyword and the macroData category.
- **delta**—Limits the display to events that occurred after the time set with the log baseline command.
- **severity**—Displays events that have a specific severity level.

### ■ Example

```
host1(config)# show log data category macroData severity debug
NOTICE 01/07/2006 09:46:57 macroData: Macro 'badInterfaceCommandMacro' in file 'testInterfaceCommand.mac'
 starting execution (Id: 402) on vty, 0
ERROR 01/07/2006 09:46:57 macroData: (Id: 402) Command error: interface fastEthernet 500, Command execution
 error
NOTICE 01/07/2006 09:46:57 macroData: (Id: 402) commandError is interface fastEthernet 500
NOTICE 01/07/2006 09:46:57 macroData: (Id: 402) commandErrorStatus is Command execution error
NOTICE 01/07/2006 09:46:57 macroData: (Id: 402) runStatus is Loop:500
NOTICE 01/07/2006 09:46:57 macroData: Macro 'badInterfaceCommandMacro' in file 'testInterfaceCommand.mac'
 ending execution (Id: 402) on vty, 0
```

### ■ See show log data.

## onError Macro Examples

The following examples provide an indication of how the onError macro can assist in using and troubleshooting macro files. The examples purposely contain errors and show the result when using the onError macro.

### Detecting Invalid Command Formats

In this example, the following macro file (*badInterfaceCommand.mac*) performs a loop. Within each loop, the CLI executes the **interface fastEthernet** command using an invalid interface format:

```
<# badInterfaceCommandMacro #>
<# env.setResult("runStatus","start") #>
<# theLoopCount := 500 #>
conf t
<# while theLoopCount > 0 #>
<# env.setResult("runStatus", "Loop:" $ theLoopCount) #>
interface fastEthernet <# theLoopCount; '\n' #>
<# -theLoopCount #>
<# endwhile #>
<# env.setResult("runStatus","complete") #>
<#endtmpl#>
<# onError #>
<# env.setResult("commandError", env.getErrorCommand) #>
<# env.setResult("commandErrorStatus", env.getErrorStatus) #>
<#endtmpl#>
```

If the macro were to run to completion, the CLI would execute the commands as follows:

```
interface fastEthernet 500
interface fastEthernet 499
.
.
.
interface fastEthernet 1
```

Because the macro uses invalid interface formats, executing the macro without the embedded `onError` macro would result in error output for each loop. However, the `onError` macro detects the error and stops the macro. Using the `onError` macro, the output appears as follows:

```
host1(config)# macro testInterfaceCommand.mac badInterfaceCommandMacro
Macro 'badInterfaceCommandMacro' in file 'testInterfaceCommand.mac' starting execution (Id: 402)
Enter configuration commands, one per line. End with ^Z.
ERX-40-94-fb(config)#interface fastEthernet 500
 ^
% invalid interface format
Macro 'badInterfaceCommandMacro' in file 'testInterfaceCommand.mac' ending execution (Id: 402)
```

You can determine the execution progress through the `runStatus` result entry in the `macroData` log file. For this example, the `runStatus` value of 500 indicates that the macro ended early.

```
host1(config)# show log data category macroData severity debug
NOTICE 01/07/2006 09:46:57 macroData: Macro 'badInterfaceCommandMacro' in file 'testInterfaceCommand.mac'
 starting execution (Id: 402) on vty, 0
ERROR 01/07/2006 09:46:57 macroData: (Id: 402) Command error: interface fastEthernet 500, Command execution
 error
NOTICE 01/07/2006 09:46:57 macroData: (Id: 402) commandError is interface fastEthernet 500
NOTICE 01/07/2006 09:46:57 macroData: (Id: 402) commandErrorStatus is Command execution error
NOTICE 01/07/2006 09:46:57 macroData: (Id: 402) runStatus is Loop:500
NOTICE 01/07/2006 09:46:57 macroData: Macro 'badInterfaceCommandMacro' in file 'testInterfaceCommand.mac'
 ending execution (Id: 402) on vty, 0
```

## Detecting Invalid Commands

In this example, the following macro file (*badExecCommand.mac*) is programmed to execute four `exec` mode commands. However, the second command in the sequence is invalid.

```
<# badExecCommandMacro #>
<# env.setResult("runStatus","start") #>
show clock
<# env.setResult("runStatus","after first show clock") #>
foo
<# env.setResult("runStatus","after foo") #>
show privilege
<# env.setResult("runStatus","after show privilege") #>
show clock
<# env.setResult("runStatus","complete") #>
<#endtmpl#>
<# onerror #>
<# errCmd := env.getErrorCommand #>
<# errStatus := env.getErrorStatus #>
<# env.setResult("commandError", errCmd) #>
<# env.setResult("commandErrorStatus", errStatus) #>
<#endtmpl#>
```

If the macro were to run to completion, the following commands would be executed:

```
show clock
foo
show privilege
show clock
```

Without the `onError` macro, the macro would indicate the invalid command, but it would also continue with the rest of the configuration. When using the `onError` macro, the macro stops when it encounters the invalid command.

Executing the macro that contains the `onError` macro, the output appears as follows:

```
host1# macro badExecCommandTest.mac badExecCommandMacro
Macro 'badExecCommandMacro' in file 'badExecCommandTest.mac' starting execution (Id: 101)
SUN JAN 08 2005 07:21:50 UTC
ERX-40-94-fb#foo
 ^
% Invalid input detected at '^' marker.
Privilege level is 15
Macro 'badExecCommandMacro' in file 'badExecCommandTest.mac' ending execution (Id: 101)
```

You can determine the execution progress through the `runStatus` result entry in the `macroData` log file. For this example, the log output indicates the command error and displays the following to indicate that the macro ended early:

`runStatus` is after `foo`

```
host1# show log data category macroData severity debug
NOTICE 01/08/2006 07:14:13 macroData: Macro 'startmin' in file 'master.mac' starting execution (Id: 1)
on vty, 0
NOTICE 01/08/2006 07:14:18 macroData: Macro 'startmin' in file 'master.mac' ending execution (Id: 1) on
vty, 0
NOTICE 01/08/2006 07:21:50 macroData: Macro 'badExecCommandMacro' in file 'badExecCommandTest.mac' starting
execution (Id: 101) on vty, 0
ERROR 01/08/2006 07:21:50 macroData: (Id: 101) Command error: foo, Command syntax error
NOTICE 01/08/2006 07:21:50 macroData: (Id: 101) commandError is foo
NOTICE 01/08/2006 07:21:50 macroData: (Id: 101) commandErrorStatus is Command syntax error
NOTICE 01/08/2006 07:21:50 macroData: (Id: 101) runStatus is after foo
NOTICE 01/08/2006 07:21:50 macroData: Macro 'badExecCommandMacro' in file 'badExecCommandTest.mac' ending
execution (Id: 101) on vty, 0
```

## Detecting Missing Macros

In this example, the following macro file (*badMacroInvocation.mac*) is programmed to invoke a missing or nonexistent macro (*tmpl.foo*).

```
<# badMacroInvocation #>
<# env.setResult("runStatus","start") #>
<# tmpl.foo #>
<# env.setResult("runStatus","complete") #>
<#endtmpl#>
<# onerror #>
<# errCmd := env.getErrorCommand #>
<# errStatus := env.getErrorStatus #>
<# env.setResult("commandError", errCmd) #>
```

```
<# env.setResult("commandErrorStatus", errStatus) #>
<#endtmpl#>
```

When using the `onError` macro, the macro stops when it encounters the missing macro. The output appears as follows:

```
host1# macro badMacroInvocation.mac badMacroInvocation
Macro 'badMacroInvocation' in file 'badMacroInvocation.mac' starting execution (Id: 407)
% can't find macro foo
Macro 'badMacroInvocation' in file 'badMacroInvocation.mac' ending execution (Id: 407)
```

You can determine the execution progress through the `runStatus` result entry in the `macroData` log file. For this example, the log output indicates the macro error and displays the following to indicate that the macro ended prior to invoking the macro:

start

```
host1# show log data category macrodata severity debug
NOTICE 05/27/2005 12:39:10 macroData: Macro 'badMacroInvocation' in file 'badMacroInvocation.mac' starting
 execution (Id: 407) on vty, 0
ERROR 05/27/2005 12:39:10 macroData: (Id: 407) Command error: foo, macro not found
NOTICE 05/27/2005 12:39:10 macroData: (Id: 407) commandError is foo
NOTICE 05/27/2005 12:39:10 macroData: (Id: 407) commandErrorStatus is macro not found
NOTICE 05/27/2005 12:39:10 macroData: (Id: 407) runStatus is start
NOTICE 05/27/2005 12:39:10 macroData: Macro 'badMacroInvocation' in file 'badMacroInvocation.mac' ending
 execution (Id: 407) on vty, 0
```

## Running Macros

Although you must write macros on a computer, you can copy them to the system. Issue the **macro** command from the CLI to execute both local macros and macros stored remotely.

You can display the commands that are generated by the macro file without executing the commands by using the **test** keyword. We recommend you confirm that the test display matches your expectations before you execute the macro to run the commands.

You can terminate a macro while it is running by pressing `Ctrl + c`. You can close Telnet and SSH windows while a macro is running, but the macro does not terminate until it completes the current command.

### **macro**

- Use to execute a macro that generates—and can execute—CLI commands. This command is available in all command modes.
- This command invokes a hidden FTP client and takes place in the context of the current virtual router (VR) rather than the default VR. You must configure the FTP server so that any traffic destined for the VR can reach the VR; typically, you configure the FTP server to reach the default address of the system, which will always be able to reach the VR.

- You can specify both a macro filename and a macro contained within that file. For example, the following command looks for the file *confatm.mac* and runs the macro named *atmOverDs3* contained within the file:

```
host1(config)#macro confatm.mac atmOverDs3
```

- You can specify only a macro filename. The command searches in the specified file for a macro named *start*. The command fails if the *start* macro does not exist. For example, the following command looks for the file *confatm.mac* and runs the macro named *start* contained within the file:

```
host1(config)#macro confatm.mac
```

- You can specify only the macro name, using the **name** keyword, if the macro file is stored locally in NVS and has the same name as the included macro you want to invoke. For example, the following command looks for the file *confatm.mac* and runs the macro named *confatm* contained within the file:

```
host1(config)#macro name confatm
```

- You must specify a macro filename for remotely stored macro files, as in the following example:

```
host1(config)#macro pc:/macros.mac atmOverDs3
```

- You can pass arguments to the macro; if the argument contains a space or other special character, you must enclose the argument within double quotation marks.
- Use the **test** keyword to specify that the macro generate, but not execute, the commands. You can look at the output to verify that it is what you want. The test mode is verbose and displays comments.
- Use the **verbose** keyword to echo commands to the display and display comments as the macro executes. By default the command executes in nonverbose mode.
- There is no **no** version.
- See macro.

**Example** A typical macro application is to iteratively generate a series of commands, as shown in the following macro, *atmOverDs3*:

```
<# atmOverDs3 #>
<# i:=0; while i++ < 3 #>
controller t3 9/<#i;'n'#>
no shut
clock source internal module
framing cbitadm
ds3-scramble
!
interface atm 9/<#i;'n'#>
atm vc-per-vp 256
!
<# endwhile #>
!
interface atm 9/1.1
```

```

encap pppoe
!
<# i:=1; while i < 100 #>
interface atm 9/1.1.<#i;'\n'#>
encap ppp
no ppp shut
no ppp keep
atm pvc <# i #> 1 <# i #> aal5mux ip
ip addr 10.1.<#i#>.1 255.255.255.0
!
<# i++ #>
<# endwhile #>
!
<# endtmp1 #>

```

If you stored this macro remotely in the macro file, *pc:/macros.mac*, you issue the following commands to execute the macro:

```

host1>enable
host1#conf t
host1(config)#macro pc:/macros.mac atmOverDs3

```

Alternatively, if you stored this macro locally in the macro file *atmOverDs3.mac*, you issue the following commands to execute the macro:

```

host1>enable
host1#conf t
host1(config)#macro verbose atmOverDs3

```

The following example shows a portion of the output resulting from executing the *atmOverDs3* macro from a local file (the starting and ending comments vary for a remote macro):

```

host1(config)#!Macro 'atmOverDs3' in the file 'atmOverDs3.mac' starting execution
(Id: 103)
host1(config)#controller t3 9/1
host1(config)#no shut
host1(config)#clock source internal module
host1(config)#framing cbitadm
host1(config)#ds3-scramble
host1(config)#interface atm 9/1
host1(config)#atm vc-per-vp 256
host1(config)#controller t3 9/2
host1(config)#no shut
host1(config)#clock source internal module
host1(config)#framing cbitadm
host1(config)#ds3-scramble
host1(config)#interface atm 9/2
host1(config)#atm vc-per-vp 256
host1(config)#controller t3 9/3
host1(config)#no shut
host1(config)#clock source internal module
host1(config)#framing cbitadm
host1(config)#ds3-scramble
host1(config)#interface atm 9/3
host1(config)#atm vc-per-vp 256

```



```

host1(config)#interface atm 9/1.1
host1(config)#encap pppoe

host1(config)#interface atm 9/1.1.1
host1(config)#encap ppp
host1(config)#no ppp shut
host1(config)#no ppp keep
host1(config)#atm pvc 1 1 1 aal5mux ip
host1(config)#ip addr 10.1.1.1 255.255.255.0

[display omitted]

host1(config)#interface atm 9/1.1.99
host1(config)#encap ppp
host1(config)#no ppp shut
host1(config)#no ppp keep
host1(config)#atm pvc 99 1 99 aal5mux ip
host1(config)#ip addr 10.1.99.1 255.255.255.0
host1(config)#!Macro 'atmOverDs3' in the file 'atmOverDs3.mac' ending execution
(Id: 103)

```

## Scheduling Macros

You can schedule a macro to run once at a specific time, after a periodic interval, or at a periodic time of day, day of the week, or day of the month. You can schedule macros for automatic configurations and use it for troubleshooting.

A single macro file can contain many macro definitions. You can schedule every definition individually. Scheduled macros must be local files and cannot be deleted from the file system. A directory report lists scheduled macros. The maximum number of scheduled macros is 100. In Global Configuration mode, the setting persists on reboot, but in Privileged Exec mode, it does not persist on reboot.

After unified ISSU is started, scheduled macros do not run. Macro scheduling supports high availability (HA) using mirrored storage. Macros scheduled to run persist during an SRP switchover operation, whether scheduled in Privilege Exec or Global Configuration mode.

To schedule macros to run at a specified time or interval:

1. To schedule a macro to run every 30 minutes:

```
host1(config)#schedule macro interval frequency 30 abc.mac getuptime
```

2. Issue the **show macro** command to verify the scheduled time.

```

host1#show schedule macro abc.mac
abc.mac getuptime scheduled to run at 2007-02-14 11:58:06

```

### Example

Scheduling macro commands.

```
host1#schedule macro interval frequency 30 john.mac getuptime
```

```

host1#schedule macro interval time-of-day 00:10 day-of-month 2 fred.mac freddie
host1#configure terminal
host1(config)#schedule macro joe.mac interval time-of-day 00:00 day-of-week sunday
start
host1(config)#exit
host1#schedule macro at 20:00 February 14 john.mac getuptime
host1#schedule macro at 20:00 February 16 larry.mac getuptime

```

To show the set of currently scheduled macros (asterisks indicate persistent macros):

```
host1#show schedule macro
```

| interval<br>macro<br>file name | macro     | privilege<br>level | interval<br>time-of-day | frequency<br>(minutes) | schedule            | started |
|--------------------------------|-----------|--------------------|-------------------------|------------------------|---------------------|---------|
| fred.mac                       | Freddie   | 15                 | 00:10 DayOfMonth:2      | ---                    | 2007-03-02 00:10:00 | ---     |
| *joe.mac                       | start     | 15                 | 00:00 sunday            | ---                    | 2007-02-18 00:00:00 | ---     |
| john.mac                       | getuptime | 15                 | ---                     | 30                     | 2007-02-14 14:26:38 | ---     |
| larry.mac                      | start     | 15                 | ---                     | ---                    | 2007-02-16 20:00:00 | ---     |
| moe.mac                        | start     | 15                 | ---                     | ---                    | 2007-02-14 20:00:00 | ---     |

To display the run time of one macro scheduled in Global Configuration mode, creating an entry that I persists across reboots:

```

host1#show schedule macro joe.mac
joe.mac start is persistent and scheduled to run at 2007-02-18 00:00:00

```

To display the start time of one running macro:

```

host1#show schedule macro john.mac
john.mac getuptime started at 2007-02-14 14:26:39

```

When you show the running configuration, joe.mac is the only one reported, because the other macros were scheduled in Privileged Exec mode.

```

host1#show conf | include schedule
schedule macro joe.mac interval time-of-day 00:00 day-of-week sunday start

```

When you display the directory listing, it shows the scheduled macros are all in-use and cannot be deleted:

| file            | unshared<br>size | in<br>size | date (UTC)          | use |
|-----------------|------------------|------------|---------------------|-----|
| disk0:m.mac     | 438              | 438        | 01/26/2007 10:12:26 | !   |
| disk0:fc.mac    | 515              | 515        | 01/26/2007 12:29:14 | !   |
| disk0:b.mac     | 7728             | 7728       | 02/05/2007 13:55:10 | !   |
| disk0:c.mac     | 146              | 146        | 02/07/2007 16:09:12 | !   |
| disk0:mmcX2.rel | 83859484         | 83859484   | 02/05/2007 16:01:50 | !   |

**Example**

```
host1#delete joe.mac
% File in use
```

Running a scheduled macro one time. Run macro m in m.mac at 14:35 today.

```
host# more m.mac
<# m(left,right,third) #>
<# mult := left * right #>
<# multFinal := mult * third #>
<# env.setResult("operation", "" $ left $ " * " $ right $ " * " $ third) #>
<# env.setResult("theResult", "" $ multFinal) #>
<#endtmpl#>
```

```
host1#schedule macro at 14:35 m.mac m
```

```
host1#show schedule macro m.mac
```

| macro<br>file name | macro   | privilege<br>level | interval<br>time-of-day | interval<br>frequency<br>(minutes) | schedule            | started |
|--------------------|---------|--------------------|-------------------------|------------------------------------|---------------------|---------|
| m.mac              | Freddie | 15                 | 00:10 sunday            | ---                                | 2008-09-28 00:00:00 | ---     |

```
host1#
```

When you show the directory listing, the schedule macro m.mac is marked in use and cannot be modified.

| file            | size     | unshared<br>size | date (UTC)          | in<br>use |
|-----------------|----------|------------------|---------------------|-----------|
| disk0:m.mac     | 438      | 438              | 01/26/2007 10:12:26 | !         |
| disk0:fc.mac    | 515      | 515              | 01/26/2007 12:29:14 |           |
| disk0:b.mac     | 7728     | 7728             | 02/05/2007 13:55:10 | !         |
| disk0:c.mac     | 146      | 146              | 02/07/2007 16:09:12 |           |
| disk0:mmcX2.rel | 83859484 | 83859484         | 02/05/2007 16:01:50 | !         |

Observe the macroScheduler log for the execution of macro m.mac:

```
NOTICE 02/14/2007 14:35:01 macroScheduler: macro m.mac started with ID 3
NOTICE 02/14/2007 14:35:01 macroScheduler: macro m.mac with ID 3 ran
successfully
NOTICE 02/14/2007 14:35:01 macroScheduler: (Id: 3) operation is 7 * 6 * 5
NOTICE 02/14/2007 14:35:01 macroScheduler: (Id: 3) theResult is 210
```

After the macro is executed, it is no longer in the list of scheduled macros.

```
host1#show schedule macro m.mac
% Command failed
```

| file         | size | unshared<br>size | date (UTC)          | in<br>use |
|--------------|------|------------------|---------------------|-----------|
| disk0:m.mac  | 438  | 438              | 01/26/2007 10:12:26 |           |
| disk0:fc.mac | 515  | 515              | 01/26/2007 12:29:14 |           |
| disk0:b.mac  | 7728 | 7728             | 02/05/2007 13:55:10 | !         |

**Example**

```

disk0:c.mac 146 146 02/07/2007 16:09:12
disk0:mmcX2.rel 83859484 83859484 02/05/2007 16:01:50 !

```

Macro `getuptime`, scheduled to run at a regular interval uses regular expression matching to find the system running time in the **show version** report. It then uses regular expression matching on the line containing the system running time to determine the days, hours, minutes, and seconds.

```
host1#schedule macro interval frequency 60 b.mac getuptime
```

```
host1#show schedule macro
```

```
b.mac getuptime scheduled to run at 2007-02-14 11:58:06
```

See the macroScheduler log for the execution of macro `b.mac`.

```

NOTICE 02/14/2007 11:26:20 macroScheduler: macro b.mac started with ID 3
NOTICE 02/14/2007 11:26:21 macroScheduler: macro b.mac with ID 3 ran
successfully
NOTICE 02/14/2007 11:26:21 macroScheduler: (Id: 3) Days: is 0 days
NOTICE 02/14/2007 11:26:21 macroScheduler: (Id: 3) Hours: is 0 hours
NOTICE 02/14/2007 11:26:21 macroScheduler: (Id: 3) Minutes: is 17 minutes
NOTICE 02/14/2007 11:26:21 macroScheduler: (Id: 3) Seconds: is 16 seconds

```

After the macro is run, display the next scheduled run time:

```
host1#show schedule macro b.mac
```

```
b.mac at 2007-02-14 12:59:09
```

```
host1#
```

The file `b.mac` continues to be in use and cannot be deleted.

| file            | size     | unshared<br>size | date (UTC)          | in<br>use |
|-----------------|----------|------------------|---------------------|-----------|
| disk0:m.mac     | 438      | 438              | 01/26/2007 10:12:26 |           |
| disk0:fc.mac    | 515      | 515              | 01/26/2007 12:29:14 |           |
| disk0:b.mac     | 7728     | 7728             | 02/05/2007 13:55:10 | !         |
| disk0:c.mac     | 146      | 146              | 02/07/2007 16:09:12 |           |
| disk0:mmcX2.rel | 83859484 | 83859484         | 02/05/2007 16:01:50 | !         |

```
host1#delete b.mac
```

```
% File in use
```

The macro `b.mac` runs every 60 minutes.

```

NOTICE 02/14/2007 14:47:47 macroScheduler: macro b.mac started with ID 5
NOTICE 02/14/2007 14:47:49 macroScheduler: macro b.mac with ID 5 ran
successfully
NOTICE 02/14/2007 14:47:49 macroScheduler: (Id: 5) Days: is 0 days
NOTICE 02/14/2007 14:47:49 macroScheduler: (Id: 5) Hours: is 1 hour
NOTICE 02/14/2007 14:47:49 macroScheduler: (Id: 5) Minutes: is 25 minutes
NOTICE 02/14/2007 14:47:49 macroScheduler: (Id: 5) Seconds: is 33 seconds

```

```
host1#show schedule macro
```

```
b.mac getuptime scheduled to run at 2007-02-14 14:52:47
```

- Related Topics**
- schedule macro command
  - show schedule macro command

## Practical Examples

You can use the macros in this section for configuring your router or as examples of useful macros you can build yourself.

### Configuring Frame Relay

You can organize your macros in many different ways to suit your needs. The first sample macro in this section, *ds1mac.mac*, shows a typical method of organization. It consists of a number of related macros for configuring interfaces on CT1 and CE1 modules, as described in Table 60 on page 573.

Some of the macros provide a single configuration function, like configuring the controller. These are invoked by other macros that are executable from the command line. A high-level macro invokes several of the executables, acting much like a script to provide greater functionality.

**Table 60: Contents of ds1mac.mac**

| Macro Name    | Description                                                                                                      |
|---------------|------------------------------------------------------------------------------------------------------------------|
| Help          | Lists the executable macros in ds1mac.mac                                                                        |
| controllerDs1 | Executable macro that configures Cx1 ports; calls macro cntrDs1                                                  |
| ds1Encap      | Executable macro that configures Frame Relay encapsulation on Cx1 serial interfaces; calls macro cx1Encap        |
| ds1FrCir      | Executable macro that configures Frame Relay circuits on Cx1 subinterfaces; calls macro cx1FRCir                 |
| configCx1     | Executable macro that configures Cx1 serial Frame Relay interfaces; calls macros cntrDs1, cx1Encap, and cx1FrCir |
| cntrDs1       | Configures the Cx1 controller; called by other macros                                                            |
| cx1Encap      | Configures Frame Relay encapsulation on serial interfaces; called by other macros                                |
| cx1FrCir      | Configures Frame Relay circuits on the subinterfaces; called by other macros                                     |

The following examples list the complete set of macros contained in ds1mac.mac. You can run the Help macro to list the other executable macros contained in ds1mac.mac. To configure Frame Relay on your router with ds1mac.mac, you can do one of the following:

- Run the controllerDS1, ds1Encap, and ds1FrCir macros in that order

■ Run the configCx1 macro

In either case, to run the macros you must provide the required values described in the macros.

```
<# Help #>
! This file contains the following executable macros:
! controllerDs1
! ds1Encap
! ds1FrCir
! configCx1
<# endtpl #>
<# controllerDs1 #>
<# if env argc = 0 #>
! This macro configures your Cx1 controller.
! This macro will configure e1 ports as unframed.
! This macro should be called with 4 arguments.
! The argument list should be as follows:
! type; number of numPorts; slot; port; clock; framing; lineCoding
<# return #>
<# endif #>
<# type := env.argv(1) #>
<# ifCount := env.argv(2) #>
<# slot := env.argv(3) #>
<# port := env.argv(4) #>
<# clock := env.argv(5) #>
<# framing := env.argv(6) #>
<# coding := env.argv(7) #>
<# if clock = 'internal' #>
<# clock := 'internal mod' #>
<# endif #>
<# tpl.cntrDs1(type, ifCount, slot, port, clock, framing, coding) #>
<# endtpl #>
<# ds1Encap #>
<# if env argc = 0 #>
! This macro configures Frame Relay encapsulation on Cx1 serial
! interfaces.
! This macro must be called with 4 arguments.
! If the protocol is Frame Relay (fr), then specify the type (DTE
! or DCE) and the lmi type.
! The argument list should be as follows:
! number of numPorts; slot; port; proto; frType; frLmi
<# return #>
<# endif #>
<# ifCount := env.argv(1) #>
<# slot := env.argv(2) #>
<# port := env.argv(3) #>
<# proto := env.argv(4) #>
<# if proto = 'fr' #>
<# proto := 'frame-relay ietf' #>
<# endif #>
<# tpl.cx1Encap(ifCount, slot, port, proto) #>
<# endtpl #>
<# ds1FrCir #>
<# if env argc = 0 #>
! This macro configures Frame Relay circuits on Cx1
! subinterfaces.
! This macro must be called with 4 arguments.
! The argument list should be as follows:
! number of numPorts; slot; port; numCirs; dlci
```

```

<# return #>
<# endif #>
<# ifCount := env.argv(1) #>
<# slot := env.argv(2) #>
<# port := env.argv(3) #>
<# numCirs := env.argv(4) #>
<# dlci := env.argv(5) #>
<# tmp1.cx1FrCir(ifCount, slot, port, numCirs, dlci) #>
<# endtmp1 #>
<# configCx1 #>
<# if env argc = 0 #>
! This macro configures Cx1 serial Frame Relay interfaces.
! This macro must be called with 4 arguments.
! The argument list should be as follows:
! type; number of numPorts; slot; port; clock; framing; coding; proto; frType;
frLmi; numCirs; dlci
<# return #>
<# endif #>
<# type := env.argv(1) #>
<# ifCount := env.argv(2) #>
<# slot := env.argv(3) #>
<# port := env.argv(4) #>
<# clock := env.argv(5) #>
<# framing := env.argv(6) #>
<# coding := env.argv(7) #>
<# proto := env.argv(8) #>
<# tmp1.cntrDs1(type, ifCount, slot, port, clock, framing, coding) #>
<# if proto = 'fr' #>
<# frType := env.argv(9) #>
<# frLmi := env.argv(10) #>
<# numCirs := env.argv(11) #>
<# dlci := env.argv(12) #>
<# tmp1.cx1Encap(ifCount, slot, port, proto, frType, frLmi) #>
<# tmp1.cx1FrCir(ifCount, slot, port, numCirs, dlci) #>
<# else #>
<# tmp1.cx1Encap(ifCount, slot, port, proto, type, type) #>
<# endif #>
<# endtmp1 #>
<# cntrDs1 #>
<# //This macro is called by other macros to configure DS1 ports #>
<# //Parameters in order are interface Type; numPorts; slot; port; clock; framing;
lineCoding #>
!
! Configure Cx1 Controller
!
<# type := param[1] #>
<# ifCount := env.atoi(param[2]) #>
<# slot := param[3] #>
<# port := env.atoi(param[4]) #>
<# clock := param[5] #>
<# framing := param[6] #>
<# coding := param[7] #>
<# while ifCount-- > 0 #>
controller <# type; ' '; slot; '/' ; port; '\n' #>
<# if framing = 'unframed' #>
unframed
<# else #>
framing <# framing; '\n' #>
linecoding <# coding; '\n' #>
<# endif #>
clock source <# clock; '\n' #>

```

```

no shutdown
<# port++ #>
<# endwhile #>
<# endtmpl #>
<# cx1Encap #>
<# //This macro is called by other macros to configure Frame Relay encapsulation
 on serial interfaces. #>
<# //Parameters in order are interface Type; numPorts; slot; port; clock; framing;
 lineCoding #>
!
! Configure Encapsulation
!
<# ifCount := env.atoi(param[1]) #>
<# slot := param[2] #>
<# port := env.atoi(param[3]) #>
<# proto := param[4] #>
<# if proto = 'fr' #>
<# proto := 'frame-relay ietf' #>
<# endif #>
<# while ifCount-- > 0 #>
interface serial <# slot; '/' ; port ; ':1.' ; '\n' #>
encapsulation <# proto ; '\n' #>
<# if proto = 'frame-relay ietf' #>
frame-relay intf-type <# param[5] ; '\n' #>
frame-relay lmi-type <# param[6] ; '\n' #>
<# endif #>
<# port++ #>
<# endwhile #>
<# endtmpl #>
<# cx1FrCir #>
<# //This macro is called by other macros to configure Frame Relay circuits on
 subinterfaces. #>
<# //Parameters in order are interface numPorts; slot; port; numCirs; dlci #>
!
! Configure Frame Relay Circuits
!
<# ifCount := env.atoi(param[1]) #>
<# slot := param[2] #>
<# port := env.atoi(param[3]) #>
<# numCirs := env.atoi(param[4]) #>
<# startDlci := env.atoi(param[5]) #>
<# id := env.atoi('1') #>
<# while ifCount-- > 0 #>
<# cirs := numCirs #>
<# id := env.atoi('1') #>
<# dlci := startDlci #>
<# while cirs-- > 0 #>
interface serial <# slot; '/' ; port ; ':1.' ; id ; '\n' #>
frame-relay interface-dlci <# dlci #> ietf
<# id++; dlci++ #>
<# endwhile #>
<# port++ #>
<# endwhile #>
<# endtmpl #>

```

## Configuring ATM Interfaces

This sample macro configures ATM interfaces based on the inputs you provide when prompted by the macro.



```

<# atmIf #>
<# slotPort:=env.getline("slot/port?") #>
<# while (vcType != 1 && vcType != 2);
vcTypeStr :=env.getline("VC type (1 = AAL5MUX IP, 2 = AAL5SNAP)?");
vcType := env.atoi(vcTypeStr);
endwhile #>
<# if vcType = 1; vcTypeStr := "aal5mux ip"; else; vcTypeStr := "aal5snap"; endif
#>
<# encapRouted:=1; encapBridged:=2; encapPPP:=3 #>
<# while (encapType < encapRouted || encapType > encapPPP);
encapTypeStr :=env.getline("encapsulation (1 = routed, 2 = bridged, 3 =
ppp)?");
encapType := env.atoi(encapTypeStr);
endwhile #>
<# if encapType = encapPPP #>
<# authNone:=1; authPap:=2; authChap:=3; authPapChap:=4; authChapPap:=5 #>
<# while (authType < authNone || authType > authChapPap);
authTypeStr :=env.getline("authentication (1 = None, 2 = PAP, 3 = CHAP, 4 =
PAP/CHAP; 5 = CHAP/PAP)?");
authType := env.atoi(authTypeStr);
endwhile #>
<# endif #>
<# vpStartStr := env.getline("Starting VP number?");
vpStart:=env.atoi(vpStartStr)#>
<# vpEndStr := env.getline("Ending VP number?"); vpEnd
:=env.atoi(vpEndStr)#>
<# vcStartStr := env.getline("Starting VC number?");
vcStart:=env.atoi(vcStartStr)#>
<# vcEndStr := env.getline("Ending VC number?"); vcEnd
:=env.atoi(vcEndStr)#>
<# loopbackStr := env.getline("Loopback interface number or <cr>?") #>
<# vp := vpStart; while vp <= vpEnd, ++vp #>
<# vc := vcStart; while vc <= vcEnd, ++vc #>
interface atm <#slotPort $ '.' $ ++i;\n'#>
atm pvc <# i; ' ' ; vp; ' ' ; vc; ' ' ; vcTypeStr;\n'#>
<# if encapType = encapPpp #>
encap ppp
<# if authType = authPap#>
ppp authentication pap
<# elseif authType = authPapChap#>
ppp authentication pap chap
<# elseif authType = authChapPap#>
ppp authentication chap pap
<# elseif authType = authChap#>
ppp authentication chap
<# endif #>
<# elseif encapType = encapBridged #>
encap bridged1483
<# endif #>
<# if loopbackStr != "" #>
ip unnumbered loopback <# loopbackStr;"\n" #>
<# endif #>
!
<# endwhile #>
!
<# endwhile #>
<# if encapType = encapPPP #>
<# authNone:=1; authPap:=2; authChap:=3; authPapChap:=4; authChapPap:=5 #>
<# while (authType < authNone || authType > authChapPap);
authTypeStr :=env.getline(" authentication (1 = None, 2 = PAP, 3 = CHAP, 4 =

```

```

PAP/CHAP; 5 = CHAP/PAP)?");
authType := env.atoi(authTypeStr);
endwhile #>
<# endif #>
<# vpStartStr := env.getline(" Starting VP number?");
vpStart:=env.atoi(vpStartStr)#>
<# vpEndStr := env.getline(" Ending VP number?"); vpEnd
:=env.atoi(vpEndStr)#>
<# vcStartStr := env.getline(" Starting VC number?");
vcStart:=env.atoi(vcStartStr)#>
<# vcEndStr := env.getline(" Ending VC number?"); vcEnd
:=env.atoi(vcEndStr)#>
<# loopbackStr := env.getline(" Loopback interface number or <cr>?") #>
<# vp := vpStart; while vp <= vpEnd, ++vp #>
<# vc := vcStart; while vc <= vcEnd, ++vc #>
interface atm <#slotPort $ '.' $ ++i;\n'#>
atm pvc <# i; ' '; vp; ' '; vc; ' '; vcTypeStr;\n'#>
<# if encapType = encapPpp #>
encap ppp
<# if authType = authPap#>
ppp authentication pap
<# elseif authType = authPapChap#>
ppp authentication pap chap
<# elseif authType = authChapPap#>
ppp authentication chap pap
<# elseif authType = authChap#>
ppp authentication chap
<# endif #>
<# elseif encapType = encapBridged #>
encap bridged1483
<# endif #>
<# if loopbackStr != " " #>
ip unnumbered loopback <# loopbackStr;" \n" #>
<# endif #>
!
<# endwhile #>
!
<# endwhile #>
<# endtmpl #>

```

## Chapter 11

# Booting the System

This chapter provides information about booting your E-series router.



**NOTE:** The type of file you must always use for booting your system is a software release file with the extension .rel.

This chapter contains the following sections:

- Platform Considerations on page 579
- Configuring Your System for Booting on page 579
- Rebooting Your System on page 584
- Operations in Boot Mode on page 587
- Displaying Boot Information on page 588

## Platform Considerations

System booting is supported on all E-series routers.

For information about the modules supported on E-series routers:

- See the *ERX Module Guide* for modules supported on ERX-7xx models, ERX-14xx models, and the ERX-310 router.
- See the *E120 and E320 Module Guide* for modules supported on the E120 router and the E320 router.

## Configuring Your System for Booting

Juniper Networks delivers your E-series router already set up with a factory default configuration and a software release (.rel) file. You can, however, create a new configuration file (.cnf) and select a different software release file to use in future reboots of your router. When you reboot your router, you can use:

- An existing configuration file to be used each time the system reboots
- An existing configuration file limited to a single reboot
- An existing script file to be used on only the next reboot

- An existing script file to be used on the next and every subsequent reboot using backup mode
- The configuration that is already running on the system
- The factory default configuration

In addition, you can configure the system to load a different software release file on its next reboot. Use the **boot system** command to do this. If you do not configure your system with a backup release, it reverts to the release and configuration it had before the crash.

You can use the **boot backup** command to specify a software release and configuration for the system to use in case the system resets too many times in a given period.

The **boot subsystem** command enables you to override the system release setting for a given subsystem—for example, OC3.

## Booting the GE-2 Line Module

The GE-2 line module can now detect whether it supports the software release installed on the primary SRP module in an E-series router. When the GE-2 line module is booting and it detects that it supports the software release on the SRP module, the line module boots successfully with that software release. However, if the GE-2 line module detects that it does not support the software release on the SRP module, the module does not boot successfully and the following messages appear in the system log:

```
ERROR 05/04/2005 06:09:05 system (slot 13): Line card failed diags in slot 13 with
status: Autoboot disabled
ERROR 05/04/2005 06:09:05 system (slot 13): board failed diagnostics
```

### **boot backup**

- Use to set the release version and the configuration to be used when the boot logic chooses backup mode.
- This command does not reboot the system; it configures the system for rebooting.
- You can require the system to reboot from an existing configuration file, from an existing local script file, or with the factory default configuration.
- Example

```
host1(config)#boot backup rel_1_1_0.rel newfile.cnf
```

- Use the **no** version of this command to remove the backup setting.
- See boot backup.

### **boot config**

- Use to specify the configuration with which the system is rebooted.



**CAUTION:** All versions of this command except those using the **running-configuration** or **startup-configuration** keywords erase the current system running configuration. Before issuing one of those versions, you might want to save the running configuration to a .cnf file by issuing the **copy running-configuration** command.

---

- You can require the system to reboot from a configuration file.

To specify an existing system configuration (.cnf) file that the system uses for the next reboot and all subsequent reboots:

```
host1(config)#boot config newconffile.cnf
```

To specify an existing system configuration (.cnf) file that the system uses only on the next reboot. On subsequent reboots, the system will use the running configuration current at the time of that reboot:

```
host1(config)#boot config newconffile.cnf once
```

- You can require the system to reboot from an existing local script (.scr) file that the system uses only on the next reboot. On subsequent reboots, the system will use the running configuration current at the time of that reboot:

```
host1(config)#boot config scriptfile.scr
```

Configuring this option causes the system to ignore—only at the next reboot—an autocfg.scr file that you may also have configured.

- If you specify a .cnf file, upon the next reboot the system resets to the factory defaults; it then opens the .cnf file and begins applying it immediately. If you specify a .scr file, upon the next reboot the system resets to the factory defaults; it then waits for a 600-second countdown timer to expire before applying the script. This period gives the line modules an opportunity to fully initialize before configuration begins. Upon timer expiration or system initialization (whichever occurs first), the script executes regardless of the state of the line modules. You can escape from the countdown by pressing Ctrl + c; the system prompts you to execute the script immediately or return to the system console.
- You can require the system to reboot from the configuration running on the system at the time of the reboot.

If the system is in Automatic Commit mode:

```
host1(config)#boot config running-configuration
```

If the system is in Manual Commit mode:

```
host1(config)#boot config startup-configuration
```

See “Saving the Current Configuration” on page 257 in “Managing the System” on page 235, for information about Automatic and Manual Commit modes.

- You can require the system to reboot from the factory default configuration. On subsequent reboots, the system will use the running configuration current at the time of that reboot:

```
host1(config)#boot config factory-defaults
```

- This command does not reboot the system.
- Use the **no** version to clear a previous request to reboot in a specified manner.
- See boot config.

### **boot force-backup**

- Use to force the system to use the backup release/configuration on the next boot.
- This command does not reboot the system.
- Example

```
host1(config)#boot force-backup mysafe.rel mysafe.cnf
```



**NOTE:** Even if you request the normal release/configuration, the boot logic still checks the reboot history file. It may force the backup mode regardless of your request. To guarantee that the boot logic does not override your request to use the normal release/configuration, do either of the following:

- Delete the reboot history file after issuing the **no boot force-backup** command.
  - Do not configure a backup release or configuration file.
- 

- Use the **no** version to set the system to return to its normal release/configuration on the next boot.
- See boot force-backup.

### **boot revert-tolerance**

- Use to set the reversion tolerances that the boot logic uses to determine whether to use normal or backup settings.
- The default settings tolerate up to three resets in 30 minutes.
- This command does not reboot the system when high availability is not enabled.
- Issuing this command when high availability is enabled results in the system cold-restarting the router and using the backup settings if the tolerance settings are met.
- Example

```
host1(config)#boot revert-tolerance 2 60
```

- Use the **no** version to restore the default values, 3 and 1800.
- See boot revert-tolerance.

### **boot revert-tolerance never**

- Use to set the boot logic to never revert to the backup image/configuration.
- This command does not reboot the system.
- Example

```
host1(config)#boot revert-tolerance never
```



**NOTE:** This command is functionally equivalent to specifying no backup image/configuration, but it allows you to leave the backup settings alone and to toggle autoreversion on and off. This command is undone by using the **no boot revert-tolerance** command, which restores the default settings, or the **boot revert-tolerance** command. The default settings are count = 3 (crashes) and time = 1800 (seconds); that is, 3 crashes in 30 minutes.

---

- There is no **no** version.
- See boot revert-tolerance never.

### **boot subsystem**

- Use to configure the software release the selected subsystem will use the next time it reboots.
- This command does not reboot the subsystem.
- Example 1

```
host1(config)#boot subsystem ct3 rel_1_0_1.rel
```

- The **boot backup subsystem** version of this command enables you to configure a backup subsystem for booting.
- Example 2

```
host1(config)#boot backup subsystem ct3 rel_1_0_1.rel
```

- Use the **no** version to remove the configuration setting.
- See boot subsystem.

### **boot system**



**CAUTION:** This command attempts to reprogram the SRP boot PROMs, if necessary. The SRP has a primary and, typically, a backup boot PROM. If the **boot system** command is executed on an SRP with no backup boot PROM, the following message is displayed: “ Write to Backup Boot ROM failed.” In this instance, this message is correct, and you can ignore it.

---

- Use to specify the software release (.rel) file that your system will use when rebooting.
- This command does not reboot the system.
- In a dual SRP configuration, when this information is synchronized to the standby SRP, the standby SRP is reloaded to boot the specified release. The high availability feature requires the release to be the same on the active and the standby SRP. This means that arming the system to boot with a different release causes the standby to reload and prevent high availability from becoming active or disable high availability if it is active or pending.
- Example
 

```
host1(config)#boot system release1.rel
```
- There is no **no** version.
- See boot system.

## Rebooting Your System

---

You can reboot your system as a whole or select a single slot in the system to be rebooted. You can reboot your system immediately or in a designated interval of time, and can configure the system to prompt you if the modules are in a state that could lead to a loss of configuration data or an NVS corruption.

If you reboot the system before it has completely written configuration updates to NVS, the system will start with the last saved configuration. If you reboot the system after it has written the configuration updates to NVS, but before it has applied those updates to actual configuration data, the configuration update process resumes immediately following the reboot and completes before any application accesses its configuration data.

### **reload**

- Use to reload the software on the system immediately.
- Reloads the system software (.rel) file and the configuration (.cnf) file on the system.
- When you issue this command, the system prompts you for a confirmation before the procedure starts.
- If you specify the **force** keyword, the procedure will fail if the system is updating the boot prom. In this case, the system will display a message that indicates that the procedure cannot currently be performed and the cause. However, if the system is in a state that could lead to a loss of configuration data or an NVS corruption, such as during the synchronization of SRP modules, the system displays a message that describes the state, and asks you to confirm (enter y for yes, n for no) whether you want to proceed.
- If you do not specify the **force** keyword, the procedure will fail if the system is in a state that could lead to a loss of configuration data or an NVS corruption, and the system will display a message that explains why the procedure failed.



- Use the **standby-srp** keyword to reload the system software (.rel) file and the configuration (.cnf) file on the standby SRP module without having to look up its slot number to use with the **reload slot** command.
- When you issue this command, the system prompts you for a confirmation before the procedure starts.
- If you remove a standby SRP module without issuing the **slot erase** command to delete the configuration, the E-series router cannot guarantee that the SRP modules were synchronized. In this situation, you must do either of the following to reload the router:
  - Issue the **reload** command with the **force** keyword.
  - Issue the **slot erase** command followed by the **reload** command.
- Example

```
host1#reload
host1#reload force
```

- There is no **no** version.
- See reload.

## **reload**

- Use to reload the software on the system at an absolute time.
- This command halts the system.
- Reloads the system software (.rel) file and the configuration (.cnf) file on the system. If the system is in a state that could lead to a loss of configuration data or an NVS corruption, it will delay the procedure for one minute. Each time the system delays the procedure, it adds a message to the os log that explains why the procedure was delayed. If the system cannot reload on its sixth attempt, the reboot procedure will fail, and the system will add an explanation to the os log.
- Example

```
host1#reload at 10:10 May 5
```

This command reloads the software 10 minutes after 10 on May 5th.

- There is no **no** version.
- See reload.

## **reload**

- Use to reload the software on the system in a relative period of time.
- This command halts the system.
- Reloads the system software (.rel) file and the configuration (.cnf) file on the system.
- If the system is in a state that could lead to a loss of configuration data or an NVS corruption, it will delay the procedure for one minute. Each time the system delays the procedure, it adds a message to the os log that explains why the

procedure was delayed. If the system cannot reload on its sixth attempt, the reboot procedure will fail, and the system will add an explanation to the os log.

- Example

```
host1#reload in 00:10
```

This command reloads the software in 10 minutes.

- There is no **no** version.
- See reload.

### **reload slot**

- Use to reboot a selected slot on the router.
- Reloads the system software (.rel) file and the configuration (.cnf) file on the module in the selected slot.
- When you issue this command, the system prompts you for a confirmation before the procedure starts.
- If you specify the **force** keyword and the slot number of the primary SRP module, the procedure will fail if the system is updating the boot prom. In this case, the system will display a message that indicates that the procedure cannot currently be performed and the cause. However, if the system is in a state that could lead to a loss of configuration data or an NVS corruption, such as using the synchronization of SRP modules, it displays a message that describes the state, and asks you to confirm (enter yes or no) whether you want to proceed.
- If you do not specify the **force** keyword, the procedure will fail if the system is in a state that could lead to a loss of configuration data or an NVS corruption, and the system will display a message that explains why the procedure failed.
- Example

```
host1#reload slot 3
```

- There is no **no** version.
- See reload slot.

## **Rebooting When a Command Takes a Prolonged Time to Execute**

Although some commands might take a relatively long time to execute, most do not. If the CLI displays no output other than “ Please wait...” for a prolonged period, you can press Ctrl + x to reset the system. Use Ctrl + x only as a last resort; if at all possible, wait until the command is completed, or attempt to connect to the system through a Telnet or SSH client through which you can use the **reload** command.

### **service ctrl-x-reboot**

- Use to enable the Ctrl + x key combination to reset the system from any location.
- Issuing the Ctrl + x command has no effect if you are accessing the system through Telnet.
- This feature is disabled by default.

- Loading the factory default configuration does not override this feature.
- Example

```
host1(config)#service ctrl-x-reboot
```

- Use the **no** version to disable this feature.
- See service ctrl-x-reboot.

## Configuration Caching

Configuration caching prevents the system from being partially configured with changes in the event of a reset. When a script or macro begins execution, the resulting configuration changes are automatically cached in system RAM rather than being committed to nonvolatile storage (NVS). When the script or macro completes execution, the cache is flushed as a background operation, saving the configuration changes to NVS.

If the SRP module resets during the script or macro execution, the system boots as though the script were never started because no NVS files have changed. If the SRP module resets during the flush operation, the system boots with factory defaults.

If you start another script or macro in the middle of an ongoing flush operation, the current flush is halted; now if the SRP module resets during the script, the system boots with factory defaults.

If you issue the **reload** command to manually reset the system, the system checks for an ongoing cache flush and warns you if a flush operation is discovered.

## Operations in Boot Mode

---

To access Boot mode:

1. Reload the system from Privileged Exec mode:

```
host1#reload
WARNING: Execution of this command will cause the system to reboot.
Proceed with reload? [confirm]
Reload operation commencing, please wait...
7
```

2. Press the < mb > key sequence (case-insensitive) during the countdown that is displayed immediately after the BPOST tests are bypassed. This puts the CLI in Boot mode.

```
:boot##
```

If you do not press the < mb > key sequence before the countdown timer expires, the reloading process continues and returns the CLI to the normal User Exec mode.

## Displaying Boot Information

You can display information about the system's booting configuration, installed hardware versions, and installed software versions.

### **show boot**

- Use to show the current boot settings.
- Example

```
host1#show boot
System Release: release.rel
System Configuration: running-configuration
```

Note: This system is not configured with backup settings.

- See show boot.

### **show hardware**

- Use to display detailed information about the system hardware.
- Field descriptions
  - slot—Physical slot that contains the module
  - type—Type of module
  - serial number—Serial number of the module
  - assembly number—Part number of the module
  - assembly rev—Hardware revision of the module
  - ram (MB)—Memory capacity of the host processor
  - number of MAC addresses—Total number of Ethernet addresses on an I/O module
  - base MAC address—Lowest Ethernet address on an I/O module
- Example

```
host1#show hardware
```

| slot | type             | serial<br>number | assembly<br>number | assembly<br>rev. | ram<br>(MB) |
|------|------------------|------------------|--------------------|------------------|-------------|
| 0    | SRP-10Ge         | 4305358981       | 3500005472         | A06              | 2048        |
| 1    | SRP-10Ge         | 4305359020       | 3500005472         | A06              | 2048        |
| 2    | ---              | ---              | ---                | ---              | ---         |
| 3    | ---              | ---              | ---                | ---              | ---         |
| 4    | CT3-12           | 4305337201       | 3500010901         | A07              | 128         |
| 5    | OC3/OC12/DS3-ATM | 4605300290       | 3500103958         | A06              | 256         |
| 6    | GE/FE            | 4605340294       | 3500104554         | A08              | 256         |

| serial | assembly | assembly | number<br>of<br>MAC |
|--------|----------|----------|---------------------|
|--------|----------|----------|---------------------|

| slot | type           | number     | number     | rev.  | addresses |
|------|----------------|------------|------------|-------|-----------|
| ---  | -----          | -----      | -----      | ----- | -----     |
| 0    | ---            | ---        | ---        | ---   | ---       |
| 1    | SRP-10Ge I/O   | 4605250426 | 3500003302 | A02   | 1         |
| 2    | ---            | ---        | ---        | ---   | ---       |
| 3    | ---            | ---        | ---        | ---   | ---       |
| 4    | CT3/T3-12 I/O  | 4305316605 | 3500010801 | A02   |           |
| 5    | OC3(8)-MM I/O  | 4304443600 | 4500001501 | A03   | 4         |
| 6    | GE-SFP I/O     | 4605310064 | 4500002001 | A05   | 1         |
|      | base           |            |            |       |           |
| slot | MAC address    |            |            |       |           |
| ---  | -----          |            |            |       |           |
| 0    | ---            |            |            |       |           |
| 1    | 0090.1aa0.577a |            |            |       |           |
| 2    | ---            |            |            |       |           |
| 3    | ---            |            |            |       |           |
| 4    |                |            |            |       |           |
| 5    | 0090.1a41.7c68 |            |            |       |           |
| 6    | 0090.1aa0.6216 |            |            |       |           |

- See show hardware.

### **show last-reset**

- Use to display the reason for the system's last user-directed reload or error-caused reset.
- Example

```
host1#show last-reset
last reset: power cycle
```

- See show last-reset.

### **show reload**

- Use to display the system's reload status.
- Example

```
host1#show reload
reload scheduled for TUE OCT 2 2001 10:10:00 UTC
```

- See show reload.

### **show version**

- Use to display the configuration of the system hardware and the software version.
- Example

```
host1#show version
Juniper Edge Routing Switch ERX-700
Copyright (c) 1999-2005 Juniper Networks, Inc. All rights reserved.
System Release: erx_7-1-0.rel Partial
Version: 7.1.0 [BuildId 4518] (December 21, 2005 11:23)
System running for: 25 days, 3 hours, 31 minutes, 5 seconds
(since THU DEC 22 2005 11:36:41 UTC)
```

| slot | state   | type       | admin   | spare | running release | slot uptime    |
|------|---------|------------|---------|-------|-----------------|----------------|
| 0    | standby | SRP-10Ge   | enabled | ---   | erx_7-1-0.rel   | ---            |
| 1    | online  | SRP-10Ge   | enabled | ---   | erx_7-1-0.rel   | 25d03h:28m:49s |
| 2    | ---     | ---        | ---     | ---   | ---             | ---            |
| 3    | ---     | ---        | ---     | ---   | ---             | ---            |
| 4    | online  | CT3-12     | enabled | ---   | erx_7-1-0.rel   | 25d03h:24m:46s |
| 5    | online  | OC3-4A-APS | enabled | ---   | erx_7-1-0.rel   | 25d03h:24m:22s |
| 6    | online  | GE         | enabled | ---   | erx_7-1-0.rel   | 25d03h:24m:44s |

- See show version.

## Output Filtering

The output filtering feature of the **show** command is not available in Boot mode.

## Chapter 12

# Configuring the System Clock

Use the procedures described in this chapter to configure the E-series router clock.

This chapter contains the following sections:

- Overview on page 591
- Platform Considerations on page 594
- References on page 594
- Setting the System Clock Manually on page 595
- Before You Configure NTP on page 597
- NTP Configuration Tasks on page 597
- Monitoring NTP on page 603

### Overview

---

You can use the **clock** commands to set the time and date on your system manually. These commands allow you to specify settings such as the source of the time, the time zone, and dates for seasonal time changes.

You can configure your router to update its clock automatically by configuring it as a Network Time Protocol (NTP) client. NTP provides a method of synchronizing the system clocks of hosts on the Internet to Universal Coordinated Time (UTC). Using NTP allows the system to record accurate times of events. You can view the log file of events to monitor the status of the network.

Since there is only one system clock, you can configure an NTP client on one virtual router only. Other virtual routers obtain clock parameters from the system clock. However, multiple virtual routers can act as NTP servers.

### NTP

NTP uses a hierarchical structure of hosts, such as computers and routers, that form client-server and peer *associations*. An NTP client synchronizes with an NTP server, which in turn synchronizes with another time source. If two hosts provide synchronization for each other, they are peers.

*Primary* or *stratum 1* servers synchronize directly with an accurate time source, such as a radio clock or an atomic clock. *Secondary* or *stratum n* servers synchronize with other servers, and are *n* hops from an accurate time source.

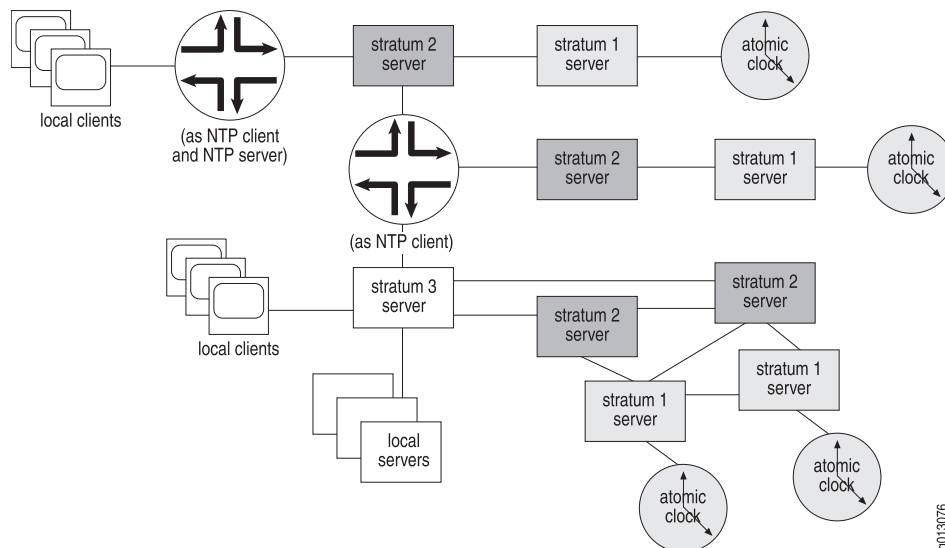
To obtain high precision and reliability with NTP, clients typically synchronize with several NTP servers at different physical locations. Peer associations, especially for stratum 1 and 2 servers, provide redundancy for the network.

Hosts synchronize by exchanging NTP messages through UDP. NTP uses the IP and UDP checksums to confirm data integrity.

By default, the router is an NTP client. You must configure NTP client parameters to start NTP client operation. You can also configure the router as an NTP server, whether or not you configure NTP client parameters.

Figure 30 on page 592 shows an example of an NTP hierarchy.

**Figure 30: Example of an NTP Hierarchy**



## System Operation as an NTP Client

To synchronize to the clock of a server, the system must receive time information from NTP servers recurrently. The way the system receives such information depends on how you configure it:

- If you configure the system to poll NTP servers, it sends time requests to the servers periodically. NTP servers receive the requests, add time information to the messages, and send replies to the system.
- If you configure the system as a broadcast client, it receives NTP broadcasts from servers periodically. The broadcasts include time information from the servers.

By default, NTP servers respond to the interface from which an NTP request originated. You can direct responses from all NTP servers to one interface on the system, or from a specific NTP server to a specific interface.





**NOTE:** When the system is not configured as either an NTP client or an NTP server, it responds to NTP requests with an invalid stratum number.

## Synchronization

There are three stages to synchronization:

- Preliminary synchronization
- Frequency calibration
- Progressive synchronization

### Preliminary Synchronization

Preliminary synchronization is a stage during which the system evaluates the initial time situation and decides how to proceed with longer-term synchronization. This stage involves the following steps:

1. The system obtains several readings of time data from NTP servers.
2. The system analyzes time data in the messages and compares the readings from different servers. Using this information, the system identifies the initial best time source (the *best server*).
3. The system calculates the difference between its own clock and the best server's clock (the *offset*) and proceeds as follows:
  - If the offset is greater than 15 minutes, the system disables NTP and displays a message advising you to check the time zone and clock settings.
  - If the offset is less than 15 minutes, the system sets its clock to that of the best server.
4. Provided the system has not disabled NTP, it proceeds to the next stage:
  - If a frequency calibration is available, the system starts progressive synchronization.
  - If the system has never performed a frequency calibration or the calibration has been deleted, the system starts a frequency calibration.

### Frequency Calibration

Frequency calibration takes place the first time you use NTP or when you reboot the system. During this stage, the system evaluates the frequency error of its clock by measuring change in the offset error. A frequency calibration takes 15 minutes.

### Progressive Synchronization

After the system has established initial NTP parameters, it continues to synchronize to a server as follows:

1. The system acquires time information from servers periodically.

2. The system evaluates which server is currently the best time source (the *master*) by analyzing time data in the messages and comparing the data from different servers.
3. The system gradually synchronizes its clock to that of the master.

## System Operation as an NTP Server

The NTP server supports both unicast (user-to-user addressing protocol) and broadcast modes. Depending on the server configuration you choose, the system functions in different ways:

- When the system is configured as a unicast NTP server, it synchronizes clients to its own clock by responding to NTP requests from clients as follows:
  1. Swaps the destination and source addresses in the request packet.
  2. Sets all timestamps and NTP attributes in the packet.
  3. Returns the packet to the client.
- When the system is configured as a broadcast NTP server, it periodically sends NTP time synchronization messages to the local network broadcast address (255.255.255.255). The broadcast server would also respond to any NTP unicast requests from clients.

If the system is configured both as an NTP client and an NTP server, the system effectively synchronizes its clients to its master's clock. If the system is configured as an NTP server but not an NTP client, the system synchronizes its clients to its own clock, which can be set by the **clock** commands.



**NOTE:** When the system is not configured as either an NTP client or an NTP server, it responds to NTP requests with an invalid stratum number.

---

## Platform Considerations

The system clock is supported on all E-series routers.

For information about the modules supported on E-series routers:

- See the *ERX Module Guide* for modules supported on ERX-7xx models, ERX-14xx models, and the ERX-310 router.
- See the *E120 and E320 Module Guide* for modules supported on the E120 router and the E320 router.

## References

This implementation of NTP meets the following specifications:

- RFC 1305—Network Time Protocol (version 3) Specification, Implementation and Analysis (March 1992)

- RFC 2030—Simple Network Time Protocol (SNTP) (Version 4) for IPv4, IPv6, and OSI (October 1996)

## Setting the System Clock Manually

---

Before you set the system clock, obtain the following information about your time zone:

- The name of the time zone
- The difference (offset) between the time zone and UTC
- The dates and times of transitions to and from summer time (daylight saving time)
- The difference between the standard time and summer time (daylight saving time)

The international Web site [www.timeanddate.com](http://www.timeanddate.com) contains information about time zones.



**NOTE:** Be sure to set the time zone (default is UTC) and summer time dates before you set the clock.

---

You can set the system clock at any time. This process involves the following steps:

1. Set the time zone.
2. Set the summer time dates.
3. Set the time.
4. Check the clock settings.

### **clock set**

- Use to set the time and date on your system manually.
- Use the following syntax for setting the time: HH:MM:SS. This is the current time in 24-hour format—hours:minutes:seconds.
- There are two acceptable date forms for this command. Both produce the same display when you run the **show clock** command.
  - Day:month:year
  - Month:day:year
- Examples

```
host1#clock set 08:12:42 12 March 2000
host1#clock set 11:12:55 March 10 2000
```

- There is no **no** version.
- See clock set.

**clock summer-time date**

- Use to set the clock to switch automatically to summer time (daylight saving time).

- Example

```
host1(config)#clock summer-time PDT date 1 April 200X 2:00
31 October 200X 2:00 60
```

- Use the **no** version to prevent automatic switching to summer time.
- See clock summer-time date.

**clock summer-time recurring**

- Use to set the clock to summer time at the same time each year.
- Example—This overrides the default settings for PDT,

```
host1(config)#clock summer-time PDT recurring first Sunday April 2:00 last
Sunday October 2:00
```

- Use the **no** version to prevent automatic switching to summer time.
- See clock summer-time recurring.

**clock timezone**

- Use to set the time zone for display.
- Example—This sets the time zone to 5 hours behind UTC.

```
host1(config)#clock timezone EST -5
```

- Use the **no** version to set the time zone to UTC, the default setting.
- See clock timezone.

**show clock**

- Use to display the system time and the date.
- Example 1—Shows time source value when clock is manually configured

```
host1#show clock detail
TUE JAN 23 2007 11:50:47 UTC
time source: manually entered by user
timezone: UTC (0 minutes from UTC)
```

- Example 2—Shows time source value when clock is synchronized with NTP

```
host1#show clock detail
TUE JAN 23 2007 11:50:47 UTC
time source: Configured via NTP
timezone: UTC (0 minutes from UTC)
```

- See show clock.

## Before You Configure NTP

---

Before you configure NTP, complete the following procedures:

1. Configure at least one IP address on the router.
2. Check that the system clock reads the correct time to within 15 minutes, and that the time zone and summer time settings are correct.
3. Reset the system clock manually if the time, time zone, or summer time settings are incorrect.
4. If you want to configure the NTP system as an NTP client, choose the NTP servers.

## Choosing NTP Servers

For the system, synchronizing to several stratum 2 or higher servers on the Internet provides sufficient accuracy for the timing of event messages. You can find a list of stratum 2 servers at [www.eecis.udel.edu/~mills/ntp](http://www.eecis.udel.edu/~mills/ntp).

If you have access to an NTP server that you know to be reliable and accurate, you can synchronize the system to that server alone. You may prefer this method if you have used Simple Network Time Protocol (SNTP) with other equipment.

If you know that an NTP server broadcasts on a network to which the system has an interface, you do not need to configure NTP servers. Simply enable the system to accept NTP broadcasts on that interface.

## NTP Configuration Tasks

---

By default, the system is an NTP client. You must configure NTP client parameters to start NTP client operation. You can also configure the system as an NTP server, whether or not you configure NTP client parameters.

## Enabling NTP Services

Before you can configure NTP client parameters or enable a virtual router to act as an NTP server, you must enable NTP services. When you enable NTP services, the NTP client associates itself with the current virtual router. Because there is only one system clock to update, only the virtual router on which you configure NTP can act as the NTP client. However, any virtual router can act as an NTP server. To enable NTP services:

1. (Optional) Access the virtual router with which you want to associate NTP services.
2. Issue the **ntp enable** command.

### **ntp enable**

- Use to enable NTP services on the system.
- This command associates NTP services and the NTP client with the current virtual router.
- Example

host1:boston(config)#**ntp enable**

- Use the **no** version to disable NTP polling and clock correction and to remove the association between NTP services and the virtual router.
- See ntp enable.

## **NTP Client Configuration**

To configure the system as an NTP client:

1. Ping the selected NTP servers to ensure that the system can reach them.
2. Configure the system to acquire NTP data by completing one or both of the following actions:
  - Assign the NTP servers.
  - Enable the system to receive broadcasts on an interface.
3. If you enable the system to receive broadcasts on an interface, set the estimated round-trip delay between the system and an NTP broadcast server.
4. Disable NTP on interfaces that you do not want to receive NTP communications for security or other reasons.

### **ntp broadcast-client**

- Use to enable the system to receive NTP broadcasts on an interface.
- Example

host1(config-if)#**ntp broadcast-client**

- Use the **no** version to prevent the system from receiving NTP broadcasts.
- See ntp broadcast-client.

### **ntp broadcast-delay**

- Use to set the estimated round-trip delay in the range 0 to 999,999 microseconds between the system and an NTP broadcast server.
- Example

host1(config)#**ntp broadcast-delay 2000**

- Use the **no** version to set the estimated round-trip delay to the default, 3000 microseconds.
- See ntp broadcast-delay.

### **ntp disable**

- Use to disable NTP on an interface.
- Example

host1(config-if)#**ntp disable**

- Use the **no** version to reenable NTP on an interface.
- See `ntp disable`.

### ***ntp server***

- Use to assign an NTP server to the system and to customize the way the server communicates with the system.
- Specify the **source** option to direct responses from the NTP server to a specific interface on the system and override the **ntp source** command.
- Example

```
host1(config)#ntp server 192.35.42.1 version 3 prefer source atm 3/0.1
```

- Use the **no** version to terminate communications between the system and an NTP server.
- See `ntp server`.

### ***ping***

- Use to check that the system can reach an NTP server.
- Example

```
host1(config)#ping 192.35.42.1
```

- There is no **no** version.
- See `ping`.

## **Directing Responses from NTP Servers**

By default, an NTP server sends a response to the interface from which an NTP request originated. You can now direct responses from all NTP servers to one interface on the system or direct responses from a specific NTP server to a specific interface.

### ***ntp source***

- Use to direct responses from all NTP servers to a specific interface. Using the **source** option with the **ntp server** command overrides the **ntp source** command.
- Example

```
host1(config)#ntp source atm 3/1
```

- Use the **no** version to direct all servers to reply to the interface from which the NTP request was sent (the default setting).
- See `ntp source`.

## Refusing Broadcasts from NTP Servers

You can prevent the system from receiving certain types of broadcasts and specify the servers from which the system will accept NTP broadcasts. To do so:

1. Issue the **ntp access-group** command.
2. Configure an access list.

### **access-list**

- Use to configure an access list.
- Example  
  
host1(config)#**access-list europe permit any**
- Use the **no** version to remove the access list.
- See access-list.

### **ntp access-group**



**NOTE:** The system can accept, but does not use, NTP control queries.

---

- Use to specify the types of broadcasts that the system will accept and respond to, and to specify an access list of servers from which the system will accept broadcasts. You can enable the system to:
  - Receive time requests, receive NTP control queries, and synchronize itself to the servers specified on the access-list
  - Only receive time requests and NTP control queries from specified servers
  - Only receive time requests from specified servers
  - Only receive NTP control queries from specified servers
- Example  
  
host1(config-line)#**ntp access-group peer europe**
- Use the **no** version to enable the system to receive all NTP broadcasts on interfaces configured to receive broadcasts.
- See ntp access-group.

## NTP Server Configuration

To enable a virtual router to act as an NTP server:

1. Access the virtual router context.
2. Specify that the virtual router acts as an NTP server.





**CAUTION:** Be sure that you do not override a valid time source if you specify the stratum of the NTP server. Issuing the **ntp master** command on multiple systems in the network might lead to unreliable timestamps if those systems do not agree on the time.

3. (Optional) Specify the stratum of this NTP server.

### **ntp broadcast**

- Use to enable broadcast server on an interface to send NTP broadcast messages periodically.
- The server sends the NTP broadcast messages to the local network broadcast address (255.255.255.255).
- Example—In this example, the interface supports NTP software, version 4, and a poll interval of 5 (32 seconds) for broadcasting NTP messages.

```
host1:boston(config-if)#ntp broadcast version 4 5
```

- Use the **no** version to prevent the interface from sending NTP broadcast messages.
- See ntp broadcast.

### **ntp master**

- Use to specify the stratum number of a virtual router you configured as an NTP server
- By default, the stratum number is set to the stratum number of the master plus one.



**CAUTION:** Although you can specify a stratum number of 1, the system does not support stratum 1 service. The system can synchronize only with an NTP server, and not directly with an atomic clock or radio clock.

- Specify a stratum number for the system in the range 1 – 15. A stratum *n* server is *n* hops from an accurate time source.
- Example

```
host1:boston(config)#ntp master
```

- Use the **no** version to restore the default stratum number.
- See ntp master.

### **ntp server enable**

- Use to enable a virtual router to act as an NTP server.
- Example

```
host1:boston(config)#ntp server enable
```

- Use the **no** version to prevent a virtual router from acting as an NTP server.
- See ntp server enable.

## Configuration Examples

The following examples show how to configure the system as an NTP client and an NTP server.

- Example 1** NTP communications are established on the virtual router boston. The system is a client of the NTP server with IP address 172.16.5.1.

```
host1#virtual-router boston
host1:boston#ping 172.16.5.1
Sending 5 ICMP echos to 172.16.5.1, timeout = 2 sec.
.....
Success rate = 100% (0/5), round-trip min/avg/max = 0/0/0 ms
host1:boston#configure terminal
host1:boston(config)#ntp server 172.16.5.1
host1:boston(config)#ntp enable
```

- Example 2** NTP communications are established on the virtual router boston. The system is specified as an NTP server.

```
host1#virtual-router boston
host1:boston#configure terminal
host1:boston(config)#ntp server
```

- Example 3** NTP communications are established on the virtual router boston. The router is specified as an NTP broadcast server and synchronizes with NTP server 172.16.5.1. The specified interface enabled for NTP broadcasting is configured with version 4 and poll interval 5 for broadcasting NTP messages.

```
host1#virtual-router boston
host1:boston#configure terminal
host1:boston#ntp enable
host1:boston(config)#ntp server 172.16.5.1
host1:boston(config)#interface fastethernet 9/3
host1:boston(config-if)#ntp broadcast 4 5
```



**NOTE:** In Example 3, the router that acts as the NTP broadcast server must either synchronize to another server or master (specified by the **ntp server** command) or act as master (**ntp master** command).

---

## Monitoring NTP

After you configure the system as an NTP client, you can use **show** commands to view information about the NTP servers you assigned and the status of NTP on the interface.



**NOTE:** For about 30 minutes after you configure the system as an NTP client, the data varies rapidly, and then starts to stabilize. Wait at least 1 hour before using the data to make decisions about NTP servers.

Many of the fields in the displays of these **show** commands take their values from the NTP messages. The NTP client uses this data to compare the performance of its NTP servers and to choose a master.

### **show ntp associations**

- Use to view the information about the NTP servers you assigned.
- Field descriptions
  - \* (Master)—System is synchronizing to this server
  - # (Master - unsynchronized)—System has chosen this server as master, but the master has not yet synchronized to UTC
  - + (Selected)—System will consider this server when it chooses the master
  - - (Candidate)—System may consider this server when it chooses the master
  - x (Unusable)—Server does not meet the initial criteria for master
  - p (Preferred)—Server that you specified as the preferred server
  - ~ (Configured)—Server is a configured server; no tilde indicates a broadcast server
  - Peer Address—IP address of server
  - Stratum—Number of hops between the server and the accurate time source
  - Poll—Time between NTP requests from system to server
  - Reachable—8-bit number that shows whether or not the NTP server responded to the last eight requests from the system; one indicates a response, zero indicates no response. For example, 11111111 indicates that the NTP server responded to the last eight requests. If the system reaches one server less often than it does other servers, that server is not a good choice for the master.
  - Precision—Length of the clock tick (interrupt interval) of server's clock
  - Delay—Round-trip delay, with the lowest dispersion value in the sample buffer, between the system and the server

- Offset—Difference, with the lowest dispersion in the sample buffer, between the system's clock and the server's clock
- Disp.—Lowest measure, in the sample buffer, of the error associated with the peer offset, based on the peer delay
- Example

```

host1# show ntp associations
Peer Address Stratum Poll Reachable Precision Delay Offset
Disp.
- 10.6.129.58 3 512s 01111111 0.000000s 0.000s 0.052s
0.010s
+~152.2.21.1 2 256s 11111111 0.000015s 0.070s 0.039s
0.020s
+~128.182.58.100 2 256s 11011111 0.000004s 0.030s 0.019s
0.074s
*p128.118.25.3 2 256s 10111111 0.000015s 0.020s 0.038s
0.073s
(* Master, + Selected, - Candidate, x Unusable) (p Preferred, ~
Configured)

```

- See show ntp associations.

### **show ntp associations**

- Use to view the information about the NTP servers you assigned.
- Field descriptions
  - Peer—IP address of server, status of the server: configured, master, selected, candidate, correct, or unusable
    - configured—Confirmation that you assigned this NTP server to the system
    - master—System has chosen this server as the master
    - selected—System will consider this server when it chooses the master
    - candidate—System may consider this server when it chooses the master
    - correct—System considers the server's clock to be reasonably correct
    - unusable—Server does not meet the initial criteria for the master
  - stratum—Number of hops between the server and its stratum 1 server
  - Peer is a Broadcast/Configured Server—Type of NTP server: one that broadcasts NTP messages or one you have configured for NTP services
  - version—Version of NTP on the server
  - polled every—Time between NTP requests from the system to the server
  - polls every—Time between NTP requests from the server to its NTP servers
  - Root Delay—Round-trip time between the server and its stratum 1 root server

- Root Dispersion—Measure of all the errors associated with the network hops and servers between the server and its stratum 1 server
- Sync Dist.—Measure of the total time error since the update in the path to the stratum 1 server
- Peer Delay—Round-trip delay, with the lowest dispersion value in the sample buffer, between the system and the server
- Peer Dispersion—Lowest measure, in the sample buffer, of the error associated with the peer offset, based on the peer delay and precision
- Offset—Difference, with the lowest dispersion in the sample buffer, between the system's clock and the server's clock
- Reachability—8-bit number that shows whether or not the NTP server responded to the last eight requests from the system; one indicates a response; zero indicates no response. For example, 11111111 indicates that the NTP server responded to the last eight requests. If the system reaches one server less often than it does other servers, that server is not a good choice for the master.
- Precision—Length of the clock tick (interrupt interval) of the server's clock
- Source—IP address of the interface to which NTP servers should send NTP responses
- Timestamps of latest time samples from this peer; actual timestamps displayed depends on how the server is configured
  - Root reference at—Last time at which the stratum 1 server sent an NTP reply to the server
  - Last request sent—Last time at which the system sent an NTP request to the server
  - Response/Broadcast was sent—Last time at which the server sent an NTP reply or broadcast to the system
  - Response/Broadcast received—Last time at which the system received an NTP reply or broadcast from this server
- Sample buffer for this peer contains the following samples:
  - Delay—Round-trip delay from client to server
  - Offset—Difference between client's and server's clocks
  - Dispersion—Measure of the errors of the offset values, based on the round-trip delay and the precisions of the system and the server
- Example

```

host1# show ntp associations detail
Peer 10.6.129.58 is selected, stratum 3
 Peer is a Broadcast Server, version 3, broadcasts every 64 sec
 Root Delay 0.059052 sec, Dispersion 0.189056 sec, Sync Dist. 0.229679

```

```

sec
Peer Delay -0.000016 sec, Dispersion 0.009665 sec, Offset 0.050714 sec

Reachability 11111110, Precision 0.000000 sec
'Source' Interface : default (transmit interface)
Timestamps of latest time sample from this peer:
Root reference at: Thu, Apr 13 2000 17:27:17.145 from 128.118.25.3
Broadcast was sent: Thu, Apr 13 2000 17:42:02.118
Broadcast received: Thu, Apr 13 2000 17:42:02.067
Sample buffer for this peer contains the following samples:
Delay (sec): 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000
Offset (sec): 0.049 0.050 0.050 0.050 0.050 0.050 0.051
0.051
Dispersion (sec): 0.015 0.015 0.014 0.013 0.012 0.011 0.010
0.009

```

- See `show ntp associations`.

### ***show ntp status***

- Use to view the configuration and status of the system.
- Field descriptions
  - NTP Status—State of NTP on the system and the stratum number of the server
  - No. of associations—Number of peer associations for the NTP server
  - Clock Status:
    - Offset Error—Time difference between the system and the master, in seconds
    - Frequency Error—Error in the frequency of the system's clock, in seconds per second
    - Last Update—Last time received from the master
    - Root Dispersion—Measure of all the errors associated with the network hops and servers between the system and its stratum 1 server, in seconds
  - Configuration:
    - Admin. State—Status of NTP on the router (enabled or disabled)
    - Virtual Router Name—Name of the virtual router to which you attached NTP
    - Broadcast Delay—Time for a broadcast message to travel between the server and the client, in microseconds
    - Client Mode—NTP client status (True – system is an NTP client; False – system is not an NTP client)
    - Master Mode—NTP server status (True – system is configured as an NTP server; False – system is not configured as an NTP server)
    - Stratum No.—Stratum number of system if configured as NTP server

- Summer Time—Status of seasonal time, True or False
- Summer Timezone Name—Name of summer time zone
- Timezone Name—Name of time zone
- Timezone Offset—Time difference between the time zone and UTC, in hours:minutes
- Access List—Identities of access lists of servers from which the system does not accept broadcasts
- ‘Server Source’ Interface—Interface through which responses from the NTP server are directed; configured through the **ntp server source** command, which overrides the interface configured through the **ntp source** command.
- ‘Client Source’ Interface—Interface through which all NTP server responses are directed; configured through the **ntp source** command.
- Source Interface—IP address of the interface to which NTP servers should send NTP responses
- Address—IP address of interface
- Enable—Status of NTP on the interface, On or Off
- BcastClient—Indication of whether or not this interface accepts broadcasts from NTP servers, On or Off
- BcastServer—Indication of whether or not this interface functions as a broadcast server, On or Off
- Name—Type of interface and its location
- Example

```

host1# show ntp status
Network Time Protocol (NTP v.4)
NTP Status :No valid NTP server available
 No. of associations : 0
Clock Status :Initializing: frequency to be calibrated
 Offset Error : 0 sec, amortizing asymptotically
 Frequency Error : 0 sec/sec, compensating every second
 Last Update :
 Root Dispersion : 0 sec
Configuration:
 Admin. State : NTP Enabled
 Virtual Router Name : default
 Broadcast Delay : 3000 microseconds
 Client Mode : True
 Master Mode : False
 Stratum No. : Unspecified
 Summer Time : False
 Summer Timezone Name :
 Timezone Name : UTC
 Timezone Offset : 00:0 hours:minutes
 Access List :

```

```
'Server Source' Interface :
'Client Source' Interface : Default (transmit interface)
Interface Configuration :
Address Enable BcastClient BcastServer Name
1.1.1.1 ON ON ON FastEthernet1/0
```

- See show ntp status.



## Chapter 13

# Configuring Virtual Routers

E-series routers allow you to create multiple logical or *virtual* routers in a single router. Each virtual router has its own separate set of IP interfaces, forwarding table, and instances of routing protocols.

This chapter contains the following sections:

- Overview on page 609
- Platform Considerations on page 611
- References on page 611
- Configuring Virtual Routers on page 611
- Monitoring Virtual Routers on page 615

### Overview

---

Multiple distinct routers are supported within a single router, which allows service providers to configure multiple, separate, secure routers within a single chassis. These routers are identified as *virtual routers (VRs)*. Applications for this function include the creation of individual routers dedicated to wholesale customers, corporate virtual private network (VPN) users, or a specific traffic type.

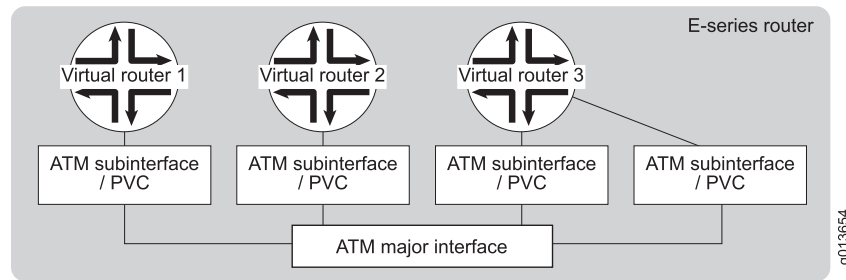
### Default Virtual Router

When you first boot your router, it creates a *default* virtual router. The only difference between the default VR and any other router is that you cannot create or delete the default VR. Just like any other router, the default VR gets its IP addresses when you add interfaces to it.

### Virtual Router Instances

E-series routers can support up to 1,000 forwarding tables; that is, up to a total of 1,000 VRs and VPN routing and forwarding (VRF) instances. Each VRF has a forwarding table. A network device attaching to a router detects a router interface. The attaching device has no notion of the *virtual* router behind the interface.

For example, a physical ATM link may have circuits that are connected to different VRs. The physical and data link layers are not aware that there are multiple router instances. See Figure 31 on page 610.

**Figure 31: Virtual Routers**

VRs and VRFs are tools for implementing VPNs.

## Routing Protocols

Your router implements the VRs by maintaining a separate instance of each data structure for each VR and allowing each protocol (for example, TCP/UDP, RIP, OSPF, and IS-IS) to be enabled on a case-by-case basis. A table of router interfaces associates user connections (for example, PPP or ATM) with one or more IP interfaces within a VR.

## VPNs and VRFs

Your router supports VPNs and VRFs. For information about VPNs and VRFs, see *JUNOS BGP and MPLS Configuration Guide*.

### VPNs

A VPN is a set of sites attached to a common network, but whose data is handled separately from that common network.

VPNs enable private IP traffic to travel over a public TCP/IP network by tunneling that traffic between VPN member sites. Different levels of security are available depending on the security of the tunnel used between sites.

Your router supports VPNs consisting of VRs or VRFs. See *RFC 2547—BGP/MPLS VPNs (March 1999)*. Additionally, your router supports tunnels built from GRE, IPSec, L2TP, MPLS, and tunnels built from layer 2 circuits, such as Frame Relay and ATM.

### VRFs

A VRF is a virtual routing and forwarding instance that exists within the context of a VR. The VRF provides forwarding information to your router. The system looks up a packet's destination in the VRF associated with the interface on which the packet is received. In general, any application that can be enabled in a VR can be enabled in a VRF. VRFs are generally associated with the VPN behavior described in *RFC 4364—BGP/MPLS IP Virtual Private Networks (VPNs)*.

When a VRF receives an update message, it needs to know whether it should add the route to its routing table. Similarly, when a VRF sends update messages, it needs

to identify the VPNs that it wants to receive the updates. See *JUNOSe BGP and MPLS Configuration Guide*.

## Platform Considerations

---

Virtual routers are supported on all E-series routers.

For information about the modules supported on E-series routers:

- See the *ERX Module Guide* for modules supported on ERX-7xx models, ERX-14xx models, and the ERX-310 router.
- See the *E120 and E320 Module Guide* for modules supported on the E120 router and the E320 router.

## References

---

For more information about virtual routers, VPNs, or VRFs, consult the following resources:

- *JUNOSe Release Notes, Appendix A, System Maximums*—Refer to the Release Notes corresponding to your software release for information about maximum values.
- *JUNOSe BGP and MPLS Configuration Guide*
- *RFC 2917—A Core MPLS IP Architecture (September 2000)*
- *RFC 4364—BGP/MPLS IP Virtual Private Networks (VPNs) (February 2006)*

## Configuring Virtual Routers

---

This section provides examples of some of the more common virtual router tasks.

There are different uses of the **virtual-router** command. You can create or access VRs and VRFs in Global Configuration mode or map a VR to a domain map in Domain Map Configuration mode. After you have created a VR, you can continue to work in different command modes and configure the same user interface parameters as before the virtual router was created.

For information about the many VR tasks you can configure, see the related chapter; for example, *JUNOSe IP, IPv6, and IGP Configuration Guide* or *JUNOSe BGP and MPLS Configuration Guide*.

To configure a virtual router:

- Create and name a VR in Configuration mode.

```
host1(config)#virtual-router western
host1:western(config)#
```

- Create a VRF to provide forwarding information to your router. In this example, the VRF created is in context with the VR created above.

```

host1:western(config)#ip vrf eastern
Proceed with new VRF creation? [confirm]
host1:western(config-vrf)#virtual-router:eastern
host1:western:eastern(config)#

```

- Access a VRF from the context of a different VR.

```

host1(config)#virtual-router western:eastern
host1:western:eastern(config)#

```

- View your configuration choices from a VR or VRF context.

```

host1:western:eastern(config)#?
aaa Configure authentication, authorization,
 and accounting characteristics
access-list Configure an access list entry
arp Configure a static ARP entry
bandwidth Configure slot-group bandwidth control
banner Define a banner line
baseline Configure baseline operations
boot Configure boot time behavior
bulkstats Configure bulkstats parameters
classifier-list Configure a classifier list entry
clns Configure CLNS characteristics
clock Set the system's clock
controller Configure controller parameters
crypto Configure cryptographic parameters
disable-autosync Disable automatic synchronization of
 redundant system controller file system
disable-switch-on-error Disable automatic switch to redundant system
 controller upon software/hardware error
enable Configure security related options
end Exit Global Configuration mode
exception Configure core dump
exclude-subsystem Exclude copying a subsystem from the release
exit Exit from the current command mode
ftp-server Configure FTP Server characteristics
help Describe the interactive help system
host Add/modify an entry to the host table
hostname Set the host (system) name
interface Enter Interface Configuration mode
ip Configure IP characteristics
l2tp Configure L2TP parameters
license Configure licenses
line Enter Line Configuration mode
log Configure logging settings
macro Run a CLI macro
map-list Create an NBMA static map
memory Configure and administer memory operations
mpls Configure MPLS global parameters
no Negate a command or set its default(s)
ntp Configure the Network Time Protocol
policy-list Enter Policy Configuration mode
pppoe Configure PPPoE
profile Specify a profile
radius Configure RADIUS server
rate-limit-profile Enter rate limit profile configuration mode
redundancy Perform a redundancy configuration
route-map Configure a route map

```

|                       |                                                           |
|-----------------------|-----------------------------------------------------------|
| router                | Configure a routing protocol                              |
| rtr                   | Configure rtr parameters                                  |
| service               | Configure system-level services                           |
| set                   | Configure                                                 |
| sleep                 | Make the Command Interface pause for a specified duration |
| slot                  | Configure and administer slot operation                   |
| snmp-server           | Configure SNMP parameters                                 |
| sscc                  | The SSC Client                                            |
| telnet                | telnet daemon configuration                               |
| timing                | Configure network timing                                  |
| traffic-shape-profile | Enter traffic shape profile configuration mode            |
| virtual-router        | Specify a virtual router                                  |

host1:western:eastern(config)#

- View the VRF configuration choices from VRF Configuration mode.

```
host1:western(config-vrf)#?
exit Exit from the current command mode
export Specify VRF export characteristics
help Describe the interactive help system
import Specify VRF import characteristics
log Configure logging settings
macro Run a CLI macro
no Negate a command or set its default(s)
rd Specify route distinguisher
route-target Specify VPN extended community Target
sleep Make the Command Interface pause for a
 specified duration
host1:western(config-vrf)#
```

- Access a VR to configure it with an interior gateway protocol (IGP) or exterior gateway protocol (EGP) to learn routes from a customer edge (CE) device. See the related routing protocol chapters for detailed information.

**Example 1**  
**VR with an IGP**

```
host1(config)#virtual-router miami
host1:miami(config)#router ospf 5
host1:miami(config-router)#
```

**Example 2**  
**VR with an EGP**

```
host1(config)#virtual-router western
host1:western(config)#router bgp 359
host1:western(config-router)#
```

- Configure a Telnet daemon to listen in VRs other than the default VR.

```
host1(config)#virtual-router boston
host1:boston(config)#telnet listen port 23
```

- List all VRs and VRFs on the router.

```
host1#show virtual-router
Virtual Router : default
Virtual Router : thursday
Virtual Router : western
```

```

 VRF : eastern
Virtual Router : boston
Virtual Router : miami
Virtual Router : northern
 VRF : southern
host1#

```

- Map a VR to a user domain name in Domain Map Configuration mode. The VR must already exist.

```

host1(config)#aaa domain-map jacksonville
host1(config-domain-map)#virtual-router western
host1(config-domain-map)#

```

### **aaa domain-map**

- Use to map a user domain name to a virtual router.
- Examples

```

host1-0-1-90(config)#aaa domain-map juniper.net vrouter_1
host1-0-1-90(config)#aaa domain-map none vrouter__all_purpose
host1-0-1-90(config)#aaa domain-map DEFAULT vrouter_all_purpose

```

- Use the **no** version to delete the domain map.
- See `aaa domain-map`.

### **ip vrf**

- Use to create a VRF or access VRF Configuration mode to configure a VRF.
- You must specify a route distinguisher after you create a VRF. Otherwise, the VRF will not operate.
- Example

```

host1-00-02-80:boston(config)#ip vrf vpn-A

```

- Use the **no** version to remove a VRF.
- See `ip vrf`.

### **telnet listen**

- Use to create a Telnet daemon to listen in a virtual router.
- Example

```

host1(config)#virtual-router 3
host1:3(config)#telnet listen port 3223

```

- Use the **no** version to delete the daemon.
- See `telnet listen`.

### **virtual-router**

- From Global Configuration mode, use this command to create a virtual router or access the context of a previously created virtual router or a VRF.
- From Domain Map Configuration mode, use this command to map the VR to a user domain name. Use the **no** version in this mode to delete the VR parameter and assign the default VR.
- A VR name consists of 1–32 alphanumeric characters.
- After you are in the context of a particular VR or VRF (indicated by the change in the prompt), all subsequent commands you enter apply to that context until you exit the context.
- Use the **no** version of the command only to delete the VR and return the router to the default VR. Issuing the command **no virtual-router vrName.vrfName** has no effect.
- Issuing a **no** version of this command (**no virtual-router : vrfName** or **no virtual-router vrName : vrfName**) that specifies an existing VRF displays only the error message: “Cannot delete a VRF with this command.” You must use the **no ip vrf** command to remove a VRF.



**NOTE:** See the *JUNOS Command Reference Guide* for additional information.

---

- Use the **wait-for-completion** keyword with the **no** version if you require a synchronous deletion of a VR, such as when executing Telnet or console commands through an external script. Alternatively, you might want to use this keyword if the VR being deleted has many configured VRFs and someone might attempt to re-create the VR before all the VRFs have been deleted. If you do not issue the **wait-for-completion** keyword in those circumstances, a **virtual-router** command issued as soon as the prompt appears could fail because the router is still deleting VRFs. You can specify a period during which the CLI waits before it returns a prompt. If you do not specify a wait time, then the CLI does not return a prompt until the operation is complete. You can press Ctrl + c to break out of the wait period early.
- See virtual-router.

## Monitoring Virtual Routers

---

Use the **show virtual-router**, the **show configuration virtual router**, and **show aaa domain-map** commands to display virtual router and user-domain-to-virtual-router mapping information. Use the **show ip forwarding table** command to display information about memory usage by virtual routers.

### **show aaa domain-map**

- Use to display the mapping between user domains and virtual routers.
- The following keywords have significance when used as user domains:
  - **none**—All client requests with no user domain name are associated with the virtual router mapped to the *none* entry

- **default**—All client requests with a domain present that has no map are associated with the virtual router mapped to the *default* entry

- Example

```
host1#show aaa domain-map
Domain: boston; virtual-router: default
```

| Tunnel<br>Tag | Peer   | Source | Type  | Medium | Password | Tunnel<br>Id | Tunnel<br>Hostname |
|---------------|--------|--------|-------|--------|----------|--------------|--------------------|
| -----         | -----  | -----  | ----- | -----  | -----    | -----        | -----              |
| 31            | <null> | <null> | l2tp  | ipv4   | <null>   | <null>       | <null>             |

| Tunnel<br>Tag | Tunnel<br>Server<br>Name | Tunnel<br>Preference |
|---------------|--------------------------|----------------------|
| -----         | -----                    | -----                |
| 31            | <null>                   | 2000                 |

- See show aaa domain-map.

### **show configuration**

- Use to display configuration information for the virtual routers configured on your router.
- You can create a configuration script from the output by saving it as a file with the .scr extension.
- You can exclude information about a particular type of interface.
- You can use the output filtering feature of the **show** command to include or exclude lines of output based on a text string that you specify. See “Command-Line Interface” on page 29, for details.
- Example

```
host1#show configuration virtual-router default
virtual-router default
ip domain-lookup
ip name-server 10.2.0.3
ip domain-name "junipercom.com"
!
host f 10.10.0.129 ftp anonymous null
interface null 0
!
interface fastEthernet 0/0
ip address 192.168.1.155 255.255.255.0
!
ip route 0.0.0.0 0.0.0.0 192.168.1.1
no ip multicast-routing
!
mpls rsvp profile default
mpls ldp profile default
!
rtr 1
type echo protocol ipIcmpEcho 10.5.0.200 source fastEthernet0/0
frequency 1
samples-of-history-kept 5
```



```

 timeout 10000
 !

```

- See show configuration.

### **show ip forwarding-table slot**

- Use to display the memory used by each VR configured on a line module and free memory available on the line module.
- Field descriptions
  - Free Memory—Amount of memory free on the line module, in kilobytes
  - Virtual Router—Name of the virtual routers configured on the line module
  - Memory (KB)—Amount of memory consumed by the VR, in kilobytes
  - Load Errors—Counts errors made while loading the routing table on the line module
  - Status—Indicates whether the routing table for the VR is valid
- Example

```

host1#show ip forwarding-table slot 9
Free Memory = 14,328KB

```

| Virtual Router | Memory (KB) | Load Errors | Status |
|----------------|-------------|-------------|--------|
| vr1            | 4128        | 0           | Valid  |
| vr2            | 3136        | 0           | Valid  |
| vr3            | 2256        | 0           | Valid  |
| vr4            | 1512        | 0           | Valid  |
| default        | 1024        | 0           | Valid  |

- See show ip forwarding-table slot.

### **show virtual-router**

- Use to display the virtual routers and VRFs configured on your router.
- Use the **summary** keyword to display only the total number of virtual routers and the total number of VRF instances.
- Use the **detail** keyword to display the status of the routing protocols configured for each virtual router.
- Use the **summary** keyword with the **detail** keyword to display the number of VRF instances for each virtual router.
- Use the output filtering feature of the **show** command to include or exclude lines of output based on a text string you specify. See “Command-Line Interface” on page 29, for details.
- Example 1

```

host1#show virtual-router
Virtual Router : default
Virtual Router : vr1
 VRF : eastern
 VRF : western
 VRF : northern
 VRF : southern
Virtual Router : vr2
 VRF : eastern
 VRF : western
 VRF : northern
 VRF : southern
Virtual Router : vr3
 VRF : eastern
 VRF : western
 VRF : northern
 VRF : southern

```

#### ■ Example 2

```

host1#show virtual-router detail
Virtual Router : default
 Ip: Present
 Ipv6: Not Present
 Mgtm: Not Present
 Mgtmv6: Not Present
 Bgp: Not Present
 Isis: Present
 Ospf: Not Present
 Pim: Not Present
 Rip: Not Present
 Igmp: Not Present
 Mld: Not Present
 Dvmrp: Not Present
Virtual Router : vr1
 Ip: Present
 Ipv6: Not Present
 Mgtm: Present
 Mgtmv6: Not Present
 Bgp: Not Present
 Isis: Present
 Ospf: Present
 Pim: Present
 Rip: Not Present
 Igmp: Not Present
 Mld: Not Present
 Dvmrp: Not Present

```

#### ■ Example 3

```

host1#show virtual-router summary detail
Virtual Router default VRF Count: 0
Virtual Router vr1 VRF Count: 4
Virtual Router vr2 VRF Count: 4
Virtual Router vr3 VRF Count: 4

Total VR Count: 4
 VRs with VRFs Count: 3

```

```
VRs without VRFs Count: 1
Total VRF Count: 12
Total Count : 16
```

- See show virtual-router.



## **Part 2**

# **Reference Material**

- Abbreviations and Acronyms on page 623
- References on page 641



## Appendix A

# Abbreviations and Acronyms

| Abbreviation<br>or Acronym | Term                                                              |
|----------------------------|-------------------------------------------------------------------|
| <b>A</b>                   |                                                                   |
| AAA                        | authentication, authorization, and accounting                     |
| AAAA                       | authentication, authorization, accounting, and address assignment |
| AAL                        | ATM Adaptation Layer                                              |
| ABR                        | area border router                                                |
| AC                         | alternating current; access concentrator                          |
| ACCM                       | Async Control Character Map                                       |
| ADSL                       | asymmetric digital subscriber line                                |
| AESA                       | ATM end system address                                            |
| AF                         | assured forwarding                                                |
| AFI                        | authority and format identifier                                   |
| AH                         | authentication header                                             |
| AIS                        | alarm indication signal                                           |
| AIS-L                      | alarm indication signal – line                                    |
| AIS-P                      | alarm indication signal – path                                    |
| ALG                        | application-level gateway                                         |
| ANSI                       | American National Standards Institute                             |
| API                        | application programming interface                                 |
| APS                        | Automatic Protection Switching                                    |
| ARP                        | Address Resolution Protocol                                       |
| AS                         | autonomous system; Australia (re standards compliance)            |

| Abbreviation<br>or Acronym | Term                                                              |
|----------------------------|-------------------------------------------------------------------|
| AS boundary router         | autonomous system boundary router                                 |
| ASCII                      | American Standard Code for Information Interchange                |
| ASIC                       | application-specific integrated circuit                           |
| AS number                  | autonomous system number                                          |
| ATM                        | Asynchronous Transfer Mode                                        |
| AVP                        | attribute-value pair                                              |
| <b>B</b>                   |                                                                   |
| backup DR                  | backup designated router                                          |
| BECN                       | backward explicit congestion notification                         |
| BER                        | bit error rate                                                    |
| BERT                       | bit error rate test                                               |
| BFD                        | Bidirectional Forwarding Detection (protocol)                     |
| BGP                        | Border Gateway Protocol                                           |
| BMA                        | broadcast multiaccess                                             |
| BOOTP                      | bootstrap protocol                                                |
| B-RAS                      | Broadband Remote Access Server                                    |
| BSD                        | Berkeley Software Distribution                                    |
| <b>C</b>                   |                                                                   |
| CA                         | certificate authority                                             |
| CAC                        | call admission control (MPLS); connection admission control (ATM) |
| CAM                        | content-addressable memory                                        |
| CAP                        | carrierless amplitude phase                                       |
| CAR                        | committed access rate                                             |
| CARS                       | committed access rate service                                     |
| CBC                        | cipher block chaining                                             |
| CBR                        | constant bit rate                                                 |
| CC                         | continuity check                                                  |
| CCITT                      | International Telegraph and Telephone Consultative Committee      |



| Abbreviation<br>or Acronym | Term                                                  |
|----------------------------|-------------------------------------------------------|
| CCP                        | Compression Control Protocol                          |
| CDV                        | cell delay variation                                  |
| CDVT                       | cell delay variation tolerance                        |
| CE                         | customer edge device                                  |
| CHAP                       | Challenge Handshake Authentication Protocol           |
| CIDR                       | classless interdomain routing                         |
| CISPR                      | International Special Committee on Radio Interference |
| CLACL                      | classifier control list                               |
| CLEC                       | competitive local exchange carrier                    |
| CLI                        | command-line interface                                |
| CLNP                       | Connectionless Network Protocol                       |
| CLNS                       | Connectionless Network Service                        |
| CLP                        | cell loss priority                                    |
| CMDA                       | code division multiple access                         |
| CMTS                       | cable modem termination system                        |
| CoA                        | change of authorization                               |
| cOC                        | channelized optical carrier                           |
| COPS                       | Common Open Policy Service (protocol)                 |
| CORBA                      | Common Object Request Broker Architecture             |
| CoS                        | class of service                                      |
| CPE                        | customer premises equipment                           |
| CPU                        | central processing unit                               |
| CRC                        | cyclic redundancy check                               |
| CR-LDP                     | Constraint-Based Routed Label Distribution Protocol   |
| CR-LSP                     | constraint-based routed label-switched path           |
| CSNP                       | complete sequence number PDU (protocol data unit)     |
| CSU                        | channel service unit                                  |
| CT1, CT3                   | channelized T1, T3                                    |

| Abbreviation or Acronym | Term                                                                                                            |
|-------------------------|-----------------------------------------------------------------------------------------------------------------|
| CTI                     | computer telephony integration                                                                                  |
| CTS                     | clear to send                                                                                                   |
| CTT                     | connection traffic table                                                                                        |
| CUL                     | agreement between Underwriter Laboratories and Canadian Standards Association for joint product safety approval |
| <b>D</b>                |                                                                                                                 |
| DC                      | direct current                                                                                                  |
| DCC                     | Data Country Code                                                                                               |
| DCD                     | data carrier detect                                                                                             |
| DCE                     | data communication equipment                                                                                    |
| DCM                     | dynamic configuration manager                                                                                   |
| DE                      | discard eligibility                                                                                             |
| DES; 3DES               | Data Encryption Standard; triple DES                                                                            |
| DF                      | don't fragment (bit)                                                                                            |
| DHCP                    | Dynamic Host Configuration Protocol                                                                             |
| DIS                     | designated intermediate system                                                                                  |
| DLCI                    | data-link connection identifier                                                                                 |
| DLCMI                   | data-link connection management interface                                                                       |
| DMZ                     | demilitarized zone                                                                                              |
| DNIS                    | dialed number identification service                                                                            |
| DNS                     | Domain Name System                                                                                              |
| DNS-ALG                 | Domain Name System – Application Level Gateway                                                                  |
| DOCSIS                  | Data over Cable System Interface Specifications                                                                 |
| DoS                     | denial of service                                                                                               |
| DPD                     | dead peer detection                                                                                             |
| DR                      | designated router                                                                                               |
| DS                      | digital signal; DiffServ                                                                                        |
| DS-BGP                  | dual-stack Border Gateway Protocol                                                                              |

| Abbreviation<br>or Acronym | Term                                                      |
|----------------------------|-----------------------------------------------------------|
| DSI                        | dynamic subscriber interface                              |
| DSL                        | digital subscriber line                                   |
| DSLAM                      | digital subscriber line access multiplexer                |
| DSP                        | domain-specific part                                      |
| DSR                        | data set ready                                            |
| DSS                        | Digital Signature Standard                                |
| DST                        | Daylight Saving Time                                      |
| DSU                        | data service unit                                         |
| DTE                        | data terminal equipment                                   |
| DTR                        | data terminal ready                                       |
| DU                         | downstream unsolicited                                    |
| DVMRP                      | Distance Vector Multicast Routing Protocol                |
| DXI                        | data exchange interface (abbreviation pronounced “dixie”) |
| <b>E</b>                   |                                                           |
| EAP                        | Extensible Authentication Protocol                        |
| EBGP                       | external Border Gateway Protocol                          |
| ECC                        | error checking and correction; error-checking code        |
| ECMP                       | equal-cost multipath                                      |
| ECP                        | Encryption Control Protocol                               |
| EEPROM                     | electrically erasable programmable read-only memory       |
| EF                         | expedited forwarding                                      |
| EFA                        | egress forwarding ASIC                                    |
| EGP                        | exterior gateway protocol                                 |
| E-LSP                      | EXP-inferred-PSC LSP                                      |
| EN                         | European Norm                                             |
| EPD                        | early packet discard                                      |
| ES                         | end system                                                |
| ESD                        | electrostatic discharge                                   |

| Abbreviation<br>or Acronym | Term                                                            |
|----------------------------|-----------------------------------------------------------------|
| ESF                        | extended superframe                                             |
| ESI                        | end system identifier                                           |
| ESP                        | Encapsulating Security Payload                                  |
| EXP                        | experimental (refers to bits in MPLS shim header)               |
| <b>F</b>                   |                                                                 |
| FAT                        | file allocation table                                           |
| FCC                        | Federal Communications Commission                               |
| FCS                        | frame check sequence                                            |
| FDL                        | facilities data link                                            |
| FE                         | Fast Ethernet                                                   |
| FE-2                       | dual-port Fast Ethernet                                         |
| FEC                        | forwarding equivalence class (abbreviation pronounced “ feck” ) |
| FECN                       | forward explicit congestion notification                        |
| FERF                       | far-end receive failure                                         |
| FFA                        | frame forwarding ASIC                                           |
| FIB                        | forwarding information base                                     |
| FIFO                       | first-in, first-out                                             |
| FIN                        | finish (bit)                                                    |
| FPGA                       | field programmable gate array                                   |
| FQDN                       | fully qualified domain name                                     |
| FRU                        | field-replaceable unit                                          |
| FSM                        | finite state machine                                            |
| FTE                        | forwarding table entry                                          |
| FTP                        | File Transfer Protocol                                          |
| <b>G</b>                   |                                                                 |
| Gbps                       | gigabits per second                                             |
| GE                         | Gigabit Ethernet                                                |
| giaddr                     | gateway IP address                                              |

| Abbreviation<br>or Acronym | Term                                                          |
|----------------------------|---------------------------------------------------------------|
| GRE                        | Generic Routing Encapsulation                                 |
| GRxx                       | (refers to Bellcore standards)                                |
| GUI                        | graphical user interface                                      |
| <b>H</b>                   |                                                               |
| HAR                        | hierarchical assured rate                                     |
| HDLC                       | High-Level Data Link Control; High-Speed Data Link Control    |
| HMAC                       | Hashed Message Authentication Code                            |
| HO-DSP                     | high-order domain-specific part                               |
| HRR                        | hierarchical round-robin                                      |
| HSSI                       | high-speed serial interface (abbreviation pronounced “hissy”) |
| <b>I</b>                   |                                                               |
| I/O                        | input/output                                                  |
| IANA                       | Internet Assigned Numbers Authority                           |
| IAPP                       | Inter Access Point Protocol                                   |
| IBGP                       | internal Border Gateway Protocol                              |
| IC CS                      | Industry Canada Communications Section                        |
| ICD                        | International Code Designator                                 |
| ICMP                       | Internet Control Message Protocol                             |
| ICRQ                       | incoming-call request                                         |
| ID                         | identification; identifying; identifier                       |
| I-DAS                      | integrated DHCP access server                                 |
| IDI                        | initial domain identifier                                     |
| IDP                        | initial domain part                                           |
| IDSL                       | ISDN digital subscriber line                                  |
| IEC                        | International Electrotechnical Commission                     |
| IEEE                       | Institute of Electrical and Electronics Engineers             |
| IETF                       | Internet Engineering Task Force                               |
| IGMP                       | Internet Group Management Protocol                            |

| Abbreviation<br>or Acronym | Term                                                                      |
|----------------------------|---------------------------------------------------------------------------|
| IGP                        | interior gateway protocol                                                 |
| IIF                        | incoming interface                                                        |
| IKE                        | Internet Key Exchange                                                     |
| ILEC                       | incumbent local exchange carrier                                          |
| ILMI                       | Integrated Local Management Interface                                     |
| InARP                      | Inverse Address Resolution Protocol                                       |
| IOA                        | input/output adapter                                                      |
| IP                         | Internet Protocol                                                         |
| IPCP                       | Internet Protocol Control Protocol                                        |
| IPoA                       | Internet Protocol over Asynchronous Transfer Mode                         |
| IPSec                      | Internet Protocol Security                                                |
| IRDP                       | ICMP Router Discovery Protocol                                            |
| ISAKMP                     | Internet Security Association and Key Management Protocol                 |
| ISDN                       | Integrated Services Digital Network                                       |
| IS-IS                      | Intermediate System-to-Intermediate System                                |
| ISM                        | IPSec Service module                                                      |
| ISO                        | International Organization for Standardization                            |
| ISP                        | Internet service provider                                                 |
| IS Voice                   | Intelligent Service Voice application                                     |
| ITU-T                      | International Telecommunication Union – Telecommunication Standardization |
| <b>J</b>                   |                                                                           |
| JATE                       | Japan Approvals Institute for Telecommunications Terminal Equipment       |
| JDBC                       | Java Database Connectivity                                                |
| <b>K</b>                   |                                                                           |
| KB                         | kilobyte(s)                                                               |
| Kbps                       | kilobits per second                                                       |
| <b>L</b>                   |                                                                           |
| L2TP                       | Layer 2 Tunneling Protocol                                                |

| Abbreviation<br>or Acronym | Term                                                     |
|----------------------------|----------------------------------------------------------|
| LAC                        | L2TP access concentrator                                 |
| LAG                        | link aggregation group                                   |
| LAN                        | local area network                                       |
| LCP                        | Link Control Protocol                                    |
| LDAP                       | Lightweight Directory Access Protocol                    |
| LDP                        | Label Distribution Protocol                              |
| LED                        | light-emitting diode                                     |
| LER                        | label edge router                                        |
| LIB                        | label information base                                   |
| LIP                        | Link Integrity Protocol                                  |
| LLC                        | logical link control                                     |
| L-LSP                      | label-only-inferred-PSC LSP                              |
| LMI                        | local management interface; link management interface    |
| LNS                        | L2TP network server                                      |
| LOF                        | loss of frame                                            |
| LOP                        | loss of pointer                                          |
| LOS                        | loss of signal                                           |
| LSA                        | link-state advertisement                                 |
| LSDB                       | link-state database                                      |
| LSP                        | label-switched path; link-state PDU; link-state protocol |
| LSR                        | label-switching router                                   |
| <b>M</b>                   |                                                          |
| MAC                        | media access control; Message Authentication Code        |
| MAU                        | medium attachment unit                                   |
| MB                         | megabyte(s)                                              |
| MBGP                       | multicast Border Gateway Protocol                        |
| MBone                      | multicast backbone                                       |
| Mbps                       | megabits per second                                      |

| Abbreviation<br>or Acronym | Term                                                                                                              |
|----------------------------|-------------------------------------------------------------------------------------------------------------------|
| MBS                        | maximum burst size                                                                                                |
| MD5                        | Message Digest 5                                                                                                  |
| MDL                        | maintenance data link                                                                                             |
| MDx                        | Message Digest x (hash algorithm)                                                                                 |
| MED                        | multiple exit discriminator                                                                                       |
| MGTM                       | multicast group table manager                                                                                     |
| MIB                        | Management Information Base                                                                                       |
| MLFR                       | Multilink Frame Relay                                                                                             |
| MLPPP                      | Multilink Point-to-Point Protocol                                                                                 |
| motd                       | message of the day                                                                                                |
| MOTM                       | message of the minute                                                                                             |
| MP-BGP                     | Border Gateway Protocol multiprotocol extensions (sometimes referred to as multiprotocol Border Gateway Protocol) |
| MPLS                       | Multiprotocol Label Switching                                                                                     |
| mrinfo                     | multicast router information                                                                                      |
| MRRU                       | multilink maximum received reconstructed unit                                                                     |
| MRU                        | maximum receive unit                                                                                              |
| MSDP                       | Multicast Source Discovery Protocol                                                                               |
| MSO                        | multiple service operator                                                                                         |
| MSP                        | Multiplex Section Protection                                                                                      |
| MSS                        | maximum segment size                                                                                              |
| MTU                        | maximum transmission unit; multitenant unit                                                                       |
| <b>N</b>                   |                                                                                                                   |
| NAK                        | negative acknowledgment                                                                                           |
| NAPT                       | Network Address Port Translation                                                                                  |
| NAS                        | network access server                                                                                             |
| NAT                        | Network Address Translation                                                                                       |
| NBMA                       | nonbroadcast multiaccess                                                                                          |



| Abbreviation<br>or Acronym | Term                                                                   |
|----------------------------|------------------------------------------------------------------------|
| NCP                        | Network Control Protocol                                               |
| ND                         | Neighbor Discovery                                                     |
| NEBS                       | Network Equipment Building System                                      |
| NET                        | network entity title                                                   |
| NLRI                       | network layer reachability information                                 |
| NMC                        | Network Management Center                                              |
| NMS                        | network management system                                              |
| NNI                        | network-to-network interface                                           |
| NRZ                        | nonreturn to zero                                                      |
| NRZI                       | nonreturn to zero inverted                                             |
| NSAP                       | network service access point                                           |
| NSF                        | nonstop forwarding                                                     |
| NSSA                       | not-so-stubby area (refers to OSPF routing)                            |
| NTP                        | Network Time Protocol                                                  |
| NVRAM                      | nonvolatile random-access memory                                       |
| NVS                        | nonvolatile storage                                                    |
| <b>O</b>                   |                                                                        |
| OAM                        | operations, administration, and management                             |
| OC                         | optical carrier                                                        |
| ODBC                       | Open Database Connectivity                                             |
| OID                        | object identifier                                                      |
| OIF                        | outgoing interface                                                     |
| ORF                        | outbound route filter; outbound route filtering                        |
| OSI                        | Open Systems Interconnection                                           |
| OSINLCP                    | OSI Internet Link Control Protocol; OSI Network Layer Control Protocol |
| OSPF                       | Open Shortest Path First                                               |
| OSS                        | operations support system                                              |
| <b>P</b>                   |                                                                        |

| Abbreviation<br>or Acronym | Term                                                     |
|----------------------------|----------------------------------------------------------|
| P                          | provider core router                                     |
| PADI                       | PPPoE Active Discovery Initiation                        |
| PADM                       | PPPoE Active Discovery Message                           |
| PADN                       | PPPoE Active Discovery Network                           |
| PADO                       | PPPoE Active Discovery Offer                             |
| PADR                       | PPPoE Active Discovery Request                           |
| PADS                       | PPPoE Active Discovery Session                           |
| PADT                       | PPPoE Active Discovery Termination                       |
| PAP                        | Password Authentication Protocol                         |
| PBX                        | private branch exchange                                  |
| PCMCIA                     | Personal Computer Memory Card International Association  |
| PCR                        | peak cell rate                                           |
| PDU                        | protocol data unit                                       |
| PE                         | provider edge router                                     |
| PFC                        | Protocol Field Compression                               |
| PFS                        | perfect forward secrecy                                  |
| PHB                        | per-hop behavior                                         |
| PHP                        | penultimate hop pop                                      |
| PIB                        | Policy Information Base                                  |
| PIM                        | Protocol Independent Multicast; power input module       |
| PIM DM                     | Protocol Independent Multicast dense mode                |
| PIM S-DM                   | Protocol Independent Multicast sparse-dense mode         |
| PIM SM                     | Protocol Independent Multicast sparse mode               |
| PIM SSM                    | Protocol Independent Multicast source-specific multicast |
| PKI                        | public key infrastructure                                |
| PLCP                       | physical layer convergence procedure                     |
| PM                         | policy manager                                           |
| PNNI                       | private network-to-network interface                     |

| Abbreviation<br>or Acronym | Term                                             |
|----------------------------|--------------------------------------------------|
| POP                        | point of presence                                |
| POS                        | packet over SONET                                |
| POST                       | power-on self-test                               |
| PPP                        | Point-to-Point Protocol                          |
| PPPoE                      | Point-to-Point Protocol over Ethernet            |
| pps                        | packets per second                               |
| PROM                       | programmable read-only memory                    |
| PSC                        | per-hop scheduling class                         |
| PSNP                       | partial sequence number PDU (protocol data unit) |
| PVC                        | permanent virtual circuit (or connection)        |
| <b>Q</b>                   |                                                  |
| QoS                        | quality of service                               |
| <b>R</b>                   |                                                  |
| RADIUS                     | Remote Authentication Dial-In User Service       |
| RD                         | route distinguisher                              |
| RDBS                       | relational database system                       |
| RDI                        | remote defect indication                         |
| RED                        | random early detection                           |
| REI                        | remote error indication                          |
| RESV                       | reservation                                      |
| RFC                        | Request for Comments                             |
| RIB                        | routing information base                         |
| RIP                        | Routing Information Protocol                     |
| RISC                       | reduced instruction set computing                |
| RMI                        | Remote Method Invocation (Java)                  |
| RP                         | rendezvous point (router)                        |
| RPF                        | reverse-path forwarding                          |
| RSA                        | Rivest-Shamir-Adleman (encryption algorithm)     |

| Abbreviation<br>or Acronym | Term                                                                               |
|----------------------------|------------------------------------------------------------------------------------|
| RSVP                       | Resource Reservation Protocol                                                      |
| RSVP-TE                    | Resource Reservation Protocol with traffic engineering extensions                  |
| RTM                        | resource threshold monitor                                                         |
| RTR                        | Response Time Reporter                                                             |
| RTSP                       | Real-Time Streaming Protocol                                                       |
| RWS                        | receive window size                                                                |
| RX                         | receive                                                                            |
| <b>S</b>                   |                                                                                    |
| SA                         | security association                                                               |
| SAFI                       | subsequent address family identifier                                               |
| SAR                        | segmentation and reassembly                                                        |
| SC                         | system controller                                                                  |
| SCCRQ                      | Start-Control-Connection-Request                                                   |
| SCEP                       | Simple Certificate Enrollment Protocol                                             |
| SCR                        | sustained cell rate                                                                |
| SCSI                       | small computer system interface (abbreviation pronounced “scuzzy”)                 |
| SDH                        | Synchronous Digital Hierarchy                                                      |
| SDRAM                      | synchronous dynamic random access memory                                           |
| SDSL                       | symmetric digital subscriber line                                                  |
| SDU                        | service data unit                                                                  |
| SDX                        | Service Deployment System (formerly SSC)                                           |
| SEF                        | severely errored framing                                                           |
| SES                        | severely errored second                                                            |
| SFP                        | small form-factor pluggable transceiver                                            |
| (S,G)                      | source (S) of the multicast packet and the destination multicast group address (G) |
| SHA                        | Secure Hash Algorithm                                                              |
| SIP                        | SMDS Interface Protocol                                                            |

| Abbreviation<br>or Acronym | Term                                                      |
|----------------------------|-----------------------------------------------------------|
| SLA                        | service level agreement                                   |
| SLARP                      | Serial Line Address Resolution Protocol                   |
| SM                         | Service line module                                       |
| SMF                        | single-mode fiber                                         |
| SMM                        | switch management module                                  |
| SNAP                       | Subnetwork Access Protocol; subnetwork attachment point   |
| SNI                        | SMDS network interface                                    |
| SNMP                       | Simple Network Management Protocol                        |
| SNPA                       | subnet point of attachment                                |
| SNTP                       | Simple Network Time Protocol                              |
| SODIMM                     | small outline dual inline memory module                   |
| SONET                      | Synchronous Optical Network                               |
| SPD                        | security policy database                                  |
| SPF                        | shortest path first                                       |
| SPI                        | security parameter index                                  |
| SPQ                        | strict-priority queues                                    |
| SPVC                       | soft permanent virtual circuit                            |
| SQL                        | Structured Query Language                                 |
| SRP                        | switch route processor                                    |
| SRT                        | source-rooted tree                                        |
| SSC                        | Service Selection Center (no longer used; <i>see</i> SDX) |
| SSH                        | Secure Shell                                              |
| SSN                        | short sequence number                                     |
| STM                        | Synchronous Transport module                              |
| SVC                        | switched virtual circuit                                  |
| S-VLAN                     | stacked virtual local area network                        |
| SYN                        | synchronize (bit)                                         |
| <b>T</b>                   |                                                           |

| Abbreviation<br>or Acronym | Term                                                                         |
|----------------------------|------------------------------------------------------------------------------|
| TAC                        | Technical Assistance Center                                                  |
| TACACS                     | Terminal Access Controller Access Control System                             |
| TC                         | transmission convergence                                                     |
| TCP                        | Transmission Control Protocol                                                |
| TE                         | traffic engineering                                                          |
| TFTP                       | Trivial File Transfer Protocol                                               |
| TIP                        | terminal interface processor                                                 |
| TLV                        | type-length-value                                                            |
| ToS                        | type of service                                                              |
| TPID                       | Tag Protocol Identifier                                                      |
| TSM                        | Tunnel Service line module                                                   |
| TTL                        | time-to-live                                                                 |
| TU                         | tributary unit                                                               |
| TUG                        | tributary unit group                                                         |
| TX                         | transmit                                                                     |
| <b>U</b>                   |                                                                              |
| U                          | unit of measurement for rack-mounted equipment (a U is 1.75 in., or 4.44 cm) |
| UBR                        | unspecified bit rate                                                         |
| UDP                        | User Datagram Protocol                                                       |
| UI                         | user interface                                                               |
| UL                         | Underwriter Laboratories                                                     |
| UMTS                       | universal mobile telecommunications system                                   |
| UNI                        | user-network interface (ATM usage); user-to-network interface                |
| UPC                        | user parameter control                                                       |
| URL                        | Uniform Resource Locator                                                     |
| USM                        | user-based security model                                                    |
| UTC                        | Coordinated Universal Time                                                   |
| <b>V</b>                   |                                                                              |

| Abbreviation<br>or Acronym | Term                                       |
|----------------------------|--------------------------------------------|
| VAC                        | volts alternating current                  |
| VBR                        | variable bit rate                          |
| VBR-NRT                    | variable bit rate, non-real time           |
| VBR-RT                     | variable bit rate, real time               |
| VC                         | virtual circuit (or connection)            |
| VCC                        | virtual channel connection                 |
| VCCI                       | Voluntary Control Council for Interference |
| VCD                        | virtual circuit descriptor                 |
| VCI                        | virtual channel identifier                 |
| VDC                        | volts direct current                       |
| VDSL                       | very-high-bit-rate digital subscriber line |
| VLAN                       | virtual local area network                 |
| VoIP                       | voice over Internet Protocol               |
| VOQL                       | virtual output queue length                |
| VP                         | virtual path                               |
| VPC                        | virtual path connection                    |
| VPI                        | virtual path identifier                    |
| VPN                        | virtual private network                    |
| VR                         | virtual router                             |
| VRF                        | VPN routing and forwarding instance        |
| VRID                       | virtual router identifier                  |
| VRRP                       | Virtual Router Redundancy Protocol         |
| VSA                        | vendor-specific attribute (RADIUS)         |
| VT                         | virtual tributary                          |
| VTs                        | VPN Tunnel Server                          |
| vtty                       | virtual terminal                           |
| <b>W</b>                   |                                            |
| WAN                        | wide area network                          |

| Abbreviation<br>or Acronym | Term                                                      |
|----------------------------|-----------------------------------------------------------|
| WAP                        | wireless access point                                     |
| WEP                        | Wired Equivalent Privacy                                  |
| WFQ                        | weighted fair queuing                                     |
| WINS                       | Windows Internet Name Service (Microsoft)                 |
| WLAN                       | wireless local area network                               |
| WLL                        | wireless local loop                                       |
| WRED                       | weighted random early detection                           |
| WRR                        | weighted round-robin                                      |
| <b>X</b>                   |                                                           |
| xDSL                       | combined term used to refer to ADSL, HDSL, SDSL, and VDSL |
| XFP                        | 10-gigabit small form-factor pluggable transceiver        |



## Appendix B

# References

This document lists RFCs, draft RFCs, other software standards, hardware standards, and other references that provide information about the protocols and features supported by the system.

- RFCs on page 641
- Draft RFCs on page 654
- Other Software Standards on page 657
- Hardware Standards on page 660

### RFCs

**Table 61: E-series RFCs**

| Reference                                                                                                                                                                   | Protocol or Feature |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| RFC 4893—BGP Support for Four-octet AS Number Space (May 2007)                                                                                                              | BGP                 |
| RFC 4875—Extensions to Resource Reservation Protocol - Traffic Engineering (RSVP-TE) for Point-to-Multipoint TE Label Switched Paths (LSPs) (May 2007)                      | MPLS                |
| RFC 4762—Virtual Private LAN Service (VPLS) Using Label Distribution Protocol (LDP) Signaling (January 2007)                                                                | VPLS                |
| RFC 4684—Constrained Route Distribution for Border Gateway Protocol/MultiProtocol Label Switching (BGP/MPLS) Internet Protocol (IP) Virtual Private Networks (VPNs) ( 2006) | BGP/MPLS VPNs       |
| RFC 4679—DSL Forum Vendor-Specific RADIUS Attributes (September 2006)                                                                                                       | RADIUS              |
| RFC 4661—Signaling Requirements for Point-to-Multipoint Traffic-Engineered MPLS Label Switched Paths (LSPs) (April 2006)                                                    | MPLS                |
| RFC 4447—Pseudowire Setup and Maintenance Using the Label Distribution Protocol (LDP) (April 2006)                                                                          | VPLS                |
| RFC 4379—Detecting Multi-Protocol Label Switched (MPLS) Data Plane Failures (February 2006)                                                                                 | MPLS; BGP/MPLS VPNs |
| RFC 4364—BGP/MPLS IP Virtual Private Networks (VPNs) (February 2006)                                                                                                        | BGP/MPLS VPNs       |

**Table 61: E-series RFCs** *(continued)*

| Reference                                                                                                                                              | Protocol or Feature                   |
|--------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|
| RFC 4271—A Border Gateway Protocol 4 (BGP-4) (January 1996)                                                                                            | BGP                                   |
| RFC 4243—Vendor-Specific Information Suboption for the Dynamic Host Configuration Protocol (DHCP) Relay Agent Option (December 2005)                   | DHCP 8.0.0b1 RLI-2978 (Bruce)         |
| RFC 4090—Fast Reroute Extensions to RSVP-TE for LSP Tunnels (May 2005)                                                                                 | MPLS                                  |
| RFC 3847—Restart Signaling for Intermediate System to Intermediate System (IS-IS) (July 2004)                                                          | IS-IS                                 |
| RFC 3784—Intermediate System to Intermediate System (IS-IS) Extensions for Traffic Engineering (TE) (June 2004)                                        | IS-IS                                 |
| RFC 3748—Extensible Authentication Protocol (EAP) (June 2004)                                                                                          | PPP7.3.0b1 RLI-606                    |
| RFC 3715—IPsec-Network Address Translation (NAT) Compatibility Requirements (March 2004)                                                               | L2TP over IPsec                       |
| RFC 3710—Multicast Listener Discovery (MLD) for IPv6 (October 1999)                                                                                    | IPv6 multicasting                     |
| RFC 3706—A Traffic-Based Method of Detecting Dead Internet Key Exchange (IKE) Peers (February 2004)                                                    | IPsec 5.3.0b1 -- RLI-322              |
| RFC 3646—DNS Configuration options for Dynamic Host Configuration Protocol for IPv6 (DHCPv6) (December 2003)                                           | DHCP 6.1.0b1 replaces draft -- Bruce  |
| RFC 3633—IPv6 Prefix Options for Dynamic Host Configuration Protocol (DHCP) Version 6 (December 2003)                                                  | DHCP 7.1.xFRS replaces draft -- Bruce |
| RFC 3630—Traffic Engineering (TE) Extensions to OSPF Version 2 (September 2003)                                                                        | OSPF                                  |
| RFC 3623—Graceful OSPF Restart (November 2003)                                                                                                         | OSPF                                  |
| RFC 3579—RADIUS EAP (September 2003)                                                                                                                   | PPP7.3.0b1 RLI-606                    |
| RFC 3576—Dynamic Authorization Extensions to Remote Authentication Dial In User Service (RADIUS) (July 2003)                                           | RADIUS                                |
| RFC 3569—An Overview of Source-Specific Multicast (SSM) (July 2003)                                                                                    | IP multicasting                       |
| RFC 3564—Requirements for support of Differentiated Services-aware MPLS Traffic Engineering (July 2003)                                                | MPLS                                  |
| RFC 3539—Authentication, Authorization and Accounting (AAA) Transport Profile (June 2003)                                                              | RADIUS 6.0.0b1                        |
| RFC 3498—Definitions of Managed Objects for Synchronous Optical Network (SONET) Linear Automatic Protection Switching (APS) Architectures (March 2003) | SONET APS redundancy                  |
| RFC 3479—Fault Tolerance for the Label Distribution Protocol (LDP) (February 2003)                                                                     | MPLS                                  |

**Table 61: E-series RFCs** *(continued)*

| Reference                                                                                                                                                   | Protocol or Feature  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| RFC 3478—Graceful Restart Mechanism for Label Distribution Protocol (February 2003)                                                                         | MPLS                 |
| RFC 3473—Generalized Multi-Protocol Label Switching (GMPLS) Signaling Resource ReserVation Protocol-Traffic Engineering (RSVP-TE) Extensions (January 2003) | MPLS                 |
| RFC 3471—Generalized Multi-Protocol Label Switching (GMPLS) Signaling Functional Description (January 2003)                                                 | MPLS                 |
| RFC 3447—Public-Key Cryptography Standards (PKCS) #1: RSA Cryptography Specifications Version 2.1 (February 2003)                                           | Digital certificates |
| RFC 3443—Time To Live (TTL) Processing in Multi-Protocol Label Switching (MPLS) Networks (January 2003)                                                     | MPLS                 |
| RFC 3419—Textual Conventions for Transport Addresses (December 2002)                                                                                        | IP                   |
| RFC 3418—Management Information Base (MIB) for the Simple Network Management Protocol (SNMP) (December 2002)                                                | SNMP                 |
| RFC 3417—Transport Mappings for the Simple Network Management Protocol (SNMP) (December 2002)                                                               | SNMP                 |
| RFC 3416—Version 2 of the Protocol Operations for the Simple Network Management Protocol (SNMP) (December 2002)                                             | SNMP                 |
| RFC 3415—View-based Access Control Model (VACM) for the Simple Network Management Protocol (SNMP) (December 2002)                                           | SNMP                 |
| RFC 3414—User-based Security Model (USM) for version 3 of the Simple Network Management Protocol (SNMPv3) (December 2002)                                   | SNMP                 |
| RFC 3413—Simple Network Management Protocol (SNMP) Applications (December 2002)                                                                             | SNMP                 |
| RFC 3412—Message Processing and Dispatching for the Simple Network Management Protocol (SNMP) (December 2002)                                               | SNMP                 |
| RFC 3411—An Architecture for Describing Simple Network Management Protocol (SNMP) Management Frameworks (December 2002)                                     | SNMP                 |
| RFC 3410—Introduction and Applicability Statements for Internet Standard Management Framework (December 2002)                                               | SNMP                 |
| RFC 3392—Capabilities Advertisement with BGP-4 (November 2002)                                                                                              | BGP; BGP/MPLS VPNs   |
| RFC 3376—Internet Group Management Protocol (October 2002)                                                                                                  | IP multicasting      |
| RFC 3373—Three-Way Handshake for Intermediate System to Intermediate System (IS-IS) Point-to-Point Adjacencies (September 2002)                             | IS-IS                |

**Table 61: E-series RFCs** *(continued)*

| Reference                                                                                                                                                                   | Protocol or Feature   |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| RFC 3344—IP Mobility Support for IPv4 (August 2002)                                                                                                                         | Mobile IP             |
| RFC 3318—Framework Policy Information Base (March 2003)                                                                                                                     | COPS                  |
| RFC 3315—Dynamic Host Configuration Protocol for IPv6 (DHCPv6) (July 2003)                                                                                                  | DHCP                  |
| RFC 3293—General Switch Management Protocol (GSMP) Packet Encapsulations for Asynchronous Transfer Mode (ATM), Ethernet and Transmission Control Protocol (TCP) (June 2002) | ANCP                  |
| RFC 3292—General Switch Management Protocol (GSMP) V3 (June 2002)                                                                                                           | IP multicasting; ANCP |
| RFC 3291—Textual Conventions for Internet Network Addresses (May 2002)                                                                                                      | IP                    |
| RFC 3280—Internet X.509 Public Key Infrastructure Certificate and Certificate Revocation List (CRL) Profile (April 2002)                                                    | Digital certificates  |
| RFC 3277—Intermediate System to Intermediate System (IS-IS) Transient Blackhole Avoidance (April 2002)                                                                      | IS-IS                 |
| RFC 3270—Multi-Protocol Label Switching (MPLS) Support of Differentiated Services (May 2002)                                                                                | MPLS                  |
| RFC 3260—New Terminology and Clarifications for Diffserv (April 2002)                                                                                                       | QoS                   |
| RFC 3246—An Expedited Forwarding PHB (Per-Hop Behavior) (March 2002)                                                                                                        | MPLS; QoS             |
| RFC 3210—Applicability Statement for Extensions to RSVP for LSP-Tunnels (December 2001)                                                                                     | BGP/MPLS VPNs         |
| RFC 3209—RSVP-TE: Extensions to RSVP for LSP Tunnels (December 2001)                                                                                                        | BGP/MPLS VPNs         |
| RFC 3198—Terminology for Policy-Based Management (November 2001)                                                                                                            | Policy management     |
| RFC 3193—Securing L2TP using IPSec (November 2001)                                                                                                                          | L2TP over IPSec       |
| RFC 3159—Structure of Policy Provisioning Information (SPPI) (August 2001)                                                                                                  | COPS                  |
| RFC 3145—L2TP Disconnect Cause Information (July 2001)                                                                                                                      | L2TP                  |
| RFC 3140—Per Hop Behavior Identification Codes (June 2001)                                                                                                                  | MPLS                  |
| RFC 3107—Carrying Label Information in BGP-4 (May 2001)                                                                                                                     | BGP/MPLS VPNs         |
| RFC 3097—RSVP Cryptographic Authentication -- Updated Message Type Value (April 2001)                                                                                       | MPLS                  |

**Table 61: E-series RFCs** *(continued)*

| Reference                                                                                     | Protocol or Feature        |
|-----------------------------------------------------------------------------------------------|----------------------------|
| RFC 3084—COPS Usage for Policy Provisioning (COPS-PR) (March 2001)                            | COPS                       |
| RFC 3065—Autonomous System Confederations for BGP (February 2001)                             | MPLS                       |
| RFC 3046—DHCP Relay Agent Information Option (January 2001)                                   | Dynamic interfaces, RADIUS |
| RFC 3037—LDP Applicability (January 2001)                                                     | MPLS                       |
| RFC 3036—LDP Specification (January 2001)                                                     | MPLS, VPLS                 |
| RFC 3035—MPLS using LDP and ATM VC Switching (January 2001)                                   | MPLS                       |
| RFC 3032—MPLS Label Stack Encoding (January 2001)                                             | MPLS                       |
| RFC 3031—Multiprotocol Label Switching Architecture (January 2001)                            | MPLS                       |
| RFC 3027—Protocol Complications with the IP Network Address Translator (January 2001)         | NAT                        |
| RFC 3024—Reverse Tunneling for Mobile IP, revised (January 2001)                              | Mobile IP                  |
| RFC 3022—Traditional IP Network Address Translator (Traditional NAT) (January 2001)           | NAT                        |
| RFC 3014—Notification Log MIB (November 2000)                                                 | SNMP                       |
| RFC 2998—A Framework for Integrated Services Operation over Diffserv Networks (November 2000) | QoS                        |
| RFC 2993—Architecture Implications of NAT (November 2000)                                     | NAT                        |
| RFC 2990—Next Steps for the IP QoS Architecture (November 2000)                               | QoS                        |
| RFC 2986—PKCS #10: Certification Request Syntax Specification Version 1.7 (November 2000)     | Digital certificates       |
| RFC 2981—Event MIB (October 2000)                                                             | Event Mgr                  |
| RFC 2973—IS-IS Mesh Groups (October 2000)                                                     | IS-IS                      |
| RFC 2966—Domain-wide Prefix Distribution with Two-Level IS-IS (October 2000)                  | IS-IS                      |
| RFC 2961—RSVP Refresh Overhead Reduction Extensions (April 2001)                              | MPLS                       |
| RFC 2934—Protocol Independent Multicast MIB for IPv4 (October 2000)                           | SNMP                       |
| RFC 2933—Internet Group Management Protocol MIB (October 2000)                                | SNMP                       |
| RFC 2932—IPv4 Multicast Routing MIB (October 2000)                                            | SNMP                       |

**Table 61: E-series RFCs** *(continued)*

| Reference                                                                                                   | Protocol or Feature                      |
|-------------------------------------------------------------------------------------------------------------|------------------------------------------|
| RFC 2925—Definitions of Managed Objects for Remote Ping, Traceroute, and Lookup Operations (September 2000) | SNMP                                     |
| RFC 2923—TCP Problems with Path MTU Discovery (September 2000)                                              | IP                                       |
| RFC 2918—Route Refresh Capability for BGP-4 (September 2000)                                                | BGP                                      |
| RFC 2917—A Core MPLS IP Architecture (September 2000)                                                       | MPLS                                     |
| RFC 2890—Key and Sequence Number Extensions to GRE (September 2000)                                         | GRE                                      |
| RFC 2869—RADIUS Extensions (June 2000)                                                                      | RADIUS                                   |
| RFC 2868—RADIUS Attributes for Tunnel Protocol Support (June 2000)                                          | RADIUS                                   |
| RFC 2867—RADIUS Accounting Modifications for Tunnel Protocol Support (June 2000)                            | RADIUS                                   |
| RFC 2866—RADIUS Accounting (June 2000)                                                                      | Dynamic interfaces;<br>RADIUS            |
| RFC 2865—Remote Authentication Dial In User Service (RADIUS) (June 2000)                                    | Dynamic interfaces;<br>RADIUS; Mobile IP |
| RFC 2864—The Inverted Stack Table Extension to the Interfaces Group MIB (June 2000)                         | SNMP                                     |
| RFC 2863—The Interfaces Group MIB (June 2000)                                                               | Ethernet; SNMP                           |
| RFC 2858—Multiprotocol Extensions for BGP-4 (June 2000)                                                     | BGP                                      |
| RFC 3392—Capabilities Advertisement with BGP-4 (November 2002)                                              | BGP                                      |
| RFC 2836—Per Hop Behavior Identification Codes (May 2000)                                                   | MPLS; Policy,<br>Management; QoS         |
| RFC 2796—BGP Route Reflection—An Alternative to Full Mesh IBGP (April 2000)                                 | BGP                                      |
| RFC 2794—Mobile IP Network Access Identifier Extension for IPv4 (March 2000)                                | Mobile IP                                |
| RFC 2790—Host Resources MIB (March 2000)                                                                    | SNMP                                     |
| RFC 2787—Definitions of Managed Objects for the Virtual Router Redundancy Protocol (March 2000)             | VRRP                                     |
| RFC 2784—Generic Routing Encapsulation (GRE) (March 2000)                                                   | IP tunnels                               |
| RFC 2763—Dynamic Hostname Exchange Mechanism for IS-IS (February 2000)                                      | IS-IS                                    |

**Table 61: E-series RFCs** *(continued)*

| Reference                                                                                           | Protocol or Feature          |
|-----------------------------------------------------------------------------------------------------|------------------------------|
| RFC 2748—The COPS (Common Open Policy Service) Protocol (January 2000)                              | COPS                         |
| RFC 2747—RSVP Cryptographic Authentication (January 2000)                                           | MPLS                         |
| RFC 2740—OSPF for IPv6                                                                              | OSPF                         |
| RFC 2737—Entity MIB (Version 2) (December 1999)                                                     | SNMP                         |
| RFC 2716—PPP EAP TLS Authentication Protocol (October 1999)                                         | PPP7.3.0b1 RLI-606           |
| RFC 2702—Requirements for Traffic Engineering over MPLS (September 1999)                            | MPLS                         |
| RFC 2698—A Two Rate Three Color Marker (September 1999)                                             | Policy management; QoS       |
| RFC 2697—A Single Rate Three Color Marker (September 1999)                                          | Policy management            |
| RFC 2694—DNS extensions to Network Address Translators (DNS_ALG) (September 1999)                   | NAT                          |
| RFC 2685—Virtual Private Networks Identifier (September 1999)                                       | MPLS                         |
| RFC 2684—Multiprotocol Encapsulation over ATM Adaptation Layer 5 (September 1999)                   | ATM                          |
| RFC 2668—Definitions of Managed Objects for IEEE 802.3 Medium Attachment Units (MAUs) (August 1999) | Ethernet; SNMP               |
| RFC 2667—IP Tunnel MIB (August 1999)                                                                | SNMP; IP tunnels             |
| RFC 2665—Definitions of Managed Objects for the Ethernet-like Interface Types (August 1998)         | Ethernet; SNMP               |
| RFC 2663—IP Network Address Translator (NAT) Terminology and Considerations (August 1999)           | NAT                          |
| RFC 2661—Layer Two Tunneling Protocol “L2TP” (August 1999)                                          | L2TP                         |
| RFC 2616—Hypertext Transfer Protocol – HTTP/1.1 (June 1989)                                         | HTTP                         |
| RFC 2615—PPP over SONET/SDH (June 1999)                                                             | POS                          |
| RFC 2598—An Expedited Forwarding PHB (June 1999)                                                    | QoS                          |
| RFC 2597—Assured Forwarding PHB Group (June 1999)                                                   | MPLS; Policy management; QoS |
| RFC 2580—Conformance Statements for SMIPv2 (April 1999)                                             | SNMP                         |
| RFC 2579—Textual Conventions for SMIPv2 (April 1999)                                                | SNMP                         |

**Table 61: E-series RFCs** *(continued)*

| Reference                                                                                                                                      | Protocol or Feature                         |
|------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|
| RFC 2578—Structure of Management Information Version 2 (SMIv2) (April 1999)                                                                    | SNMP                                        |
| RFC 2576—Coexistence between Version 1, Version 2, and Version 3 of the Internet-standard Network Management Framework (March 2000)            | SNMP                                        |
| RFC 2558—Definitions of Managed Objects for the SONET/SDH Interface Type (March 1999)                                                          | SNMP; cOCx/STMx and OCx/STMx interfaces     |
| RFC 2545—Use of BGP-4 Multiprotocol Extensions for IPv6 Inter-Domain Routing (March 1999)                                                      | BGP                                         |
| RFC 2519—A Framework for Inter-Domain Route Aggregation (February 1999)                                                                        | BGP                                         |
| RFC 2516—Method for Transmitting PPP over Ethernet (PPPoE) (February 1998)                                                                     | PPPoE                                       |
| RFC 2515—Definitions of Managed Objects for ATM Management (February 1999)                                                                     | ATM; SNMP                                   |
| RFC 2514—Definitions of Textual Conventions and OBJECT-IDENTITIES for ATM Management (February 1999)                                           | SNMP                                        |
| RFC 2513—Managed Objects for Controlling the Collection and Storage of Accounting Information for Connection-Oriented Networks (February 1999) | SNMP                                        |
| RFC 2496—Definitions of Managed Objects for the DS3/E3 Interface Types (January 1999)                                                          | SNMP; cOCx/STMx, CT3, E3, and T3 interfaces |
| RFC 2495—Definitions of Managed Objects for the DS1, E1, DS2 and E2 Interface Types (January 1999)                                             | SNMP; CE1, CT1, and CT3 interfaces          |
| RFC 2493—Textual Conventions for MIB Modules Using Performance History Based on 15 Minute Intervals (January 1999)                             | SNMP                                        |
| RFC 2486—The Network Access Identifier (January 1999)                                                                                          | Mobile IP                                   |
| RFC 2475—An Architecture for Differentiated Services (December 1998)                                                                           | MPLS; Policy, Management; QoS               |
| RFC 2474—Definition of the Differentiated Services Field (DS Field) in the IPv4 and IPv6 Headers (December 1998)                               | MPLS; Policy management; QoS                |
| RFC 2466—Management Information Base for IP Version 6: ICMPv6 Group (December 1998)                                                            | IPv6; Neighbor Discovery                    |
| RFC 2465—Management Information Base for IP Version 6: Textual Conventions and General Group (December 1998)                                   | IPv6                                        |
| RFC 2464—Transmission of IPv6 Packets over Ethernet Networks (December 1998)                                                                   | IPv6; Neighbor Discovery                    |



**Table 61: E-series RFCs** *(continued)*

| Reference                                                                                                                    | Protocol or Feature      |
|------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| RFC 2463—Internet Control Message Protocol (ICMPv6) for the Internet Protocol Version 6 (IPv6) Specification (December 1998) | IPv6                     |
| RFC 2462—IPv6 Stateless Address Autoconfiguration (December 1998)                                                            | IPv6; Neighbor Discovery |
| RFC 2461—Neighbor Discovery for IP Version 6 (IPv6) (December 1998)                                                          | IPv6; Neighbor Discovery |
| RFC 2460—Internet Protocol, Version 6 (IPv6) (December 1998)                                                                 | IPv6                     |
| RFC 2459—Internet X.509 Public Key Infrastructure Certificate and CRL Profile (January 1999)                                 | Digital certificates     |
| RFC 2453—RIP Version 2 (November 1998)                                                                                       | RIP                      |
| RFC 2439—BGP Route Flap Damping (November 1998)                                                                              | BGP                      |
| RFC 2427—Multiprotocol Interconnect over Frame Relay (September 1998)                                                        | Frame Relay              |
| RFC 2410—The NULL Encryption Algorithm and Its Use With IPSec (November 1998)                                                | IPSec                    |
| RFC 2409—The Internet Key Exchange (IKE) (November 1998)                                                                     | IPSec                    |
| RFC 2408—Internet Security Association and Key Management Protocol (ISAKMP) (November 1998)                                  | IPSec                    |
| RFC 2407—The Internet IP Security Domain of Interpretation for ISAKMP (November 1998)                                        | IPSec                    |
| RFC 2406—IP Encapsulating Security Payload (ESP) (November 1998)                                                             | IPSec                    |
| RFC 2405—The ESP DES-CBC Cipher Algorithm With Explicit IV (November 1998)                                                   | IPSec                    |
| RFC 2404—The Use of HMAC-SHA-1-96 within ESP and AH (November 1998)                                                          | IPSec                    |
| RFC 2403—The Use of HMAC-MD5-96 within ESP and AH (November 1998)                                                            | IPSec                    |
| RFC 2402—IP Authentication Header (November 1998)                                                                            | IPSec                    |
| RFC 2401—Security Architecture for the Internet Protocol (November 1998)                                                     | IPSec                    |
| RFC 2390—Inverse Address Resolution Protocol (September 1998)                                                                | ATM                      |
| RFC 2385—Protection of BGP Sessions via the TCP MD5 Signature Option (August 1998)                                           | BGP                      |
| RFC 2373—IP Version 6 Addressing Architecture (July 1998)                                                                    | IPv6                     |

**Table 61: E-series RFCs** *(continued)*

| Reference                                                                                             | Protocol or Feature                                                      |
|-------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|
| RFC 2370—The OSPF Opaque LSA Option (July 1998)                                                       | OSPF                                                                     |
| RFC 2364—PPP over AAL5 (July 1998)                                                                    | E3 and T3 interfaces                                                     |
| RFC 2362—Protocol Independent Multicast-Sparse Mode (PIM-SM): Protocol Specification (June 1998)      | IP multicasting; SNMP 6.1.0 - removed draft reference (not needed; Mark) |
| RFC 2338—Virtual Router Redundancy Protocol (April 1998)                                              | VRRP                                                                     |
| RFC 2328—OSPF Version 2 (April 1998)                                                                  | OSPF                                                                     |
| RFC 2308—Negative Caching of DNS Queries (DNS NCACHE) (March 1998)                                    | System management                                                        |
| RFC 2284—PPP Extensible Authentication Protocol (EAP) (March 1998)                                    | RADIUS                                                                   |
| RFC 2270—Using a Dedicated AS for Sites Homed to a Single Provider (January 1998)                     | BGP                                                                      |
| RFC 2246—The TLS Protocol Version 1.0 (January 1999)                                                  | PPP7.3.0b1 RLI-606                                                       |
| RFC 2236—Internet Group Management Protocol, Version 2 (November 1997)                                | IP multicasting                                                          |
| RFC 2233—The Interfaces Group MIB using SMIv2 (November 1997)                                         | Frame Relay                                                              |
| RFC 2211—Specification of the Controlled-Load Network Element Service (September 1997)                | MPLS                                                                     |
| RFC 2210—The Use of RSVP with IETF Integrated Services (September 1997)                               | MPLS                                                                     |
| RFC 2209—Resource ReSerVation Protocol (RSVP) -- Version 1, Message Processing Rules (September 1997) | MPLS                                                                     |
| RFC 2205—Resource ReSerVation Protocol (RSVP) -- Version 1, Functional Specification (September 1997) | MPLS                                                                     |
| RFC 2153—PPP Vendor Extensions (May 1997)                                                             | PPP                                                                      |
| RFC 2132—DHCP Options and BOOTP Vendor Extensions (March 1997)                                        | DHCP                                                                     |
| RFC 2131—Dynamic Host Configuration Protocol (March 1997)                                             | DHCP                                                                     |
| RFC 2115—Management Information Base for Frame Relay DTEs Using SMIv2 (September 1997)                | Frame Relay; SNMP                                                        |
| RFC 2104—HMAC: Keyed-Hashing for Message Authentication (February 1997)                               | MPLS                                                                     |
| RFC 2096—IP Forwarding Table MIB (January 1997)                                                       | SNMP                                                                     |

**Table 61: E-series RFCs** *(continued)*

| Reference                                                                                                      | Protocol or Feature |
|----------------------------------------------------------------------------------------------------------------|---------------------|
| RFC 2030—Simple Network Time Protocol (SNTP) (Version 4) for IPv4, IPv6, and OSI (October 1996)                | NTP                 |
| RFC 2013—SNMPv2 Management Information Base for the User Datagram Protocol using SMIPv2 (November 1996)        | SNMP                |
| RFC 2012—SNMPv2 Management Information Base for the Transmission Control Protocol using SMIPv2 (November 1996) | SNMP                |
| RFC 2011—SNMPv2 Management Information Base for the Internet Protocol using SMIPv2 (November 1996)             | SNMP                |
| RFC 2006—The Definitions of Managed Objects for IP Mobility Support using SMIPv2 (October 1996)                | Mobile IP           |
| RFC 2003—IP Encapsulation within IP (October 1996)                                                             | IP tunnels          |
| RFC 1998—An Application of the BGP Community Attribute in Multi-home Routing (August 1996)                     | BGP                 |
| RFC 1997—BGP Communities Attribute (August 1996)                                                               | BGP                 |
| RFC 1994—PPP Challenge Handshake Authentication Protocol (CHAP) (August 1996)                                  | MLPPP; PPP          |
| RFC 1990—The PPP Multilink Protocol (MP) (August 1996)                                                         | MLPPP               |
| RFC 1966—BGP Route Reflection An alternative to full mesh IBGP (June 1996)                                     | BGP                 |
| RFC 3065—Autonomous System Confederations for BGP (February 2001))                                             | BGP                 |
| RFC 1930—Guidelines for creation, selection, and registration of an Autonomous System (AS) (March 1996)        | BGP                 |
| RFC 1901—Introduction to Community-based SNMPv2 (January 1996)                                                 | SNMP                |
| RFC 1877—PPP Internet Protocol Control Protocol Extensions for Name Server Addresses (December 1995)           | PPP                 |
| RFC 1863—A BGP/IDRP Route Server alternative to a full mesh routing (October 1995)                             | BGP                 |
| RFC 1850—OSPF Version 2 Management Information Base (November 1995)                                            | OSPF                |
| RFC 1812—Requirements for IP Version 4 Routers (June 1995)                                                     | IP                  |
| RFC 1774—BGP-4 Protocol Analysis (March 1995)                                                                  | BGP                 |
| RFC 1773—Experience with the BGP-4 protocol (March 1995)                                                       | BGP                 |
| RFC 1772—Application of the Border Gateway Protocol in the Internet (March 1995)                               | BGP                 |

**Table 61: E-series RFCs** *(continued)*

| Reference                                                                                                                     | Protocol or Feature                                                                                         |
|-------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|
| RFC 1745—BGP4/IDRP for IP—OSPF Interaction (December 1994)                                                                    | BGP                                                                                                         |
| RFC 1724—RIP Version 2 MIB Extension (November 1994)                                                                          | RIP                                                                                                         |
| RFC 1702—Generic Routing Encapsulation over IPv4 Networks (October 1994)                                                      | IP tunnels                                                                                                  |
| RFC 1701—Generic Routing Encapsulation (October 1994)                                                                         | IP tunnels                                                                                                  |
| RFC 1700—Assigned Numbers (October 1994)                                                                                      | IP tunnels                                                                                                  |
| RFC 1662—PPP in HDLC-like Framing (July 1994)                                                                                 | POS                                                                                                         |
| RFC 1661—The Point-to-Point Protocol (PPP) (July 1994)                                                                        | PPP; MLPPP;<br>cOCx/STMx,<br>channelized E1,<br>channelized T1,<br>channelized T3, E3, and<br>T3 interfaces |
| RFC 1657—Definitions of Managed Objects for the Fourth Version of the Border Gateway Protocol (BGP-4) using SMIv2 (July 1997) | BGP; SNMP                                                                                                   |
| RFC 1587—The OSPF NSSA Option (March 1994)                                                                                    | OSPF                                                                                                        |
| RFC 1493—Definitions of Managed Objects for Bridges (July 1993)                                                               | Transparent bridging                                                                                        |
| RFC 1490—Multiprotocol Interconnect over Frame Relay (July 1993)                                                              | Frame Relay                                                                                                 |
| RFC 1483—Multiprotocol Encapsulation over ATM Adaptation Layer 5 (July 1993)                                                  | ATM; E3 and T3<br>interfaces                                                                                |
| RFC 1473—The Definitions of Managed Objects for the IP Network Control Protocol of the Point-to-Point Protocol (June 1993)    | SNMP                                                                                                        |
| RFC 1472—The Definitions of Managed Objects for the Security Protocols of the Point-to-Point Protocol (June 1993)             | SNMP                                                                                                        |
| RFC 1471—The Definitions of Managed Objects for the Link Control Protocol of the Point-to-Point Protocol (June 1993)          | SNMP                                                                                                        |
| RFC 1407—Definitions of Managed Objects for the DS3/E3 Interface Types (January 1993)                                         | SNMP; cOCx/STMx,<br>channelized T3, E3, and<br>T3 interfaces                                                |
| RFC 1406—Definitions of Managed Objects for the DS1 and E1 Interface Types (January 1993)                                     | SNMP; channelized E1,<br>channelized T1, and<br>channelized T3<br>interfaces                                |
| RFC 1350—Trivial File Transfer Protocol (TFTP) (Revision 2) (July 1992)                                                       | TFTP; System<br>management                                                                                  |
| RFC 1332—The PPP Internet Protocol Control Protocol (IPCP) (May 1992)                                                         | PPP                                                                                                         |

**Table 61: E-series RFCs** *(continued)*

| Reference                                                                                                  | Protocol or Feature    |
|------------------------------------------------------------------------------------------------------------|------------------------|
| RFC 1305—Network Time Protocol (version 3) Specification, Implementation and Analysis (March 1992)         | NTP                    |
| RFC 1215—A Convention for Defining Traps for use with the SNMP (March 1991)                                | SNMP                   |
| RFC 1213—Management Information Base for Network Management of TCP/IP-based Internets: MIB-II (March 1991) | SNMP                   |
| RFC 1212—Concise MIB Definitions (March 1991)                                                              | SNMP                   |
| RFC 1195—Use of OSI IS-IS for Routing in TCP/IP and Dual Environments (December 1990)                      | IS-IS                  |
| RFC 1158—Management Information Base for Network Management of TCP/IP-based internets: MIB-II (May 1990)   | TCP/IP                 |
| RFC 1157—A Simple Network Management Protocol (SNMP) (May 1990)                                            | SNMP                   |
| RFC 1155—Structure and Identification of Management Information for TCP/IP-based Internets (May 1990)      | SNMP                   |
| RFC 1122—Requirements for Internet Hosts—Communication Layers (October 1989)                               | IP                     |
| RFC 1112—Host Extensions for IP Multicasting (August 1989)                                                 | Ethernet; IP           |
| RFC 1094—Network File System Protocol Specification (March 1989)                                           | NFS                    |
| RFC 1058—Routing Information Protocol (June 1998)                                                          | RIP                    |
| RFC 1057—Remote Procedure Call Protocol Specification (June 1988)                                          | RPC                    |
| RFC 1042—A Standard for the Transmission of IP Datagrams over IEEE 802 Networks (February 1988)            | Ethernet               |
| RFC 1035—Domain Names – Implementation and Specification (November 1987)                                   | System management      |
| RFC 959—File Transfer Protocol (FTP) (October 1985)                                                        | FTP; System management |
| RFC 950—Internet Standard Subnetting Procedure (August 1985)                                               | IP                     |
| RFC 922—Broadcasting Internet Datagrams in the Presence of Subnets (October 1984)                          | IP                     |
| RFC 919—Broadcasting Internet Datagrams (October 1984)                                                     | IP                     |
| RFC 894—A Standard for the Transmission of IP Datagrams over Ethernet Networks (April 1984)                | Ethernet               |
| RFC 854—Telnet Protocol Specification (May 1983)                                                           | IP                     |

**Table 61: E-series RFCs** *(continued)*

| Reference                                                                                | Protocol or Feature |
|------------------------------------------------------------------------------------------|---------------------|
| RFC 826—An Ethernet Address Resolution Protocol (November 1982)                          | Ethernet            |
| RFC 793—Transmission Control Protocol (September 1981)                                   | IP                  |
| RFC 792—Internet Control Message Protocol (September 1981)                               | IP                  |
| RFC 791—Internet Protocol DARPA Internet Program Protocol Specification (September 1981) | IP                  |
| RFC 768—User Datagram Protocol (August 1980)                                             | IP                  |

## Draft RFCs



**NOTE:** IETF drafts are valid for only 6 months from the date of issuance. They must be considered as works in progress. Please refer to the IETF Web site at <http://www.ietf.org> for the latest drafts.

**Table 62: E-series Draft RFCs**

| Reference                                                                                                                 | Protocol or Feature |
|---------------------------------------------------------------------------------------------------------------------------|---------------------|
| Address Prefix Based Outbound Route Filter for BGP-4—draft-chen-bgp-prefix-orf-07.txt (March 2004 expiration)             | BGP                 |
| A Policy Control Mechanism in IS-IS Using Administrative Tags—draft-ietf-isis-admin-tags-02.txt (January 2005 expiration) | IS-IS               |
| A “traceroute” Facility for IP Multicast—draft-ietf-idmr-traceroute-ipm-07.txt (January 2001 expiration)                  | IP multicasting     |
| BFD for IPv4 and IPv6 (Single Hop)—draft-ietf-bfd-v4v6-1hop-00.txt (January 2005 expiration)                              | BFD                 |
| BGP Extended Communities Attribute—draft-ietf-idr-bgp-ext-communities-07.txt (February 2004 expiration)                   | BGP                 |
| BGP-MPLS VPN extension for IPv6 VPN—draft-ietf-l3vpn-bgp-ipv6-03.txt (December 2004 expiration)                           | BGP/MPLS VPNs       |
| Bidirectional Forwarding Detection—draft-ietf-bfd-base-00.txt. (January 2005 expiration)                                  | BFD                 |
| Connecting IPv6 Islands across IPv4 Clouds with BGP—draft-ietf-ngtrans-bgp-tunnel-04.txt (July 2002 expiration)           | BGP                 |

**Table 62: E-series Draft RFCs** (continued)

| Reference                                                                                                                                         | Protocol or Feature       |
|---------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| Cooperative Route Filtering Capability for BGP-4—draft-ietf-idr-route-filter-09.txt (February 2003 expiration)                                    | BGP                       |
| Definitions of Managed Objects for SONET Linear APS Architectures—draft-ietf-atommib-sonetaps-mib-05.txt (November 2001 expiration)               | SONET APS redundancy      |
| Distance Vector Multicast Routing Protocol—draft-ietf-idmr-dvmrp-v3-11.txt (April 2004 expiration)                                                | IP multicasting           |
| Dynamic Capability for BGP-4—draft-ietf-idr-dynamic-cap-04.txt (February 2004 expiration)                                                         | BGP                       |
| Encapsulation Methods for Transport of ATM Over MPLS Networks—draft-ietf-pwe3-atm-encap-07.txt (April 2005 expiration)                            | Layer 2 services          |
| Encapsulation Methods for Transport of Ethernet Frames Over IP/MPLS Networks—draft-ietf-pwe3-ethernet-encap-05.txt (June 2004 expiration)         | Layer 2 services          |
| Encapsulation Methods for Transport of Layer 2 Frames Over IP and MPLS Networks—draft-martini-l2circuit-encap-mpls-08.txt (March 2005 expiration) | Layer 2 services          |
| Encapsulation Methods for Transport of PPP/HDLC Over IP and MPLS Networks—draft-ietf-pwe3-hdlc-ppp-encap-mpls-03.txt (October 2004 expiration)    | Layer 2 services          |
| Encapsulating MPLS in IP or Generic Routing Encapsulation (GRE)—draft-ietf-mpls-in-ip-or-gre-03.txt (September 2003 expiration)                   | MPLS                      |
| Extended Authentication within IKE (XAUTH)—draft-beaulieu-ike-xauth-02.txt (April 2002 expiration)                                                | Dynamic IPsec subscribers |
| Extended Authentication within ISAKMP/Oakley (XAUTH)—draft-ietf-ipsec-isakmp-xauth-06.txt (May 2000 expiration)                                   | Dynamic IPsec subscribers |
| Extended Ethernet Frame Size Support—draft-ietf-isis-ext-eth-01.txt (November 2001 expiration)                                                    | IS-IS                     |
| Extensions to a Method for Transmitting PPP over Ethernet (PPPoE)—draft-carrel-info-pppoe-ext-00.txt (November 2000 expiration)                   | PPPoE                     |
| Fail Over extensions for L2TP “failover”—draft-ietf-l2tpext-failover-06.txt (April 2006 expiration)                                               | L2TP                      |
| Framework for Pseudo Wire Emulation Edge-to-Edge (PWE3)—draft-ietf-pwe3-arch-06.txt (April 2004 expiration)                                       | Layer 2 services          |
| Graceful Restart Mechanism for BGP—draft-ietf-idr-restart-10.txt (March 2004 expiration)                                                          | BGP                       |
| GSMPv3 Base Specification—draft-ietf-gsmp-v3-base-spec-07.txt (March 2006 expiration)                                                             | ANCP                      |

**Table 62: E-series Draft RFCs** (continued)

| Reference                                                                                                                                                  | Protocol or Feature |
|------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| GSMP extensions for layer2 control (L2C) Topology Discovery and Line Configuration—draft-wadhwa-gsmp-l2control-configuration-00.txt (July 2006 expiration) | ANCP                |
| IGMP-based Multicast Forwarding (“IGMP Proxying”)—draft-ietf-magma-igmp-proxy-00.txt (May 2002 expiration)                                                 | IP multicasting     |
| IGMP/MLD-based Multicast Forwarding (“IGMP/MLD Proxying”)—draft-ietf-magma-igmp-proxy-06.txt (October 2004 expiration)                                     | IPv6 multicasting   |
| L2TP Proxy Authenticate Extensions for EAP—draft-ietf-l2tpext-proxy-authen-ext-eap-01.txt (December 2006 expiration)                                       | PPP7.3.0b1 RLI-606  |
| Layer 2 VPNs over Tunnels—draft-kompella-l2vpn-l2vpn-01.txt (July 2006 expiration)                                                                         | L2VPNs              |
| LDP IGP Synchronization—draft-jork-ldp-igp-sync-01.txt (August 2005 expiration)                                                                            | MPLS                |
| Management Information Base for IS-IS—draft-ietf-isis-wg-mib-16.txt (January 2005 expiration)                                                              | IS-IS; SNMP         |
| Multicast Group Membership Discovery MIB—draft-ietf-magma-mgmd-mib-06.txt (October 2004 expiration)                                                        | IPv6 multicasting   |
| Multicast in MPLS/BGP VPNs—draft-rosen-vpn-mcast-06.txt (April 2004 expiration)                                                                            | Multicast VPNs      |
| Multicast in MPLS/BGP IP VPNs—draft-rosen-vpn-mcast-08.txt (June 2005 expiration)                                                                          | Multicast VPNs      |
| Negotiation of NAT-Traversal in the IKE—draft-ietf-ipsec-nat-t-ike-08.txt (July 2004 expiration)                                                           | L2TP over IPsec     |
| Point-to-point operation over LAN in link-state routing protocols—draft-ietf-isis-igp-p2p-over-lan-05.txt (January 2005 expiration)                        | IS-IS               |
| Protocol Independent Multicast MIB for IPv4—draft-ietf-idmr-pim-mib-10.txt (July 2000 expiration)                                                          | IP multicasting     |
| Pseudowire Setup and Maintenance Using LDP—draft-ietf-pwe3-control-protocol-08.txt (January 2005 expiration)                                               | Layer 2 services    |
| Requirements for Pseudo-Wire Emulation Edge-to-Edge (PWE3)—draft-ietf-pwe3-requirements-08.txt (June 2004 expiration)                                      | Layer 2 services    |
| Routing IPv6 with IS-IS—draft-ietf-isis-ipv6-06.txt (April 2006 expiration)                                                                                | IS-IS               |



**Table 62: E-series Draft RFCs** (continued)

| Reference                                                                                                           | Protocol or Feature       |
|---------------------------------------------------------------------------------------------------------------------|---------------------------|
| Source-Specific Multicast for IP—draft-ietf-ssm-arch-06.txt (March 2005 expiration)                                 | IP multicasting           |
| Source-Specific Protocol Independent Multicast in 232/8—draft-ietf-mboned-ssm232-08.txt (September 2004 expiration) | IP multicasting           |
| Subcodes for BGP Cease Notification Message—draft-ietf-idr-cease-subcode-05.txt (March 2004 expiration)             | BGP                       |
| The ISAKMP Configuration Method—draft-dukes-ike-mode-cfg-02.txt (March 2002 expiration)                             | Dynamic IPsec subscribers |
| The TACACS+ Protocol, Version 1.78—draft-grant-tacacs-02.txt (January 1997 expiration)                              | TACACS+                   |
| Transport of Layer 2 Frames Over MPLS—draft-martini-12circuit-trans-mpls-11.txt (October 2003 expiration)           | Layer 2 services          |
| UDP Encapsulation of IPsec ESP Packets—draft-ietf-ipsec-udp-encaps-09.txt (November 2004 expiration)                | L2TP over IPsec           |
| Virtual Private LAN Service—draft-ietf-l2vpn-vpls-bgp-05.txt (October 2005 expiration)                              | VPLS                      |

## Other Software Standards

**Table 63: E-series Non-RFC Software Standards**

| Reference                                                                                                                                                              | Protocol or Feature             |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| ANSI T1.107a-1990 Standard for Telecommunications—Digital Hierarchy – Supplement to Formats Specification (August 1990)                                                | MDL (T3 interfaces)             |
| ANSI T1.403-1989 Standard for Telecommunications—Network and Customer Installation Interfaces – DS1 Metallic Interface – Robbed-bit Signaling State Definitions (1989) | FDL (T1 interfaces)             |
| ANSI T1.404-1994 Standard for Telecommunications—Network-to-Customer – DS3 Metallic Interface Specification (1994)                                                     | Remote loopback (T3 interfaces) |
| ANSI T1.617 Annex D                                                                                                                                                    | Frame Relay                     |
| AT&T Technical Reference 54016—Requirements for Interfacing Digital Terminal Equipment to Services Employing the Extended Superframe Format (September 1989)           | FDL (T1 interfaces)             |
| ATM Forum—ATM User-Network Interface Specification, Version 3.0 (September 1993)                                                                                       | ATM                             |

**Table 63: E-series Non-RFC Software Standards** *(continued)*

| Reference                                                                                                                      | Protocol or Feature                   |
|--------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|
| ATM Forum—ATM User-Network Interface Specification, Version 3.1 (September 1994)                                               | ATM                                   |
| ATM Forum—Integrated Local Management Interface (ILMI) Specifications, Versions 3.0, 3.1, and 4.0 (September 1996)             | ATM                                   |
| ATM Forum—Traffic Management Specification, Version 4.0 (April 1996)                                                           | ATM                                   |
| ATM Forum—User-Network Interface (UNI) versions 3.0, 3.1, 4.0                                                                  | ATM                                   |
| Draft Standard P802.1Q/D9 IEEE Standards for Local and Metropolitan Area Networks: Virtual Bridged Local Area Networks         | Ethernet; VLANs; Transparent bridging |
| DSL Forum Technical Report (TR)-059—DSL Evolution - Architecture Requirements for the Support of QoS-Enabled IP Services       | QoS; DSL                              |
| DSL Forum Technical Report (TR)-101—Migration to Ethernet-Based DSL Aggregation (April 2006)                                   | Dynamic VLANs; PPPoE; DHCP            |
| ERX system Cisco HDLC is compatible with Cisco Systems HDLC protocol                                                           | Cisco HDLC                            |
| Frame Relay Forum—Frame Relay Fragmentation Implementation Agreement, FRF.12 (December 1997)                                   | Frame Relay                           |
| Frame Relay Forum—User-to-Network Implementation Agreement (UNI), FRF 1.1 (January 1996)                                       | Frame Relay                           |
| IEEE 802.1D—Media access control (MAC) bridges                                                                                 | Transparent bridging                  |
| IEEE 802.1q (Virtual LANs)                                                                                                     | Ethernet; VLANs                       |
| IEEE 802.1w (Rapid Reconfiguration of Spanning Tree)                                                                           | Ethernet                              |
| IEEE 802.1x-2001—Port-Based Network Access Control                                                                             | Wireless authentication               |
| IEEE 802.3 (Fast Ethernet and Gigabit Ethernet)                                                                                | Ethernet                              |
| IEEE 802.3ad (Link Aggregation)                                                                                                | Link Aggregation, Layer 2 over MPLS   |
| IEEE 802.3ae (10-Gigabit Ethernet only)                                                                                        | 10-Gigabit Ethernet                   |
| IEEE 802.3u (Fast Ethernet only)                                                                                               | Ethernet                              |
| IEEE 802.3z (Gigabit Ethernet only)                                                                                            | Ethernet                              |
| ISO International Standard 8473-1:1993—Information technology – Protocol for providing the connectionless-mode network service | IS-IS                                 |

**Table 63: E-series Non-RFC Software Standards** *(continued)*

| Reference                                                                                                                                                                                                                                                                                                     | Protocol or Feature   |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| ISO International Standard 9542:1988 (E)—Information processing systems – Telecommunications and information exchange between systems – End System-to-Intermediate System Routing Exchange Protocol for use in conjunction with the protocol for providing the connectionless-mode network service (ISO 8473) | IS-IS                 |
| ISO/IEC 10589:1992—Information technology – Telecommunications and information exchange between systems – Intermediate System-to-Intermediate System Intra-Domain Routing Exchange Protocol for use in conjunction with the protocol for providing the connectionless-mode network service (ISO 8473)         | IS-IS                 |
| ITU O.151—Error performance measuring equipment operating at the primary rate and above (October 1992)                                                                                                                                                                                                        | BERT Patterns         |
| ITU O.153—Basic parameters for the measurement of error performance at bit rates below the primary rate (October 1992)                                                                                                                                                                                        | BERT Patterns         |
| ITU-T Draft Recommendation I.363 (AAL5 support) (January 1993)                                                                                                                                                                                                                                                | ATM                   |
| ITU-T G.783—Characteristics Of Synchronous Digital Hierarchy (SDH) Multiplexing Equipment Functional Blocks: Annex A – Multiplex Section Protection (MSP) Protocol, Commands And Operation (1990)                                                                                                             | SDH MSP redundancy    |
| ITU-T Q.933 Annex A                                                                                                                                                                                                                                                                                           | Frame Relay           |
| ITU-T Recommendation I.610—B-ISDN Operation and Maintenance Principles and Functions (February 1999)                                                                                                                                                                                                          | ATM                   |
| ITU-T Recommendation Q.922, Integrated Services Digital Network (ISDN) Data Link Layer Specification for Frame Mode Bearer Services; Annex A (February 1992)                                                                                                                                                  | Frame Relay           |
| ITU-T V.35: Data transmission at 48 kbit/s using 60-108 kHz group band circuits (October 1984 - now obsolete)                                                                                                                                                                                                 | V.35                  |
| ITU-T X.21: Interface between Data Terminal Equipment and Data Circuit-terminating Equipment for synchronous operation on public data networks (September 1992)                                                                                                                                               | X.21                  |
| Lawfully Authorized Electronic Surveillance (LAES) for IP Network Access, American National Standard for Telecommunications, version PTSC-LAES-2006-084R6                                                                                                                                                     | Packet Mirroring      |
| Multilink Frame Relay UNI/NNI Implementation Agreement, FRF.16 (April 2000)                                                                                                                                                                                                                                   | Multilink Frame Relay |
| T1M1.3 Working Group—A Technical Report on Test Patterns for DS1 Circuits (November 1993)                                                                                                                                                                                                                     | BERT Patterns         |
| Telcordia document GR-253—Synchronous Optical Network (SONET) Transport Systems: Common Generic Criteria, Revision 3 (September 2000)                                                                                                                                                                         | SONET APS redundancy  |

## Hardware Standards

**Table 64: E-series Hardware Standards**

| Reference                                                                                                                                                                                                                                                                 | Protocol or Feature   |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| ACA TS 016-1997                                                                                                                                                                                                                                                           | Telecom               |
| ANSI T1.102-1993 Digital Hierarchy – Electrical Interfaces (1999)                                                                                                                                                                                                         | Cables                |
| ANSI T1.646-1995 Telecommunications – Broadband ISDN—Physical Layer Specification for User-Network Interfaces Including DS1/ATM (1995)                                                                                                                                    | Cables and connectors |
| ANSI T1.646a-1997 Telecommunications – Broadband ISDN—Physical Layer Specification for User-Network Interfaces Including DS1/ATM (1997)                                                                                                                                   | Cables and connectors |
| AS/NZS 3260:1993, Safety of Information Technology Equipment Including Electrical Business Equipment                                                                                                                                                                      | Safety                |
| AS/NZS 3548:1995 (CISPR 22 Class A)                                                                                                                                                                                                                                       | EMC                   |
| CAN/CSA C22.2, No. 60950-00, 3rd Edition, Safety of Information Technology Equipment                                                                                                                                                                                      | Safety                |
| CTR13—Commission Decision of 9 July 1997 on a common technical regulation for attachment requirements for terminal equipment interface for connection to 2048 kbit/s digital structured ONP leased lines: 97/521/EC – OJ No. L215 Vol. 40, August 1997                    | Telecom               |
| CTR24—Commission Decision of 9 September 1997 on a common technical regulation for attachment requirements for terminal equipment interface for connection to 34 Mbit/s digital unstructured and structured leased lines: 97/639/EC – OJ No. L271 Vol. 40, 3 October 1997 | Telecom               |
| EIA-310-D Cabinets, Racks, Panels, and Associated Equipment, September 1992                                                                                                                                                                                               | Mechanical            |
| EMC Directive (89/336/EEC)                                                                                                                                                                                                                                                | EMC                   |
| EN300 386-2:1997 EMC requirements for Telecom Network Equipment-Telco Centers                                                                                                                                                                                             | Telecom               |
| EN55022 Class A (CISPR-22 Class A)                                                                                                                                                                                                                                        | EMC                   |
| EN55024, Annex C for WAN Equipment Performance Criteria A, B, and C                                                                                                                                                                                                       | EMC                   |
| EN60825-1, Safety of Laser Products - Part 1: Equipment Class, Requirements, and User's Guide (2001)                                                                                                                                                                      | Safety                |
| EN60950:2000, 3rd Edition, Safety of Information Technology Equipment                                                                                                                                                                                                     | Safety                |
| ETSI 300-386, Telecommunication Network Equipment; ElectroMagnetic Compatibility (EMC) requirements                                                                                                                                                                       | EMC                   |
| FCC Part 15 Class A                                                                                                                                                                                                                                                       | EMC                   |
| FCC PART 68                                                                                                                                                                                                                                                               | EMC                   |

**Table 64: E-series Hardware Standards** *(continued)*

| Reference                                                                                                                                                                                                                                                                       | Protocol or Feature |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| GR-63 (LSSGR, FD-15): Network Equipment Building System (NEBS) Requirements: Physical Protection, Issue 1, October 1995                                                                                                                                                         | NEBS                |
| GR-1089 (LSSGR, FD-15): Electromagnetic Compatibility and Electrical Safety - Generic Criteria for Network Telecommunications Equipment, Issue 2, Revision 1, February 1999                                                                                                     | NEBS                |
| IEC 825-1, Safety of Laser Products - Part 1                                                                                                                                                                                                                                    | Safety              |
| IEC 60950-1 (2001-10) Ed. 1.0 Information technology equipment - Safety - Part 1: General requirements                                                                                                                                                                          | Safety              |
| IECS-003 Issue 3 Class A                                                                                                                                                                                                                                                        | EMC                 |
| ITU-T G.703, Physical/electrical characteristics of hierarchical digital interfaces (November 2001)                                                                                                                                                                             | Cables              |
| Low Voltage Directive (73/23/EEC)                                                                                                                                                                                                                                               | Safety              |
| PD7024—Essential requirements for terminal equipment intended for connection to unstructured digital leased circuits of the public telecommunications network using a CCITT recommendation G.703 interface at a rate of 2048 kbit/s with a 75 ohm unbalanced presentation, 1994 | Telecom             |
| RTTE Directive (1999/5/EEC)                                                                                                                                                                                                                                                     | Telecom             |
| SR-3580 (FD-15): Network Equipment Building System (NEBS) Criteria Levels, Issue 1, November 1995                                                                                                                                                                               | Safety              |
| UL 60950, 3rd Edition, Safety of Information Technology Equipment                                                                                                                                                                                                               | Safety              |
| VCCI (Voluntary Control Council for Interference by Information Technology Equipment)                                                                                                                                                                                           | EMC                 |



## **Part 3**

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## Symbols

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