



JunosE™ Software for E Series™ Broadband Services Routers

IP, IPv6, and IGP Configuration Guide

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

YEAR 2000 NOTICE

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

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Abbreviated Table of Contents

	About the Documentation	xxi
Part 1	Internet Protocol	
Chapter 1	Configuring IP	3
Chapter 2	Monitoring IP	83
Chapter 3	Configuring IPv6	149
Chapter 4	Monitoring IPv6	189
Chapter 5	Configuring Neighbor Discovery	249
Part 2	Internet Protocol Routing	
Chapter 6	Configuring RIP	259
Chapter 7	Configuring OSPF	293
Chapter 8	Configuring IS-IS	377
Part 3	Index	
	Index	469

Table of Contents

	About the Documentation	xxi
	E Series and JunosE Documentation and Release Notes	xxi
	Audience	xxi
	E Series and JunosE Text and Syntax Conventions	xxi
	Obtaining Documentation	xxiii
	Documentation Feedback	xxiii
	Requesting Technical Support	xxiii
	Self-Help Online Tools and Resources	xxiv
	Opening a Case with JTAC	xxiv
Part 1	Internet Protocol	
Chapter 1	Configuring IP	3
	IP Overview	4
	IP Packets	4
	IP Functions	5
	Moving Data Between the Network Access Layer and the Host-to-Host Transport Layer	5
	Routing Datagrams to Remote Hosts	5
	Fragmenting and Reassembling Datagrams	5
	IP Layering	5
	Network Interface Layer	6
	Internet Layer	6
	Transport Layer	6
	Application Layer	6
	IP Platform Considerations	6
	IP References	7
	Supported IP Features	8
	IP Addressing Overview	9
	Physical and Logical Addresses	9
	Internet Addresses	9
	Subnetwork Mask Format Options	10
	Subnet Addressing	11
	Classless Addressing with CIDR	12
	Adding and Deleting IP Addresses	13
	Adding and Deleting a Primary Address	13
	Adding and Deleting a Secondary (Multinet) Address	14

Indirect Next-Hop Overview	15
Before You Configure IP	16
IP Profiles	16
IP Profiles Overview	17
Creating a Profile	17
Configuring Profile Attributes for IP	18
Assigning a Profile to an Interface	19
Address Resolution Protocol	20
ARP Overview	20
Understanding How ARP Works	20
Configuring ARP	22
Adding a Static Entry in the ARP Cache	22
Checking for Spoofed ARP Packets	22
Configuring ARP Cache Entry Timeout	23
Clearing Dynamic Entries from the ARP Cache	24
Enabling Proxy ARP	24
MAC Address Validation Overview	24
Adding IP Address-MAC Address Validation Pairs	25
Transmission of GARP Packets Overview	26
GARP Packets Transmission Scenarios	27
Configuring the Transmission of GARP Packets	28
Broadcast Addressing Overview	29
Configuring Broadcast-Related IP Tasks	30
IP Fragmentation Overview	30
Configuring IP Fragmentation-Related Attributes	31
IP Routing Overview	32
IP Routing Information Tables Overview	32
Setting the Administrative Distance for a Route	34
IP Routing Operations Overview	35
Identifying a Router Within an Autonomous System	36
Establishing an IP Static Route	36
Understanding ICMP Unreachable Messages for Static Routes Sent on Null Interfaces	37
Enabling or Disabling the Transmission of ICMP Unreachable Messages for Static Routes on Null Interfaces	38
Configuring IP Static Routes with Indirect Next Hops	39
Next-Hop Verification for Static Routes Overview	40
BFD Next-Hop Verification Overview	41
Enabling BFD on a Static Route	41
Configuring BFD Next-Hop Verification	42
RTR Next-Hop Verification Overview	42
Establishing an IP Static Route and Associating it with a Configured RTR Operation	43
Example: Configuring the RTR Next-Hop Verification Feature	43
IP Default Route Overview	48
Configuring IP Source Address Validation	48
Enabling IP Source Address Validation	48
Enabling IP Source Address Validation Traps	49

Configuring TCP for IP	49
Defining TCP Maximum Segment Size for IP	50
Setting MSS for TCP Connections for IP	50
Configuring TCP PMTU Discovery for IP	51
Enabling TCP PMTU Discovery	51
Limiting TCP PMTU Discovery Values	52
Configuring Black Hole Thresholds for TCP PMTU	52
Protecting Against TCP RST or SYN DoS Attacks	53
Preventing TCP PAWS Timestamp DoS Attacks	53
Protecting Against TCP Out-of-Order DoS Attacks	54
Limiting TCP Resequence Buffers per Router	55
Limiting TCP Resequence Buffers per Virtual Router	55
Limiting TCP Resequence Buffers per Connection	55
Managing IP Interfaces	56
Setting Up an Unnumbered Interface	57
Adding a Host Route to a Peer on a PPP Interface	57
Shutting Down an IP Interface	58
Removing an IP Configuration	58
Clearing IP Interface Counters	58
Disabling the Forwarding of IP Packets on an SRP Ethernet Interface	59
Forcing an IP Interface to Appear Up	59
Adding a Description to an IP Interface or Sub-Interface	60
Enabling SNMP Link Status Traps on an IP Interface	60
Configuring the Speed of an IP Interface	61
Clearing and Reinstalling IP Routes	61
Enabling the Forwarding of IP Source-Routed Packets	62
Specifying an IP Debounce Time	63
ECMP Load Sharing for IP	63
ECMP Hashed Mode Overview	63
Defining the Maximum Parallel Routes Supported by the Routing Protocol	63
ECMP Round-Robin Mode Overview	64
Configuring ECMP Round-Robin Load Sharing	64
ECMP Fast Reroute Protection Overview	64
Setting a TTL Value for the IP Header	65
Distributing Routing Table Updates to Line Modules	65
IP Tunnel Routing Table Overview	66
Shared IP Interfaces	66
Shared IP Interfaces Overview	66
Creating a Shared IP Interface	67
Statically Associating the Shared IP Interface with the Layer 2 Interface	67
Dynamically Associating the Shared IP Interface with the Layer 2 Interface	68
Example: Configuring Shared IP Interfaces	69
Moving IP Shared Interfaces	70
IP Shared Interface Statistics Overview	70
Subscriber Interfaces Overview	70

	Internet Control Message Protocol	71
	ICMP Overview	71
	Configuring ICMP Tasks	71
	Specifying a Source Address for ICMP Messages	72
	Determining Reachability of IP Destinations in the Network	73
	Sending Echo Request Packets to the IP Address	73
	Discovering the Routes Followed by Router Packets when Traveling to the IP Destination	74
	Response Time Reporter	75
	Configuring RTR	75
	Configuring the Probe Type for RTR	75
	Configuring the Probe Characteristics for RTR	76
	Setting the Reaction Conditions for the RTR Probe	78
	Scheduling the RTR Probe	79
	Capturing Statistics and Collecting Error Information for the RTR Probe	80
	Collecting History for the RTR Probe	80
	Setting the Receiving Interface for the RTR Entry	81
	Shutting Down the RTR Probe	81
Chapter 2	Monitoring IP	83
	Establishing a Baseline for IP Statistics	84
	Setting a Baseline for IP Interface Statistics	84
	Setting a Baseline for IP Statistics	84
	Setting a Baseline for IP UDP Statistics	85
	Setting a Baseline for IP TCP Statistics	85
	System Event Logs Used to Troubleshoot and Monitor IP	85
	Commands Used to Monitor IP	86
	Monitoring RTR	88
	Monitoring RTR Global Information	88
	Monitoring Statistics Information for RTR Probes	88
	Monitoring Configuration Details for RTR Probes	89
	Monitoring Data Samples for RTR Probes	91
	Monitoring RTR Hops Information	93
	Monitoring Operational Information of RTR	93
	Monitoring Access Lists for IP	94
	Monitoring the AS-Path Access Lists for IP	95
	Monitoring ARP Details	95
	Monitoring General Information for IP	96
	Monitoring Detailed or Summary Information for IP Interfaces	97
	Monitoring the Routes Permitted by IP Community Lists	100
	Monitoring IP Forwarding Table Details for a Line Module	101
	Monitoring the Route Hold-Down Time for IP Forwarding Tables	102
	Monitoring the Current State of IP Interfaces	102
	Monitoring IP Shared Interfaces	108
	Monitoring IP Protocols	113
	Monitoring IP Route Redistribution Policy	116
	Monitoring the Current State of IP Routing Tables	116
	Monitoring IP Routing Table Details for a Line Module	120

	Monitoring BSD Socket Statistics	120
	Monitoring the Status of IP Static Routes in the Routing Table	126
	Monitoring the Status of TCP Protection	128
	Monitoring TCP PMTU Information	128
	Monitoring TCP PAWS Status	129
	Monitoring the TCP Resequencing Buffer Management Functions	129
	Monitoring TCP Statistics for IP	131
	Monitoring IP Traffic Statistics	141
	Monitoring IP UDP Statistics	145
	Monitoring an IP Profile	145
	Monitoring Profile Names	147
	Monitoring Route Map Details	147
Chapter 3	Configuring IPv6	149
	IPv6 Overview	150
	IPv6 Packet Headers	151
	IPv4 and IPv6 Header Differences	151
	Standard IPv6 Headers	151
	Extension Headers	152
	IPv6 Addressing Overview	152
	Address Representation	153
	IPv6 Address Compression	153
	IPv6 Address Prefix	153
	Address Types	154
	Address Scope	155
	Address Structure	155
	ICMP Support	155
	IPv6 Tunnel Routing Tables Overview	156
	Indirect Next-Hop Overview	156
	IPv6 Platform Considerations	157
	Supported Management Applications for IPv6	158
	IPv6 References	159
	Before You Configure IPv6	159
	Configuring an IPv6 License	160
	IPv6 Profiles	160
	IPv6 Profiles Overview	160
	Creating a Profile	161
	Configuring Profile Attributes for IPv6	161
	Assigning a Profile to an Interface	163
	Enabling IPv6 Source Address Validation	164
	Establishing an IPv6 Static Route	165
	Understanding ICMPv6 Unreachable Messages for Static Routes Sent on Null Interfaces	165
	Enabling or Disabling the Transmission of ICMPv6 Unreachable Messages for Static Routes on Null Interfaces	167
	Configuring IPv6 Static Routes with Tags for Redistribution of Routes	168

Redistributing a Specific IPv6 Static Route Based on the Tag Value	169
Next-Hop Verification for IPv6 Static Routes Overview	170
BFD Next-Hop Verification Overview for IPv6 Static Routes	170
Enabling BFD on an IPv6 Static Route	171
Configuring BFD Next-Hop Verification for IPv6 Static Routes	171
Specifying an IPv6 Hop-Count Limit	172
Managing IPv6 Interfaces	173
Enabling or Disabling an IPv6 Interface	173
Clearing IPv6 Interface Counters	173
Sending Echo Request Packets to the IPv6 Address	173
Discovering the Routes Followed by Router Packets when Traveling to the IPv6 Destination	174
Shared IPv6 Interfaces	175
Creating a Shared IPv6 Interface	175
Associating the Shared IPv6 Interface with the Layer 2 Interface	176
Example: Configuring Shared IPv6 Interfaces	176
Adding a Description to an IPv6 Interface or Subinterface	177
Configuring TCP for IPv6	178
Setting MSS for TCP Connections	178
Configuring TCP PMTU Discovery for IPv6	179
Enabling TCP PMTU Discovery	179
Limiting TCP PMTU Discovery Values	180
Configuring Black Hole Thresholds for TCP PMTU	181
Protecting Against TCP RST or SYN DoS Attacks	181
Preventing TCP PAWS Timestamp DoS Attacks	182
Protecting Against TCP Out-of-Order DoS Attacks	182
Limiting TCP Resequence Buffers per Router	183
Limiting TCP Resequence Buffers per Virtual Router	183
Limiting TCP Resequence Buffers per Connection	184
ECMP Load Sharing for IPv6	185
ECMP Hashed Mode Overview	185
Defining the Maximum Parallel Routes Supported by the Routing Protocol	185
ECMP Fast Reroute Protection Overview	185
Removing an IPv6 Configuration	186
Clearing IPv6 Routes	187
Creating Static IPv6 Neighbors	187
Clearing Static or Dynamic IPv6 Neighbors	188
Chapter 4 Monitoring IPv6	189
Establishing a Baseline for IPv6 Statistics	189
Setting a Baseline for IPv6 Statistics	190
Setting a Baseline for IPv6 Interface Statistics	190
Setting a Baseline for IPv6 Local Address Pool Statistics	191
Setting a Baseline for IPv6 TCP Statistics	191
System Event Logs Used to Troubleshoot and Monitor IPv6	192
Commands Used to Monitor IPv6	192
Monitoring General Information for IPv6	193
Monitoring Detailed or Summary Information for IPv6 Addresses	194

	Monitoring IPv6 Forwarding Table Details for a Line Module	202
	Monitoring Detailed or Summary Information for IPv6 Interfaces	203
	Monitoring Static or Dynamic Entries of the IPv6 Neighbor Discovery Cache	218
	Monitoring an IPv6 Profile	220
	Monitoring Active IPv6 Protocols	221
	Monitoring the IPv6 Route Redistribution Policy	223
	Monitoring the Current State of IPv6 Routing Tables	224
	Monitoring Received IPv6 Router Advertisements	226
	Monitoring the Status of IPv6 Static Routes in the Routing Table	227
	Monitoring IPv6 Traffic Statistics	229
	Monitoring IPv6 UDP Statistics	233
	Monitoring the IPv6 License Key on the Router	233
	Monitoring TCP Statistics for IPv6	234
	Monitoring the Configuration Details for IPv6 Local Address Pools	244
Chapter 5	Configuring Neighbor Discovery	249
	Understanding Neighbor Discovery	249
	Neighbor Discovery Platform Considerations	250
	Neighbor Discovery References	250
	Configuring Neighbor Discovery	251
	Before You Configure Neighbor Discovery	251
	Configuring Neighbor Discovery	251
	Using IPv6 Profiles and RADIUS to Configure Neighbor Discovery Route Advertisements	252
	IPv6 Profile-Based Configuration	253
	RADIUS-Based Configuration	254
	Configuring Proxy Neighbor Advertisements	254
	Duplicate Address Detection Attempts Overview	255
	Monitoring Neighbor Discovery	255
Part 2	Internet Protocol Routing	
Chapter 6	Configuring RIP	259
	Overview	259
	RIP Metric	259
	RIP Messages	260
	Platform Considerations	260
	References	260
	Features	261
	Route Tags	261
	Authentication	261
	Subnet Masks	262
	Next Hop	262
	Multicasting	262
	Route Summaries	263
	Split Horizon	263
	Equal-Cost Multipath	264
	Applying Route Maps	264
	Before You Run RIP	264

	Configuration Tasks	264
	Relationship Between address and network Commands	266
	Enabling RIP on Dynamic IP Interfaces	276
	Clearing Dynamic RIP Interfaces	277
	Using RIP Routes for Multicast RPF Checks	277
	Configuring the BFD Protocol for RIP	278
	Remote Neighbors	279
	Monitoring RIP	282
	debug Commands	283
	show Commands	283
Chapter 7	Configuring OSPF	293
	Overview	294
	OSPF Terms	294
	Platform Considerations	297
	References	298
	Features	298
	Intra-area, Interarea, and External Routes	298
	Routing Priority	299
	Virtual Links	299
	Authentication	299
	Opaque LSAs	300
	Route Leakage	300
	Equal-Cost Multipath	300
	OSPF MIB	300
	Interacting with Other Routing Protocols	300
	Implementing OSPF for IPv6	301
	Understanding the OSPFv3 Difference	301
	Supported LSA Types	301
	Unsupported OSPF Components	302
	OSPF Configuration Tasks	303
	Starting OSPF	303
	Enabling OSPFv2	303
	Enabling OSPFv3	304
	Creating a Range of OSPF Interfaces	304
	Creating a Single OSPFv2 Interface	306
	Specifying an OSPF Router ID	307
	Aggregating OSPF Networks	308
	Configuring OSPF Interfaces	309
	address Commands	310
	ip ospf and ipv6 ospf Commands	312
	Comparison Example	317
	Precedence of Commands	317
	Configuring OSPF Areas	318
	Optimizing the Cost to Reach a Range of OSPF Routers Within an Area	322
	Configuring Authentication	323
	Authentication Requirements	324
	Configuring the BFD Protocol for OSPF	328

	Configuring Additional Parameters	329
	Methods for Calculating OSPF Interface Cost	338
	Default Metrics	339
	Configuring OSPF for NBMA Networks	339
	Traffic Engineering	340
	Configuring OSPF for Traffic Engineering	341
	Using OSPF Routes for Multicast RPF Checks	342
	OSPF and BGP/MPLS VPNs	343
	Remote Neighbors	343
	Remote Neighbors and Sham Links	347
	Configuring OSPF Graceful Restart	347
	Disabling and Reenabling Incremental SPF	349
	Configuring OSPF Traps	350
	Configuring OSPFv3 Traps	350
	Neighbor Uptime Tracking	352
	Monitoring OSPF	353
	debug Commands	353
	show Commands	354
Chapter 8	Configuring IS-IS	377
	Overview	377
	IS-IS Terms	378
	ISO Network Layer Addresses	380
	Level 1 Routing	380
	Level 2 Routing	380
	Dynamic Hostname Resolution	380
	Authentication	381
	Simple Authentication	381
	HMAC MD5 Authentication	382
	MD5 Authentication Example	382
	Specifying MD5 Start and Stop Timing	383
	Halting MD5 Authentication	384
	Managing and Replacing MD5 Keys	384
	Enabling and Disabling Authentication of CSNPs and PSNPs	384
	Extensions for Traffic Engineering	385
	Integrated IS-IS	385
	Equal-Cost Multipath	386
	Static PPP Interfaces	386
	Route Tags	386
	Route Tag Applications	386
	Route Tag Structure	386
	Setting Route Tags	387
	Using Route Tags	387
	Unsupported Features	388
	Table Maps	388
	Graceful Restart	389
	Features	389
	How Graceful Restart Works	389

IS-IS for IPv6	390
Platform Considerations	391
References	391
Features	392
Before You Run IS-IS	393
Configuration Tasks	393
Enabling IS-IS for IP Routing	393
Summary Example	395
Enabling and Configuring IS-IS for IPv6 Routing	395
Summary Example	397
Configuring IS-IS Interface-Specific Parameters	398
Configuring Authentication	398
Configuring Link-State Metrics	399
Configuring a Reference Bandwidth to Set a Default Metric	399
Setting the CSNP Interval	400
Configuring Hello Packet Parameters	400
Padding IS-IS Hello Packets	401
Configuring LSP Parameters	402
Setting the Designated Router Priority	403
Configuring Passive Interfaces	404
Configuring Adjacency	405
Configuring Route Tags for IS-IS Interfaces	406
Configuring Point-to-Point-over-LAN Circuits	407
Summary Example	408
Configuring Global IS-IS Parameters	408
Setting Authentication Passwords	408
Configuring Authentication of CSNPs and PSNPs	410
Configuring Redistribution	411
Redistributing Routes Between Levels	413
Advertising IPv4 and IPv6 Prefixes of Passive Interfaces	415
Controlling Granularity of Routing Information	416
Configuring a Global Default Metric	417
Configuring Metric Type	417
Setting the Administrative Distance	419
Configuring Default Routes	419
Disregarding the Attach Bit in Level 1 LSPs	420
Setting Router Type	421
Summarizing Routes	421
Avoiding Transient Black Holes	422
Waiting for BGP Convergence	423
Example Topology	423
Suppression for IS-IS Graceful Restart	424
Configuration	424
Ignoring LSP Errors	425
Logging Adjacency State Changes	426
Configuring LSP Parameters	426
Specifying the SPF Interval	428
Defining the SPF Route Calculation Level	429
Setting CLNS Parameters	429

Setting the Maximum Parallel Routes	431
Configuring a Virtual Multiaccess Network	431
Configuring Table Maps	431
Configuring Graceful Restart	432
Summary Example	435
Configuring IS-IS for MPLS	436
Using IS-IS Routes for Multicast RPF Checks	437
Configuring the BFD Protocol for IS-IS	438
Disabling the IS-IS Protocol	439
Monitoring IS-IS	439
System Event Logs	440
Monitoring IS-IS Parameters	440
Displaying CLNS	452

Part 3

Index

Index	469
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List of Figures

Part 1	Internet Protocol	
Chapter 1	Configuring IP	3
	Figure 1: TCP/IP Conceptual Layers	5
	Figure 2: IP Address Classes	9
	Figure 3: Basic Network Masking	11
	Figure 4: Subnetting	12
	Figure 5: Routing With and Without CIDR	12
	Figure 6: Direct Next Hops	15
	Figure 7: Indirect Next Hops	15
	Figure 8: Sample ARP Process—1 through 3	21
	Figure 9: Sample ARP Process—4 and 5	21
	Figure 10: Routers in a Small Network	33
	Figure 11: Static Routes with Indirect Next Hops	39
	Figure 12: Sample Configuration for Next-Hop Verification	44
Chapter 3	Configuring IPv6	149
	Figure 13: IPv4 and IPv6 Header Comparison	151
	Figure 14: Direct Next Hops	157
	Figure 15: Indirect Next Hops	157
Part 2	Internet Protocol Routing	
Chapter 7	Configuring OSPF	293
	Figure 16: OSPF Topology	297
	Figure 17: Optimizing OSPF Area Aggregate Costs	322
Chapter 8	Configuring IS-IS	377
	Figure 18: Overview of IS-IS Topology	379
	Figure 19: Packet Flow Between Routers With and Without Authentication Set	383
	Figure 20: Example of Level 1 and Level 2 Routing	413
	Figure 21: Transit Router Topology	423

List of Tables

	About the Documentation	xxi
	Table 1: Notice Icons	xxii
	Table 2: Text and Syntax Conventions	xxii
Part 1	Internet Protocol	
Chapter 1	Configuring IP	3
	Table 3: Routing Table for Router NY	33
	Table 4: Routing Table for Router LA	34
	Table 5: Default Administrative Distances for Route Sources	34
	Table 6: Next-Hop Verification Results for Sample Configuration	45
	Table 7: Probe Characteristics	76
Chapter 2	Monitoring IP	83
	Table 8: show rtr application Output Fields	88
	Table 9: show rtr collection-statistics Output Fields	89
	Table 10: show rtr configuration Output Fields	90
	Table 11: show rtr history Output Fields	92
	Table 12: show rtr hops Output Fields	93
	Table 13: show rtr operational-state Output Fields	94
	Table 14: show arp Output Fields	96
	Table 15: show ip Output Fields	96
	Table 16: show ip address Output Fields	98
	Table 17: show ip forwarding-table slot Output Fields	101
	Table 18: show ip interface Output Fields	104
	Table 19: show ip interface shares Output Fields	111
	Table 20: show ip protocols Output Fields	114
	Table 21: show ip redistribute Output Fields	116
	Table 22: show ip route Output Fields	119
	Table 23: show ip route slot Output Fields	120
	Table 24: show ip socket statistics Output Fields	122
	Table 25: show ip static Output Fields	127
	Table 26: show tcp path-mtu-discovery Output Fields	128
	Table 27: show tcp resequence-buffers Output Fields	130
	Table 28: show ip tcp statistics Output Fields	134
	Table 29: show ip traffic Output Fields	142
	Table 30: show ip udp statistics Output Fields	145
	Table 31: show ip profile Output Fields	146
	Table 32: show profile brief Output Fields	147
Chapter 3	Configuring IPv6	149

	Table 33: Compressed IPv6 Formats	153
Chapter 4	Monitoring IPv6	189
	Table 34: show ipv6 Output Fields	193
	Table 35: show ipv6 address Output Fields	196
	Table 36: show ipv6 forwarding-table slot Output Fields	203
	Table 37: show ipv6 interface Output Fields	212
	Table 38: show ipv6 neighbors Output Fields	219
	Table 39: show ipv6 profile Output Fields	220
	Table 40: show ipv6 protocols Output Fields	222
	Table 41: show ipv6 redistribute Output Fields	224
	Table 42: show ipv6 route Output Fields	225
	Table 43: show ipv6 routers Output Fields	227
	Table 44: show ipv6 static Output Fields	228
	Table 45: show ipv6 traffic Output Fields	230
	Table 46: show ipv6 udp statistics Output Fields	233
	Table 47: show ipv6 tcp statistics Output Fields	237
	Table 48: show ipv6 local pool Output Fields	245
Part 2	Internet Protocol Routing	
Chapter 7	Configuring OSPF	293
	Table 49: OSPF-Related Terms	294
	Table 50: Routing Priority	299
	Table 51: Additional Configuration Tasks	329
	Table 52: Methods and Precedence for Calculating OSPF Interface Cost	338
Chapter 8	Configuring IS-IS	377
	Table 53: IS-IS Terms	378
	Table 54: Configuration Tasks for Setting IS-IS Route Tags	387
	Table 55: IS-IS Graceful Restart Timers	390

About the Documentation

- E Series and JunosE Documentation and Release Notes on page xxi
- Audience on page xxi
- E Series and JunosE Text and Syntax Conventions on page xxi
- Obtaining Documentation on page xxiii
- Documentation Feedback on page xxiii
- Requesting Technical Support on page xxiii

E Series and JunosE Documentation and Release Notes

For a list of related JunosE documentation, see
<http://www.juniper.net/techpubs/software/index.html>.

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

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

Audience

This guide is intended for experienced system and network specialists working with Juniper Networks E Series Broadband Services Routers in an Internet access environment.

E Series and JunosE Text and Syntax Conventions

Table 1 on page xxii 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 xxii defines text and syntax conventions that we use throughout the E Series and JunosE 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>

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

Convention	Description	Examples
(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
[] (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 } { clusterId ipAddress }

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

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or are covered under warranty, and need post-sales technical support, you can access our tools and resources online or open a case with JTAC.

- JTAC policies—For a complete understanding of our JTAC procedures and policies, review the *JTAC User Guide* located at <http://www.juniper.net/us/en/local/pdf/resource-guides/7100059-en.pdf>.
- Product warranties—For product warranty information, visit <http://www.juniper.net/support/warranty/>.
- JTAC hours of operation—The JTAC centers have resources available 24 hours a day, 7 days a week, 365 days a year.

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

- Find CSC offerings: <http://www.juniper.net/customers/support/>
- Search for known bugs: <http://www2.juniper.net/kb/>
- Find product documentation: <http://www.juniper.net/techpubs/>
- Find solutions and answer questions using our Knowledge Base: <http://kb.juniper.net/>
- Download the latest versions of software and review release notes: <http://www.juniper.net/customers/csc/software/>
- Search technical bulletins for relevant hardware and software notifications: <https://www.juniper.net/alerts/>
- Join and participate in the Juniper Networks Community Forum: <http://www.juniper.net/company/communities/>
- Open a case online in the CSC Case Management tool: <http://www.juniper.net/cm/>

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

Opening a Case with JTAC

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

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

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

PART 1

Internet Protocol

- [Configuring IP on page 3](#)
- [Monitoring IP on page 83](#)
- [Configuring IPv6 on page 149](#)
- [Monitoring IPv6 on page 189](#)
- [Configuring Neighbor Discovery on page 249](#)

CHAPTER 1

Configuring IP

This chapter describes how to configure IP routing on your E Series router.

- [IP Overview on page 4](#)
- [IP Platform Considerations on page 6](#)
- [IP References on page 7](#)
- [Supported IP Features on page 8](#)
- [IP Addressing Overview on page 9](#)
- [Adding and Deleting IP Addresses on page 13](#)
- [Indirect Next-Hop Overview on page 15](#)
- [Before You Configure IP on page 16](#)
- [IP Profiles on page 16](#)
- [Address Resolution Protocol on page 20](#)
- [Transmission of GARP Packets Overview on page 26](#)
- [Configuring the Transmission of GARP Packets on page 28](#)
- [Broadcast Addressing Overview on page 29](#)
- [Configuring Broadcast-Related IP Tasks on page 30](#)
- [IP Fragmentation Overview on page 30](#)
- [Configuring IP Fragmentation-Related Attributes on page 31](#)
- [IP Routing Overview on page 32](#)
- [IP Routing Information Tables Overview on page 32](#)
- [Setting the Administrative Distance for a Route on page 34](#)
- [IP Routing Operations Overview on page 35](#)
- [Identifying a Router Within an Autonomous System on page 36](#)
- [Establishing an IP Static Route on page 36](#)
- [Understanding ICMP Unreachable Messages for Static Routes Sent on Null Interfaces on page 37](#)
- [Enabling or Disabling the Transmission of ICMP Unreachable Messages for Static Routes on Null Interfaces on page 38](#)
- [Configuring IP Static Routes with Indirect Next Hops on page 39](#)

- [Next-Hop Verification for Static Routes Overview on page 40](#)
- [IP Default Route Overview on page 48](#)
- [Configuring IP Source Address Validation on page 48](#)
- [Configuring TCP for IP on page 49](#)
- [Managing IP Interfaces on page 56](#)
- [Clearing and Reinstalling IP Routes on page 61](#)
- [Enabling the Forwarding of IP Source-Routed Packets on page 62](#)
- [Specifying an IP Debounce Time on page 63](#)
- [ECMP Load Sharing for IP on page 63](#)
- [Setting a TTL Value for the IP Header on page 65](#)
- [Distributing Routing Table Updates to Line Modules on page 65](#)
- [IP Tunnel Routing Table Overview on page 66](#)
- [Shared IP Interfaces on page 66](#)
- [Internet Control Message Protocol on page 71](#)
- [Determining Reachability of IP Destinations in the Network on page 73](#)
- [Response Time Reporter on page 75](#)

IP Overview

TCP/IP is a suite of data communications protocols. Two of the more important protocols in the suite are the TCP and the IP.

IP provides the basic packet delivery service for all TCP/IP networks. IP is a connectionless protocol, which means that it does not exchange control information to establish an end-to-end connection before transmitting data. A connection-oriented protocol exchanges control information with the remote computer to verify that it is ready to receive data before sending it.

IP relies on protocols in other layers to establish the connection if connection-oriented services are required and to provide error detection and error recovery. IP is sometimes called an unreliable protocol, because it contains no error detection or recovery code.

- [IP Packets on page 4](#)
- [IP Functions on page 5](#)
- [IP Layering on page 5](#)

IP Packets

A *packet* is a block of data that carries with it the information necessary to deliver it to a destination address. A *packet-switching network* uses the addressing information in the packets to switch packets from one physical network to another, moving them toward their final destination. Each packet travels the network independently of any other packet. The *datagram* is the packet format defined by IP.

IP Functions

Some of the functions IP performs include:

- [Moving Data Between the Network Access Layer and the Host-to-Host Transport Layer on page 5](#)
- [Routing Datagrams to Remote Hosts on page 5](#)
- [Fragmenting and Reassembling Datagrams on page 5](#)

Moving Data Between the Network Access Layer and the Host-to-Host Transport Layer

When IP receives a datagram that is addressed to the local host, it must pass the data portion of the datagram to the correct host-to-host transport layer protocol. IP uses the *protocol number* in the datagram header to select the transport layer protocol. Each host-to-host transport layer protocol has a unique protocol number that identifies it to IP.

Routing Datagrams to Remote Hosts

Internet gateways are commonly referred to as IP routers because they use IP to route packets between networks. In traditional TCP/IP terms, there are only two types of network devices: gateways and hosts. Gateways forward packets between networks, and hosts do not. However, if a host is connected to more than one network (called a *multihomed host*), it can forward packets between the networks. When a multihomed host forwards packets, it acts like any other gateway and is considered to be a gateway.

Fragmenting and Reassembling Datagrams

As a datagram is routed through different networks, it may be necessary for the IP module in a gateway to divide the datagram into smaller pieces. A datagram received from one network may be too large to be transmitted in a single packet on a different network. This condition occurs only when a gateway interconnects dissimilar physical networks.

Each type of network has a maximum transmission unit (MTU) that determines the largest packet it can transfer. If the datagram received from one network is longer than the other network's MTU, it is necessary to divide the datagram into smaller fragments for transmission in a process called *fragmentation*.

IP Layering

TCP/IP is organized into four conceptual layers (as shown in [Figure 1 on page 5](#)).

Figure 1: TCP/IP Conceptual Layers

Application
Transport
Internet
Network Interface

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Network Interface Layer

The network interface layer is the lowest level of the TCP/IP protocol stack. It is responsible for transmitting datagrams over the physical medium to their final destinations.

Internet Layer

The Internet layer is the second level of the TCP/IP protocol stack. It provides host-to-host communication. In this layer, packets are encapsulated into datagrams, routing algorithms are run, and the datagram is passed to the network interface layer for transmission on the attached network.

Transport Layer

The transport layer is the third level of the TCP/IP protocol stack. It is responsible for providing communication between applications residing in different hosts. By placing identifying information in the datagram (such as socket information), the transport layer enables process-to-process communication.

The transport layer provides either a reliable transport service (TCP) or an unreliable service (User Data Protocol). In a reliable delivery service, the destination station acknowledges the receipt of a datagram.

Application Layer

The application layer is the fourth and highest level of the TCP/IP protocol stack. Some applications that run in this layer are:

- Telnet
- FTP
- SMTP
- Simple Network Management Protocol (SNMP)
- Domain Name System (DNS)

Related Documentation

- [IP Platform Considerations on page 6](#)
- [IP References on page 7](#)
- [Supported IP Features on page 8](#)
- [IP Addressing Overview on page 9](#)
- [IP Fragmentation Overview on page 30](#)

IP Platform Considerations

For information about modules that support IP on the ERX7xx models, ERX14xx models, and the Juniper Networks ERX310 Broadband Services Router:

- See *ERX Module Guide, Table 1, Module Combinations* for detailed module specifications.

- See *ERX Module Guide, Appendix A, Module Protocol Support* for information about the modules that support IP.

For information about modules that support IP on the Juniper Networks E120 and E320 Broadband Services 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 IP.

**Related
Documentation**

- [IP Overview on page 4](#)
- [IP References on page 7](#)

IP References

For more information about IP, consult the following resources:

- RFC 768—User Datagram Protocol (August 1980)
- RFC 791—Internet Protocol DARPA Internet Program Protocol Specification (September 1981)
- RFC 792—Internet Control Message Protocol (September 1981)
- RFC 793—Transmission Control Protocol (September 1981)
- RFC 854—Telnet Protocol Specification (May 1983)
- RFC 919—Broadcasting Internet Datagrams (October 1984)
- RFC 922—Broadcasting Internet Datagrams in the Presence of Subnets (October 1984)
- RFC 950—Internet Standard Subnetting Procedure (August 1985)
- RFC 1112—Host Extensions for IP Multicasting (August 1989)
- RFC 1122—Requirements for Internet Hosts—Communication Layers (October 1989)
- RFC 1812—Requirements for IP Version 4 Routers (June 1995)
- RFC 3419—Textual Conventions for Transport Addresses (December 2002)
- *JunosE Release Notes, Appendix A, System Maximums*—Refer to the Release Notes corresponding to your software release for information about maximum values.

**Related
Documentation**

- [IP Overview on page 4](#)
- [IP Platform Considerations on page 6](#)
- [Supported IP Features on page 8](#)

Supported IP Features

The E Series router supports the following IP features:

- Internet Control Message Protocol (ICMP)
- Traceroute
- UDP
- TCP
- Classless Interdomain Routing (CIDR)
- Maximum transmission unit (MTU)
- Support for simultaneous multiple logical IP stacks on the same router
- Flexible IP address assignment to support any portion of a physical interface (for example, a channel or circuit), exactly one physical interface, or multilink Point-to-Point Protocol (PPP) interfaces
- Packet segmentation and reassembly
- Loose source routing to specify the IP route
- Strict source routing to specify the IP route for each hop
- Record route to track the route taken
- Internet timestamp
- Broadcast addressing, both limited broadcast and directed broadcast
- Support for 32,000 discrete, simultaneous IP interfaces per router to support thousands of logical connections
- Capability of detecting and reporting changes in the up or down state of any IP interface
- IP policy support. See *JunosE IP Services Configuration Guide*, for more information about policy configuration.
- Indirect next hops
- IP tunnel routing tables

**Related
Documentation**

- [IP Overview on page 4](#)
- [IP References on page 7](#)

- Physical and Logical Addresses on page 9
- Internet Addresses on page 9
- Subnetwork Mask Format Options on page 10

IP is used by all protocols in the layers above and below it to deliver data. This means that all TCP/IP data flows through IP when it is sent and received, regardless of its final destination.

Four types of IP classes lend themselves to different network configurations, depending on the desired ratio of networks to hosts. [Figure 2 on page 9](#) shows the format of IP address classes.

The diagram illustrates the structure of four IP address classes (A, B, C, and D) based on their bit positions (0 to 31). Each class is represented by a horizontal bar divided into segments for network and host/multicast addresses.

- Class A:** Bit positions 0, 1, ..., 7, 8 are shown above the bar. The bar is divided into three segments: a single bit (0), a "Network" segment (bits 1-7), and a "Local host address" segment (bits 8-31).
- Class B:** Bit positions 0, 1, 2, ..., 15, 16 are shown above the bar. The bar is divided into three segments: two bits (0, 1), a "Network" segment (bits 2-15), and a "Local host address" segment (bits 16-31).
- Class C:** Bit positions 0, 1, 2, 3, ..., 23, 24 are shown above the bar. The bar is divided into four segments: three bits (0, 1, 2), a "Network" segment (bits 3-23), and a "Local host address" segment (bits 24-31).
- Class D:** Bit positions 0, 1, 2, 3, 4 are shown above the bar. The bar is divided into two segments: four bits (0, 1, 2, 3) and a "Multicast address" segment (bits 4-31).

- Class A—The leading bit is set to 0, a 7-bit number, and a 24-bit local host address. Up to 125 class A networks can be defined, with up to 16,777,214 hosts per network.
- Class B—The two highest-order bits are set to 1 and 0, a 14-bit network number, and a 16-bit local host address. Up to 16,382 class B networks can be defined, with up to 65,534 hosts per network.
- Class C—The three leading bits are set to 1, 1, and 0, a 21-bit network number, and an 8-bit local host address. Up to 2,097,152 class C networks can be defined, with up to 254 hosts per network.
- Class D—The four highest-order bits are set to 1, 1, 1, and 0. Class D is used as a multicast address.

Subnetwork Mask Format Options

Most commands allow you to specify IPv4 subnetwork masks in one of two ways: dotted decimal or prefix length notation.



NOTE: Protocol commands that use a reverse mask format (for example, RIP) cannot use the prefix notation format. Use the command-line interface (CLI) help to verify if a command supports the /N prefix notation.

Dotted decimal notation expresses IP addresses and masks in dotted quads - four octets separated by dots (A.B.C.D). In this format, each octet in the address or mask is represented as a decimal number and the dots are used as octet separators.

For example, an IP address and subnetwork mask in dotted decimal notation would appear as follows:

10.10.24.6 255.255.0.0

Prefix length notation (often called network prefix format) allows for more efficient allocation of IP addresses than the old Class A, B, and C address scheme. The prefix length is the number of leftmost contiguous bits equal to 1 in the subnetwork mask. This format appears immediately following the dotted decimal IP address using a /N format.



NOTE: You can issue the network prefix with or without a space between the IP address and the network prefix (/N).

For example, the same IP address and subnetwork mask mentioned above would appear as follows using /N format:

10.10.24.6/16
or
10.10.24.6 /16

The following sections describe each subnetwork mask addressing method in more detail:

- [Subnet Addressing on page 11](#)
- [Classless Addressing with CIDR on page 12](#)

Subnet Addressing

A subnet is a subset of a class A, B, or C network. Subnets cannot be used with class D (multicast) addresses.

A network mask is used to separate the network information from the host information about an IP address. [Figure 3 on page 11](#) shows the network mask 255.0.0.0 applied to network 10.0.0.0. The mask in binary notation is a series of 1s followed by a series of contiguous 0s. The 1s represent the network number; the 0s represent the host number. The sample address splits the IP address 10.0.0.1 into a network portion of 10 and a host portion of 0.0.1.



NOTE: The router supports a 31-bit mask on point-to-point links. This means that the IP address 1.2.3.4 255.255.255.254 is valid. A point-to-point link in which only one end supports the use of 31-bit prefixes may not operate correctly.

Figure 3: Basic Network Masking

	Decimal			Binary		
IP address	40.	0.0.1	00101000	00000000	00000000	00000001
Mask	255.	0.0.0	11111111	00000000	00000000	00000000
			Network portion		Host portion	

Classes A, B, and C have the following *natural masks*, which define the network and host portions of each class:

- Class A natural mask 255.0.0.
- Class B natural mask 255.255.0.0
- Class C natural mask 255.255.255.0

The use of masks can divide networks into subnetworks by extending the network portion of the address into the host portion. Subnetting increases the number of subnetworks and reduces the number of hosts.

For example, a network of the form 10.0.0.0 accommodates one physical segment with about 16 million hosts on it. [Figure 4 on page 12](#) shows how the mask 255.255.0.0 is applied to network 10.0.0.0. The mask divides the IP address 10.0.0.1 into a network portion of 10, a subnet portion of 0, and a host portion of 0.1. The mask has borrowed a portion of the host space and has applied it to the network space. The network space of the class 10 has increased from a single network 10.0.0.0 to 256 subnetworks, ranging from 10.0.0.0 to 10.255.0.0. This process decreases the number of hosts per subnet from 16,777,216 to 65,536.

Figure 4: Subnetting

Decimal			Binary		
IP address	40.	0 .0.1	00101000	00000000	00000000 00000001
Mask	255.	255 .0.0	11111111	00000000	00000000 00000000
			Network portion	Subnet portion	Host portion

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Classless Addressing with CIDR

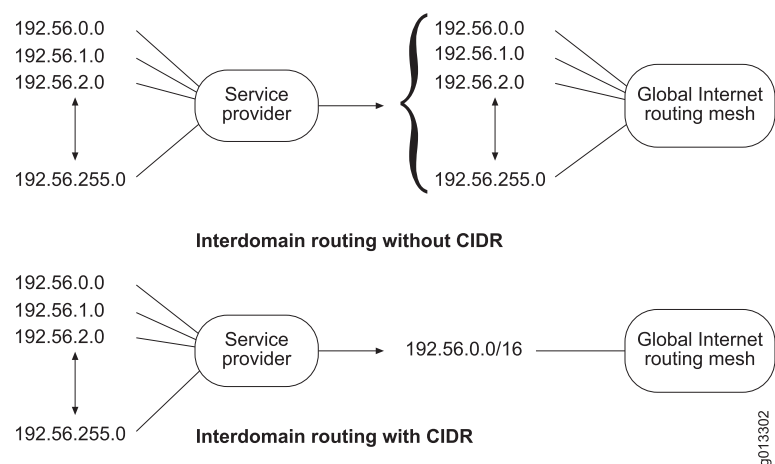
CIDR is a system of addressing that improves the scaling factor of routing in the Internet. CIDR does not use an implicit mask based on the class of network. In CIDR, an IP network is represented by a prefix, which is an IP address and an indication of the leftmost contiguous significant bits within this address.

For example, without CIDR, the class C network address 192.56.0.0 would be an illegal address. With CIDR, the address becomes valid with the notation: 192.56.0.0/16. The /16 indicates that 16 bits of mask are being used (counting from the far left). This would be similar to an address 198.32.0.0. with a mask of 255.255.0.0.

A network is called a *supernet* when the prefix boundary contains fewer bits than the network's natural mask. For example, a class C network 192.56.10.0 has a natural mask of 255.255.255.0. The representation 192.56.0.0/16 has a shorter mask than the natural mask (16 is less than 24), so it is a supernet.

Figure 5 on page 12 shows how CIDR can reduce the number of entries globally in Internet routing tables. A service provider has a group of customers with class C addresses that begin with 192.56. Despite this relationship, the service provider announces each of the networks individually into the global Internet routing mesh.

Figure 5: Routing With and Without CIDR



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Related Documentation

- [IP Overview on page 4](#)
- [Adding and Deleting IP Addresses on page 13](#)
- [Address Resolution Protocol on page 20](#)
- [Broadcast Addressing Overview on page 29](#)

Adding and Deleting IP Addresses

This topic provides information about adding or deleting IP addresses.

Multinetting is adding more than one IP address to an IP interface—that is, a primary address and one or more secondary addresses.



NOTE:

- Before you configure IP, you must create the lower-layer interfaces over which IP traffic flows.
- All IP configurations will be removed from the interface when you issue the **no ip interface** command in Interface Configuration mode.

You can add or delete IP primary and secondary addresses for an interface with the following tasks:

- [Adding and Deleting a Primary Address on page 13](#)
- [Adding and Deleting a Secondary \(Multinet\) Address on page 14](#)

Adding and Deleting a Primary Address

You can add IP primary address to an interface or delete the existing primary address using the **ip address** command.



NOTE:

- The primary address must be the first address added to the interface.
- Adding a new primary address overwrites the existing primary address.
- You can change a secondary address to be the primary address on an interface only via SNMP.
- An unnumbered address is always the primary address; adding an unnumbered address, therefore, overwrites any other numbered address.
- You must always remove the primary address from an interface last.
- You cannot delete the primary address if the interface still has assigned secondary addresses.

To add a primary address:

- Issue the **ip address** command in Interface Configuration mode.

```
host1(config-if)#ip address 192.168.2.77 255.255.255.0
```

You can specify the subnetwork mask value in either dotted decimal or prefix length notation.



NOTE: You can use this command in Subinterface Configuration mode or Profile Configuration mode.

Use the **no** version to remove an IP address. If you remove a primary IP address, IP processing is disabled on the interface.

Adding and Deleting a Secondary (Multinet) Address

You can add a secondary IP address to an interface or delete the assigned secondary address using the **ip address** command with the **secondary** keyword.



NOTE:

- You cannot add a secondary address until you add the primary address.
- You cannot add a secondary address to bridged Ethernet interfaces.
- You cannot change a primary address to a secondary address.
- An interface can have multiple secondary addresses.
- You must delete secondary addresses before deleting the primary address.
- If you add an address using the **ip address** command and do not include the **secondary** keyword, the new address becomes the primary address.

To add a secondary address:

- Issue the **ip address** command with the **secondary** keyword.

```
host1(config-if)#ip address 172.31.7.22 255.255.255.0 secondary
```

You can specify the subnetwork mask value in either dotted decimal or prefix length notation.



NOTE: You can use this command in Subinterface Configuration mode or Profile Configuration mode.

Use the **no** version to remove an IP address.

Related Documentation

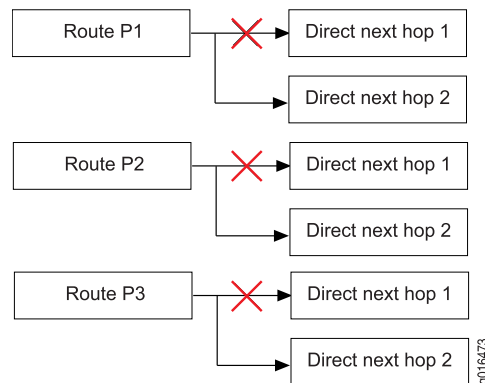
- [IP Addressing Overview on page 9](#)
- [Setting Up an Unnumbered Interface on page 57](#)
- [Monitoring Detailed or Summary Information for IP Interfaces on page 97](#)
- `ip address`
- `no ip interface`

Indirect Next-Hop Overview

The router uses indirect next hops to promote faster network convergence (for example, in BGP networks) by decreasing the number of routing table changes required when a change in the network topology occurs.

Direct next-hops point routes in the routing table toward individual, direct next-hop connections. (See [Figure 6 on page 15.](#))

Figure 6: Direct Next Hops

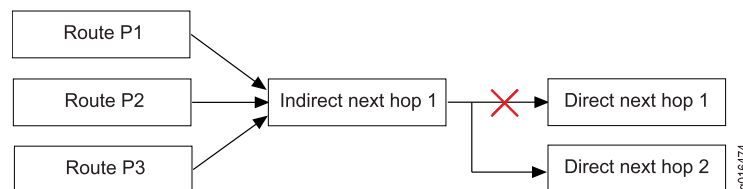


Indirect next hops enable multiple routes in the routing table to point to a single next hop, thereby accelerating convergence. (See [Figure 7 on page 15.](#))



NOTE: Indirect next hops are not limited to any number of levels. In other words, an indirect next hop can point to a direct next hop or another indirect next hop.

Figure 7: Indirect Next Hops



By using indirect next hops, if a topology change occurs in the network, only the indirect next hop is modified in the routing table, decreasing the number of state changes required to achieve convergence.

Related Documentation

- [Configuring IP Static Routes with Indirect Next Hops on page 39](#)
- [Configuring ECMP Round-Robin Load Sharing on page 64](#)
- [Enabling IPv6 Source Address Validation on page 164](#)
- [ECMP Fast Reroute Protection Overview on page 64](#)

Before You Configure IP

Before you configure IP, you must create the lower-layer interfaces over which IP traffic flows. For information about the modules that support IP:

- See *E120 and E320 Module Guide, Appendix A, IOA Protocol Support* for modules supported on E120 and E320 routers.
- See *ERX Module Guide, Appendix A, Module Protocol Support* for modules supported on the ERX310, ERX710, ERX1410, and ERX1440 routers.

For example, to configure an ATM interface:

```
host1(config)#interface atm 1/0
host1(config-if)#atm sonet stm-1
host1(config-if)#no loopback
host1(config-if)#atm clock internal chassis
host1(config-if)#interface atm 1/0.10
host1(config-if)#atm pvc 10 0 20 aal5snap
```

See *JunosE Link Layer Configuration Guide* for information about configuring an ATM interface. See *JunosE Physical Layer Configuration Guide* for information about configuring an Ethernet interface.



NOTE: If you choose to configure VRRP, we recommend that you complete all IP address configurations before you configure VRRP. See *JunosE Services Availability Configuration Guide*, for additional information.

Related Documentation

- [IP Profiles on page 16](#)
- [atm clock internal](#)
- [atm pvc](#)
- [atm sonet stm-1](#)
- [interface atm](#)
- [loopback](#)

IP Profiles

You can create a profile, add IP characteristics to the profile, and assign the profile to IP interfaces.

- [IP Profiles Overview on page 17](#)
- [Creating a Profile on page 17](#)
- [Configuring Profile Attributes for IP on page 18](#)
- [Assigning a Profile to an Interface on page 19](#)

IP Profiles Overview

You can configure an IP interface dynamically by creating a profile. A profile is a set of characteristics that acts as a pattern that can be dynamically assigned to an IP interface. You can manage a large number of IP interfaces efficiently by creating a profile with a specific set of characteristics. In addition, you can create a profile to assign an IP interface to a virtual router.

A profile can contain one or more of the following characteristics:

- **access-route**—Enables the creation of host access routes on an interface
- **address**—Configures an IP address on an interface
- **auto-configure**—Configures the interface for auto-configure mode
- **auto-detect**—Configures the interface for auto-detect mode
- **directed-broadcast**—Enables directed broadcast forwarding
- **filter-options-all**—Enables filtering of packets with IP options on an interface
- **igmp**—Configures an Internet Group Management Protocol (IGMP) interface
- **ignore-df-bit**—Specifies that the don't-fragment bit is ignored
- **inactivity-timer**—Configures inactivity time for IP interfaces
- **inspection**—Associates an inspection list to the interface for firewalling
- **mtu**—Configures the maximum transmission unit for a network
- **nat**—Configures the interface as inside or outside for Network Address Translation (NAT)
- **policy**—Assigns a policy to the ingress or egress of an interface
- **redirects**—Enables transmission of Internet Control Message Protocol (ICMP) redirect messages
- **route-maps**—Configures the interface for route-map processing
- **source address validation**—Verifies that a packet has been sent from a valid source address
- **tcp adjust-mss**—Adjusts maximum packet sizes on TCP connections when path maximum transmission unit detection is not sufficient
- **unnumbered**—Configures IP on this interface without a specific address
- **virtual-router**—Specifies a virtual router to which interfaces created by this profile will be attached

Creating a Profile

You can use the **profile** command from Global Configuration mode to create or edit a profile. You can specify a profile name with up to 80 characters.

To create a profile on the router:

- Issue the **profile** command in Global Configuration mode.

```
host1(config)#profile foo
```

Use the **no** version to remove a profile.

See *JunosE Link Layer Configuration Guide* for information about creating profiles and on other characteristics that can be applied to the profile.

Configuring Profile Attributes for IP

You can add a specific set of IP characteristics to a created profile and assign the profile to many IP interfaces.

To assign IP characteristics to a profile:

1. Assign an IP address.

```
host1(config-profile)#ip address 192.56.32.2 255.255.255.0
```

2. (Optional) Enable an access route.

```
host1(config-profile)#ip access-routes
```

3. (Optional) Enable a directed broadcast address.

```
host1(config-profile)#ip directed-broadcast
```

4. (Optional) Assign the MTU size sent on an IP interface to which the profile is assigned.

```
host1(config-profile)#ip mtu 5000
```

5. (Optional) Enable the sending of redirect messages if the software is forced to resend a packet through the same interface (to which the profile is assigned) on which it was received.

```
host1(config-profile)#ip redirects
```

6. (Optional) Modify the maximum segment size (MSS) for TCP SYN packets traveling through the interface to which the profile is assigned. The router compares the MSS value of incoming or outgoing packets against the MSS adjustment value. For any packet that contains an MSS value larger than the MSS adjustment value, the router replaces the MSS option with the configured adjustment value. If the packet does not contain an MSS value, the router assumes a value of 536 for the packet MSS on which to base the comparison.

```
host1(config-profile)#ip tcp adjust-mss 5000
```



NOTE: The purpose behind using MSS is to alleviate problems with path maximum transmission unit discovery and resulting black hole detection issues. (See RFC 2923, “TCP Problems with Path MTU Discovery,” for additional information about the black hole scenario.)

7. (Optional) Specify the numbered interface with which dynamic unnumbered interfaces created with the profile are associated. You can specify an unnumbered interface using RADIUS instead of using the **ip unnumbered** command in a profile.

```
host1(config-profile)#ip unnumbered fastEthernet 0/0
```

8. (Optional) Assign a virtual router. You can configure a virtual router using RADIUS instead of adding one to the profile by using the **ip virtual-router** command.

```
host1(config-profile)#ip virtual-router VR1
```

9. (Optional) Force the router to ignore the DF bit if it is set in the IP packet header for packets on an interface to which the profile is assigned.

```
host1(config-profile)#ip ignore-df-bit
```

10. (Optional) Enable source address validation.

```
host1(config-profile)#ip sa-validate
```

Assigning a Profile to an Interface

You can assign a profile to a PPP interface using the **profile** command. The profile configuration is used to dynamically create an upper IP interface.

To assign a profile to an interface:

- Issue the **profile** command in Interface Configuration mode.

```
host1(config-if)#profile foo
```

Use the **no** version to remove the assignment from the interface.

Related Documentation

- [System Event Logs Used to Troubleshoot and Monitor IP on page 85](#)
- [Monitoring Detailed or Summary Information for IP Interfaces on page 97](#)
- [Monitoring an IP Profile on page 145](#)
- [Monitoring Profile Names on page 147](#)
- [ip access-routes](#)
- [ip address](#)
- [ip directed-broadcast](#)
- [ip ignore-df-bit](#)
- [ip mtu](#)
- [ip redirects](#)
- [ip sa-validate](#)
- [ip tcp adjust-mss](#)
- [ip unnumbered](#)
- [ip virtual-router](#)
- [profile](#)

Address Resolution Protocol

This topic describes Address Resolution Protocol (ARP).

- [ARP Overview on page 20](#)
- [Understanding How ARP Works on page 20](#)
- [Configuring ARP on page 22](#)
- [Enabling Proxy ARP on page 24](#)
- [MAC Address Validation Overview on page 24](#)
- [Adding IP Address-MAC Address Validation Pairs on page 25](#)

ARP Overview

Sending IP packets on a multiaccess network requires mapping from an IP address to a media access control (MAC) address (the physical or hardware address).

In an Ethernet environment, ARP is used to map a MAC address to an IP address. ARP dynamically binds the IP address (the logical address) to the correct MAC address. Before IP unicast packets can be sent, ARP discovers the MAC address used by the Ethernet interface where the IP address is configured.

Hosts that use ARP maintain a cache of discovered Internet-to-Ethernet address mappings to minimize the number of ARP broadcast messages. To keep the cache from growing too large, an entry is removed if it is not used within a certain period of time. Before sending a packet, the host searches its cache for Internet-to-Ethernet address mapping. If the mapping is not found, the host sends an ARP request.

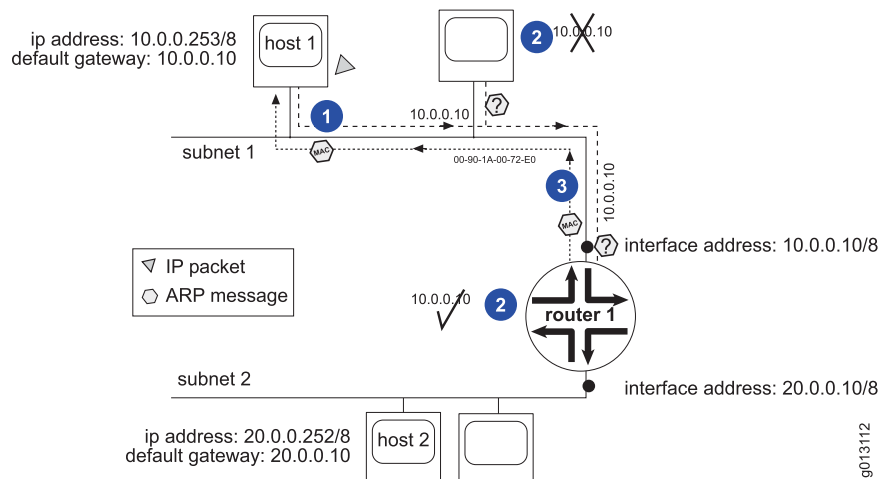
Understanding How ARP Works

[Figure 8 on page 21](#) and [Figure 9 on page 21](#) show how ARP works where host 1 sends an IP packet to host 2 on a different subnet. To complete this transmission, host 1 needs the MAC address of router 1, to be used as the forwarding gateway.

A typical scenario is:

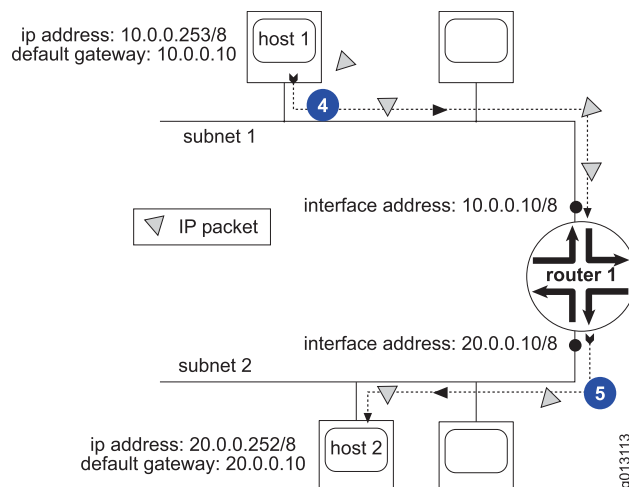
1. Host 1 broadcasts an ARP request to all devices on subnet 1, composed by a query with the IP address of router 1. The IP address of router 1 is needed because host 2 is on a different subnet.
2. All devices on subnet 1 compare their IP address with the enclosed IP address sent by host 1.
3. Having the matching IP address, router 1 sends an ARP response, which includes its MAC address, to host 1.

Figure 8: Sample ARP Process—1 through 3



4. Host 1 transmits the IP packet to layer 3 DA (host 2) using router 1's MAC address.
5. Router 1 forwards IP packet to host 2. Router 1 might send an ARP request to identify the MAC of host 2. (See [Figure 9 on page 21](#).)

Figure 9: Sample ARP Process—4 and 5



ARP forces all receiving hosts to compare their IP addresses with the IP address of the ARP request. So if host 1 sends another IP packet to host 2, host 1 searches its ARP table for the router 1 MAC address.

If the default router/gateway becomes unavailable, then all the routing/packet forwarding to remote destinations ceases. Usually, manual intervention is required to restore connectivity, even though alternative paths may be available. Alternatively, Virtual Router Redundancy Protocol (VRRP) may be used to prevent loss of connectivity. See *JunosE IP Services Configuration Guide*.

Configuring ARP

ARP can be configured on an E Series router with the following tasks:

- [Adding a Static Entry in the ARP Cache on page 22](#)
- [Checking for Spoofed ARP Packets on page 22](#)
- [Configuring ARP Cache Entry Timeout on page 23](#)
- [Clearing Dynamic Entries from the ARP Cache on page 24](#)

Adding a Static Entry in the ARP Cache

You can add a static (permanent) entry in the ARP cache using the **arp** command.

You can specify the *ipAddress*, *interfaceType* and *interfaceSpecifier* (as indicated in Interface Types and Specifiers in *JunosE Command Reference Guide*), and an optional MAC address.

To add a static entry in the ARP cache:

- Issue the **arp** command in Global Configuration mode.

```
host1(config)#arp 192.56.20.1 gig 2/0 0090.1a00.0170
```



.....
NOTE: You can issue this command only for Fast Ethernet interfaces, Gigabit Ethernet interfaces, 10-Gigabit Ethernet interfaces, and bridged Ethernet interfaces configured over ATM 1483.
.....

Use the **no** version to remove an entry from the ARP cache.

Checking for Spoofed ARP Packets

You can configure the router to check for spoofed ARP packets received on an IP interface or an IP subinterface using the **arp spoof-check** command.

By default, E Series routers check all received ARP packets for spoofing and process only those ARP packets whose source IP address is outside the range of the network mask. ARP packets with a source IP address of 0.0.0.0 and the router IP address as the destination address are dropped because the router identifies them as spoofed packets.

In networks with digital subscriber line access multiplexers (DSLAMs), even if you configure the router to check for spoofed ARP packets, DSLAMs perform this task instead of the router. If you disable checking for spoofed ARP packets on the router in such networks, DSLAMs forward the received packets to the router for processing. You can, therefore, configure the router accordingly, depending on the way in which you want spoof-checking to be performed.

You cannot configure ARP spoof-checking on interfaces that do not support ARP, such as loopback interfaces and ATM point-to-point PVCs.

If you disable checking for spoofed ARP packets, all packets received by the router are processed. You can reenale checking for spoofed ARP packets on an interface at any time by using the **arp spoof-check** command after disabling it.



NOTE:

- Before you configure IP, you must create the lower-layer interfaces over which IP traffic flows.
- All IP configurations will be removed from the interface when you issue the **no ip interface** command in Interface Configuration mode.

To enable spoof-checking for ARP packets received on an interface:

- Issue the **arp spoof-check** command in Interface Configuration mode.

```
host1(config-if)#arp spoof-check
```

Use the **no** version to disable checking for spoofed ARP packets received on a major IP interface or an IP subinterface.

Configuring ARP Cache Entry Timeout

You can specify how long an entry remains in the ARP cache using the **arp timeout** command. The default value is 21,600 seconds (6 hours). You can use the **show config** command to display the current value. If you specify a timeout of 0 seconds, entries are never cleared from the ARP cache.



NOTE:

- Before you configure IP, you must create the lower-layer interfaces over which IP traffic flows.
- All IP configurations will be removed from the interface when you issue the **no ip interface** command in Interface Configuration mode.

To specify how long an entry remains in the ARP cache:

- Issue the **arp timeout** command in Interface Configuration mode.

```
host1(config-if)#arp timeout 8000
```



NOTE: You can issue this command only for Fast Ethernet interfaces, Gigabit Ethernet interfaces, 10-Gigabit Ethernet interfaces, and bridged Ethernet interfaces configured over ATM 1483.

Use the **no** version to restore the default value.

Clearing Dynamic Entries from the ARP Cache

You can clear a particular dynamic entry from the ARP cache using the **clear arp** command by specifying all of the following options:

- *ipAddress*—IP address in four-part dotted-decimal format corresponding to the local data link address
- *interfaceType*—Interface type; see Interface Types and Specifiers in *JunosE Command Reference Guide*
- *interfaceSpecifier*—Particular interface; format varies according to interface type; see Interface Types and Specifiers in *JunosE Command Reference Guide*

You can clear all dynamic entries from the ARP cache using the **clear arp** command with an asterisk (*).

To clear all dynamic entries:

- Issue the **clear arp** command with an asterisk (*) in Privileged Exec mode.
`host1#clear arp`

Enabling Proxy ARP

You can enable proxy ARP on an Ethernet or bridge1483 interface using the **ip proxy-arp** command. Proxy ARP is enabled by default.



NOTE:

- Before you configure IP, you must create the lower-layer interfaces over which IP traffic flows.
 - All IP configurations will be removed from the interface when you issue the **no ip interface** command in Interface Configuration mode.
-

To enable proxy ARP on an interface:

- Issue the **ip proxy-arp** command in Interface Configuration mode.

`host1(config-if)#ip proxy-arp unrestricted`

Use the **no** version to disable proxy ARP on the interface.

MAC Address Validation Overview

MAC address validation is a verification process performed on each incoming packet to prevent spoofing on IP Ethernet-based interfaces, including bridged Ethernet interfaces. When an incoming packet arrives on a layer 2 interface, the validation table is used to compare the packet's source IP address with its MAC address. If the MAC address and IP address match, the packet is forwarded; if it does not match, the packet is dropped.



NOTE: MAC address validation for bridged Ethernet interfaces is supported only on OC12 ATM line modules on ERX routers and on OC3/OC12 ATM IOAs on the E120 and E320 routers.

MAC address validation on the E Series router can be accomplished in two ways:

- You can statically configure it on a physical interface via the **arp validate** command
- You can enable Dynamic Host Configuration Protocol (DHCP) to perform the function independently and dynamically. See *JunosE Link Layer Configuration Guide*.

The **arp validate** command adds the IP-MAC address pair to the validation table maintained on the physical interface.

If the validation is added statically via the command-line interface (CLI), the IP address–MAC address pairs are stored in nonvolatile storage (NVS). The entries are used for MAC validation only if MAC validation is enabled on the interface via the **ip mac-validate** command.



CAUTION: When you configure an interface using the **arp validate** command, you cannot overwrite the ARP values that were added by DHCP.

You can enable or disable MAC address validation on a per interface basis by issuing the **ip mac-validate** command. See *JunosE Physical Layer Configuration Guide* or *JunosE Link Layer Configuration Guide* for information.

A dynamic IP subscriber interface inherits the MAC address validation state (enabled or disabled) configured for its parent static primary IP interface. See *Configuring Subscriber Interfaces* in the *JunosE Broadband Access Configuration Guide* for information.

Adding IP Address-MAC Address Validation Pairs

You can add IP address–MAC address validation pairs using the **arp** command with the **validate** keyword. When validation is enabled, all packets with the source IP address received on this IP interface are validated against the IP-MAC entries.

You can add a validation pair by specify one of the following:

- *ipAddress* and *macAddress* of the interface.
- *ipAddress*, *interfaceType* and *interfaceSpecifier* (as indicated in Interface Types and Specifiers in *JunosE Command Reference Guide*), and an optional MAC address.

**NOTE:**

- You can issue this **arp** command with the **validate** keyword only for an IP Ethernet-based interface.
- For subscriber interface configurations, the IP address–MAC address pair must have a matching source prefix that already exists on the subscriber interface. If the matching source prefix does not exist, the IP–MAC address pair is rejected. See *Configuring Subscriber Interfaces* in the *JunosE Broadband Access Configuration Guide* for information about using subscriber interfaces.

To add a validation pair:

- Issue the **arp** command with the **validate** keyword in Global Configuration mode.

```
host1(config)#arp 192.56.20.1 gig 2/0 0090.1a00.0170 validate
```

Use the **no** version to remove an entry from the ARP cache.

Related Documentation

- [IP Addressing Overview on page 9](#)
- [IP Routing Information Tables Overview on page 32](#)
- [Monitoring ARP Details on page 95](#)
- [Monitoring Detailed or Summary Information for IP Interfaces on page 97](#)
- [Monitoring the Current State of IP Interfaces on page 102](#)
- [Monitoring IP Traffic Statistics on page 141](#)
- [arp](#)
- [arp spoof-check](#)
- [arp timeout](#)
- [clear arp](#)
- [ip mac-validate](#)
- [ip proxy-arp](#)
- [no ip interface](#)

Transmission of GARP Packets Overview

Gratuitous Address Resolution Protocol (GARP) requests provide duplicate IP address detection. A GARP request is a broadcast request for a router's own IP address. If a router sends an Address Resolution Protocol (ARP) request for its own IP address and no ARP replies are received, the router's assigned IP address is not being used by other nodes. If a router sends an ARP request for its own IP address and an ARP reply is received, the router's assigned IP address is already being used by another node.

A GARP is an ARP broadcast in which the source and destination MAC addresses are the same. It is used primarily by a host to inform the network about its IP address. A spoofed gratuitous ARP message can cause network mapping information to be stored incorrectly, causing a network malfunction.

GARP is a method of establishing an association between a logical IP address and a hardware address whenever an interface is created or the state of the interface shifts to the operationally up state. On the other hand, ARP dynamically binds the IP address (the logical address) to the correct MAC address. The device that transmits a GARP populates both the source and destination fields with its own information. The devices that receive the GARP requests might update the ARP caches with the new information contained in the GARP packets.

By default, updating the ARP cache on GARP replies is disabled on the router. On Ethernet interfaces, you can enable transmission of GARP packets on a specific interface by using the **ip gratuitous-arps** command in Interface Configuration mode and specify the number of GARP packets to be sent, depending on the changes to IP interface settings. If an IP address is configured directly on the physical Ethernet interface and a VLAN major interface is not configured on the Ethernet interface for VLAN encapsulation, transmission of GARP packets does not take place.

When you create an IP interface or the administrative status of the interface transitions to the up state, three GARP packets are transmitted for each IP address. Each GARP packet is sent at an interval of 10 seconds. By default, the router generates GARP requests. An IP interface can support up to a maximum of 16 secondary IP addresses. Therefore, with the maximum number of secondary IP addresses configured, a total of 48 GARP messages for each IP interface are sent. In a fully scaled environment, such a transmission of a large number of GARP messages creates a storm of GARP packets in the entire broadcast domain, which contains dynamic subscriber line access multiplexers (DSLAMs) and other BRAS devices within the same Metro Ethernet network. In such a network, reducing the number of GARP packets transmitted for interface changes reduces performance impact on the router and improves the processing efficiency of the router.

GARP Packets Transmission Scenarios

The following scenarios describe the manner in which GARP packets are generated, based on the default configuration settings for transmission of GARP packets and the network topology:

- Three GARP packets are sent when you configure a new primary or secondary IP address on an IP interface.
- Three GARP packets are transmitted when an IP interface state transitions from the down state to the up state.
- Three GARP packets are sent for each IP address of the numbered interface when a new unnumbered interface associated with the numbered interface is created.

- Three GARP packets are sent for all the unnumbered interfaces whenever any secondary IP address on the numbered interface that it is associated with is modified.
- Three GARP packets are sent for all the unnumbered interfaces for all the IP addresses whenever the primary IP address of the numbered interface that it is associated with is modified.

In all of the these scenarios, you can modify the number of GARP packets to be transmitted to be less than three by using the **ip gratuitous-arps** command.

The following two scenarios describe the method of transmission of GARP packets, regardless of whether the sending of GARP packets is disabled. In such cases, even if you configure the **no ip gratuitous-arps** command to disable sending GARPs, these packets are sent to denote the changes in system and interface conditions.

- One GARP packet is always sent for each virtual address of a VRRP interface. If you configure VRRP on a virtual router and associate the IP address with the VRRP instance ID (VRID) using the **ip vrrp** command in Interface Configuration mode, one GARP packet is always transmitted for each virtual address of the interface enabled for VRRP.
- Three GARP packets are always sent when a failover occurs to the secondary link of the redundant port on GE-2 and GE-HDE line modules that are paired with GE-2 SFP I/O modules, 2xGE APS I/O SFP modules, and GE-2 APS I/O SFP modules, with physical link redundancy.

**Related
Documentation**

- [Configuring the Transmission of GARP Packets on page 28](#)

Configuring the Transmission of GARP Packets

You can enable the generation of Gratuitous Address Resolution Protocol (GARP) packets using the **ip gratuitous-arps** command in Interface Configuration mode and specify the number of GARP packets to be sent at a frequency of 10 seconds. By default, three GARPs are sent at an interval of 10 seconds of one another.



NOTE: You must first configure the Ethernet interface for VLAN encapsulation using the **encapsulation vlan** command in Interface Configuration mode before configuring the transmission of GARP packets. Otherwise, an error message is displayed stating that VLAN encapsulation must be enabled on the Ethernet interface to enable configuration of GARP transmission parameters.

To configure the transmission of GARP packets:

1. Specify a Fast Ethernet, Gigabit Ethernet, or 10-Gigabit Ethernet interface.

```
host1(config)#interface gigabitEthernet 2/0/1
```

2. Specify VLAN as the encapsulation method.

```
host1(config-if)#encapsulation vlan
```

The VLAN major interface is added. If an IP address is configured directly on the physical Ethernet interface and a VLAN major interface is not configured on the Ethernet interface for VLAN encapsulation, transmission of GARP packets does not take place.

3. Configure the transmission of GARP packets.

```
host1(config-if)#ip gratuitous-arps 2
```

In this example, two GARP packets are sent at an interval of 10 seconds when the interface state transitions from the down state to the up state, if the primary IP address is modified, or a new secondary IP address is configured.

**Related
Documentation**

- [Transmission of GARP Packets Overview on page 26](#)
- `ip gratuitous-arps`

Broadcast Addressing Overview

A broadcast is a data packet destined for all hosts on a particular physical network. Network hosts recognize broadcasts by special addresses.

The router supports the following kinds of broadcast types:

- Limited broadcast—A packet is sent to a specific network or series of networks. A limited broadcast address includes the network or subnet fields. In a limited broadcast packet destined for a local network, the network identifier portion and host identifier portion of the destination address is either all ones (255.255.255.255) or all zeros (0.0.0.0).
- Flooded broadcast—A packet is sent to every network.
- Directed broadcast—A packet is sent to a specific destination address where only the host portion of the IP address is either all ones or all zeros (such as 192.20.255.255 or 190.20.0.0).

Several early IP implementations do not use the current broadcast address standard. Instead, they use the old standard, which calls for all zeros instead of all ones to indicate broadcast addresses. Many of these implementations do not recognize a broadcast address of all ones and fail to respond to the broadcast correctly. Others forward broadcasts of all ones, which causes a serious network overload known as a *broadcast storm*. Implementations that exhibit these problems include systems based on versions of BSD UNIX before version 4.3.

Routers provide some protection from broadcast storms by limiting their extent to the local cable. Bridges (including intelligent bridges), because they are layer 2 devices, forward broadcasts to all network segments, thus propagating all broadcast storms.

The best solution to the broadcast storm is to use a single broadcast address scheme on a network. Most IP implementations allow the network manager to set the address to be used as the broadcast address. Many implementations of IP, including the one on your router, can accept and interpret all possible forms of broadcast addresses.

- Related Documentation**
- [IP Addressing Overview on page 9](#)
 - [Configuring Broadcast-Related IP Tasks on page 30](#)

Configuring Broadcast-Related IP Tasks

You can perform broadcast-related tasks using the **ip broadcast-address** and **ip directed-broadcast** commands.



NOTE:

- Before you configure IP, you must create the lower-layer interfaces over which IP traffic flows.
- All IP configurations will be removed from the interface when you issue the **no ip interface** command in Interface Configuration mode.

To configure broadcast information:

- Specify the broadcast IP address for an interface.
`host1(config-if)#ip broadcast-address 255.255.255.255`
Use the **no** version to restore the default IP broadcast address.
- Enable translation of directed broadcasts to physical broadcasts.
`host1(config-if)#ip directed-broadcast`
Use the **no** version to disable the function.

- Related Documentation**
- [Broadcast Addressing Overview on page 29](#)
 - [Monitoring IP Routing Table Details for a Line Module on page 120](#)
 - `ip broadcast-address`
 - `ip directed-broadcast`
 - `no ip interface`

IP Fragmentation Overview

Fragmentation is the process of segmenting a large IP datagram into several smaller pieces. Fragmentation is required when IP must transmit a large packet through a network that transmits smaller packets, or when the maximum transmission unit (MTU) size of the other network is smaller.

By default, the router does not fragment the packet if the don't-fragment bit (DF bit) is set in the IP header. You can specify that the router not consider the DF bit before determining whether to fragment a packet.



NOTE: Lower-layer protocols can also set the MTU value. If MTU values set in lower layers differ from the one set at the IP layer, the router always uses the MTU lower-layer value.

**Related
Documentation**

- [IP Overview on page 4](#)
- [Configuring IP Fragmentation-Related Attributes on page 31](#)

Configuring IP Fragmentation-Related Attributes

You can configure the IP datagrams fragmenting attributes using the **ip ignore-df-bit** and **ip mtu** commands.



NOTE:

- Before you configure IP, you must create the lower-layer interfaces over which IP traffic flows.
- All IP configurations will be removed from the interface when you issue the **no ip interface** command in Interface Configuration mode.
- Force the router to ignore the don't-fragment bit (DF bit) if it is set in the IP packet header for packets on an interface.


```
host1(config-if)#ip ignore-df-bit
```

Use the **no** version to restore the default behavior, which is to consider the DF bit before fragmentation.
- Set the maximum transmission unit (MTU) size of IP packets sent on an interface. The range is 128–10240.



NOTE: Do not configure both Multilink Point-to-Point Protocol (MLPPP) fragmentation (with the **ppp fragmentation** command) and IP fragmentation of Layer 2 Tunneling Protocol (L2TP) packets (with the **ip mtu** command) on the same interface. Instead, you must choose only one of the fragmentation configurations by setting it to the necessary value and set the other fragmentation configuration to the maximum allowable value.

```
host1(config-if)#ip mtu 1000
```

Use the **no** version to restore the default MTU size.

**Related
Documentation**

- [IP Fragmentation Overview on page 30](#)
- [Monitoring Detailed or Summary Information for IP Interfaces on page 97](#)
- **ip ignore-df-bit**

- ip mtu
- no ip interface
- ppp fragmentation

IP Routing Overview

The Internet is a large collection of hosts that communicate with each other and use routers as intermediate packet switches.

Routers forward a packet through the interconnected system of networks and routers until the packet reaches a router that is attached to the same network as the destination host. The router delivers the packet to the specified host on its local network.

Related Documentation

- [IP Routing Information Tables Overview on page 32](#)
- [IP Routing Operations Overview on page 35](#)
- [IP Default Route Overview on page 48](#)
- [IP Tunnel Routing Table Overview on page 66](#)

IP Routing Information Tables Overview

A router makes forwarding decisions based on the information that is contained in its routing table. Routers announce and receive route information to and from other routers. They build tables of routes based on the collected information about all the best paths to all the destinations they know how to reach.

Each configured protocol has one or more local routing tables, sometimes referred to as a routing information base (RIB). This table is a database local to the protocol that contains all the routes known by that protocol to the prefixes in the table. For example, OSPF might have four different routes to 10.23.40.5.32. Only one of these routes is the best route to that prefix known to OSPF, but all four routes are in the OSPF local routing table.

The global routing table is a database maintained by IP on the switch route processor (SRP) module. It contains at most one route per protocol to each prefix in the table. Each of these routes is the best route known by a given protocol to get to that prefix. The IP routing table does not, for example, have two OSPF routes to 10.5.11.0/24; it will have only one (if any) OSPF route to that prefix. It might also have a BGP route to the prefix, and a RIP route to the prefix, but no more than one route to a prefix per protocol.

IP compares the administrative distances for the routes to each prefix and selects the overall best route regardless of protocol. The best route to 10.5.11.0/24 might be via IS-IS. The best route to 192.168.0.0/16 might be via EBGP, and so on. These selected overall best routes to each prefix are used to create the forwarding table. The forwarding table is pushed to each line module. The line modules use their local instance of the forwarding table to forward the packets that they receive. When the global IP routing table is updated, so are the forwarding tables on the line modules.

Figure 10 on page 33 illustrates a very simple network composed of three networks and two routers. The hosts that are attached to each network are not shown, because each router makes its forwarding decisions based on the network number and not on the address of each individual host. The router uses Address Resolution Protocol (ARP) to find the physical address that corresponds to the Internet address for any host or router on networks directly connected to it.

Figure 10: Routers in a Small Network

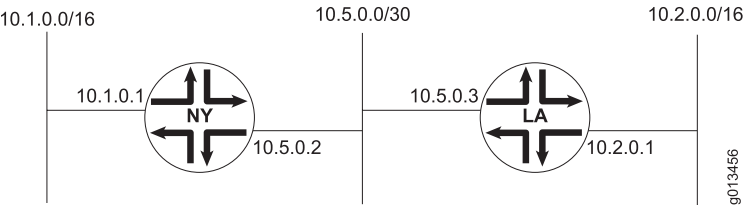


Table 3 on page 33 and Table 4 on page 34 represent information from the routing tables for routers NY and LA. Each routing table contains one entry for each route for each protocol or route type. Each routing table entry includes the following information:

- The destination IP network address.
- The IP address of the next-hop router.
- The type of network, such as static, directly connected, or the particular protocol.
- An administrative distance that is used to select the least-cost route among multiple routes to the same destination network. The least-cost (best) route is placed in the forwarding table. The administrative distance is not included in the forwarding table.
- A metric that is used by protocols to which the route is redistributed to select the least-cost route among multiple routes to the same destination network. The metric is not used to determine the best route to be placed in the forwarding table. The metric is also not listed in the forwarding table.

Table 3: Routing Table for Router NY

Destination Network	Next-Hop Router	Route Type	Administrative Distance	Metric
10.1.0.0/16	10.1.0.1	connected	0	0
10.2.0.0/16	10.5.0.3	OSPF	110	10
10.2.0.0/16	10.5.0.3	IS-IS	115	10
10.2.0.0/16	10.5.0.3	EBGP	20	15
10.2.0.0/16	10.5.0.3	RIP	120	5
10.5.0.0/30	10.5.0.2	connected	0	0

Table 4: Routing Table for Router LA

Destination Network	Next-Hop Router	Route Type	Administrative Distance	Metric
10.1.0.0/16	10.5.0.2	static	1	0
10.1.0.0/16	10.5.0.2	OSPF	110	10
10.1.0.0/16	10.5.0.2	RIP	120	4
10.2.0.0/16	10.2.0.1	connected	0	0
10.5.0.0/30	10.5.0.3	connected	0	0

Related Documentation

- [Address Resolution Protocol on page 20](#)
- [IP Routing Overview on page 32](#)
- [IP Routing Operations Overview on page 35](#)
- [IP Default Route Overview on page 48](#)
- [ECMP Load Sharing for IP on page 63](#)

Setting the Administrative Distance for a Route

The administrative distance is an integer that is associated with each route known to a router. The distance represents how reliable the source of the route is considered to be. A lower value is preferred over a higher value. An administrative distance of 255 indicates no confidence in the source; routes with this distance are not installed in the routing table.

[Table 5 on page 34](#) lists the default distance for each type of source from which a route can be learned.

Table 5: Default Administrative Distances for Route Sources

Route Source	Default Distance
Connected interface	0
Static route	1
Internal access route	2
Access route	3
External BGP	20
OSPF	110

Table 5: Default Administrative Distances for Route Sources *(continued)*

Route Source	Default Distance
IS-IS	115
RIP	120
Internal BGP	200
Unknown	255

If the IP routing table contains several routes to the same prefix—for example, an OSPF route and a RIP route—the route with the lowest administrative distance is used for forwarding.

To set the administrative distance for BGP routes, see *JunosE BGP and MPLS Configuration Guide*.

You can set the administrative distance for RIP, IS-IS, and OSPF using the **distance** and **distance ip** commands.

To set an administrative distance:

- For RIP and OSPF, issue the **distance** command in Router Configuration mode.
`host1(config-router)#distance 100`
The range for administrative distance is 0–255. The default value is 120 for RIP routes and 110 for OSPF routes. You can use the **no** version to restore the default value.
- For IS-IS, issue the **distance ip** command in Router Configuration mode.
`host1(config-router)#distance 80 ip`
The range for administrative distance is 1–255. The default value is 115 for IS-IS routes. You can use the **no** version to restore the default value.

Related Documentation

- [IP Routing Information Tables Overview on page 32](#)
- [Monitoring IP Protocols on page 113](#)
- [Monitoring the Current State of IP Routing Tables on page 116](#)
- [Monitoring the Status of IP Static Routes in the Routing Table on page 126](#)
- [distance](#)
- [distance ip](#)

IP Routing Operations Overview

Routers keep track of next-hop information that enables a data packet to reach its destination through the network. A router that does not have a direct physical connection to the destination checks its routing table and forwards packets to another next-hop

router that is closer to that destination. This process continues until the packet reaches its final destination.

- Related Documentation**
- [IP Routing Overview on page 32](#)
 - [IP Routing Information Tables Overview on page 32](#)

Identifying a Router Within an Autonomous System

The router identifier (ID) is commonly one of the router's defined IP addresses. Although the router ID is, by convention, formatted as an IP address, it is not required to be a configured address of the router. If you do not use the **ip router-id** command to assign a router ID, the router uses one of its configured IP addresses as the router ID. The router ID is a unique identifier that IP routing protocols use to identify the router within an autonomous system.

To assign a router ID:

- Issue the **ip router-id** command in Global Configuration mode.

```
host1(config)#ip router-id 192.32.15.23
```

Use the **no** version to remove the router ID assignment.

- Related Documentation**
- [Monitoring General Information for IP on page 96](#)
 - [Monitoring IP Protocols on page 113](#)
 - [Monitoring IP Traffic Statistics on page 141](#)
 - [ip router-id](#)

Establishing an IP Static Route

You can set a destination to receive and send traffic by a specific route through the network using the **ip route** command.

For null 0 interfaces, you can use the **reject** keyword to enable the sending of Internet Control Message Protocol (ICMP) unreachable messages to the originator for discarded ping and traceroute packets that reach the null 0 interface with a static route.

Alternatively, you can use the **discard** keyword to disable the sending of ICMP unreachable messages to the originator for such dropped packets. For more information about the usage of ICMP unreachable messages for packets that reach null 0 interfaces with static routes, see [“Understanding ICMP Unreachable Messages for Static Routes Sent on Null Interfaces” on page 37](#).

To establish a static route:

- Issue the **ip route** command in Global Configuration mode.

```
host1(config)#ip route 192.56.15.23 255.255.255.0 192.66.0.1
```

Use the **no** version to remove a static route from the routing table.

- Related Documentation**
- [IP Routing Information Tables Overview on page 32](#)
 - [Monitoring the Current State of IP Routing Tables on page 116](#)
 - [Monitoring the Status of IP Static Routes in the Routing Table on page 126](#)
 - `ip route`

Understanding ICMP Unreachable Messages for Static Routes Sent on Null Interfaces

You can handle undesired traffic by sending data packets to the null interface. The null interface is automatically created by the router, is always up, cannot be deleted, and acts as a data sink. The null interface cannot forward or receive traffic. However, the command-line interface (CLI) does enable you to access the null interface. You can configure a static route using the **ip route** command and direct traffic to the null interface by specifying the **null 0** keyword with this command, instead of a next-hop or destination address. You can also use access control lists to filter undesired traffic.

When a ping or traceroute packet from a subscriber reaches the null 0 interface configured with a static route, it is discarded in the forwarding plane. You can configure the router to either send or not send Internet Control Message Protocol (ICMP) unreachable messages to the subscriber for such discarded packets. An advantage of this feature is that it enables synchronization of the RADIUS configuration of the client environment with the network topology.

You can use the **reject** keyword with the **ip route** command to cause the router to send ICMP unreachable messages to the originator from which ping and traceroute packets are received on the null 0 interface with a static route. The switch route processor (SRP) module drops these ping and traceroute packets destined for null 0 interface without further processing and sends ICMP unreachable messages to the originator.

For ICMP unreachable messages to be sent from the router for packets that are received from clients on the static routes configured on null 0 interfaces, you must configure the router to enable generation of ICMP unreachable messages for IPv4 (ping and traceroute) that the router cannot deliver using the **ip unreachable** command in Interface Configuration mode.

The option to send ICMP unreachable messages is available for all IPv4 static routes in a virtual router that are configured with null 0 interface as the next-hop. The Denial of Service (DoS) protection feature can be enabled to monitor the ping and traceroute packets that are discarded from flooding the network. A new DoS type is used to apply a rate-control limit on these packets.

By default, generation of ICMP unreachable messages is enabled on an interface. If the capability to generate ICMP unreachable messages is disabled on the interface, you must enable this functionality using the **ip unreachable** command in Interface Configuration mode to send ICMP unreachables for packets that reached null 0 interfaces with static routes and were discarded.

If you disable generation of ICMP unreachable messages for null interfaces on the router using the **no ip unreachable** command, ICMP unreachable messages are not sent for

packets that are dropped or not processed by such interfaces, even if you configure static routes for such interfaces to send ICMP unreachable (using the **reject** keyword with the **ip route** command).

To enable backward compatibility with versions of JunosE Software in which functionality is not available, the default behavior is to discard the ping and traceroute packets destined for null 0 interfaces at the forwarding layer without the transmission of ICMP unreachable messages to the originator.

You can use the output of the **show ip static** command to determine whether the sending of ICMP unreachable messages is enabled on each interface for which static routes are configured. The ICMP Unreach field in the output of these commands specifies whether the **reject** or **discard** keyword is configured for each static route on the router interface.

Related Documentation

- [IP Routing Information Tables Overview on page 32](#)
- [Establishing an IP Static Route on page 36](#)
- [Enabling or Disabling the Transmission of ICMP Unreachable Messages for Static Routes on Null Interfaces on page 38](#)
- **ip route**
- **ip unreachable**
- **show ip static**

Enabling or Disabling the Transmission of ICMP Unreachable Messages for Static Routes on Null Interfaces

You can configure a static route using the **ip route** command and direct traffic to the null interface by specifying the **null 0** keyword with this command, instead of a next-hop or destination address.

To configure an IP static route with a null 0 interface as the next-hop:

- Issue the **ip route** command with the **null 0** keyword in Global Configuration mode.

```
host1(config)#ip route 192.168.10.0/24 null0
```

The default behavior for packets reaching null 0 interfaces with static routes takes effect, which is to discard the received packets and not send ICMP unreachable messages to the originator.

To enable the transmission of ICMP unreachable messages for IPv4 packets that reach the static route configured on the null 0 interface and are discarded:

- Issue the **ip route** command with the **null 0** and **reject** keywords in Global Configuration mode.

```
host1(config)#ip route 192.168.10.0/24 null0 reject
```

To disable the transmission of ICMP unreachable messages for IPv4 packets that reach the static route configured on the null 0 interface and are discarded:

- Issue the **ip route** command with the **null 0** and **discard** keywords in Global Configuration mode.

```
host1(config)#ip route 192.168.10.0/24 null0 discard
```

Use the **no** version to remove a static route from the routing table.

Related Documentation

- [Understanding ICMP Unreachable Messages for Static Routes Sent on Null Interfaces on page 37](#)
- [Monitoring the Current State of IP Interfaces on page 102](#)
- [Monitoring the Status of IP Static Routes in the Routing Table on page 126](#)
- [Monitoring TCP Statistics for IP on page 131](#)
- [Monitoring IP Traffic Statistics on page 141](#)
- `ip route`

Configuring IP Static Routes with Indirect Next Hops

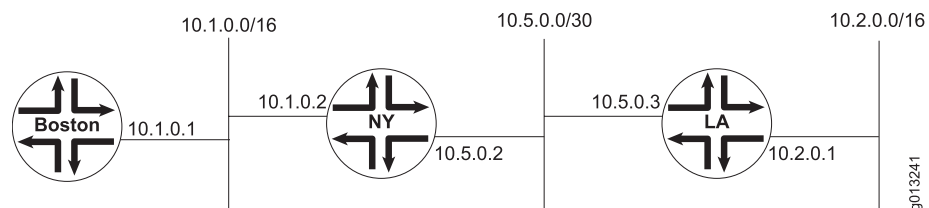
You can configure static routes where next hops are not on directly connected interfaces. Such a route is usable, and appears in the route table, only if another route in the route table can resolve the next hop.

The resolving route can be either statically created or dynamically learned by a routing protocol (like RIP, BGP, OSPF, and so on).



NOTE: When configuring this type of static route, the route that resolves the next hop must have an administrative distance value that is better (lower) than the distance of the static route you want to resolve.

Figure 11: Static Routes with Indirect Next Hops



On the Boston router in the network shown in [Figure 11 on page 39](#):

1. Configure a static route to 10.2.0.0/16 with a next hop of 10.5.0.2 (which is not directly connected) and an administrative distance of 254 (which is worse [higher] than the default administrative distance for static routes [1]).

```
host1(config)#ip route 10.2.0.0 255.255.0.0 10.5.0.2 254
```

2. Configure another static route that resolves 10.5.0.2 and uses the default administrative distance.

```
host1(config)#ip route 10.5.0.0 255.255.255.252 10.1.0.2 [ 1 ]
```



NOTE: The previous example shows the default administrative distance value, 1, to illustrate the difference between the two static route commands. However, you do not have to enter this value when issuing the command.

A static route to 10.2.0.0 is added to the route table with a next hop of 10.1.0.2 (on the directly connected Ethernet interface).



NOTE: A dynamically learned route can also resolve indirect next hops, as long as the administrative distance value of the learned route is better (lower) than the static route whose next hop is being resolved.

**Related
Documentation**

- [Indirect Next-Hop Overview on page 15](#)
- [IP Routing Information Tables Overview on page 32](#)
- [Monitoring the Current State of IP Routing Tables on page 116](#)
- `ip route`

Next-Hop Verification for Static Routes Overview

You can configure either Bidirectional Forwarding Detection (BFD) or Response Time Reporter (RTR) probes to further control when a static route is installed in the routing table. Using either BFD or RTR, static route installation is based on two factors: whether the next hop to the specified destination is resolved, and whether an IP service running above the static route application is currently available.

Next-hop verification is useful for static route configurations in which the layer 2 and layer 3 interfaces are up and the next hop to the specified destination is available, but the IP services that run above the static route are currently unavailable. When the upper-layer IP services are unavailable, the router does not install the static route in its routing table.

- [BFD Next-Hop Verification Overview on page 41](#)
- [Enabling BFD on a Static Route on page 41](#)
- [Configuring BFD Next-Hop Verification on page 42](#)
- [RTR Next-Hop Verification Overview on page 42](#)
- [Establishing an IP Static Route and Associating it with a Configured RTR Operation on page 43](#)
- [Example: Configuring the RTR Next-Hop Verification Feature on page 43](#)

BFD Next-Hop Verification Overview

Static routes on E Series routers can use BFD to verify the availability of the next hop and obtain the state of the IP service. For additional information about BFD, see *JunosE IP Services Configuration Guide*.

If you specify the **bfd-liveness-detection** keyword with a minimum receive interval, minimum transmit interval, or multiplier when you issue the **ip route** command to establish a static route, the router verifies the next-hop status and installs the static route in the routing table under the following conditions:

- You configure the static routes with the actual next hop address and not just interface details.
- The BFD protocol is operational on both ends of the verification.
- The next hop is adjacent to the router (that is, only one hop away).



NOTE: BFD next-hop verification does not currently function in a multi-hop configuration.

- The next hop to the specified IP destination address is resolved.

You can further control the installation of static routes by specifying the **last-resort** keyword, which is valid when you use the **bfd-liveness-detection** keyword in the **ip route** command. The **last-resort** keyword instructs the router to install the static route in the routing table even if the specified BFD operation is unreachable, provided that no other static route to the same network prefix is available.

The static route is removed from the routing table if the next hop is no longer reachable and reinstalled when the route becomes reachable again.

Enabling BFD on a Static Route

You can enable BFD on a static route using the **ip route** command with the **bfd-liveness-detection** keyword.

You can use the following optional keywords along with the **bfd-liveness-detection** keyword:

- The **minimum-interval** keyword to specify a value in the range 100–65535 milliseconds. This keyword defines both the minimum receive interval and minimum transmit interval using the same value.
- The **minimum-receive-interval** keyword to specify a minimum receive interval value in the range 100–65535 milliseconds.
- The **minimum-transmit-interval** keyword to specify a minimum transmit interval value in the range 100–65535 milliseconds.

- The **multiplier** keyword to specify a multiplier number in the range 1–255.
- The **last-resort** keyword to instruct the router to install the static route in the routing table even if the specified BFD operation is currently unreachable, provided that no other static route to the same network prefix is available.

You can change parameters at any time without stopping or restarting the existing session; BFD automatically adjusts to the new parameter value. However, no changes to BFD parameters take place until the values resynchronize with each BFD peer.

To enable BFD on a static route with:

- Next-hop address and last resort.

```
host1(config)#ip route 192.56.15.23 255.255.255.0 192.66.0.1 verify  
bfd-liveness-detection minimum-interval 800 multiplier 2 last-resort
```

- Next-hop address and interface.

```
host1(config)#ip route 192.56.15.24 255.255.255.0 192.66.0.2 fast 6/0 verify  
bfd-liveness-detection
```

- Next-hop address with different receive and transmit intervals.

```
host1(config)#ip route 192.56.15.23 255.255.255.0 192.66.0.1 verify  
bfd-liveness-detection minimum-receive-interval 800 minimum-transmit-interval  
300 multiplier 2 last-resort
```

Use the **no** version to remove the static route from the routing table and thereby remove BFD from that static route.

Configuring BFD Next-Hop Verification

To enable BFD next hop verification between two adjacent peers, you configure each peer as follows:

1. Configure peer A with the next hop address of peer B along with the desired intervals and keyword options.

```
host1(config)#ip route 192.1.1.0 255.255.255.0 192.1.2.1 verify bfd-liveness-detection  
minimum-interval 500 multiplier 3 last-resort
```

2. Configure peer B with the next hop address of peer A along with the desired intervals and keyword options.

```
host1(config)#ip route 192.1.2.1 255.255.255.0 192.1.1.0 verify bfd-liveness-detection  
minimum-interval 300 multiplier 3
```

RTR Next-Hop Verification Overview

Static routes on E Series routers can use RTR probes configured as echo (ping) types to verify the availability of the next hop and obtain the state of the IP service. For more information about using RTR, see [“Response Time Reporter” on page 75](#).

If you specify the **verify rtr** keywords with an RTR operation number when you issue the **ip route** command to establish a static route, the router verifies the next-hop status and

installs the static route in the routing table only if *both* of the following conditions are met:

- The next hop to the specified IP destination address is resolved.
- The specified RTR operation is currently reachable.

You can further control the installation of static routes by specifying the **last-resort** keyword, which is valid only when you use the **verify rtr** keywords in the **ip route** command. The **last-resort** keyword instructs the router to install the static route in the routing table even if the specified RTR operation is unreachable, provided that no other static route to the same network prefix is available.

Establishing an IP Static Route and Associating it with a Configured RTR Operation

You can establish a static route and associate it with a configured RTR operation using the **ip route** command with the **verify rtr** keyword.

The **verify rtr** keyword instructs the router to install the static route in the routing table only if the next hop to the specified destination address is resolved and if the specified RTR operation is currently reachable. When you use the **verify rtr** keyword, you must also specify the number of the associated RTR operation.

Optionally, you can include the **last-resort** keyword when you use the **verify rtr** keyword to instruct the router to install the static route in the routing table even if the specified RTR operation is currently unreachable, provided that no other static route to the same network prefix is available.

To establish a static route and associate it with a configured RTR operation:

- Issue the **ip route** command with the **verify rtr** keyword in Global Configuration mode.

```
host1(config)#ip route 10.1.1.5 255.255.255.0 10.1.1.5 fastEthernet 1/0 verify rtr 5
last-resort
```

Use the **no** version to remove a static route from the routing table.

Example: Configuring the RTR Next-Hop Verification Feature

This topic describes how to configure the RTR next-hop verification feature. Although this configuration example uses Fast Ethernet interfaces, E Series routers support next-hop verification on any type of lower-layer interface.

- [Requirements on page 43](#)
- [Overview on page 44](#)
- [Configuring RTR Next-Hop Verification on page 45](#)

Requirements

This example uses the following software and hardware components:

- JunosE Release 7.1.0 or higher-numbered releases

- E Series router (ERX7xx models, ERX14xx models, the ERX310 router, the E120 router, or the E320 router)
- ASIC-based line modules that support Fast Ethernet or Gigabit Ethernet

**NOTE:**

- Before you configure IP, you must create the lower-layer interfaces over which IP traffic flows.
- All IP configurations will be removed from the interface when you issue the **no ip interface** command in Interface Configuration mode.

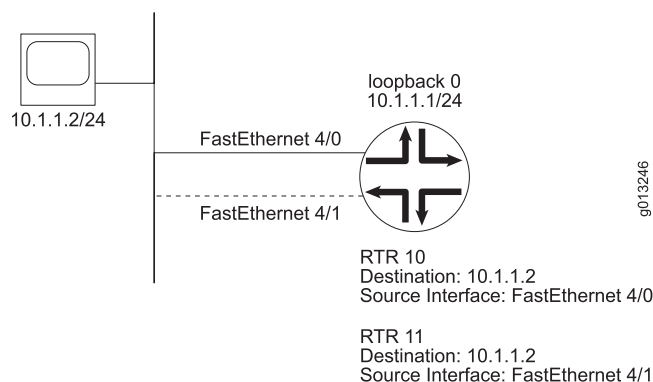
Overview

Figure 12 on page 44 shows a sample configuration that illustrates the next-hop verification feature. In this example, two Fast Ethernet interfaces are configured between a remote system and an E Series router: Fast Ethernet interface 4/0 and Fast Ethernet interface 4/1. At any given time, only one of these interfaces forwards IP traffic, even though the associated layer 2 interfaces may be up concurrently.

On the E Series router, Fast Ethernet interfaces 4/0 and 4/1 are configured as unnumbered IP interfaces. In addition, each interface has an RTR probe configured as an echo type that sends requests over the interface to determine its availability. RTR 10 sends requests over Fast Ethernet interface 4/0, and RTR 11 sends requests over Fast Ethernet interface 4/1.

In this example, both RTR 10 and RTR 11 use the IP address of the remote system (10.1.1.2) as the target address. When you configure multiple RTR entries to use the same target address, you must set the **receive-interface** attribute to specify the interface on which the probe expects to receive responses. (See Step 4c.) This action enables the router to map incoming responses to the proper RTR entry, even when multiple RTR entries have the same target address.

Figure 12: Sample Configuration for Next-Hop Verification



The **ip route** command is issued for each interface with the **verify rtr** and **last-resort** keywords to establish the necessary static routes. (See Steps 6 and 7.) This command

causes the results described in [Table 6 on page 45](#), based on the status of the associated RTR operations.

Table 6: Next-Hop Verification Results for Sample Configuration

RTR 10 Status	RTR 11 Status	Results
Up	Up	The router installs an equal-cost multipath (ECMP) route to 10.1.1.2 in the routing table, using Fast Ethernet interfaces 4/0 and 4/1 as the next hops.
Up	Down	The router installs a route to 10.1.1.2, using Fast Ethernet interface 4/0 as the next hop.
Down	Up	The router installs a route to 10.1.1.2, using Fast Ethernet interface 4/1 as the next hop.
Down	Down	<p>Although both RTR operations are down, the <i>last-resort</i> keyword instructs the router to install an ECMP route to 10.1.1.2, using Fast Ethernet interfaces 4/0 and 4/1 as the next hops.</p> <p>When all of the RTR operations associated with your static routes are down, you can control which route is installed in the routing table by including the <i>last-resort</i> keyword in the <i>ip route verify rtr</i> command only for the route that you want to install.</p>

Configuring RTR Next-Hop Verification

To configure the next-hop verification example shown in [Figure 12 on page 44](#):

- Configure a loopback interface, and assign an IP address and mask to the interface.


```
host1(config)#interface loopback 0
host1(config-if)#ip address 10.1.1.1 255.255.255.255
host1(config-if)#exit
```
- Configure Fast Ethernet port 4/0 with an unnumbered primary IP interface associated with the loopback interface configured in Step 1.


```
host1(config)#interface fastEthernet 4/0
host1(config-if)#ip unnumbered loopback 0
host1(config-if)#exit
```
- Repeat Step 2 for Fast Ethernet port 4/1.


```
host1(config)#interface fastEthernet 4/1
host1(config-if)#ip unnumbered loopback 0
host1(config-if)#exit
```
- Define probe RTR 10 for Fast Ethernet interface 4/0.
 - Assign an operation number to the RTR probe, and access RTR Configuration mode. For information, see [“Configuring the Probe Type for RTR” on page 75](#).


```
host1(config)#rtr 10
host1(config-rtr)#
```

- b. Configure the RTR probe as an echo type, and set the IP destination address and source interface.

You must configure the RTR probe as an echo type to use next-hop verification. For information, see [“Configuring the Probe Type for RTR” on page 75](#).

```
host1(config-rtr)#type echo protocol ipIcmpEcho 10.1.1.2
source fastEthernet 4/0
```

- c. Specify the interface on which the RTR probe expects to receive responses.

You must set the **receive-interface** attribute when multiple RTR operations use the same target address. For information, see [“Setting the Receiving Interface for the RTR Entry” on page 81](#).

```
host1(config-rtr)#receive-interface fastEthernet 4/0
```

- d. (Optional) Configure optional probe characteristics, such as the frequency and samples-of-history kept. For information, see [“Configuring the Probe Characteristics for RTR” on page 76](#).

```
host1(config-rtr)#frequency 1
host1(config-rtr)#samples-of-history-kept 0
```

- e. Exit RTR Configuration mode.

```
host1(config-rtr)#exit
```

- f. Enable the probe to react to the test-failure event and the test-completion event.

You must configure both the test-failure and test-completion reaction conditions to use next-hop verification. For information, see [“Setting the Reaction Conditions for the RTR Probe” on page 78](#).

```
host1(config)#rtr reaction-configuration 10 test-failure 3
host1(config)#rtr reaction-configuration 10 test-completion
```

- g. Schedule the probe operation. For information, see [“Scheduling the RTR Probe” on page 79](#).

```
host1(config)#rtr schedule 10 life 3
host1(config)#rtr schedule 10 restart-time 1
host1(config)#rtr schedule 10 start now
```

5. Repeat Step 4 to define RTR 11 for Fast Ethernet interface 4/1.

```
host1(config)#rtr 11
host1(config-rtr)#type echo protocol ipIcmpEcho 10.1.1.2
source fastEthernet 4/1
host1(config-rtr)#receive-interface fastEthernet 4/1
host1(config-rtr)#frequency 1
host1(config-rtr)#samples-of-history-kept 0
host1(config-rtr)#exit
host1(config)#rtr reaction-configuration 11 test-failure 3
host1(config)#rtr reaction-configuration 11 test-completion
host1(config)#rtr schedule 11 life 3
host1(config)#rtr schedule 11 restart-time 1
host1(config)#rtr schedule 11 start now
```

6. Establish a static route associated with RTR 10.

This command creates a static route and installs it in the routing table only if RTR 10 is currently reachable *or* if no other static route to IP destination address 10.1.1.2 is usable.

```
host1(config)#ip route 10.1.1.2 255.255.255.255 10.1.1.2 fastEthernet 4/0 verify rtr 10
last-resort
```

7. Establish a static route associated with RTR 11.

This command creates a static route and installs it in the routing table only if RTR 11 is currently reachable *or* if no other static route to IP destination address 10.1.1.2 is usable.

```
host1(config)#ip route 10.1.1.2 255.255.255.255 10.1.1.2 fastEthernet 4/1 verify rtr 11
last-resort
```

When both RTR 10 and RTR 11 are unreachable, you can control which static route is installed in the routing table by including the **last-resort** keyword in the **ip route verify rtr** command only for the route that you want to install.



NOTE: For detailed information about the commands for configuring RTR probes, see [“Response Time Reporter” on page 75](#).

Related Documentation

- [IP Routing Information Tables Overview on page 32](#)
- [Response Time Reporter on page 75](#)
- [Monitoring the Status of IP Static Routes in the Routing Table on page 126](#)
- frequency
- interface fastEthernet
- interface loopback
- ip address
- ip route
- ip unnumbered
- no ip interface
- receive-interface
- rtr
- rtr reaction-configuration test-completion
- rtr reaction-configuration test-failure
- rtr schedule
- rtr schedule life
- rtr schedule restart-time

- [samples-of-history-kept](#)
- [type](#)

IP Default Route Overview

A router examines its routing table to find a path for each packet. If the router cannot locate a route, it must discard the packet. You can set up a default route using the special address: 0.0.0.0. If the router cannot locate a path to a destination network and a default route is defined, the router forwards the packet to the default router. For example:

```
host1(config)#ip route 0.0.0.0 0.0.0.0 192.56.21.3
```

Default routes are typically used to reduce the size of the routing table. Routing is simplified because the router can test for a few local networks or use the default route. However, a disadvantage of default routes is the possible creation of multiple paths and routing loops.

Related Documentation

- [IP Routing Overview on page 32](#)
- [IP Routing Information Tables Overview on page 32](#)
- [ip route](#)

Configuring IP Source Address Validation

You can configure IP source address validation on an E Series router with the following tasks:

- [Enabling IP Source Address Validation on page 48](#)
- [Enabling IP Source Address Validation Traps on page 49](#)

Enabling IP Source Address Validation

Source address validation verifies that a packet has been sent from a valid source address. When a packet arrives on an interface, the router performs a routing table lookup using the source address. The result from the routing table lookup is an interface to which packets destined for that address are routed. This interface must match the interface on which the packet arrived. If it does not match, the router drops the packet.



NOTE:

- Before you configure IP, you must create the lower-layer interfaces over which IP traffic flows.
 - All IP configurations will be removed from the interface when you issue the **no ip interface** command in Interface Configuration mode.
-

To enable source address validation:

- Issue the **ip sa-validate** command in Interface Configuration mode.


```
host1(config-if)#ip sa-validate
```

Use the **no** version to disable source address validation.

Enabling IP Source Address Validation Traps

You can enable the generation of traps for source address validation failure using the **ip sa-validate trap-enable** command.

You can specify a VRF context for which you want to enable trap validation for source address validation.



NOTE: To fully enable source address validation traps, you must also enable the IP trap category with the **snmp-server trap enable** command. See *JunosE System Basics Configuration Guide* for more information.

To enable the generation of traps for source address validation failure on the router:

- Issue the **ip sa-validate trap-enable** command in Global Configuration mode.

```
host1(config)#ip sa-validate trap-enable
```

Use the **no** version to disable the generation of source address validation failure traps on the router.

Related Documentation

- [IP Routing Information Tables Overview on page 32](#)
- [Monitoring General Information for IP on page 96](#)
- [Monitoring Detailed or Summary Information for IP Interfaces on page 97](#)
- [Monitoring the Current State of IP Interfaces on page 102](#)
- [ip sa-validate](#)
- [ip sa-validate trap-enable](#)
- [no ip interface](#)
- [snmp-server](#)

Configuring TCP for IP

IP supports TCP configuration. You use the same commands to configure TCP on IP as you do to configure TCP on IPv6. This topic describes the following tasks:

- [Defining TCP Maximum Segment Size for IP on page 50](#)
- [Setting MSS for TCP Connections for IP on page 50](#)
- [Configuring TCP PMTU Discovery for IP on page 51](#)
- [Protecting Against TCP RST or SYN DoS Attacks on page 53](#)

- [Preventing TCP PAWS Timestamp DoS Attacks on page 53](#)
- [Protecting Against TCP Out-of-Order DoS Attacks on page 54](#)

Defining TCP Maximum Segment Size for IP

You can modify the maximum segment size (MSS) for TCP sessions using the **ip tcp adjust-mss** command.

When defined, the router modifies the MSS for TCP SYN packets traveling through the interface. The router compares the MSS value of incoming or outgoing packets against the adjusted MSS setting and replaces smaller values that it detects in any packets with the larger setting. If the packet does not contain an MSS value, the router assumes a value of 536 for the packet MSS on which to base the comparison.



NOTE:

- Implementation of the MSS value is identical for both ingress and egress interface traffic. That is, the router uses the same MSS value when adjusting inbound or outbound TCP traffic.
- The purpose behind using MSS is to alleviate problems with path maximum transmission unit discovery (PMTUD) and resulting black hole detection issues. (See RFC 2923, “TCP Problems with Path MTU Discovery,” for additional information about the black hole scenario.)
- Before you configure IP, you must create the lower-layer interfaces over which IP traffic flows.
- All IP configurations will be removed from the interface when you issue the **no ip interface** command in Interface Configuration mode.

To modify the MSS for TCP SYN packets:

- Issue the **ip tcp adjust-mss** command in Interface Configuration mode.

```
host1(config-if)#ip tcp adjust-mss 1000
```

Use the **no** version to remove the MSS assignment from the interface.

Setting MSS for TCP Connections for IP

MSS is used by TCP to define the maximum amount of data that a TCP interface can accept in any single packet (or segment size). The MSS value is typically negotiated during connection establishment and is not renegotiated.

By default, the router uses an MSS value of 536 bytes and the advertised MSS is derived from the MTU of the transmitting interface. However, you can use the **tcp mss** command to set the MSS for TCP advertisements.

You can use the *vrfName* variable to specify a VRF to which you want to assign the TCP MSS value.



NOTE: The MSS value is equal to the MTU value minus the IP and TCP headers, so the MSS value is generally 40 bytes less than the MTU.

To specify the MSS value for TCP to advertise:

- Issue the **tcp mss** command in Interface Configuration mode.

```
host1(config-if)#tcp mss 1000
```

Use the **no** version to remove the MSS value so that the router uses the advertised MSS derived from the MTU of the output interface.

Configuring TCP PMTU Discovery for IP

IP hosts transmit large amounts of data to other hosts using a series of IP datagrams. To best use resources, increase performance, and avoid difficult reassembly, hosts try to send datagrams that are as large as possible without requiring fragmentation anywhere along the path from the source to the destination. This datagram size is referred to as the *path MTU (PMTU)*, and it is equal to the smallest MTU for each hop in the path.

Path MTU discovery is the process of discovering the path MTU value and using that value when transmitting TCP packets in datagrams.

- [Enabling TCP PMTU Discovery on page 51](#)
- [Limiting TCP PMTU Discovery Values on page 52](#)
- [Configuring Black Hole Thresholds for TCP PMTU on page 52](#)

Enabling TCP PMTU Discovery

You can enable PMTU discovery on the active virtual router using the **tcp path-mtu-discovery** command.

You can use the **age-timer** keyword to set the time (*minutes*) that TCP waits before attempting to increase the path MTU after receiving an ICMP Too Big message or after previously increasing the PMTU successfully (*minutes2*). The range of these two timers is 1–30 minutes. The timer defaults to 10 minutes.

You can use the **age-timer indefinite** keyword with the **tcp path-mtu-discovery** command to disable PMTU aging functions.

To enable and configure PMTU discovery on the virtual router:

- Issue the **tcp path-mtu-discovery** command in Global Configuration mode.

```
host1:VR1(config)#tcp path-mtu-discovery
```

To configure PMTU age timers:

- Set path MTU discovery age timers differently.

```
host1:VR1(config)#tcp path-mtu-discovery age-timer 20 15
```

- Set path MTU discovery age timers to the same value (5 minutes).

```
host1:VR1(config)#tcp path-mtu-discovery age-timer 5
```

- Disable path MTU discovery age timers.

```
host1:VR1(config)#tcp path-mtu-discovery age-timer indefinite
```

Use the **no** version with a keyword to return the values to their defaults. Use the **no** version without any keywords to disable path MTU discovery on the virtual router.

Limiting TCP PMTU Discovery Values

You can limit calculated PMTU values within a range by using the **tcp path-mtu-discovery** command with the **max-mtu** and **min-mtu** keywords.



NOTE: When specifying PMTU limits, keep the following in mind:

- If a PMTU discovery value is lower than the configured minimum MTU setting, PMTU discovery is disabled for that connection.
- If a PMTU discovery value is larger than the configured maximum MTU setting, the configured maximum MTU setting is used.
- The maximum MTU setting must be greater than the minimum MTU setting.

To limit the maximum MTU size used for the PMTU:

- Issue the **tcp path-mtu-discovery** command with the **max-mtu** keyword in Global Configuration mode.

```
host1:VR1(config)#tcp path-mtu-discovery max-mtu 512
```

To specify the minimum MTU value used for the PMTU:

- Issue the **tcp path-mtu-discovery** command with the **min-mtu** keyword in Global Configuration mode.

```
host1:VR1(config)#tcp path-mtu-discovery min-mtu 255
```

Use the **no** version to remove any limitation so that the virtual router uses the discovered path MTU value.

Configuring Black Hole Thresholds for TCP PMTU

Some domains might be configured not to generate certain ICMP messages (like an ICMP destination unreachable message) or to filter all ICMP messages. Under these conditions, the source of oversized ICMP packets never learns that it is sending oversized packets. The device continues sending oversized packets that never get through. This behavior is often referred to as a *black hole*.

A black hole threshold is a limit to the number of times a virtual router can retransmit identical sequences of datagrams before the retransmissions are identified as a problem.

To specify the number of permitted retransmissions before the retransmissions are determined to be a problem:

- Issue the **tcp path-mtu-discovery** command with the **black-hole-detect-threshold** keyword in Global Configuration mode.

```
host1:VR1(config)#tcp path-mtu-discovery black-hole-detect-threshold 200
```

Use the **no** version to disable black hole threshold detection.

Protecting Against TCP RST or SYN DoS Attacks

You can use the **tcp ack-rst-and-syn** command to help protect the router from DoS attacks.

Normally, when it receives an RST or SYN message for an existing connection, TCP attempts to shut down the TCP connection. This action is expected under normal conditions, but someone maliciously generating otherwise valid RST or SYN messages can cause problems for network applications and the network as a whole.

When you enable the **tcp ack-rst-and-syn** command, the router challenges any RST or SYN messages that it receives by sending an ACK message back to the expected source of the message. The source reacts in one of the following ways:

- If the source did send the RST or SYN message, it recognizes the ACK message to be spurious and resends another RST or SYN message. The second RST or SYN message causes the router to shut down the connection.
- If the source did not send the RST or SYN message, the source accepts the ACK message as part of an existing connection. As a result, the source does not send another RST or SYN message and the router does not shut down the connection.



NOTE: Enabling this command slightly modifies the way TCP processes RST or SYN messages to ensure that they are genuine.

To help protect the router from TCP RST and SYN DoS attacks:

- Issue the **tcp ack-rst-and-syn** command in Global Configuration mode.

```
host1(config)#tcp ack-rst-and-syn
```

Use the **no** version to disable this protection (the default mode).

Preventing TCP PAWS Timestamp DoS Attacks

The TCP PAWS number option works by including the TCP timestamp option in all TCP headers to help validate the packet sequence number.

Normally, in PAWS packets that have the timestamps option enabled, hosts use an internal timer to compare the value of the timestamp associated with incoming segments against the last valid timestamp the host recorded. If the segment timestamp is larger than the value of the last valid timestamp, and the sequence number is less than the last acknowledgement sent, the host updates its internal timer with the new timestamp and passes the segment on for further processing.

If the host detects a segment timestamp that is smaller than the value of the last valid timestamp or the sequence number is greater than the last acknowledgement sent, the host rejects the segment.

A remote attacker can potentially determine the source and destination ports and IP addresses of both hosts that are engaged in an active connection. With this information, the attacker might be able to inject a specially crafted segment into the connection that contains a fabricated timestamp value. When the host receives this fabricated timestamp, it changes its internal timer value to match. If this timestamp value is larger than subsequent timestamp values from valid incoming segments, the host determines the incoming segments as being too old and discards them. The flow of data between hosts eventually stops, resulting in a denial of service condition.



NOTE: Disabling PAWS does not disable other processing related to the TCP timestamp option. This means that even though you disable PAWS, a fabricated timestamp that already exists in the network can still pollute the database and result in a successful DoS attack. Enabling PAWS resets the saved timestamp state for all connections in the virtual router and stops any existing attack.

To disable the PAWS number option in TCP segments:

- Issue the **tcp paws-disable** command in Global Configuration mode.

```
host1(config)#tcp paws-disable
```

You can specify a VRF context for which you want PAWS disabled. You can use the **no** version to restore PAWS processing (the default mode).

Protecting Against TCP Out-of-Order DoS Attacks

You can use the group of **tcp resequence-buffers** commands to help protect the router from TCP out-of-order packet DoS attacks.

TCP guarantees that applications receive data in order. This means that TCP buffers any out-of-order packets it receives until ordered delivery can occur.

To prevent connections from consuming too many resources, TCP limits the amount of data it accepts to the number of data bytes that the receiver is willing to receive and buffer. TCP does not take into account the buffering scheme that the receiver uses. If the receiver uses a fixed-size receive buffer (that is, buffering all packets) regardless of length, a packet that contains only one data byte might consume many data bytes of buffer space, but only one byte of TCP space.

Under these conditions, an attacker can send a large number of 1-byte packets to an E Series router in which each packet is buffered, consuming an entire packet buffer and eventually consuming a large amount of resources.

To defend against this sort of attack, you can set defaults and limits on the number of outstanding buffers on reordering queues. You can configure these defaults and limits on a per-router, per-virtual router, or per-connection within the virtual router basis.

You can protect the router from TCP out-of-order packet DoS attacks with the following tasks:

- [Limiting TCP Resequence Buffers per Router on page 55](#)
- [Limiting TCP Resequence Buffers per Virtual Router on page 55](#)
- [Limiting TCP Resequence Buffers per Connection on page 55](#)

Limiting TCP Resequence Buffers per Router

To limit the number of outstanding buffers on the entire router:

- Issue the **tcp resequence-buffers global-maximum** command in Global Configuration mode.

```
host1(config)#tcp resequence-buffers global-maximum
```

You can specify a value of zero (0) to turn off the limit. You can use the **no** version to revert the global maximum buffer value to its default, 1000 buffers.

Limiting TCP Resequence Buffers per Virtual Router

You can limit the number of outstanding buffers on existing or newly established virtual routers using the **tcp resequence-buffers vr-maximum** command and **tcp resequence-buffers default-vr-maximum** commands.

To specify the default buffer limit assigned to all virtual routers when the virtual router is established:

- Issue the **tcp resequence-buffers default-vr-maximum** command in Global Configuration mode.

```
host1(config)#tcp resequence-buffers default-vr-maximum 200
```

You can specify a value of zero (0) to turn off the limit assignment. You can use the **no** version to revert the virtual router maximum value to its default, 100 buffers.

To define the maximum number of buffers that the current or specified virtual router can use:

- Issue the **tcp resequence-buffers vr-maximum** command in Global Configuration mode.

```
host1(config)#tcp resequence-buffers vr-maximum
```

You can specify a value of zero (0) to turn off the limit assignment. You can use the **no** version to revert the virtual router maximum value to its default, 100 buffers.

Limiting TCP Resequence Buffers per Connection

You can limit the number of outstanding buffers on existing or newly established connections using the **tcp resequence-buffers connection-maximum** command and **tcp resequence-buffers default-connection-maximum** commands.

To define the maximum number of buffers that connections on the current or specified virtual router can use:

- Issue the **tcp resequence-buffers connection-maximum** command in Global Configuration mode.

host1(config)#tcp resequence-buffers connection-maximum 50

You can specify a value of zero (0) to turn off the connection maximum. You can use the **no** version to revert the connection maximum value to its default, 10 buffers.

To specify the default buffer limit assigned to all TCP connections on a virtual router unless a specific limit is set for the virtual router in which the connection is established.

- Issue the **tcp resequence-buffers default-connection-maximum** command in Global Configuration mode.

host1(config)#tcp resequence-buffers default-connection-maximum 100

You can specify a value of zero (0) to turn off the connection maximum. You can use the **no** version to revert the connection maximum value to its default, 10 buffers.

Related Documentation

- [Monitoring the Status of TCP Protection on page 128](#)
- [Monitoring the TCP Resequencing Buffer Management Functions on page 129](#)
- [Monitoring TCP PMTU Information on page 128](#)
- [Monitoring TCP PAWS Status on page 129](#)
- [Monitoring TCP Statistics for IP on page 131](#)
- `ip tcp adjust-mss`
- `no ip interface`
- `tcp ack-rst-and-syn`
- `tcp mss`
- `tcp path-mtu-discovery`
- `tcp paws-disable`
- `tcp resequence-buffers connection-maximum`
- `tcp resequence-buffers default-connection-maximum`
- `tcp resequence-buffers default-vr-maximum`
- `tcp resequence-buffers global-maximum`
- `tcp resequence-buffers vr-maximum`

Managing IP Interfaces

You can manage IP interfaces with the following tasks:

- [Setting Up an Unnumbered Interface on page 57](#)
- [Adding a Host Route to a Peer on a PPP Interface on page 57](#)
- [Shutting Down an IP Interface on page 58](#)

- [Removing an IP Configuration on page 58](#)
- [Clearing IP Interface Counters on page 58](#)
- [Disabling the Forwarding of IP Packets on an SRP Ethernet Interface on page 59](#)
- [Forcing an IP Interface to Appear Up on page 59](#)
- [Adding a Description to an IP Interface or Sub-Interface on page 60](#)
- [Enabling SNMP Link Status Traps on an IP Interface on page 60](#)
- [Configuring the Speed of an IP Interface on page 61](#)

Setting Up an Unnumbered Interface

An unnumbered interface does not have an IP address assigned to it. Unnumbered interfaces are often used in point-to-point connections where an IP address is not required.

You can set up an unnumbered interface using the **ip unnumbered** command. This command enables IP processing on an interface without assigning an explicit IP address to the interface.

You can supply an interface location, which is the type and number of another interface on which the router has an assigned IP address. This interface cannot be another unnumbered interface.



NOTE:

- Before you configure IP, you must create the lower-layer interfaces over which IP traffic flows.
- All IP configurations will be removed from the interface when you issue the **no ip interface** command in Interface Configuration mode.

To set up an unnumbered interface:

- Issue the **ip unnumbered** command in Interface Configuration mode.

```
host1(config-if)#ip unnumbered fastEthernet 0/0
```

Use the **no** version to disable IP processing on an interface.

Adding a Host Route to a Peer on a PPP Interface

You can enable the ability to create host access routes on a Point-to-Point Protocol (PPP) interface using the **ip access-routes** command. This feature is useful in B-RAS applications.



NOTE:

- Before you configure IP, you must create the lower-layer interfaces over which IP traffic flows.
- All IP configurations will be removed from the interface when you issue the **no ip interface** command in Interface Configuration mode.

To enable the ability to create host access routes on the PPP interface:

- Issue the **ip access-routes** command in Interface Configuration mode.

```
host1(config-if)#ip access-routes
```

Use the **no** version to disable this feature.

Shutting Down an IP Interface

You can disable an interface to the router at the IP level without removing it using the **ip shutdown** command.



NOTE:

- Before you configure IP, you must create the lower-layer interfaces over which IP traffic flows.
- All IP configurations will be removed from the interface when you issue the **no ip interface** command in Interface Configuration mode.

To disable an IP interface:

- Issue the **ip shutdown** command in Interface Configuration mode.

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

Use the **no** version to restart the interface.

Removing an IP Configuration

You can remove the IP configuration from an interface or subinterface using the **no ip interface** command.

To remove the IP configuration from an interface and disable IP processing on the interface:

- Issue the **no ip interface** command in Interface Configuration mode.

```
host1(config-if)#no ip interface
```

Clearing IP Interface Counters

You can clear the counters on one or more specified IP interfaces using the **clear ip interface** command.

To clear counters on a specified IP interface:

- Issue the **clear ip interface** command in Privileged Exec mode.

```
host1#clear ip interface pos 2/0
```

Disabling the Forwarding of IP Packets on an SRP Ethernet Interface

You can disable forwarding of packets on an switch route processor (SRP) Ethernet interface using the **ip disable-forwarding** command.

The purpose of this command is to maintain router performance by maximizing the CPU time available for routing protocols. Although you can allow data forwarding on the SRP Ethernet interface, router performance will be affected.

You see an error message if you try to set this command for interfaces other than the SRP Ethernet interface.



NOTE:

- Before you configure IP, you must create the lower-layer interfaces over which IP traffic flows.
- All IP configurations will be removed from the interface when you issue the **no ip interface** command in Interface Configuration mode.

To disable forwarding of packets on the SRP Ethernet interface:

- Issue the **ip disable-forwarding** command in Interface Configuration mode.

```
host1(config-if)#ip disable-forwarding
```

Use the **no** version to enable forwarding of packets on the interface.

Forcing an IP Interface to Appear Up

You can force an IP interface to appear as if it is up using the **ip alwaysup** command, regardless of the state of the lower layers.

This command reduces route topology changes when the network attached to this link is single-homed.



NOTE:

- Before you configure IP, you must create the lower-layer interfaces over which IP traffic flows.
- All IP configurations will be removed from the interface when you issue the **no ip interface** command in Interface Configuration mode.

To force an IP interface to appear as up regardless of the state of lower layers:

- Issue the **ip alwaysup** command in Interface Configuration mode.

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

Use the **no** version to make the interface appear in the current state.

Adding a Description to an IP Interface or Sub-Interface

You can add a text description or an alias to a static IP interface or subinterface. Adding a description helps you identify the interface and keep track of interface connections. The description or alias can be a maximum of 256 characters. If no IP interface currently exists, then a static IP interface is automatically created on the current layer 2 interface and the description is applied to that static IP interface. You cannot assign a profile to a layer 2 interface that has a static interface configured above it.



NOTE:

- The **ip description** command is replacing the **description** command to assign a description to a static IP interface.
- Before you configure IP, you must create the lower-layer interfaces over which IP traffic flows.
- All IP configurations will be removed from the interface when you issue the **no ip interface** command in Interface Configuration mode.

To assign a text description or an alias to an IP interface:

- Issue the **ip description** command in Interface Configuration mode.

```
host1(config-if)#ip description canada01 ip interface
```



NOTE: You can use this command in Subinterface Configuration mode.

Use the **no** version to remove the text description or alias.

Enabling SNMP Link Status Traps on an IP Interface

You can enable link status traps on an interface using the **snmp trap ip link-status** command.



NOTE:

- Before you configure IP, you must create the lower-layer interfaces over which IP traffic flows.
- All IP configurations will be removed from the interface when you issue the **no ip interface** command in Interface Configuration mode.

To enable link status traps on an interface:

- Issue the **snmp trap ip link-status** command in Interface Configuration mode.

```
host1(config-if)#snmp trap ip link-status
```

Use the **no** version to disable link status traps on an interface.

Configuring the Speed of an IP Interface

You can set the speed of an IP interface using the **ip speed** command. By default, the speed is determined from a lower-layer interface.



NOTE:

- Before you configure IP, you must create the lower-layer interfaces over which IP traffic flows.
- All IP configurations will be removed from the interface when you issue the **no ip interface** command in Interface Configuration mode.

To set the speed of the interface in bits per second:

- Issue the **ip speed** command in Interface Configuration mode.

```
host1(config-if)#ip speed 1000
```

Use the **no** version to set the speed to the default, 0.

Related Documentation

- [Adding and Deleting IP Addresses on page 13](#)
- [Monitoring Detailed or Summary Information for IP Interfaces on page 97](#)
- [Monitoring the Current State of IP Interfaces on page 102](#)
- clear ip interface
- ip access-routes
- ip alwaysup
- ip description
- ip disable-forwarding
- ip shutdown
- ip speed
- ip unnumbered
- no ip interface
- snmp trap ip link-status

Clearing and Reinstalling IP Routes

You can clear the specified routing entries from the routing table. You must specify the IP address prefix and the mask of the IP address prefix to clear specific routes. You can later reinstall the routes you have cleared.

To clear all dynamic routes from the routing table:

- Issue the **clear ip routes** command with an asterisk (*) in Privileged Exec mode.

```
host1#clear ip routes *
```

To enable the owning protocols (BGP, IS-IS, OSPF) to reinstall routes removed from the IP routing table by the **clear ip routes** command:

- Issue the **ip refresh-route** command in Privileged Exec mode.

```
host1#ip refresh-route
```

**Related
Documentation**

- [Monitoring the Current State of IP Routing Tables on page 116](#)
- [Monitoring IP Routing Table Details for a Line Module on page 120](#)
- [Monitoring the Status of IP Static Routes in the Routing Table on page 126](#)
- clear ip routes
- ip refresh-route

Enabling the Forwarding of IP Source-Routed Packets

IP packets are normally routed according to the destination address they contain based on the routing table at each hop through a path. The originator or source of the source-routed packets specifies the path (the series of hops) that the packets must traverse; the source makes the routing decisions. The source can specify either of the following types of source routing:

- *Strict-source* routing specifies every hop that the packet must traverse. The specified path consists of adjacent hops. The source generates an Internet Control Message Protocol (ICMP) error if the exact path cannot be followed. For example, for a path going from source router A to router B to router C to router D, router A specifies a strict-source route as B, C, D.
- *Loose-source* routing specifies a set of hops that the packet must traverse, but not necessarily every hop in the path. That is, the specified hops do not have to be adjacent. For example, for a path going from source router A to router B to router C to router D, router A specifies a loose-source route as B, D or C, D, or B, C, D.

To enable forwarding of source-routed packets in a virtual router or VRF:

- Issue the **ip source-route** command in Global Configuration mode.

```
host1(config)#ip source-route
```

Forwarding is disabled by default in all virtual routers. Use the **no** version to disable forwarding of source-routed packets on the virtual router or VRF.

If the router receives IP packets that contain either the strict source-route or the loose source-route option set in the packets and if you disable forwarding of source-routed packets by entering the **no ip source-route** command, the received packets are discarded. In such a scenario, the router does not process such packets when source-route forwarding is disabled.

Related Documentation

- [ip source-route](#)

Specifying an IP Debounce Time

You can set a debounce time that requires an IP interface to be in a given state—for example, up or down—for the specified time before the state is reported. This feature prevents a link that briefly goes up or down from causing an unnecessary topology change, for example by causing an interface down condition. However, note that increasing the debounce time increases the latency of updating the routing table to reflect an up or down change, and the latency of routing protocols propagating the state change.

To set the interval in milliseconds for which an interface must maintain a given state before the state change is reported:

- Issue the **ip debounce-time** command in Global Configuration mode.

```
host1(config)#ip debounce-time 5000
```

Use the **no** version to remove the debounce time requirement.

Related Documentation

- [Monitoring Detailed or Summary Information for IP Interfaces on page 97](#)
- [Monitoring the Current State of IP Interfaces on page 102](#)
- [ip debounce-time](#)

ECMP Load Sharing for IP

Equal-cost multipath (ECMP) sets are formed when the router finds routing table entries for the same destination with equal cost. The router then balances traffic across these sets of equal-cost paths by using one of two ECMP modes—hashed (the default) or round-robin.

- [ECMP Hashed Mode Overview on page 63](#)
- [Defining the Maximum Parallel Routes Supported by the Routing Protocol on page 63](#)
- [ECMP Round-Robin Mode Overview on page 64](#)
- [Configuring ECMP Round-Robin Load Sharing on page 64](#)
- [ECMP Fast Reroute Protection Overview on page 64](#)

ECMP Hashed Mode Overview

Hashed mode uses hashing of source and destination addresses to determine which of the available paths in the ECMP set to use. Hashed mode is the default ECMP mode of operation.

Defining the Maximum Parallel Routes Supported by the Routing Protocol

You can add routing table entries manually (as static routes), or they are formed as routers discover their neighbors and exchange routing tables (via OSPF, BGP, and other routing protocols).

To control the maximum number of parallel routes that the routing protocol (BGP, IS-IS, OSPF, or RIP) can support:

- Issue the **maximum paths** command in Router Configuration mode.

```
host1(config-router)#maximum-paths 2
```

The maximum number of routes can be in the range 1–16 for BGP, IS-IS, OSPF, or RIP. Use the **no** version to restore the default value, 1 for BGP or 4 for IS-IS, OSPF, or RIP.

ECMP Round-Robin Mode Overview

Round-robin mode distributes packets equally among the available paths in the ECMP set.

If all the ECMP links are configured for the **ip multipath round-robin** command and their next hops are direct next hops, the round-robin mode uses the random algorithm for traffic distribution.

In round-robin mode, if a packet uses a path, the next packet can choose the same path or the previous path, or the next path based on the random value generated. The random algorithm does not guarantee equal distribution of the packets among the ECMP links.

Configuring ECMP Round-Robin Load Sharing

ECMP uses the round-robin mode when you have configured *all* interfaces in the set to round-robin. Otherwise, ECMP defaults to hashed mode because round-robin mode can cause reordering of packets. You must explicitly ensure that the possible reordering is acceptable on all the member interfaces by setting them to round-robin mode.

If one of the ECMP next hops is an indirect next hop, ECMP uses hashed mode load balancing.

To specify round-robin as the mode for ECMP load sharing:

- Issue the **ip multipath round-robin** command in Subinterface Configuration mode.

```
host1:router_0(config-subif)#ip multipath round-robin
```

Use the **no** version to set the ECMP mode to the default, hashed.

ECMP Fast Reroute Protection Overview

If a link goes down, ECMP uses fast reroute protection to shift packet forwarding to use operational links, thereby decreasing packet loss. Fast reroute protection updates ECMP sets for the interface without having to wait for the route table update process. When the next route table update occurs, a new ECMP set can be added with fewer links or the route might point to a single next hop.



CAUTION: To provide ECMP fast reroute functionality in the event of an interface failure, the members of an equal cost multipath must be resolved to corresponding interfaces. If the member is an indirect next hop, the interface is obtained by using the forwarding equivalence class (FEC) to which the

member points. This method of resolving members occurs only if the FEC, pointed to by the indirect next hop, is either an interface or a direct next hop.

An indirect next hop member is not resolved to an interface if it points to another indirect next hop or to an equal cost multipath. ECMP fast reroute functionality is not available if any interfaces that correspond to unresolved indirect next hop members go down.

If you modify an indirect next hop member to point to a different FEC (that is, a different interface, direct next hop, indirect next hop, or ECMP), the indirect next hop member is not resolved for the new changes.

**Related
Documentation**

- [Indirect Next-Hop Overview on page 15](#)
- [Monitoring Detailed or Summary Information for IP Interfaces on page 97](#)
- [Monitoring the Current State of IP Interfaces on page 102](#)
- `ip multipath round-robin`
- `maximum-paths`

Setting a TTL Value for the IP Header

You set the time-to-live (TTL) field in the IP header for all IP operations using the `ip ttl` command. The TTL specifies a hop count. This configured TTL value can be overridden by other commands that specify a TTL.

To set the value for the TTL field:

- Issue the `ip ttl` command in Global Configuration mode.

```
host1(config)#ip ttl 255
```

Use the `no` version to restore the default value, 127.

**Related
Documentation**

- [Monitoring General Information for IP on page 96](#)
- `ip ttl`

Distributing Routing Table Updates to Line Modules

You can configure the forwarding table hold-down time allotted after a routing table change for the accumulation of additional updates and the subsequent distribution of the set of routing table changes to the line modules.

A higher timer value can enhance switch route processor (SRP) performance, but it can also delay the implementation of routing table changes on the line modules. Be aware of the possible effect on network performance before you reconfigure the forwarding table hold-down timer.

Setting the hold-down timer to zero (0) distributes an update after each change to the routing table, which can degrade SRP performance.

To configure the forwarding table hold-down time:

- Issue the **forwarding-table route-holddown** command in Global Configuration mode.
`host1(config)#forwarding-table route-holddown 15`

Use the **no** version to set the hold-down timer to the default value, 3 seconds.

**Related
Documentation**

- [Monitoring the Route Hold-Down Time for IP Forwarding Tables on page 102](#)
- forwarding-table route-holddown

IP Tunnel Routing Table Overview

The IP tunnel routing tables include IPv4 routes that point only to tunnels, such as MPLS tunnels. The tunnel routing table is not used for forwarding. Instead, protocols resolve next hops by looking up the routes that point to tunnels. The routes in the tunnel routing table cannot be redistributed. See *JunosE BGP and MPLS Configuration Guide* for more information.

**Related
Documentation**

- [IP Routing Overview on page 32](#)
- [Monitoring the Current State of IP Routing Tables on page 116](#)

Shared IP Interfaces

You can create multiple shared IP interfaces over the same layer 2 logical interface.

- [Shared IP Interfaces Overview on page 66](#)
- [Creating a Shared IP Interface on page 67](#)
- [Statically Associating the Shared IP Interface with the Layer 2 Interface on page 67](#)
- [Dynamically Associating the Shared IP Interface with the Layer 2 Interface on page 68](#)
- [Example: Configuring Shared IP Interfaces on page 69](#)
- [Moving IP Shared Interfaces on page 70](#)
- [IP Shared Interface Statistics Overview on page 70](#)
- [Subscriber Interfaces Overview on page 70](#)

Shared IP Interfaces Overview

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. 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 unshared IP interfaces. Each shared interface has its own statistics.

Some layer 2 interfaces require a primary IP interface to negotiate certain IP parameters—for example, Internet Protocol Control Protocol (IPCP) for Point-to-Point Protocol (PPP), Address Resolution Protocol (ARP) for Ethernet, and Inverse ARP for Frame Relay. If you do not configure a primary IP interface in such cases, the layer 2 interface cannot become operationally up.

A primary IP interface is the default interface for receiving data that arrives on the layer 2 interface. If you configure shared IP interfaces for the same layer 2 interface as your primary IP interface, by default data received on the layer 2 interface is received on the virtual router corresponding to the primary IP interface. A primary IP interface and all of its shared IP interfaces have the same interface location. You can configure a shared IP interface to receive data on the same layer 2 interface as a primary IP interface. You can delete primary and shared IP interfaces independently of each other.

You can create a primary IP interface as you do any other IP interface, as shown in the following example:

```
host1(config)#virtual-router vr-a:vrf-2
host1:vr-a:vrf-2:(config)#interface atm 5/3.101
host1:vr-a:vrf-2:(config-if)#ip address 10.1.1.1 255.255.255.255
host1:vr-a:vrf-2:(config-if)#exit
```

You do not have to configure a primary IP interface if you do not need one as described above. In the absence of a primary interface, you can still configure shared IP interfaces; however, in this scenario, data received on the layer 2 interface is discarded.

You cannot create shared IP interfaces for the following kinds of interface:

- IP floating interfaces (IP interfaces that stack over MPLS stacked tunnels)
- Loopback interfaces
- Null interfaces

For information about configuring shared IP interfaces to receive data on the same layer 2 interface as a primary IP interface, see *JunosE Broadband Access Configuration Guide*.

Creating a Shared IP Interface

You can create an IP interface for interface sharing using the **interface ip** command. You can use the specified name to refer to the shared IP interface; you cannot use the layer 2 interface to refer to them, because the shared interface can be moved.

To create an IP interface for interface sharing:

- Issue the **interface ip** command in Global Configuration mode.

```
host1(config)#interface ip si0
```

Use the **no** version to delete the IP interface.

Statically Associating the Shared IP Interface with the Layer 2 Interface

You can specify the layer 2 interface used by a shared IP interface using the **ip share-interface** command. The command fails if the layer 2 interface does not yet exist.

The command is not supported (that is, it fails) if you use an RSVP tunnel (for example, **tunnel mpls:1**) to identify the layer 2 interface.

After creating the shared IP interface, you can configure it as you do any other IP interface.

The shared interface is operationally up when the layer 2 interface is operationally up.

You can create operational shared IP interfaces in the absence of a primary IP interface.



NOTE:

- All IP configurations will be removed from the interface when you issue the **no ip interface** command in Interface Configuration mode.
- You cannot issue the **ip share-nexthop** command for the IP shared interface if the **ip share-interface** command is issued on the IP shared interface.

To specify the layer 2 interface to be used by a shared IP interface:

- Issue the **ip share-interface** command in Interface Configuration mode.

```
host1(config-if)#ip share-interface atm 5/3.101
```

Use the **no** version to remove the association between the layer 2 interface and the shared IP interface. You can delete shared and primary IP interfaces independently.

Dynamically Associating the Shared IP Interface with the Layer 2 Interface

You can specify that the shared IP interface dynamically tracks a next hop using the **ip share-nexthop** command. If the next hop changes, the shared IP interface moves to the new layer 2 interface associated with the IP interface toward the new next hop.

The shared interface is operationally up when the layer 2 interface associated with the specified next hop is operationally up. However, if the layer 2 interface associated with the specified next hop is an MPLS next hop (for example, an RSVP or LDP tunnel), the shared interface remains operationally down.

If you issue the **ip share-nexthop** command on a shared IP interface, the shared interface cannot dynamically track the next hop for the specified destination if the next-hop IP address is resolvable over MPLS.

If you specify a virtual router, the command fails if the VR does not already exist. If you do not specify a VR, the current VR is assumed.



NOTE:

- All IP configurations will be removed from the interface when you issue the **no ip interface** command in Interface Configuration mode.
- You cannot issue the **ip share-interface** command for the IP shared interface if the **ip share-nexthop** command is issued on the IP shared interface.

To specify that the shared IP interface dynamically tracks a next hop:

- Issue the **ip share-nexthop** command in Interface Configuration mode.

```
host1:vr-a:vrf-1(config-if)#ip share-nexthop 10.0.0.1
```

Use the **no** version to halt tracking of the next hop.

Example: Configuring Shared IP Interfaces

This example shows you how to create and configure shared IP interfaces.

- [Requirements on page 69](#)
- [Overview on page 69](#)
- [Configuring Shared IP Interfaces on page 69](#)

Requirements

This example uses the following software and hardware components:

- JunosE Release 7.1.0 or higher-numbered releases
- E Series router (ERX7xx models, ERX14xx models, the ERX310 router, the E120 router, or the E320 router)
- ASIC-based line modules that support Fast Ethernet or Gigabit Ethernet

Overview

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.

Configuring Shared IP Interfaces

To configure shared IP interfaces:

1. Create a layer 2 interface.

```
host1(config)#interface atm 5/3
host1(config-if)#interface atm 5/3.101
```

2. (Optional) Create a primary IP interface.

```
host1(config-if)#ip address 10.1.1.1 255.255.255.255
host1(config-if)#exit
```

3. Create the shared IP interface.

```
host1(config)#interface ip si0
```

4. Associate the shared IP interface with the layer 2 interface by one of the following methods:

- Statically

```
host1(config-if)#ip share-interface atm 5/3.101
```

- Dynamically

```
host1:vr-a:vrf-1(config-if)#ip share-nexthop 10.0.0.1
```

5. To fully configure the shared interface, assign an address (or make the interface unnumbered).

```
host1(config-if)#ip address 2.2.2.2 255.0.0.0
```

Moving IP Shared Interfaces

You can move an IP shared interface from one layer 2 interface to another by issuing the **ip share-interface** command to specify a different layer 2 interface. Moving an IP interface does not affect interface statistics, packets forwarded through the interface, or policies attached to the IP interface.



NOTE: All IP configurations will be removed from the interface when you issue the **no ip interface** command in Interface Configuration mode.

To move an IP shared interface from one layer 2 interface to another:

1. Create a shared interface and assign it to one layer 2 interface.

```
host1(config)#virtual-router vr-a:vrf-1
host1:vr-a:vrf-1(config)#interface ip si0
host1:vr-a:vrf-1(config-if)#ip share-interface atm 5/3.101
host1:vr-a:vrf-1(config-if)#exit
```

2. Move the shared interface to another layer 2 interface.

```
host1:vr-a:vrf-1(config)#interface ip si0
host1:vr-a:vrf-1(config-if)#ip share-interface atm 5/3.201
```

IP Shared Interface Statistics Overview

Each shared interface has its own statistics. Packets transmitted on a shared IP interface are always counted only in the shared IP interface.

Subscriber Interfaces Overview

A subscriber interface is an extension of a shared IP interface. Shared IP interfaces are unidirectional—they can transmit but not receive traffic. In contrast, subscriber interfaces are bidirectional—they can both receive and transmit traffic.

For details about configuring and using subscriber interfaces, see *JunosE Broadband Access Configuration Guide*.

Related Documentation

- [Monitoring IP Shared Interfaces on page 108](#)
- [interface atm](#)
- [interface ip](#)
- [ip address](#)
- [ip share-interface](#)

- `ip share-nexthop`
- `no ip interface`
- `virtual-router`

Internet Control Message Protocol

This topic describes the various aspects of the Internet Control Message Protocol (ICMP).

- [ICMP Overview on page 71](#)
- [Configuring ICMP Tasks on page 71](#)
- [Specifying a Source Address for ICMP Messages on page 72](#)

ICMP Overview

IP was not designed to provide reliable delivery service. The higher-layer protocols that operate as clients of IP implement their own reliability procedures if reliable communications are required.

ICMP provides a mechanism that enables a router or destination host to report an error in data traffic processing to the original source of the packet. ICMP messages provide feedback about problems that occur in the communication environment.

ICMP messages are sent only when errors occur in either the processing of an unfragmented data packet or the first fragment of a fragmented data packet.

ICMP messages are encapsulated as part of the data portion of an IP data packet and are routed like any other IP data packets. Thus, there is no guarantee to the sender of an ICMP message that the message will be delivered to its destination.

The router supports ICMP redirects. When a packet enters an IP interface and exits the same interface, the router may send an ICMP message to the originator of the packet. This message notifies the originator that a better gateway exists to the assigned destination address.

With the **ip redirects** command (used in Interface Configuration mode) you can enable or disable ICMP redirects. This attribute is enabled by default. If it is enabled on the IP interface and if the internal ICMP redirect queue is not full, the router sends an ICMP redirect packet to the originator. When the originator receives the ICMP redirect notification, the originator determines whether to start using the better gateway.

Configuring ICMP Tasks

You can enable the following ICMP features:

- ICMP Router Discovery Protocol (IRDP)
- ICMP netmask reply
- Sending of IP redirects
- Generation of ICMP unreachable messages

**NOTE:**

- Before you configure IP, you must create the lower-layer interfaces over which IP traffic flows.
- All IP configurations will be removed from the interface when you issue the **no ip interface** command in Interface Configuration mode.

To configure the ICMP features:

- Enable IRDP processing on an interface.

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

Use the **no** version to disable the function.

- Enable ICMP netmask reply.

```
host1(config-if)#ip mask-reply
```

Use the **no** version to disable the function.

- Enable the sending of redirect messages if software is forced to resend a packet through the same interface on which it was received.

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

Use the **no** version to disable the sending of redirect messages.

- Enable the generation of an ICMP unreachable message when a packet is received that the router cannot deliver.

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

Use the **no** version to disable the function.

Specifying a Source Address for ICMP Messages

By default, ICMP uses the IP address of the outgoing interface as the source IP address for the ICMP message. However, you can use the **ip icmp update-source** command to instruct ICMP to use an already configured interface or a specified IP address, as the source address of the ICMP message.

You must use an already configured interface or an existing IP address when using the **ip icmp update-source** command. Also, you cannot specify a multicast address when using this command.

To define an update source address for all ICMP messages that the E Series router generates from the specified interface:

- Issue the **ip icmp update-source** command in Global Configuration mode.

```
host1(config)#ip icmp update-source 192.35.42.1
```

Use the **no** version to disable the function.

- Related Documentation**
- [Before You Configure IP on page 16](#)
 - [IP Profiles on page 16](#)
 - `ip icmp update-source`
 - `ip irdp`
 - `ip mask-reply`
 - `ip redirects`
 - `ip unreachable`
 - `no ip interface`

Determining Reachability of IP Destinations in the Network

You can determine reachability of destinations in the network using the **ping** and **tracert** commands.

- [Sending Echo Request Packets to the IP Address on page 73](#)
- [Discovering the Routes Followed by Router Packets when Traveling to the IP Destination on page 74](#)

Sending Echo Request Packets to the IP Address

You can send an Internet Control Message Protocol (ICMP) or ICMPv6 echo request packet to a specific IP address using the **ping** command.

The following characters can appear in the display after issuing the **ping** command:

- `!`—Reply received
- `.`—Timed out while waiting for a reply
- `?`—Unknown packet type
- `A`—Address mask request message
- `a`—Address mask reply message
- `D`—Router discovery advertisement message
- `d`—Router discovery request message
- `H`—Host unreachable
- `I`—Information request message
- `i`—Information reply message
- `L`—TTL expired message
- `M`—Could not fragment, DF bit set
- `m`—Parameter problem message
- `N`—Network unreachable

- P—Protocol unreachable
- Q—Source quench
- r—Redirect message
- T—Timestamp request message
- t —Timestamp reply message
- U—Destination unreachable

To send an ICMP echo request packet to the IP address that you specify:

- Issue the **ping** command in Privileged Exec mode.

```
host1#ping 172.16.1.1 extended interface serial 5/2:1/1
```

Discovering the Routes Followed by Router Packets when Traveling to the IP Destination

You can discover routes that router packets follow when traveling to their destination using the **traceroute** command.

You can specify the following:

- A VRF context
- Destination IP or IPv6 address
- Source interface for each of the transmitted packets
- Source address for each of the transmitted packets
- Maximum number of hops of the trace and a timeout value
- Size of the IP packets (not the ICMP payload) in the range 0–64000 bytes sent with the **traceroute** command. Including a size might help locate any MTU problems that exist between your router and a particular device.
- Extended IP header attributes, including the ToS byte (IP only), whether to set the DF bit for the transmitted packets (IP only), the traffic class (IPv6 only), and flow label (IPv6 only).

You can also force transmission of the packets on a specified interface regardless of what the IP address lookup indicates.

To discover the routes that router packets follow when traveling to their destination:

- Issue the **traceroute** command in Privileged Exec mode.

```
host1#traceroute 172.20.13.1 20 timeout 10
```

Related Documentation

- [Before You Configure IP on page 16](#)
- [IP Profiles on page 16](#)
- ping
- traceroute

Response Time Reporter

The Response Time Reporter (RTR) feature enables you to monitor network performance and resources by measuring response times and the availability of your network devices.

RTR configuration is associated with a specific virtual router, distinct from any other virtual router. This topic describes the following:

- [Configuring RTR on page 75](#)
- [Shutting Down the RTR Probe on page 81](#)

Configuring RTR

You can configure RTR with the following tasks:

- [Configuring the Probe Type for RTR on page 75](#)
- [Configuring the Probe Characteristics for RTR on page 76](#)
- [Setting the Reaction Conditions for the RTR Probe on page 78](#)
- [Scheduling the RTR Probe on page 79](#)
- [Capturing Statistics and Collecting Error Information for the RTR Probe on page 80](#)
- [Collecting History for the RTR Probe on page 80](#)
- [Setting the Receiving Interface for the RTR Entry on page 81](#)

Configuring the Probe Type for RTR

You can configure the probe type—either an *echo* probe or a *path echo* probe after entering into the RTR Configuration mode.

- **echo**—Limited to end-to-end RTR operations; corresponds to SNMP ping
- **pathEcho**—Finds a path to the destination and echoes each device in the path; corresponds to SNMP traceroute

You must specify the probe type value before any other RTR probe configuration. If you change the type for an existing RTR entry, all values are reset, including the administrative status. There is no default value. More than one RTR entry can become active, provided each entry's target address is unique.

If you configure multiple RTR entries to use the same target address, you must issue the **receive-interface** command to specify the interface on which the RTR probe expects to receive responses. (For information, see [“Setting the Receiving Interface for the RTR Entry” on page 81.](#))

If you use a target address already configured for another RTR entry that is active, the test will not run if both entries are in the same virtual router. If they are in distinct virtual routers, however, there is no restriction.

To enter into the RTR configuration mode:

- Issue the **rtr** command in Global Configuration mode.

```
host1(config)#rtr 1
```

Use the **no** version to delete all configuration information for an RTR probe.

To configure the probe type:

- Issue the **type** command in RTR configuration mode.

```
host1(config-rtr)#type echo protocol iplcmpEcho 10.10.0.9
```

Use the **no** version to remove the type configured for the probe.

Configuring the Probe Characteristics for RTR

You can configure the probe characteristics presented in [Table 7 on page 76](#).

Table 7: Probe Characteristics

Characteristic	Description
frequency	Time between tests (in seconds)
hops-of-statistics-kept	Hops per path for which statistics are gathered
max-response-failure	Maximum number of consecutive failures
operations-per-hop	Number of probes per hop
owner	Owner of the probe
receive-interface	Interface on which the probe expects to receive responses
request-data-size	Request's payload size
samples-of-history-kept	Maximum number of history samples
tag	User-defined tag
timeout	Probe timeout (in milliseconds)
tos	A value for the TOS byte



NOTE: You cannot set any of these characteristics until you have set the probe type using the **type** command. The default values of these characteristics depend on the type of the entry.

To configure the probe characteristics:

- Set the rate (in seconds) that the RTR probe uses to start a response time operation.

```
host1(config-rtr)#frequency 90
```

Use the **no** version to return to the default value, 60 seconds.

- Set the number of hops per path for which statistics are collected. (For more information, see [“Capturing Statistics and Collecting Error Information for the RTR Probe” on page 80](#).

```
host1(config-rtr)#hops-of-statistics-kept 5
```

Use the **no** version to set the default, 16 hops.

- Set the maximum number of consecutive failures to respond to a probe's request. (For more information, see [“Capturing Statistics and Collecting Error Information for the RTR Probe” on page 80](#).

```
host1(config-rtr)#max-response-failure 2
```

Use the **no** version to set the default, 5 consecutive failures.

- Set the number of RTR probe operations sent to a given hop.



NOTE: You can apply this option only to a pathEcho type.

```
host1(config-rtr)#operations-per-hop 5
```

Use the **no** version to return to the default, 3.

- Set the owner of the probe. If the SNMP agent is the owner of the probe, the owner's name can begin with *agent*.

```
host1(config-rtr)#owner 192.10.27.6 rtc.boston.com 555.1212
```

Use the **no** version to return to the default, no owner.

- Specify the interface on which the RTR probe expects to receive responses.



NOTE: You must set this attribute when multiple RTR entries are configured to use the same target address. (For more information, see [“Setting the Receiving Interface for the RTR Entry” on page 81](#)).

```
host1(config-rtr)#receive-interface fastEthernet 3/0
```

Use the **no** version to restore the default value, which is to receive a response on any interface.

- Set the protocol data size, in bytes, in the request packet.

```
host1(config-rtr)#request-data-size 20
```

Use the **no** version to return to the default value, 1 byte.

- Set the maximum number of entries in the history table for each RTR probe. (For more information, see [“Collecting History for the RTR Probe” on page 80](#)).

```
host1(config-rtr)#samples-of-history-kept 5
```

Use the **no** version to set the default, 16 hops for pathEcho type, 1 hop for echo type.

- Set an identifier for the probe.

`host1(config-rtr)#tag westford`

Use the **no** version to return to the default, no tag.

- Set the time (in milliseconds) that the probe waits for a response. If you set the timeout to 0, no timeout is set.



NOTE:

- You can apply this option only to an echo type.
- Do not set the value for timeout to more than the value set for frequency. If you do, the timeout value is ignored.

`host1(config-rtr)#timeout 3000`

Use the **no** version to return to the default value, 5000 milliseconds.

- Set the type of service (ToS) byte in the probe's IP header.

`host1(config-rtr)#tos 16`

Use the **no** version to return to the default value, 0. The default applies to both the echo and pathEcho types.

Setting the Reaction Conditions for the RTR Probe

You can set the RTR probe to react to events that take place and to send notifications about these events.



NOTE:

- You cannot set any of these characteristics until you have set the probe type using the **type** command. The default values of these characteristics depend on the type of the entry.
- The only **no** version for all the **rtr reaction-configuration** commands is **no rtr reaction-configuration rtrIndex**. Use the **no** version to clear all traps. This works for all the options.

To set one or more reaction conditions for the RTR probe:

- Specify the type of actions to occur depending on the events controlled by RTR. The default is to take the traps of enabled events.

`host1(config)#rtr reaction-configuration 1 action-type trapOnly`

- Enable the operation-failure reaction. The operation-failure event is triggered when a number of consecutive probe operations are not received or when they are received after a timeout.

`host1(config)#rtr reaction-configuration 1 operation-failure 3`

- Enable the path-change reaction. The path-change event is triggered when a change is detected in the hop table. At most, there can be one such event per test.

host1(config)#rtr reaction-configuration 1 path-change

- Enable the test-completion reaction. The test-completion event is triggered when a test is completed successfully. At most, there can be one such event per test. The completion is determined in the following ways:
 - For echo, a successful test means that all probes were sent.
 - For pathEcho, a successful test means that the destination was reached at least once.

host1(config)#rtr reaction-configuration 1 test-completion

- Enable the test-failure reaction. The test-failure event is triggered when a test fails. At most, there can be one such event per test. Failure is determined in the following ways:
 - If Echo, this event is triggered after testFailureValue probes are either not received or are received after a timeout.
 - If PathEcho, this event is triggered when the test ends and no responses are received from the destination.

host1(config)#rtr reaction-configuration 1 test-failure**Scheduling the RTR Probe**

When you have configured the RTR probe, you must schedule the operation to begin collecting statistics and other information about problems that may arise.

**NOTE:**

- You cannot set any of these characteristics until you have set the probe type using the **type** command. The default values of these characteristics depend on the type of the entry.
- The only **no** version for all the **rtr schedule** commands is **no rtr schedule rtrIndex**. Use the **no** version to stop the test. The **no** version stops the probe operation by putting it in the pending state. The **no** version also resets the restart-time attribute and the life attribute.

To schedule the probe:

- Create an RTR schedule.

host1(config)#rtr schedule 5

- Schedule the test's length. Life is a value that depends on the type of the RTR entry; it is not a length of time.
 - If the type is echo, life relates to the number of probes sent until a test finishes.
 - If the type is pathEcho, life relates to the maximum number of hops used by the traceRoute trap.

host1(config)#rtr schedule 5 life 1800

- Specify a restart time, in seconds, after which a test is restarted.

```
host1(config)#rtr schedule 5 restart-time 15
```

- Schedule a test's starting time (now or pending).

```
host1(config)#rtr schedule 5 start-time now
```

Capturing Statistics and Collecting Error Information for the RTR Probe

The primary objective of RTR is to collect statistics and information about network performance. You can control the number and type of statistics collected using the **hops-of-statistics-kept** and **max-response-failure** commands.



NOTE: You cannot set any of these characteristics until you have set the probe type using the **type** command. The default values of these characteristics depend on the type of the entry.

To control the number and type of statistics collected:

- Set the number of hops per path for which statistics are collected.

When the number of hops reaches the specified number (that is, *size*), no additional statistical information about the path is stored.

To turn off this feature, set the value to 0.



NOTE: This option applies only to pathEcho entries.

```
host1(config-rtr)#hops-of-statistics-kept 5
```

Use the **no** version to set the default, 16 hops.

- Set the maximum number of consecutive failures to respond to a probe's request.

When the maximum number is reached, the test stops.

To turn off this feature, set the value to 0.



NOTE: This option applies only to pathEcho entries.

```
host1(config-rtr)#max-response-failure 2
```

Use the **no** version to set the default, 5 consecutive failures.

Collecting History for the RTR Probe

RTR can collect data samples for a given probe. These samples are referred to as history data. When RTR collects history, it refers to tests. A test is the lifetime of a probe operation.

You can set the maximum number of entries in the history table for each RTR probe using the **samples-of-history-kept** command.

This command enables you to control the number of samples saved in the history table. If you set the number of samples to 0, no samples are kept.



NOTE: You cannot set this characteristic until you have set the probe type using the **type** command. The default values of this characteristic depend on the type of the entry.



BEST PRACTICE: Collect history only when there is a problem in your network because collecting history increases memory usage.

To set the maximum number of entries in the history table for each RTR probe:

- Issue the **samples-of-history-kept** command in RTR Configuration mode.

```
host1(config-rtr)#samples-of-history-kept 5
```

Use the **no** version to set the default: 16 hops for pathEcho type and 1 hop for echo type.

Setting the Receiving Interface for the RTR Entry

When you configure multiple RTR entries to use the same target address, you must issue the **receive-interface** command to set the interface on which the probe expects to receive responses. This action enables the router to map incoming responses to the proper RTR entry, even when multiple RTR entries have the same target address.



NOTE: You cannot set this characteristic until you have set the probe type using the **type** command.

To specify the interface on which the RTR probe expects to receive responses:

- Issue the **receive-interface** command in RTR Configuration mode.

```
host1(config-rtr)#receive-interface fastEthernet 3/0
```

Use the **no** version to restore the default value, which is to receive a response on any interface.

Shutting Down the RTR Probe

You can shut down the RTR, stop all probe operations, and clear the RTR configuration for the given virtual router using the **rtr reset** command.



NOTE: We recommend that you use this command only in extremely serious situations, such as problems with the configurations of a number of probe operations.

To shut down the RTR probe operation:

- Issue the **rtr reset** command in Global Configuration mode.

host1(config)#rtr reset

Use the **no** version to negate the reset operation.

**Related
Documentation**

- [Example: Configuring the RTR Next-Hop Verification Feature on page 43](#)
- [Monitoring RTR on page 88](#)
- frequency
- hops-of-statistics-kept
- max-response-failure
- operations-per-hop
- owner
- receive-interface
- request-data-size
- rtr
- rtr reaction-configuration action-type
- rtr reaction-configuration operation-failure
- rtr reaction-configuration path-change
- rtr reaction-configuration test-completion
- rtr reaction-configuration test-failure
- rtr reset
- rtr schedule
- rtr schedule life
- rtr schedule restart-time
- rtr schedule start-time
- samples-of-history-kept
- tag
- timeout
- tos
- type

CHAPTER 2

Monitoring IP

This chapter explains how to use the **show** commands to view your IP configuration and monitor IP interfaces and statistics.

- [Establishing a Baseline for IP Statistics on page 84](#)
- [System Event Logs Used to Troubleshoot and Monitor IP on page 85](#)
- [Commands Used to Monitor IP on page 86](#)
- [Monitoring RTR on page 88](#)
- [Monitoring Access Lists for IP on page 94](#)
- [Monitoring the AS-Path Access Lists for IP on page 95](#)
- [Monitoring ARP Details on page 95](#)
- [Monitoring General Information for IP on page 96](#)
- [Monitoring Detailed or Summary Information for IP Interfaces on page 97](#)
- [Monitoring the Routes Permitted by IP Community Lists on page 100](#)
- [Monitoring IP Forwarding Table Details for a Line Module on page 101](#)
- [Monitoring the Route Hold-Down Time for IP Forwarding Tables on page 102](#)
- [Monitoring the Current State of IP Interfaces on page 102](#)
- [Monitoring IP Shared Interfaces on page 108](#)
- [Monitoring IP Protocols on page 113](#)
- [Monitoring IP Route Redistribution Policy on page 116](#)
- [Monitoring the Current State of IP Routing Tables on page 116](#)
- [Monitoring IP Routing Table Details for a Line Module on page 120](#)
- [Monitoring BSD Socket Statistics on page 120](#)
- [Monitoring the Status of IP Static Routes in the Routing Table on page 126](#)
- [Monitoring the Status of TCP Protection on page 128](#)
- [Monitoring TCP PMTU Information on page 128](#)
- [Monitoring TCP PAWS Status on page 129](#)
- [Monitoring the TCP Resequencing Buffer Management Functions on page 129](#)
- [Monitoring TCP Statistics for IP on page 131](#)
- [Monitoring IP Traffic Statistics on page 141](#)

- [Monitoring IP UDP Statistics on page 145](#)
- [Monitoring an IP Profile on page 145](#)
- [Monitoring Profile Names on page 147](#)
- [Monitoring Route Map Details on page 147](#)

Establishing a Baseline for IP Statistics

IP 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 IP statistics by setting a group of reference counters to zero.

The router 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.

You can use the **delta** keyword with IP **show** commands to specify that baselined statistics are to be shown.



NOTE: Baselining is not supported for IP socket statistics.

You can establish a baseline for IP statistics with the following tasks:

- [Setting a Baseline for IP Interface Statistics on page 84](#)
- [Setting a Baseline for IP Statistics on page 84](#)
- [Setting a Baseline for IP UDP Statistics on page 85](#)
- [Setting a Baseline for IP TCP Statistics on page 85](#)

Setting a Baseline for IP Interface Statistics

You can set a baseline for statistics on an IP interface using the **baseline ip interface** command.

To set a baseline for a specified IP interface:

- Issue the **baseline ip interface** command in Privileged Exec mode.

```
host1#baseline ip interface pos 2/0
```

Setting a Baseline for IP Statistics

You can set a statistics baseline for IP statistics using the **baseline ip** command.

To set a statistics baseline for IP statistics:

- Issue the **baseline ip** command in Privileged Exec mode.

```
host1#baseline ip
```

Setting a Baseline for IP UDP Statistics

You can set a statistics baseline for UDP statistics using the **baseline ip udp** command.

To set a statistics baseline for UDP statistics:

- Issue the **baseline ip udp** command in Privileged Exec mode.

```
host1#baseline ip udp
```

Setting a Baseline for IP TCP Statistics

You can set a statistics baseline for all (both IPv4 and IPv6) TCP statistics or for only IPv4 or IPv6 statistics using the **baseline tcp** command.

To set a statistics baseline for only IPv4 statistics:

- Issue the **baseline tcp** command with the **ip** keyword in Privileged Exec mode.

```
host1#baseline ip tcp
```

To set a statistics baseline for all (both IPv4 and IPv6) TCP statistics:

- Issue the **baseline tcp** command in Privileged Exec mode.

```
host1#baseline tcp
```

Related Documentation

- [Monitoring the Current State of IP Interfaces on page 102](#)
- [Monitoring IP Traffic Statistics on page 141](#)
- [Monitoring IP UDP Statistics on page 145](#)
- [Monitoring TCP Statistics for IP on page 131](#)
- `baseline ip`
- `baseline ip interface`
- `baseline ip udp`
- `baseline tcp`

System Event Logs Used to Troubleshoot and Monitor IP

To troubleshoot and monitor IP, use the following system event logs:

- `ipAccessList`—IP access list matching
- `ipEngine`—IP chassis manager
- `ipGeneral`—IP general information
- `ipIfCreator`—IP interface creator events
- `ipInterface`—IP interface events
- `ipNhopTrackerGeneral`—Next-hop tracker for IP shared interfaces

- ipProfileMgr—IP profile manager events
- ipRoutePolicy—IP routing policy events
- ipRouteTable—IP routing table events
- ipTraffic—IP frame transmit and receive events
- ipTunnel—IP tunnel events

For more information about using event logs, see the *JunosE System Event Logging Reference Guide*.

**Related
Documentation**

- [IP Profiles on page 16](#)
- [Managing IP Interfaces on page 56](#)

Commands Used to Monitor IP

You can monitor the following aspects of IP using **show ip** commands:

To Display	Command
RTR information	show rtr application
	show rtr collection-statistics
	show rtr configuration
	show rtr history
	show rtr hops
	show rtr operational-state
Access lists	show access-list
	show ip as-path-access-list
ARP	show arp
General IP information	show ip
IP addresses	show ip address
Community lists	show ip community-list
Routing table	show ip forwarding-table slot
	show forwarding-table route-holddown
Interfaces	show ip interface
Shared IP interfaces	show ip interface shares

To Display	Command
Protocols	show ip protocols
Redistribution policies	show ip redistribute
Routes	show ip route
Interfaces and next hops	show ip route slot
Socket statistics	show ip socket statistics
Static routes	show ip static
TCP ACK, RST, and SYN protection status	show tcp ack-rst-and-syn status
Black hole threshold information	show tcp path-mtu-discovery
TCP PAWS protection status	show tcp paws
TCP resequence buffer information	show tcp resequence-buffers
TCP statistics	show tcp statistics
Traffic	show ip traffic
UDP statistics	show ip udp statistics
Profiles	show ip profile show profile brief
Route maps	show route-map

To set a statistics baseline for IP interfaces, use the **baseline tcp** and **baseline ip udp** commands. Use the **delta** keyword with IP show commands to specify that baselined statistics are to be shown.

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 *JunosE System Basics Configuration Guide*, for details.

Related Documentation

- [Establishing a Baseline for IP Statistics on page 84](#)

Monitoring RTR

You can monitor RTR by displaying status and configuration information using the following tasks:

- [Monitoring RTR Global Information on page 88](#)
- [Monitoring Statistics Information for RTR Probes on page 88](#)
- [Monitoring Configuration Details for RTR Probes on page 89](#)
- [Monitoring Data Samples for RTR Probes on page 91](#)
- [Monitoring RTR Hops Information on page 93](#)
- [Monitoring Operational Information of RTR on page 93](#)

Monitoring RTR Global Information

Purpose Display global information about RTR.

Action To display global information about RTR:

host1#show rtr application

	numberOfEntries	entriesEnabled	entriesActive
echo	1	1	1
pathEcho	1	1	1
total	2	2	2

Meaning [Table 8 on page 88](#) lists the **show rtr application** command output fields.

Table 8: show rtr application Output Fields

Field Name	Field Description
numberOfEntries	Number of RTR entries according to type
entriesEnabled	RTR entries with administrative status enabled
entriesActive	RTR entries with operational status enabled

Monitoring Statistics Information for RTR Probes

Purpose Display statistical information for a particular probe operation or for all operations.

Action To display statistical information for all probe operations:

host1#show rtr collection-statistics

Echo Entries:

rtrIndex	operationsSent	operationsRcvd	lastGoodResponse
1	5208	5187	08/30/2000 05:09


```

rtrIndex  operStatus  minRtt  maxRtt  avgRtt  rttSumSqr
-----
1         enabled    0       1785    3       7109208

PathEcho Entries:

rtrIndex  testAttempts  testSuccesses  lastGoodResponse
-----
2         156       156           08/30/2000 05:09

rtrIndex  operStatus  currentHop  currentOperation
-----
2         enabled    2          4

```

Meaning Table 9 on page 89 lists the **show rtr collection-statistics** command output fields.

Table 9: show rtr collection-statistics Output Fields

Field Name	Field Description
rtrIndex	Index number of the RTR probe
operationsSent	Number of probe operations sent
operationsRcvd	Number of probe operations received
lastGoodResponse	Time when last valid probe operation was received
operStatus	Operational status of the probe: enabled, disabled
minRtt	Minimum round-trip time in milliseconds
maxRtt	Maximum round-trip time in milliseconds
avgRtt	Average round-trip time in milliseconds
rttSumSqr	Sum of the square of all round-trip times in milliseconds
testAttempts	Number of times the test ran
testSuccesses	Number of times the test ran successfully
currentHop	Current hop (TTL) used in the test
currentOperation	Current probe operation index sent to the hop

Monitoring Configuration Details for RTR Probes

Purpose Display the configuration for a particular probe or for all probes.

Action To display the configuration for all probes:

```

host1#show rtr configuration
rtrIndex      type      targetAddress reqSize freq      life
-----
      1      echo      10.5.0.200      1      1      20
      2  pathEcho  10.5.0.11      1      1      30

rtrIndex      source      restartTime  owner
-----
      1      fastEthernet0/0      10
      2      fastEthernet0/0      60

rtrIndex      samples  admin      tos      reactionConfiguration
-----
      1          5      enabled      0
      2          5      enabled      0

rtrIndex      receiveInterface
-----
      1      fastEthernet0/0

rtrIndex      operFail  testFail  timeout  tag
-----
      1          1          1      10000

rtrIndex      operPerHop  maxFail  hopKpt  tag
-----
      2          5          3      16

```

Meaning [Table 10 on page 90](#) lists the **show rtr configuration** command output fields.

Table 10: show rtr configuration Output Fields

Field Name	Field Description
rtrIndex	Index number of the RTR probe
type	Probe type: echo, pathEcho
targetAddress	Address of the probe's target
reqSize	Protocol data size in the request packet
freq	Rate in seconds that the RTR probe uses to start a response time operation
life	Length of the test
source	Interface from which the probe is sent
restartTime	Restart time of the test in seconds
owner	Owner of the probe
samples	Maximum number of entries saved in the history table for this RTR probe
admin	Administrative status of the probe: enabled, disabled

Table 10: show rtr configuration Output Fields (*continued*)

Field Name	Field Description
tos	Setting of the ToS byte in the probe's IP header
reactionConfiguration	RTR reactions that are configured for the probe
receiveInterface	Type and specifier of the interface on which the probe expects to receive responses; this field is blank if the optional receive-interface characteristic is not configured
operFail	Operation failure event is triggered when this number of consecutive probe operations is not received or when the operations are received after a timeout
testFail	Test failure event is triggered when this number of probe operations is not received or when the operations are received after a timeout
timeout	Time in milliseconds that the probe waits for a response
tag	Identifier configured for the probe
operPerHop	Number of RTR probe operations sent to a given hop
maxFail	Maximum number of consecutive failures to respond to a probe's request. When the maximum number is reached, the test stops. Applies only to pathEcho entries.
hopKpt	Number of hops per path for which statistics are collected. When this number is reached, no additional statistical information about the path is stored. Applies only to pathEcho entries.

Monitoring Data Samples for RTR Probes

Purpose Display history (data samples) for a particular probe or for all probes.

Action To display history (data samples) for all probes:

host1#show rtr history

Echo Entries:

rtrIndex	operation	rtt	statusDescription	timeStamp
1	5476	0	responseReceived	08/30/2000 05:17
1	5477	0	responseReceived	08/30/2000 05:17
1	5478	0	responseReceived	08/30/2000 05:17
1	5479	0	responseReceived	08/30/2000 05:17
1	5480	0	responseReceived	08/30/2000 05:17

PathEcho Entries:

rtrIndex	test	hop	operation	rtt	statusDescription	
2	165	3	5	0	responseReceived	
2	165	3	1	0	responseReceived	
2	165	3	2	0	responseReceived	
2	165	3	3	0	responseReceived	
2	165	3	4	0	responseReceived	
rtrIndex	test	hop	operation	timeStamp		address
2	165	3	5	08/30/2000 20:39		10.5.0.11
2	165	3	1	08/30/2000 20:40		10.5.0.11
2	165	3	2	08/30/2000 20:40		10.5.0.11
2	165	3	3	08/30/2000 20:40		10.5.0.11
2	165	3	4	08/30/2000 20:40		10.5.0.11

Meaning Table 11 on page 92 lists the **show rtr history** command output fields.

Table 11: show rtr history Output Fields

Field Name	Field Description
rtrIndex	Index number of the RTR probe
operation	Index number of the probe operation
rtt	Round-trip time in milliseconds
statusDescription	<ul style="list-style-type: none"> concurrentLimitFail—Target already being used by another rtrIndex ifInactiveToTarget—Interface used to reach target is not operational invalidHostAddress—Target address is not supported noRouteToTarget—Target address is not reachable responseReceived—Probe operation replied by target requestTimedOut—Probe operation not replied to by target or reply received after timeout unknownDestAddress—Target address is invalid unableToResolveName—Target address could not be looked up
timeStamp	Date and time when the RTR entry was created
test	Index number of the pathEcho test
hop	Index number of the hop count
address	Address of router at the hop

Monitoring RTR Hops Information

Purpose Display RTR hops information.

Action To display RTR hops information:

host1#show rtr hops

```

rtrIndex   hop   address      minRtt  maxRtt  avgRtt  rttSumSqr
-----
          2    1  192.168.1.1      1      276      1      955363
          2    2  10.2.0.3         0     1109      2     10094451

rtrIndex  hop  operationsSent  operationsRcvd  lastGoodResponse
-----
          2    1           36985           36838  09/18/2000 20:20
          2    2           30717           21494  09/18/2000 20:20

```

Meaning Table 12 on page 93 lists the **show rtr hops** command output fields.

Table 12: show rtr hops Output Fields

Field Name	Field Description
rtrIndex	Index number of the RTR probe
hop	Index number of the hop count
address	Address of the router at the hop
minRtt	Minimum round-trip time in milliseconds
maxRtt	Maximum round-trip time in milliseconds
avgRtt	Average round-trip time in milliseconds
rttSumSqr	Sum of the square of all round-trip times in milliseconds
operationsSent	Number of probe operations sent
operationsRcvd	Number of probe operations received
lastGoodResponse	Time when last valid probe operation was received

Monitoring Operational Information of RTR

Purpose Display RTR operational information.

Action To display RTR operational information:

host1#show rtr operational-state

```

rtrIndex   type   entryStatus  adminStatus  operStatus
-----

```

1	echo	active	enabled	enabled
2	pathEcho	active	enabled	enabled

Meaning Table 13 on page 94 lists the **show rtr operational-state** command output fields.

Table 13: show rtr operational-state Output Fields

Field Name	Field Description
rtrIndex	Index number of the RTR probe
type	Type of RTR probe: echo, pathEcho
entryStatus	If the entry was created via the SNMP DISMAN MIB, the row may be partially constructed; if that is the case, the CLI displays notReady as the entry's status
adminStatus	Derived from the rtr schedule start-time command; if the option is now , the status is enabled; if the option is pending , the status is disabled
operStatus	Enabled only if entryStatus and adminStatus are enabled and the test is running; operStatus remains enabled if the test finishes and restart time is not 0

- Related Documentation**
- [Response Time Reporter on page 75](#)
 - show rtr application
 - show rtr collection-statistics
 - show rtr configuration
 - show rtr history
 - show rtr hops
 - show rtr operational-state

Monitoring Access Lists for IP

Purpose Display information about access lists, including the instances of each access list.

You can use the **detail** keyword to display the automatically assigned element ID for each access list entry. Only rules that you explicitly create have element IDs.

Action To display information about access lists, including the instances of each access list:

```
host1#show access-list
IP Access List 1:
  permit ip 172.31.192.217 0.0.0.0 0.0.0.0 255.255.255.255
  permit ip 12.40.0.0 0.0.0.3 0.0.0.0 255.255.255.255
  deny ip 0.0.0.0 255.255.255.255 0.0.0.0 255.255.255.255
IP Access List 2:
  permit ip 172.19.0.0 0.0.255.255 0.0.0.0 255.255.255.255
  deny ip 0.0.0.0 255.255.255.255 0.0.0.0 255.255.255.255
```

```

IP Access List 10:
  permit ip 0.0.0.0 255.255.255.255 0.0.0.0 255.255.255.255
IP Access List 11:
  deny ip 0.0.0.0 255.255.255.255 0.0.0.0 255.255.255.255

```

To display the automatically assigned element ID for each access list entry by using the **detail** keyword:

```

host1#show access-list detail
IP Access List 1:
  1: permit ip host 172.31.192.217 any
  2: permit ip 12.40.0.0 0.0.0.3 any
  deny ip any any

```

- Related Documentation**
- show access-list
 - show ipv6 access-list

Monitoring the AS-Path Access Lists for IP

Purpose Display information about AS-path access lists.

Action To display information about AS-path access lists:

```

host1#show ip as-path-access-list
AS Path Access List 1:
  permit .*
AS Path Access List 2:
  deny .*
AS Path Access List 3:
  permit _109_
  deny .*
AS Path Access List 4:
  permit _109$
  deny .*
AS Path Access List 10:
  deny _109$
  permit ^108_
  deny .*

```

- Related Documentation**
- show ip as-path-access-list

Monitoring ARP Details

Purpose Display information about ARP.

Action To display information about ARP:

```

host1#show arp
      Address      Age   Hardware Addr  Interface
172.31.192.217    21340  00d0.58f2.67e0  loopback1
192.168.1.1       20730  00e0.09ed.5312  fastEthernet6/0 *
192.168.1.1       12550  00e0.b06a.4c75  fastEthernet6/0 *
192.168.1.217     21600  0090.1a00.0230  fastEthernet6/0 *
192.168.1.255     21600  00f0.c2d1.1200  fastEthernet6/0 *
12.40.0.2         24320  0020.6393.4233  atm5/0.1

```

```

172.18.2.1    21600  0020.bed2.8738 atm5/1.1
172.18.2.2    21600  0020.5b91.60f2 atm5/1.1
172.31.192.206 21600  00d0.43b5.1032 atm5/1.1

```

Meaning [Table 14 on page 96](#) lists the **show arp** command output fields.

Table 14: show arp Output Fields

Field Name	Field Description
Address	IP address of the entry
Age	Time to live for this entry in seconds
Hardware Addr	Physical (MAC) address of the entry
Interface	Interface-specifier of the entry (for example, fastEthernet6/0 is an Ethernet interface on slot 6, port 0) *—Indicates that an ARP entry was added because of an arp validate command, rather than just an arp command.

Related Documentation

- [Adding a Static Entry in the ARP Cache on page 22](#)
- [Configuring ARP Cache Entry Timeout on page 23](#)
- [Clearing Dynamic Entries from the ARP Cache on page 24](#)
- [Adding IP Address-MAC Address Validation Pairs on page 25](#)
- **show arp**

Monitoring General Information for IP

Purpose Display general information about IP.

Action To display general information about IP:

```

host1#show ip
IP Router Id: 192.168.1.155
Router Name: default
Default TTL: 60
Reassemble Timeout: 30
SA Validate Trap: false

```

Meaning [Table 15 on page 96](#) lists the **show ip** command output fields.

Table 15: show ip Output Fields

Field Name	Field Description
IP Router Id	Router ID number

Table 15: show ip Output Fields (*continued*)

Field Name	Field Description
Router Name	Router name
Default TTL	Default IP TTL value
Reassemble Timeout	Amount of time (in minutes) IP waits for missing packet fragments before it drops the fragments it is holding
SA Validate Trap	Whether the source address validation trap is enabled

- Related Documentation**
- [Identifying a Router Within an Autonomous System on page 36](#)
 - [Enabling IP Source Address Validation Traps on page 49](#)
 - [Setting a TTL Value for the IP Header on page 65](#)
 - `show ip`

Monitoring Detailed or Summary Information for IP Interfaces

Purpose Displays detailed or summary information about a particular IP interface. You can specify a VRF name to view information for only that VRF. You can use the **brief** keyword to display summary information about the interface. You can use the **detail** keyword to display detailed information about the interface.

Action To display detailed or summary information about a particular IP interface:

```

host1#show ip address 10.6.136.73
fastEthernet0/0 is up, line protocol is up
  Network Protocols: IP
    Internet address is 10.6.136.73/255.255.128.0
    Broadcast address is 255.255.255.255
    Operational MTU = 0   Administrative MTU = 0
    Operational speed = 1   Administrative speed = 0
    Discontinuity Time = 5766
    Router advertisement = disabled
    Proxy Arp = disabled
    Administrative debounce-time = 10 mSecs
    Operational debounce-time   = disabled
    Access routing = disabled
    Multipath mode = hashed

  In Received Packets 2849, Bytes 759428
    Unicast Packets 2849, Bytes 759428
    Multicast Packets 0, Bytes 0
  In Policed Packets 0, Bytes 0
  In Error Packets 0
  In Invalid Source Address Packets 0
  In Discarded Packets 0
  Out Forwarded Packets 1866, Bytes 84650
    Unicast Packets 1866, Bytes 84650
    Multicast Routed Packets 0, Bytes 0

```

```

Out Scheduler Drops Committed Packets 0, Bytes 0
Out Scheduler Drops Conformed Packets 0, Bytes 0
Out Scheduler Drops Exceeded Packets 0, Bytes 0
Out Policed Packets 0, Bytes 0
Out Discarded Packets 0

```

Meaning [Table 16 on page 98](#) lists the **show ip address** command output fields.

Table 16: show ip address Output Fields

Field Name	Field Description
Network Protocols	Network protocols configured on this interface
Internet address	IP address and subnet mask of this interface
Broadcast address	Broadcast address of this interface
Operational MTU	MTU of this interface
Administrative MTU	Value of the MTU if it has been administratively overridden using the configuration
Operational speed	Speed of the interface
Administrative speed	Value of the speed if it has been administratively overridden using the configuration
Discontinuity Time	Value of the SysUpTime when the interface statistics last started being valid
Router advertisement	Status of router discovery advertisement: enabled, disabled
Proxy Arp	Status of the feature: enabled, disabled
Administrative debounce-time	Configured debounce behavior, enabled or disabled. If enabled, indicates time in milliseconds that the router waits before generating an up or down event in response to a state change in the interface. If the state changes back before the debounce timer expires, no state change is reported.
Operational debounce-time	Current debounce behavior, enabled or disabled. If enabled, indicates time in milliseconds that the router waits before generating an up or down event in response to a state change in the interface. If the state changes back before the debounce timer expires, no state change is reported.
Access routing	Access route addition: enabled, disabled
Multipath mode	Equal cost multipath mode method: hashed, round-robin

Table 16: show ip address Output Fields (*continued*)

Field Name	Field Description
In Received Packets, Bytes	<p>Total number of packets and bytes received on this interface:</p> <ul style="list-style-type: none"> Unicast Packets, Bytes—Unicast packets and bytes received on the IP interface; link-local received multicast packets (non-multicast-routed frames) are counted as unicast packets Multicast Packets, Bytes—Multicast packets and bytes received on the IP interface which are then multicast-routed are counted as multicast packets
In Policed Packets, Bytes	Packets and bytes that were received and dropped for any of the following reasons: exceeding the token bucket limit, exceeding the rate limit, a drop action in a policy, discarded MAC validation packets, a destination address lookup failure, or when the destination address is an IP interface that has a route configured to the null 0 interface.
In Error Packets	Number of packets received with errors
In Invalid Source Address Packets	Packets received with invalid source address (for example, spoofed packets)
In Discarded Packets	Packets received that were discarded for reasons other than rate limits, errors, and invalid source address
Out Forwarded Packets, Bytes	<p>Total number of packets and bytes that were sent from this interface:</p> <ul style="list-style-type: none"> Unicast Packets, Bytes—Unicast packets and bytes that were sent from this interface Multicast Routed Packets, Bytes—Multicast packets and bytes that were sent from this interface
Out Scheduler Drops Committed Packets, Bytes	Outgoing packets and bytes dropped by the scheduler even though they had a committed traffic contract
Out Scheduler Drops Conformed Packets, Bytes	Outgoing packets and bytes dropped by the scheduler even though they conformed to the traffic contract
Out Scheduler Drops Exceeded Packets, Bytes	Outgoing packets and bytes that were dropped by the scheduler because they exceeded the contract
Out Policed Packets, Bytes	Outgoing packets and bytes dropped because of rate limiters
Out Discarded Packets	Outgoing packets that were discarded for reasons other than those dropped by the scheduler and those dropped because of rate limits

- Related Documentation**
- [Adding and Deleting IP Addresses on page 13](#)
 - [Configuring Profile Attributes for IP on page 18](#)
 - [Configuring IP Fragmentation-Related Attributes on page 31](#)
 - [Enabling IP Source Address Validation on page 48](#)
 - [Managing IP Interfaces on page 56](#)
 - [Specifying an IP Debounce Time on page 63](#)
 - [Configuring ECMP Round-Robin Load Sharing on page 64](#)
 - `show ip address`

Monitoring the Routes Permitted by IP Community Lists

Purpose Display community list information.

The display varies if you issue the `ip bgp community new-format` command.

Action To display community list information without issuing the `ip bgp community new-format` command:

```
host1#show ip community-list
Community List 1:
  permit 81200109
  permit 81200110
  permit 81200108
Community List 2:
  deny 81200109
  permit 81200110
  permit 81200108
Community List 4:
  permit local-as
Community List 5:
  permit no-advertise
Community List 6:
  permit no-export
Community List 7:
  permit internet
```

To display the community list information by issuing the `ip bgp community new-format` command:

```
host1#show ip community-list
Community List 1:
  permit 1239:1005
  permit 1239:1006
  permit 1239:1004
Community List 2:
  deny 1239:1005
  permit 1239:1006
  permit 1239:1004
Community List 4:
  permit local-as
Community List 5:
  permit no-advertise
Community List 6:
```

```
permit no-export
Community List 7:
permit internet
```

Related Documentation • [show ip community-list](#)

Monitoring IP Forwarding Table Details for a Line Module

Purpose Display details on the forwarding table for a specific line module, including the memory used by each virtual router configured on the line module and free memory available on the module. This command is not supported on ES2 10G, ES2 10G Uplink, and ES2 10G ADV LMs.

Action To display details on the forwarding table for a specific line module:

```
host1#show ip forwarding-table slot 9
Free Memory = 3,166KB
  Virtual Router      Memory      Load Errors      Status
  -----
  vr1                 4128              0                Valid
  vr2                 3136              0                Valid
  vr3                 2256              0                Valid
default              1024              0                Valid
-----
```

Meaning [Table 17 on page 101](#) lists the **show ip forwarding-table slot** command output fields.

Table 17: show ip forwarding-table slot Output Fields

Field Name	Field Description
Free Memory	Amount of routing table memory free on the line module, in kilobytes
Virtual Router	Name of the virtual routers configured on the line module
Memory (KB)	Amount of routing table memory consumed by the virtual router, in kilobytes
Load Errors	Count of errors made while loading the routing table on the line module Records any failed routing table distribution attempt as an error. Attempts can fail for many reasons during normal operation; a failed attempt does not necessarily indicate a problem. It is normal to see many Load Errors per day.

Table 17: show ip forwarding-table slot Output Fields (*continued*)

Field Name	Field Description
Status	Whether the routing table for the virtual router is valid If the Status field does not indicate Valid, then the routing table distribution has failed constantly for that virtual router. It is normal and appropriate behavior for the Status field to indicate Valid while the Load Error field increases daily.

Related Documentation

- [show ip forwarding-table slot](#)

Monitoring the Route Hold-Down Time for IP Forwarding Tables

Purpose Display the configured hold-down time allotted after an initial routing table change for the accumulation and subsequent distribution of a set of routing table updates to the line modules. The default value is 3 seconds; the range is 0–30 seconds.

A higher hold-down setting can enhance SRP performance; however, a higher setting can also delay the implementation of routing table changes on the line modules.

A hold-down timer value of zero (0) distributes an update after each change to the routing table.

Action To display the configured hold-down time:

```
host1#show forwarding-table route-holddown
Hold-down timer value is 3 seconds.
```

Related Documentation

- [Distributing Routing Table Updates to Line Modules on page 65](#)
- [show forwarding-table route-holddown](#)

Monitoring the Current State of IP Interfaces

Purpose Display the current state of all IP interfaces or the IP interfaces you specify. The default is all interface types and all interfaces. The **show-virtual-router-keyword** displays virtual router information.

If you are losing packets because of fabric congestion, you can use the In Fabric Dropped Packets and Out Fabric Dropped Packets statistics to help determine the location of the bottleneck. Both statistics count the same thing—the same packets dropped because of fabric congestion—but in different directions.

At any given time, the total number of packets dropped in the fabric for all interfaces in the chassis is equal to the sum of all In Fabric Dropped Packets for all interfaces in the chassis, which equals the sum of all Out Fabric Dropped Packets for all interfaces in the chassis.

The In Total Dropped Packets and Out Total Dropped Packets statistics are reported while traffic is moving through the router. The router can get false statistics based on packets being forwarded or received after polling and based on which of the statistics is reported first. For example, In Forwarded Packets can be reported as greater than In Received Packets. Rather than displaying In Total Dropped Packets as a negative value, the command displays it as the sum of all drop reasons other than fabric drops; fabric drops are reported as 0, but might actually be nonzero. If you halt traffic, the In Total Dropped Packets and Out Total Dropped Packets values are always correct.

Action To display detailed current state information for a specific IP interface:

```

host1#show ip interface detail fastEthernet 0/0
fastEthernet0/0 is up, line protocol is up
  Description: boston00 fast ethernet interface
  Link up/down trap is disabled

  Internet address is 1.1.1.2/255.255.255.0
IP statistics:
  Rcvd: 0 local destination
        0 hdr errors, 0 addr errors
        0 unkn proto, 0 discards
  Frags: 0 reasm ok, 0 reasm req, 0 reasm fails
        0 frag ok, 0 frag creates, 0 frag fails
  Sent: 31656835 generated, 0 no routes, 0 discards
ICMP statistics:
  Rcvd: 0 errors, 0 dst unreachable, 0 time exceed
        0 param probs, 0 src quench, 0 redirect,
        0 echo req, 31656816 echo rpy
        0 timestamp req, 0 timestamp rpy
        0 addr mask req, 0 addr mask rpy
  Sent: 0 errors, 0 dst unreachable, 0 time excd
        0 param probs, 0 src qnch, 0 redirect
        0 timestamp req, 0 timestamp rpy
        0 addr mask req, 0 addr mask rpy
In Received Packets 246220, Bytes 344624800
  Unicast Packets 246162, Bytes 344621410
  Multicast Packets 58, Bytes 3390
In Forwarded Packets 245464, Bytes 343566400
In Total Dropped Packets 756, Bytes 1058400
  In Policed Packets 756
  In Invalid Source Address Packets 0
  In Error Packets 0
  In Discarded Packets 0
  In Fabric Dropped Packets 0

Out Forwarded Packets 117, Bytes 87297
  Unicast Packets 117, Bytes 87297
  Multicast Routed Packets 0, Bytes 0
Out Requested Packets 117, Bytes 87297
Out Total Dropped Packets 0, Bytes 0
  Out Scheduler Drops Committed Packets 0, Bytes 0
  Out Scheduler Drops Conformed Packets 0, Bytes 0
  Out Scheduler Drops Exceeded Packets 0, Bytes 0
  Out Policed Packets 0
  Out Discarded Packets 0
  Out Fabric Dropped Packets 0

```

To display the current state information for a specific IP interface:

```

host1#show ip interface gigabitEthernet 1/1.200
GigabitEthernet1/1 line protocol Ethernet is up, ip is not present
  Network Protocols: IP
  Multipath mode = hashed
  Auto Configure = disabled
  Auto Detect = disabled
  Inactivity Timer = disabled
  Use Framed Routes = disabled
  ARP spoof checking = disabled
  Warm-restart initial-sequence-preference: Operational = 0 Administrative = 0

  In Received Packets 0, Bytes 0
    Unicast Packets 0, Bytes 0
    Multicast Packets 0, Bytes 0
  In Policed Packets 0, Bytes 0
  In Error Packets 0
  In Invalid Source Address Packets 0
  In Discarded Packets 0
  Out Forwarded Packets 0, Bytes 0
    Unicast Packets 0, Bytes 0
    Multicast Routed Packets 0, Bytes 0
  Out Scheduler Dropped Packets 0, Bytes 0
  Out Policed Packets 0, Bytes 0
  Out Discarded Packets 0

  queue 0: traffic class best-effort, bound to ip GigabitEthernet1/1
    Queue length 0 bytes
    Forwarded packets 0, bytes 0
    Dropped committed packets 0, bytes 0
    Dropped conformed packets 0, bytes 0
    Dropped exceeded packets 0, bytes 0

Http Redirect Url: http://www.juniper.net

```

Meaning Table 18 on page 104 lists the **show ip interface** command output fields.

Table 18: show ip interface Output Fields

Field Name	Field Description
interface	Interface type and interface specifier
interface status	Status of the interface
HTTP Redirect Url	URL to which a subscriber's initial Web browser session is redirected
line protocol	Status of the line protocol
Description	Text description or alias if configured for the interface
Link up/down trap	Status of SNMP link up/down traps on the interface
Internet address	IP address of the interface

Table 18: show ip interface Output Fields (*continued*)

Field Name	Field Description
IP Statistics Rcvd	<ul style="list-style-type: none"> • local destination—Frames with this router as their destinations • hdr errors—Number of packets containing header errors • addr errors—Number of packets containing addressing errors • unkn proto—Number of packets received containing unknown protocols • discards—Number of discarded packets
IP Statistics Frags	<ul style="list-style-type: none"> • reasm ok—Number of reassembled packets • reasm req—Number of requests for reassembly • reasm fails—Number of reassembly failures • frag ok—Number of packets fragmented successfully • frag req—Number of frames requiring fragmentation • frag fails—Number of packets unsuccessfully fragmented
IP Statistics Sent	<ul style="list-style-type: none"> • generated—Number of packets generated • no routes—Number of packets that could not be routed • discards—Number of packets that could not be routed that were discarded <p>NOTE: If you configure the router to discard packets for static routes with null 0 interfaces as the next-hop points using the reject keyword with the ip route command, the value displayed in this field also includes the packets that reached the null 0 interface and were dropped.</p>
ICMP Statistics Rcvd	<ul style="list-style-type: none"> • errors—Error packets received • dst unreachable—Packets received with destination unreachable • time exceed—Packets received with time-to-live exceeded • param probs—Packets received with parameter errors • src quench—Source quench packets received • redirect—Receive packet redirects • echo req—Echo request (ping) packets • echo rpy—Echo replies received • timestamp req—Requests for a timestamp • timestamp rpy—Replies of timestamp requests • addr mask req—Mask requests sent • addr mask rpy—Mask replies sent

Table 18: show ip interface Output Fields (*continued*)

Field Name	Field Description
ICMP Statistics Sent	<ul style="list-style-type: none"> errors—Error packets sent dst unreachable—Packets sent with destination unreachable <p>NOTE: If you configure the router to discard packets for static routes with null 0 interfaces as the next-hop points using the reject keyword with the ip route command, the value displayed in this field also includes the number of ICMP unreachable messages sent out for packets that reached null 0 interfaces with static routes.</p> <ul style="list-style-type: none"> time excd—Packets sent with time-to-live exceeded param probs—Packets sent with parameter errors src quench—Source quench packets sent redirect—Send packet redirects timestamp req—Requests for a timestamp timestamp rpy—Replies to timestamp requests addr mask req—Address mask requests addr mask rpy—Address mask replies
ARP spoof checking	Status of the check for spoofed ARP packets received on an IP interface, enabled or disabled. This field is not displayed when you use the detail keyword.
In Received Packets, Bytes	<p>Total number of packets and bytes received on the IP interface:</p> <ul style="list-style-type: none"> Unicast Packets, Bytes—Unicast packets and bytes received on the IP interface; link-local received multicast packets (non-multicast-routed frames) are counted as unicast packets Multicast Packets, Bytes—Multicast packets and bytes received on the IP interface which are then multicast-routed are counted as multicast packets
In Forwarded Packets, Bytes	Packets and bytes forwarded into an output IP interface

Table 18: show ip interface Output Fields (*continued*)

Field Name	Field Description
In Total Dropped Packets, Bytes	<p>Total number of packets and bytes that were dropped on the interface; sum of all the drop reasons indented below this field. The router calculates In Total Dropped Packets by subtracting In Forwarded Packets from In Received Packets.</p> <ul style="list-style-type: none"> • In Policed Packets—Packets discarded on a receive IP interface for any of the following reasons: exceeding the token bucket limit, exceeding the rate limit, a drop action in a policy, discarded MAC validation packets, a destination address lookup failure, or when the destination address is an IP interface that has a route configured to the null 0 interface. • In Invalid Source Address Packets—Packets discarded on a receive IP interface due to invalid IP source address (sa-validate enabled) • In Error Packets—Packets discarded on a receive IP interface due to IP header errors • In Discarded Packets—Packets discarded on the ingress interface due to a configuration problem rather than a problem with the packet itself • In Fabric Dropped Packets—Packets discarded on a receive IP interface due to internal fabric congestion. <p>Packets not dropped for another listed reason are considered to have been dropped in the fabric. The router calculates In Fabric Dropped Packets by subtracting the total number of inbound packets dropped for all other reasons from the In Total Dropped Packets number.</p>
Out Forwarded Packets, Bytes	<p>Total number of packets and bytes forwarded out the IP interface:</p> <ul style="list-style-type: none"> • Unicast Packets, Bytes—Unicast packets and bytes forwarded out the IP interface • Multicast Routed Packets, Bytes—Multicast packets and bytes forwarded out the IP interface
Out Requested Packets, Bytes	Packets and bytes requested to be forwarded out an IP interface

Table 18: show ip interface Output Fields (*continued*)

Field Name	Field Description
Out Total Dropped Packets, Bytes	<p>Total number of packets and bytes that were discarded on the egress interface; sum of all the drop reasons indented below this field. The router calculates Out Total Dropped Packets by subtracting Out Forwarded Packets from Out Received Packets.</p> <ul style="list-style-type: none"> • Out Scheduler Drops Committed Packets, Bytes—Packets and bytes dropped by the scheduler even though they had a committed traffic contract • Out Scheduler Drops Conformed Packets, Bytes—Packets and bytes dropped by the scheduler even though they conformed to the traffic contract • Out Scheduler Drops Exceeded Packets, Bytes—Packets and bytes dropped by the scheduler because they exceeded the contract • Out Policed Packets—Packets discarded on the egress interface due to rate limiting • Out Discarded Packets—Packets discarded on the egress interface due to a configuration problem rather than a problem with the packet itself • Out Fabric Dropped Packets—Packets dropped due to internal fabric congestion <p>Packets not dropped for another listed reason are considered to have been dropped in the fabric. The router calculates Out Fabric Dropped Packets by subtracting the total number of outbound packets dropped for all other reasons from the Out Total Dropped Packets number.</p>

Related Documentation

- [Checking for Spoofed ARP Packets on page 22](#)
- [Enabling or Disabling the Transmission of ICMP Unreachable Messages for Static Routes on Null Interfaces on page 38](#)
- [Enabling IP Source Address Validation on page 48](#)
- [Managing IP Interfaces on page 56](#)
- [Specifying an IP Debounce Time on page 63](#)
- [Configuring ECMP Round-Robin Load Sharing on page 64](#)
- [Setting a Baseline for IP Interface Statistics on page 84](#)
- `show ip interface`

Monitoring IP Shared Interfaces

Purpose Display information about shared IP interfaces. If you specify an IP interface specifier, the command displays information only for that interface and any shared IP interfaces associated with it.

Action To display a brief summary of status and configuration information for all IP interfaces and their associated shared IP interfaces:

```
host1#show ip interface shares brief
```

Interface	IP-Address	Status	Protocol	Virtual Router
null0	255.255.255.255/32	up	up	
fastEthernet0/0	10.13.5.17/24	up	up	
loopback100	202.1.1.1/24	up	up	
atm4/0.1	10.1.1.1/24	up	up	
ip si0	Unnumbered	up	up	vr-a
ip si1	Unnumbered	up	up	vr-b:vrf-1

To display a brief summary of status and configuration information for the specified IP interface and its associated shared IP interfaces:

```
host1#show ip interface shares brief atm 4/0.1
```

Interface	IP-Address	Status	Protocol	Virtual Router
atm4/0.1	10.1.1.1/24	up	up	
ip si0	Unnumbered	up	up	vr-a
ip si1	Unnumbered	up	up	vr-b:vrf-1

To display all status and configuration information for the specified IP interface and its associated shared IP interfaces:

```
host1#show ip interface shares atm 4/0.1
```

```
atm4/0.1 is up, line protocol is up
  Network Protocols: IP
    Unnumbered Interface on loopback100
    ( IP address 202.1.1.1 )
    Operational MTU = 1500 Administrative MTU = 0
    Operational speed = 155520000 Administrative speed = 0
    Discontinuity Time = 0
    Router advertisement = disabled
    Administrative debounce-time = disabled
    Operational debounce-time = disabled
    Access routing = disabled
    Multipath mode = hashed

  In Received Packets 120, Bytes 12000
    Unicast Packets 60, Bytes 6000
    Multicast Packets 60, Bytes 6000
  In Policed Packets 0, Bytes 0
  In Error Packets 0
  In Invalid Source Address Packets 0
  Out Forwarded Packets 101, Bytes 5252
    Unicast Packets 101, Bytes 5252
    Multicast Routed Packets 0, Bytes 0
  Out Scheduler Drops Committed Packets 0, Bytes 0
  Out Scheduler Drops Conformed Packets 0, Bytes 0
  Out Scheduler Drops Exceeded Packets 0, Bytes 0
  Out Policed Packets 0, Bytes 0

ip si0 is up, line protocol is up
  Network Protocols: IP
  Virtual Router vr-a
  Layer 2 interface atm4/0.1
  Unnumbered Interface on loopback100
  ( IP address 202.1.1.1 )
  Operational MTU = 1500 Administrative MTU = 0
  Operational speed = 155520000 Administrative speed = 0
  Discontinuity Time = 0
```

```

Router advertisement = disabled
Administrative debounce-time = disabled
Operational debounce-time = disabled
Access routing = disabled
Multipath mode = hashed

In Received Packets 0, Bytes 0
  Unicast Packets 0, Bytes 0
  Multicast Packets 0, Bytes 0
In Policed Packets 0, Bytes 0
In Error Packets 0
In Invalid Source Address Packets 0
Out Forwarded Packets 101, Bytes 5252
  Unicast Packets 101, Bytes 5252
  Multicast Routed Packets 0, Bytes 0
Out Scheduler Drops Committed Packets 0, Bytes 0
Out Scheduler Drops Conformed Packets 0, Bytes 0
Out Scheduler Drops Exceeded Packets 0, Bytes 0
Out Policed Packets 0, Bytes 0

ip sil is up, line protocol is up
Network Protocols: IP
Virtual Router vr-b:vrf-1
Layer 2 interface atm4/0.1
.
.
.
  Out Policed Packets 0, Bytes 0

```

To display all status and configuration information for a specific shared IP interface:

```

host1#show ip interface shares ip si0
ip0 is up, line protocol is up
Network Protocols: IP
Layer 2 interface atm4/0.1
Unnumbered Interface on loopback100
( IP address 202.1.1.1 )
Operational MTU = 1500 Administrative MTU = 0
Operational speed = 155520000 Administrative speed = 0
Discontinuity Time = 0
Router advertisement = disabled
Administrative debounce-time = disabled
Operational debounce-time = disabled
Access routing = disabled
Multipath mode = hashed

In Received Packets 0, Bytes 0
  Unicast Packets 0, Bytes 0
  Multicast Packets 0, Bytes 0
In Policed Packets 0, Bytes 0
In Error Packets 0
In Invalid Source Address Packets 0
Out Forwarded Packets 101, Bytes 5252
  Unicast Packets 101, Bytes 5252
  Multicast Routed Packets 0, Bytes 0
Out Scheduler Drops Committed Packets 0, Bytes 0
Out Scheduler Drops Conformed Packets 0, Bytes 0
Out Scheduler Drops Exceeded Packets 0, Bytes 0
Out Policed Packets 0, Bytes 0

```

Meaning [Table 19 on page 111](#) lists the **show ip interface shares** command output fields.

Table 19: show ip interface shares Output Fields

Field Name	Field Description
Interface	Interface specifier or name of the interface
IP-Address	IP address associated with the interface
Status	Operational state of the interface
Protocol	State of the protocol running on the interface
Virtual Router	Virtual router in which the interface is configured
Network Protocols	Network protocols configured on this interface
Layer 2 interface	Layer 2 interface to which the shared IP interface is associated
Unnumbered Interface	Specifier for the unnumbered interface
Operational MTU	MTU of this interface
Administrative MTU	Value of the MTU if it has been administratively overridden using the configuration
Operational speed	Speed of the interface
Administrative speed	Value of the speed if it has been administratively overridden using the configuration
Discontinuity Time	Value of the SysUpTime when the interface statistics last started being valid
Router advertisement	Status of router discovery advertisement: enabled, disabled
Administrative debounce-time	Configured debounce behavior, enabled or disabled. If enabled, indicates time in milliseconds that the router waits before generating an up or down event in response to a state change in the interface. If the state changes back before the debounce timer expires, no state change is reported.
Operational debounce-time	Current debounce behavior, enabled or disabled. If enabled, indicates time in milliseconds that the router waits before generating an up or down event in response to a state change in the interface. If the state changes back before the debounce timer expires, no state change is reported.
Access routing	Access route addition: enabled, disabled

Table 19: show ip interface shares Output Fields (*continued*)

Field Name	Field Description
Multipath mode	Equal cost multipath mode method: hashed, round-robin
In Received Packets, Bytes	<p>Total number of packets and bytes received on this interface:</p> <ul style="list-style-type: none"> Unicast Packets, Bytes—Unicast packets and bytes received on the IP interface; link-local received multicast packets (non-multicast-routed frames) are counted as unicast packets Multicast Packets, Bytes—Multicast packets and bytes received on the IP interface which are then multicast-routed are counted as multicast packets
In Policed Packets, Bytes	Packets and bytes that were received and dropped for any of the following reasons: exceeding the token bucket limit, exceeding the rate limit, a drop action in a policy, discarded MAC validation packets, a destination address lookup failure, or when the destination address is an IP interface that has a route configured to the null 0 interface.
In Error Packets	Number of packets received with errors
In Invalid Source Address Packets	Packets received with invalid source address (for example, spoofed packets)
Out Forwarded Packets, Bytes	<p>Total number of packets and bytes that were sent from this interface:</p> <ul style="list-style-type: none"> Unicast Packets, Bytes—Unicast packets and bytes that were sent from this interface Multicast Routed Packets, Bytes—Multicast packets and bytes that were sent from this interface
Out Scheduler Drops Committed Packets, Bytes	Outgoing packets and bytes dropped by the scheduler even though they had a committed traffic contract
Out Scheduler Drops Conformed Packets, Bytes	Outgoing packets and bytes dropped by the scheduler even though they conformed to the traffic contract
Out Scheduler Drops Exceeded Packets, Bytes	Outgoing packets and bytes that were dropped by the scheduler because they exceeded the contract
Out Policed Packets, Bytes	Outgoing packets and bytes dropped because of rate limiters

Related Documentation

- [Shared IP Interfaces on page 66](#)
- `show ip interface shares`

Monitoring IP Protocols

Purpose Display detailed information about IP protocols currently configured on the router.

You can use the **summary** keyword to display only a list of the configured protocols.

Action To display detailed information about IP protocols currently configured on the router:

```
host1#show ip protocols
Routing Protocol is " bgp 100"
  Redistributing: ospf
  Default local preference is 100
  IGP synchronization is enabled
  Always compare MED is disabled
  Router flap damping is disabled
  Administrative Distance: external 20 internal 200 local 200
  Neighbor(s):
    Address 1.1.1.1
    Outgoing update distribute list is 2
    Outgoing update prefix list is efg
    Incoming update prefix tree is abc
    Incoming update filter list is 1
  Routing for Networks:
    192.168.1.0/24

Routing Protocol is " isis isis0ne"
  System Id: 0000.0000.0011.00 IS-Type: level-1-2
  Distance: 115
  Address Summarization:
    None
  Routing for Networks:
    fastEthernet0/0

Routing Protocol is " ospf 1" with Router ID 192.168.1.151
  Distance is 110
  Redistributing: isis
  Address Summarization:
    None
  Routing for Networks:
    192.168.1.0/255.255.255.0 area 0.0.0.0

Routing Protocol is " rip"
  Router Administrative State: enable
  System version RIP1: send = 1, receive = 1 or 2
  Update interval: 30 seconds
  Invalid after: 180 seconds
  hold down time: 120 seconds
  flushed interval: 300 seconds
  Filter applied to outgoing route update is not set
  Filter applied to incoming route update is not set
  No global route map
  Distance is 120
  Interface      Tx    Rx    Auth
  fastEthernet0/0  1     1,2  none
  Redistributing: ospf
  Routing for Networks:
    192.168.1.0/255.255.255.0
```

Meaning [Table 20 on page 114](#) lists the **show ip protocols** command output fields.

Table 20: show ip protocols Output Fields

Field Name	Field Description
For BGP:	
Redistributing	Protocol to which BGP is redistributing routes
Default local preference	Local preference value
IGP synchronization	Status of IGP synchronization: enabled, disabled
Always compare MED	Status of multiexit discrimination: enabled, disabled
Router flap damping	Status of route dampening: enabled, disabled
Administrative Distance	External, internal, and local administrative distances
Neighbor Address	IP address of the BGP neighbor
Neighbor Incoming/Outgoing update distribute list	Number of the access list for outgoing routes
Neighbor Incoming/Outgoing update prefix list	Number of the prefix list for incoming or outgoing routes
Neighbor Incoming/Outgoing update prefix tree	Number of the prefix tree for incoming or outgoing routes
Neighbor Incoming/Outgoing update filter list	Number of filter list for incoming routes
Routing for Networks	Network for which BGP is currently injecting routes
For IS-IS:	
System Id	6-byte value of the system
IS-Type	Routing type of the router: Level 1, Level 2
Distance	Administrative distance for IS-IS learned routes
Address Summarization	Aggregate addresses defined in the routing table for multiple groups of addresses at a given level or routes learned from other routing protocols
Routing for Networks	Network for which IS-IS is currently injecting routes
For OSPF:	
Router ID	OSPF process ID for the router

Table 20: show ip protocols Output Fields (*continued*)

Field Name	Field Description
Distance	Administrative distance for OSPF learned routes
Redistributing	Protocol to which OSPF is redistributing routes
Address Summarization	Aggregate addresses defined in the routing table for multiple groups of addresses at a given level or routes learned from other routing protocols
Routing for Networks	Network for which OSPF is currently injecting routes
For RIP:	
Router Administrative State	RIP protocol state. Enable means that the interface is allowed to send and receive updates. Disable means that the interface, if it is configured, is not enabled to run yet.
System version	RIP versions allowed for sending and receiving RIP updates. The router version is currently set to RIP1, which sends RIP version 1 but receives version 1 or 2. If the version is set to RIP2, the router sends and receives version 2 only. The default is configured for RIP1.
Update interval	Current setting of the update timer (in seconds)
Invalid after	Current setting of the invalid timer (in seconds)
hold down time	Current setting of the hold-down timer (in seconds)
flushed interval	Current setting of the flush timer (in seconds)
Filter applied to outgoing route update	Access list applied to outgoing RIP route updates
Filter applied to incoming route update	Access list applied to incoming RIP route updates
Global route map	Route map that specifies all RIP interfaces on the router
Distance	Value added to RIP routes added to the IP routing table; the default is 120.
Interface	Interface type on which RIP protocol is running
Redistributing	Protocol to which RIP is redistributing routes
Routing for Networks	Network for which RIP is currently injecting routes

- Related Documentation**
- [Setting the Administrative Distance for a Route on page 34](#)
 - [Identifying a Router Within an Autonomous System on page 36](#)
 - `show ip protocols`

Monitoring IP Route Redistribution Policy

- Purpose** Display configured route redistribution policy.
- Action** To display configured route redistribution policy:
- ```
host1#show ip redistribute
To ospf, From static is enabled with route map 4
To ospf, From connected is enabled with route map 3
```
- Meaning** [Table 21 on page 116](#) lists the `show ip redistribute` command output fields.

**Table 21: show ip redistribute Output Fields**

| Field Name       | Field Description                         |
|------------------|-------------------------------------------|
| To               | Protocol that routes are distributed into |
| From             | Protocol that routes are distributed from |
| status           | Redistribution status                     |
| route map number | Number of the route map                   |

- Related Documentation**
- `show ip redistribute`

## Monitoring the Current State of IP Routing Tables

- Purpose** Display the current state of the routing table, including routes not used for forwarding.
- You can display all routes, a specific route, best route to a resolved domain name, all routes beginning with a specified address, routes for a particular protocol (BGP, IS-IS, OSPF, or RIP), locally connected routes, internal control routes, static routes, or summary counters for the routing table.
- Action** To display only the best routes that are used for forwarding:
- ```
host1#show ip route
Protocol/Route type codes:
I1- ISIS level 1, I2- ISIS level2,
I- route type intra, IA- route type inter, E- route type external,
i- metric type internal, e- metric type external,
O- OSPF, E1- external type 1, E2- external type2,
N1- NSSA external type1, N2- NSSA external type2
L- MPLS label, V- VR/VRF, *- indirect next-hop
```

Prefix/Length	Type	Next Hop	Dist/Met	Intf
172.16.2.0/24	Bgp	192.168.1.102	20/1	fastEthernet0/0
10.10.0.112/32	Static	192.168.1.1	1/1	fastEthernet0/0
10.1.1.0/24	Connect	10.1.1.1	0/1	atm3/0.100

To display only static routes from the routing table:

```
host1#show ip route static
```

Protocol/Route type codes:

I1- ISIS level 1, I2- ISIS level2,
 I- route type intra, IA- route type inter, E- route type external,
 i- metric type internal, e- metric type external,
 O- OSPF, E1- external type 1, E2- external type2,
 N1- NSSA external type1, N2- NSSA external type2
 L- MPLS label, V- VR/VRF, *- indirect next-hop

Prefix/Length	Type	Next Hop	Dist/Met	Intf
10.10.0.112/32	Static	192.168.1.1	1/1	fastEthernet0/0

To display the summary information for all routes available in the routing table:

```
host1#show ip route summary
```

Unicast routes:

8 total routes, 576 bytes in route entries

0 isis routes

0 rip routes

3 static routes

2 connected routes

1 bgp routes

0 ospf routes

2 other internal routes

0 access routes

0 internally created access host routes

Last route added/deleted: 2::4/128 by BGP

At MON FEB 04 2008 14:18:25 UTC

Unicast routes used only for Multicast RPF check:

0 total routes, 0 bytes in route entries

0 isis routes

0 rip routes

0 static routes

0 connected routes

0 bgp routes

0 ospf routes

0 other internal routes

0 access routes

0 internally created access host routes

0 mbgp routes

0 dvmrp routes

Last route added/deleted: null by Invalid

At MON FEB 04 2008 14:18:04 UTC

MPLS tunnel routes (not used for forwarding):

3 total routes, 216 bytes in route entries

1 bgp tunnel routes

1 ldp tunnel routes

1 rsvp tunnel routes

Last route added/deleted: 2::4/128 by BGP Tunnel

At MON FEB 04 2008 14:18:26 UTC

To display all routes in the routing table inserted from all protocols (not just the best routes that are used for forwarding):

host1#show ip route all

Protocol/Route type codes:

I1- ISIS level 1, I2- ISIS level2,
I- route type intra, IA- route type inter, E- route type external,
i- metric type internal, e- metric type external,
O- OSPF, E1- external type 1, E2- external type2,
N1- NSSA external type1, N2- NSSA external type2
L- MPLS label, V- VR/VRF, *- indirect next-hop

Prefix/Length	Type	Next Hop	Dist/Met	Intf
0.0.0.0/0	Static	192.168.1.1	1/1	fastEthernet0/0
1.1.1.1/32	I2-E-i	192.168.1.105	115/10	fastEthernet0/0
6.6.6.0/24	Static	192.168.1.1	1/1	fastEthernet0/0
6.33.5.0/24	Static	0.0.0.0	1/1	loopback2
8.8.8.0/24	I2-E-i	192.168.1.105	115/10	fastEthernet0/0
9.9.9.9/32	I2-E-i	192.168.1.105	115/10	fastEthernet0/0
10.0.0.0/8	I2-E-i	192.168.1.105	115/10	fastEthernet0/0
10.10.0.156/32	Static	192.168.1.1	1/1	fastEthernet0/0
11.1.1.1/32	I2-E-i	192.168.1.105	115/10	fastEthernet0/0
11.11.11.12/32	I2-I-i	192.168.1.105	115/10	fastEthernet0/0
22.2.0.0/16	I2-I-i	192.168.1.105	115/10	fastEthernet0/0
34.0.0.0/8	I2-E-i	192.168.1.105	115/10	fastEthernet0/0
172.20.32.0/24	Static	192.168.1.1	1/1	fastEthernet0/0
174.20.32.0/24	I2-I-i	192.168.1.105	115/20	fastEthernet0/0
176.20.32.0/24	Connect	176.20.32.1	0/1	loopback1
192.168.1.0/24	Connect	192.168.1.214	0/1	fastEthernet0/0
201.1.1.0/24	I2-E-i	192.168.1.105	115/10	fastEthernet0/0
201.2.1.0/24	I2-E-i	192.168.1.105	115/10	fastEthernet0/0
201.3.1.0/24	I2-E-i	192.168.1.105	115/10	fastEthernet0/0
202.1.1.1/32	I2-E-i	192.168.1.105	115/10	fastEthernet0/0
207.1.1.0/24	I2-E-i	192.168.1.105	115/10	fastEthernet0/0

To display only the best routes that are used for forwarding (after adding routes that have an indirect hop):

host1#show ip route

Protocol/Route type codes:

I1- ISIS level 1, I2- ISIS level2,
I- route type intra, IA- route type inter, E- route type external,
i- metric type internal, e- metric type external,
O- OSPF, E1- external type 1, E2- external type2,
N1- NSSA external type1, N2- NSSA external type2
L- MPLS label, V- VR/VRF, *- indirect next-hop

Prefix/Length	Type	Next Hop	Dst/Met	Intf
21.21.21.2/32	Static	0.0.0.0	1/0	loopback0[V:pe2]
2.2.2.2/32	O-I	30.30.30.2	110/3	ATM2/0.30
		31.31.31.2	110/3	ATM2/0.31
10.10.10.0/24	Connect	10.10.10.1	0/0	ATM2/0.10
20.20.20.0/24	Connect	20.20.20.1	0/0	ATM2/0.21
4.4.4.4/32	Bgp	2.2.2.2*	200/2	
		3.3.3.3*	200/2	
5.5.5.5/32	Bgp	4.4.4.4*	20/2	

To display detailed information about a specific route:

```

host1#show ip route 4.4.4.4 detail
Protocol/Route type codes:
  I1- ISIS level 1, I2- ISIS level2,
  I- route type intra, IA- route type inter, E- route type external,
  i- metric type internal, e- metric type external,
  O- OSPF, E1- external type 1, E2- external type2,
  N1- NSSA external type1, N2- NSSA external type2
  L- MPLS label, V- VRF
4.4.4.4/32   Type: Bgp   Distance: 200   Metric: 0   Tag: 0
  Indirect NHop: virtual-router: pe1
  Address 1.1.1.1 Type Bgp Index 1
    NHop: 10.10.10.2 IfIndx: 28 Intf: ATM2/0.10
    NHop: 20.20.20.2 IfIndx: 28 Intf: ATM2/0.20

  Indirect NHop: virtual-router: pe1
  Address 2.2.2.2 Type Bgp Index 2
    NHop: 10.10.10.2 IfIndx: 28 Intf: ATM2/0.10
    NHop: 20.20.20.2 IfIndx: 28 Intf: ATM2/0.20

```

Meaning [Table 22 on page 119](#) lists the **show ip route** command output fields.

Table 22: show ip route Output Fields

Field Name	Field Description
Protocol/Route type codes	Protocol and route type codes for the table that follows
Prefix	IP address prefix of network destination
Length	Network mask length for prefix
Next Hop	IP address of the next hop to the route, whether it is a local interface or another router
Dist	Administrative distance for the route
Met	Number of hops
Intf	Interface type and interface specifier

- Related Documentation**
- [Setting the Administrative Distance for a Route on page 34](#)
 - [Establishing an IP Static Route on page 36](#)
 - [Configuring IP Static Routes with Indirect Next Hops on page 39](#)
 - [Clearing and Reinstalling IP Routes on page 61](#)
 - [IP Tunnel Routing Table Overview on page 66](#)
 - [show ip route](#)

Monitoring IP Routing Table Details for a Line Module

Purpose Display the interface and next hop for an IP address in the routing table of a line module.

- *slotNumber*—Number of the slot containing the linemodule
- *ipAddress*—IP address to look up in the routing table

Action To display the interface and next hop for an IP address in the routing table of a line module:

```
host1#show ip route slot 6 10.10.0.231
```

IP address	Interface	Next Hop
10.10.0.231	fastEthernet 6/0	10.10.0.231

Meaning [Table 23 on page 120](#) lists the **show ip route slot** command output fields.

Table 23: show ip route slot Output Fields

Field Name	Field Description
IP address	IP address reachable via the interface
Interface	Interface type and specifier associated with the IP address; displays “Local Interface” if a special interface index is present in the routing table for special IP addresses, such as broadcast addresses
Next Hop	<p>IP address of the next-hop router to reach the IP address; displays “---” if no next hop is associated with the IP address; displays “Down” if the ECMP set for a specific route on a slot is down</p> <p>A next hop is displayed only for protocols where ARP is used to resolve the addresses, such as for fastEthernet, gigabitEthernet, bridged Ethernet over ATM, and so on.</p>

- Related Documentation**
- [Configuring Broadcast-Related IP Tasks on page 30](#)
 - [Clearing and Reinstalling IP Routes on page 61](#)
 - `show ip route slot`

Monitoring BSD Socket Statistics

Purpose Display basic information about BSD sockets that have been instantiated in the virtual router in whose context you issue the **show ip socket statistics** command. The information includes the connection information (source and destination IP address and port numbers), socket type, the options in effect on the socket, and the socket's state.

Use the **detailed** keyword to display blocks of extensive information about every socket, such as how many times various APIs have been called and the socket event log. The

detailed keyword displays information about only the sockets that are associated with the virtual router in whose context you issue the command or sockets that are not associated with any virtual router.



NOTE: Baselining is not supported for the `show ip socket statistics` command.

Action To display basic information about BSD sockets that have been instantiated in the virtual router:

```
host1#show ip socket statistics
 5 10.13.5.70:23 --> 10.10.132.71:2000
   type: 1 (SOCK_STREAM)
   opts = 13 SO_DEBUG SO_REUSEADDR SO_KEEPALIVE
   so_state = 177 SS_NOFDREF SS_CANTSENDMORE SS_CANTRCVMORE SS_PRIV

18 0.0.0.0:23 --> 0.0.0.0:0
   type: 1 (SOCK_STREAM)
   opts = 7 SO_DEBUG SO_ACCEPTCONN SO_REUSEADDR
   so_state = 128 SS_PRIV
```

To display detailed BSD socket statistics:

```
host1#show ip socket statistics detailed
18 0.0.0.0:23 --> 0.0.0.0:0
   type: 1 (SOCK_STREAM)
   opts = 7 SO_DEBUG SO_ACCEPTCONN SO_REUSEADDR
   so_state = 128 SS_PRIV
   pending xmit byte count = 0   recv count 0
   Keep alive idle time = 14400   keep alive poll time = 150
   Additional state flags:
     so_Bound
     so_ListenOk
     ss_CalledRsSocreate

     so_SendtoCalls = 0
     so_SendMsgCalls = 0
     so_SendCalls = 0
     so_SockWriteCalls = 0
     so_SendErrors = 0
     so_SentBytes = 0
   so_BsdCloseNotClosed = 0
     so_RecvBytes = 0
     so_RecvErrors = 0
     so_RecvFroms = 0
     so_Recvs = 0
     so_RecvMsgs = 0
     so_Reads = 0
   Socket Event Log (most recent at bottom)
     rssocket
     sobind - 0
     bind - 0
     solisten - 0
     listen - 0
```

Meaning [Table 24 on page 122](#) lists the `show ip socket statistics` command output fields.

Table 24: show ip socket statistics Output Fields

Field Name	Field Description
<i>socketNumber</i> <i>ipAddress:portNumber --></i> <i>ipAddress:portNumber</i>	Socket and the IP address and port number for each end of the connection, with the E Series router shown on the left and the remote peer on the right
type	Type of connection: SOCK_STREAM (uses TCP) or DGRAM (datagram; uses UDP)
opts	Options set on the individual sockets: <ul style="list-style-type: none"> • SO_DEBUG—Turn on debugging; has no effect • SO_ACCEPTCONN—Socket can accept incoming connections • SO_REUSEADDR—Allow reuse of the local address • SO_KEEPALIVE—Do keepalives on the connection • SO_DONTROUTE—Do not route packets, use interface addresses • SO_BROADCAST—Broadcasts can be sent over the socket • SO_USELOOPBACK—Bypass the hardware if/when possible • SO_LINGER—Linger on a close() if data is present • SO_OOBINLINE—Leave received out-of-band data in-line • SO_REUSEPORT—Allow reuse of local port
so_state	State of each socket; knowledge of BSD Sockets API is useful to understand this information: <ul style="list-style-type: none"> • SS_NOFDREF—No file table reference any more • SS_ISCONNECTED—Socket is connected to a peer • SS_ISCONNECTING—Socket is in process of connecting to peer • SS_ISDISCONNECTING—Socket is in process of disconnecting • SS_CANTSENDMORE—Socket cannot send more data to peer • SS_CANTRCVMORE—Socket cannot receive more data from peer • SS_RCVATMARK—Socket at mark on input • SS_PRIV—Socket is privileged for broadcast, raw • SS_NBIO—Socket allows nonblocking operations • SS_ASYNC—Socket allows asynchronized I/O notifications • SS_ISCONFIRMING—Socket is deciding to accept connection request
pending xmit byte count = 0 rcv count	Number of bytes that are pending to be sent (queued up) and received

Table 24: show ip socket statistics Output Fields (*continued*)

Field Name	Field Description
Keep alive idle time	Number of seconds before TCP sends an initial keepalive probe to an idle remote node
keep alive poll time	Interval in seconds at which TCP sends keepalive probes to idle remote nodes
Additional state flags	State of the following flags in the socket_stats structure: ss_Bound, ss_BindError, ss_ListenOk, ss_ListenError, ss_AcceptOk, ss_AcceptError, ss_RsAcceptOk, ss_RsAcceptError, ss_ConnectOk, ss_ConnectErrors, ss_ConnectToOk, ss_ConnectToError, ss_CalledShutdown, and ss_CalledRsSocreate.

Table 24: show ip socket statistics Output Fields (*continued*)

Field Name	Field Description
Socket Event Log (most recent at bottom)	

Table 24: show ip socket statistics Output Fields (*continued*)

Field Name	Field Description
	<p>Event log on this socket. Each one shows a call to a particular function within the socket library. Includes a repetition counter that displays only nonzero values.</p> <ul style="list-style-type: none"> • Call to <code>sofree()</code>—Call included because in some circumstances an <code>sofree()</code> call does not result in the socket being destroyed (and memory being returned to the free pool) • Call to <code>rsSocket()</code>—Call to create the socket using <code>rsSocket()</code> as opposed to <code>socket()</code> • Call to <code>socket()</code>—8-bit value indicating how the call went • Call to <code>connect()</code>—8-bit value indicating how the call went • Call to <code>listen()</code>—8-bit value indicating how the call went • Call to <code>accept()</code>—8-bit value indicating how the call went • Call to <code>bind()</code>—8-bit value indicating how the call went • Call to <code>connectto()</code>—8-bit value indicating how the call went • Call to <code>rsAccept()</code>—8-bit value indicating how the call went • Call to <code>sobind()</code>—8-bit value indicating how the call went • Call to <code>solisten()</code>—8-bit value indicating how the call went • Call to <code>soclose()</code>—8-bit value indicating how the call went • Call to <code>soabort()</code>—8-bit value indicating how the call went • Call to <code>soaccept()</code>—8-bit value indicating how the call went • Call to <code>soconnect()</code>—8-bit value indicating how the call went • Call to <code>soconnect2()</code>—8-bit value indicating how the call went • Call to <code>sodisconnect()</code>—8-bit value indicating how the call went • Call to <code>soshutdown()</code>—8-bit value indicating how the call went • Call to <code>sowakeup()</code>—8-bit value indicating what kind of wakeup it is. 1 (SELREAD) indicates that data is available on the socket for the application. 2 (SELWRITE) means that more buffer space is available and the application can queue up more data to be transmitted. • Call to <code>soclose()</code>—8-bit value indicating how the call went • Call to <code>sendto()</code>—16-bit value indicating the return

Table 24: show ip socket statistics Output Fields (*continued*)

Field Name	Field Description
	status
	<ul style="list-style-type: none"> Call to write()—16-bit value indicating the return status Call to sendmsg()—16-bit value indicating the return status Call to send()—16-bit value indicating the return status Call to recvfrom()—16-bit value indicating the return status Call to recv()—16-bit value indicating the return status Call to recvmsg()—16-bit value indicating the return status Call to read()—16-bit value indicating the return status
Counters that show how often the indicated routine has been called: so_SendtoCalls, so_SendMsgCalls, so_SendCalls, so_SockWriteCalls, so_SendErrors, so_SentBytes, so_BsdCloseNotClosed, so_RecvBytes, so_RecvErrors, so_RecvFroms, so_Recvs, so_RecvMsgs, so_Reads	

Related Documentation • show ip socket statistics

Monitoring the Status of IP Static Routes in the Routing Table

Purpose Display the status of static routes in the routing table.



NOTE: You can specify an IP mask that filters specific routes.

Action To display the status of static routes in the routing table:

host1#show ip static

Prefix/Length	Next Hop	Dst/Met	Tag	Intf	Verify	ICMP Unreach
1.1.1.2/32	1.1.1.2	1/0	0	FastEthernet4/0	2 up	
1.1.1.2/32	1.1.1.2	1/0	0	FastEthernet4/1		
10.10.133.17/32	10.6.128.1	1/1	0	unresolved	1 down	
11.11.11.11/32	3.3.3.3	1/0	0	unresolved	1 down(1r)	
100.1.1.0/24	255.255.255.255	1/0	0	null0		Discard
100.10.1.0/24	255.255.255.255	1/0	0	null0		Reject

Meaning Table 25 on page 127 lists the **show ip static** command output fields.

Table 25: show ip static Output Fields

Field Name	Field Description
Prefix	IP address prefix
Length	Prefix length
Next Hop	IP address of the next hop
Dst	Administrative distance of the route
Met	Number of hops
Tag	Tag value of the route
Intf	Interface type and interface specifier
Verify	<p>Status of the RTR or BFD operation associated with the specified static route; this field is blank if the verify (BFD) or verify rtr (RTR) keywords were not specified as part of the ip route command. The display can include the following:</p> <ul style="list-style-type: none"> • BFD up/down—Current status of the associated BFD operation • operation number—Number of the associated RTR operation • up/down—Current status of the associated RTR operation • (lr)—Indicates that although the associated RTR operation is currently down, the router installs this route in the routing table, provided that no other static route to the same network prefix is available; this field appears for an RTR operation that is down when the last-resort keyword is specified as part of the ip route verify rtr command
ICMP Unreach	<p>Indicates whether the transmission of ICMP unreachable messages to the originator is enabled for packets that are discarded from processing on each interface configured with a static route:</p> <ul style="list-style-type: none"> • reject—ICMP unreachable messages are sent to the originator for packets that are received on the static route configured on the interface and are dropped from processing (the reject keyword is specified with the ip route command). • discard—ICMP unreachable messages are not sent to the originator for packets that are received on the static route configured on the interface and are dropped from processing (the discard keyword is specified with the ip route command or the default mode of the ip route command is in effect).

- Related Documentation**
- [Setting the Administrative Distance for a Route on page 34](#)
 - [Establishing an IP Static Route on page 36](#)
 - [Enabling or Disabling the Transmission of ICMP Unreachable Messages for Static Routes on Null Interfaces on page 38](#)
 - [Next-Hop Verification for Static Routes Overview on page 40](#)
 - [Clearing and Reinstalling IP Routes on page 61](#)
 - `show ip static`

Monitoring the Status of TCP Protection

- Purpose** Display the status of TCP ACK, RST, and SYN protection.
- Action** To display the status of TCP ACK, RST, and SYN protection:
- ```
host1#show tcp ack-rst-and-syn
TCP Ack Rst and Syn Protection is ENABLED
```
- Related Documentation**
- [Protecting Against TCP RST or SYN DoS Attacks on page 53](#)
  - `show tcp ack-rst-and-syn`

## Monitoring TCP PMTU Information

- Purpose** Display PMTU information.
- Action** To display PMTU information:
- ```
host1#show tcp path-mtu-discovery
TCP PMTU Discovery is ENABLED
  Administrative Minimum MTU: 512
  Administrative Maximum MTU: 65535
  Timer 1: 10 minutes
  Timer 2: 2 minutes
Black Hole Detect Threshold: 0 retransmissions
# ICMP TooBigs: 0
# ICMP TooBigs for unk. connections: 0
```
- Meaning** [Table 26 on page 128](#) lists the `show tcp path-mtu-discovery` command output fields.

Table 26: show tcp path-mtu-discovery Output Fields

Field Name	Field Description
TCP PMTU Discovery	State of the PMTUD functions (ENABLED or DISABLED)
Administrative Minimum MTU	Administrative minimum PMTU that is supported or <i>none</i> if there is no minimum

Table 26: show tcp path-mtu-discovery Output Fields (*continued*)

Field Name	Field Description
Administrative Maximum MTU	Administrative maximum PMTU that is supported or none if there is no maximum
Timer 1	Value of timer 1 in minutes
Timer 2	Value of timer 2 in minutes
Black Hole Detect Threshold	Number of retransmissions allowed before TCP/PMTUD assumes that there is a black hole and attempts to reduce impact in the MSS
# ICMP TooBigs	Number of ICMP Too Big messages that have been received
# ICMP TooBigs for unk. connections	Number of ICMP Too Big messages that have been received which were not for a valid connection

- Related Documentation**
- [Configuring TCP PMTU Discovery for IP on page 51](#)
 - [Configuring TCP PMTU Discovery for IPv6 on page 179](#)
 - `show tcp path-mtu-discovery`

Monitoring TCP PAWS Status

- Purpose** Display the TCP PAWS status.
- Action** To display the TCP PAWS status:
- ```
host1#show tcp paws
TCP PAWS is disabled
```
- Related Documentation**
- [Preventing TCP PAWS Timestamp DoS Attacks on page 53](#)
  - `show tcp paws`

## Monitoring the TCP Resequencing Buffer Management Functions

- Purpose** Display the configuration, current per-virtual router, and per-router state of the TCP resequencing buffer management functions. You can use the *vrfName* variable to specify a specific VRF for which you want to view information.
- Action** To display the configuration, current per-virtual router, and per-router state of the TCP resequencing buffer management functions:
- ```
host1#show tcp resequence-buffers
TCP Resequence Buffer Management Configuration
Global Maximum: ###
```

```

    Default Per-VR Maximum: 250
    Default Connection Maximum: 15
    This VR Maximum: 300
    This VR Connection Maximum: 15

TCP Resequence Buffer Management State
Global buffers in use: 5
    High Water: 15
VR Buffers in use: 17
    High Water: 32
Buffers Discarded Because Global Limit Exceeded: 25
Buffers Discarded Because VR Limit Exceeded: 15

```

Meaning Table 27 on page 130 lists the **show tcp resequence-buffers** command output fields.

Table 27: show tcp resequence-buffers Output Fields

Field Name	Field Description
TCP Resequence Buffer Management Configuration	
Global Maximum	Number of buffers that can be on the reordering queues of all connections in all virtual routers
Default Per-VR Maximum	Default maximum number of buffers for all connections in a single virtual router
Default Connection Maximum	Default maximum number of buffers for each connection in each virtual router
This VR Maximum	Maximum number of outstanding resequencing buffers in the current virtual router
This VR Connection Maximum	Maximum number of outstanding resequencing buffers on any one connection in this virtual router
TCP Resequence Buffer Management State	
Global buffers in use	Total number of outstanding resequencing buffers in the router: <ul style="list-style-type: none"> High Water—Largest number of outstanding resequencing buffers that the router has experienced since the last reset
VR Buffers in use	Number of outstanding resequencing buffers in the current virtual router: <ul style="list-style-type: none"> High Water—Largest number of outstanding resequencing buffers for the current virtual router since the last reset
Buffers Discarded Because Global Limit Exceeded	Number of resequencing buffers discarded because the global limit was reached

Table 27: show tcp resequence-buffers Output Fields (*continued*)

Field Name	Field Description
Buffers Discarded Because VR Limit Exceeded	Number of resequencing buffers that have been discarded in this virtual router because the virtual router buffer limit was reached

- Related Documentation**
- [Protecting Against TCP Out-of-Order DoS Attacks on page 54](#)
 - `show tcp resequence-buffers`

Monitoring TCP Statistics for IP

Purpose Display all TCP statistics (both IPv4 and IPv6). Baselining is supported for the **show tcp statistics** command. This command shows information only for the connections that are active within the context of the virtual router in which you issue the command.

You can use the **ip** keyword to display only IPv4 statistics. You can use the **ipv6** keyword to display only IPv6 statistics. You can use the **brief** keyword to display summary information or the **detailed** keyword to display extensive information. You can use the **diagnostic** keyword to display diagnostic information collected on the TCP statistics in addition to the detailed information.

Action To display TCP statistics for IPv4:

```
host1#show ip tcp statistics
TCP Global Statistics:
  Connections: 7358 attempted, 4 accepted, 7362 established
               0 dropped, 14718 closed
  Rcvd: 75923 total pkts, 53608 in-sequence pkts, 3120303 bytes
        0 chksum err pkts, 0 authentication err pkts, 0 bad offset pkts
        0 short pkts, 0 duplicate pkts, 0 out of order pkts
  Sent: 82352 total pkts, 44404 data pkts, 657095 bytes
        34 retransmitted pkts, 487 retransmitted bytes

TCP Session Statistics:
  Local addr: 0.0.0.0, Local port: 23
  Remote addr: 0.0.0.0, Remote port: 0
  State: LISTEN Authentication: None
  Rcvd: 4 total pkts, 0 in-sequence pkts, 0 bytes
        0 chksum err pkts, 0 bad offset pkts, 0 short pkts
        0 duplicate pkts, 0 out of order pkts
  Sent: 0 total pkts, 0 data pkts, 0 bytes
        0 retransmitted pkts, 0 retransmitted bytes

  Local addr: 192.168.1.250, Local port: 23
  Remote addr: 10.10.0.77, Remote port: 2170
  State: ESTABLISHED Authentication: None
  Rcvd: 61 total pkts, 34 in-sequence pkts, 41 bytes
        0 chksum err pkts, 0 bad offset pkts, 0 short pkts
        0 duplicate pkts, 0 out of order pkts
  Sent: 64 total pkts, 45 data

  Local addr: 192.168.1.250, Local port: 23
  Remote addr: 10.10.0.77, Remote port: 2170
  State: ESTABLISHED Authentication: None
```

```

Rcvd: 61 total pkts, 34 in-sequence pkts, 41 bytes
      0 chksum err pkts, 0 bad offset pkts, 0 short pkts
      0 duplicate pkts, 0 out of order pkts
Sent: 64 total pkts, 45 data pkts, 2304 bytes
      0 retransmitted pkts, 0 retransmitted bytes
Local addr: 192.168.1.250, Local port: 23
Remote addr: 192.168.1.139, Remote port: 1038
State: ESTABLISHED Authentication: None
Rcvd: 295 total pkts, 159 in-sequence pkts, 299 bytes
      0 chksum err pkts, 0 bad offset pkts, 0 short pkts
      0 duplicate pkts, 0 out of order pkts
Sent: 281 total pkts, 210 data pkts, 3089 bytes
      0 retransmitted pkts, 0 retransmitted bytes

```

To display diagnostic information for IPv4 TCP statistics:

```
host1#show ip tcp statistics diagnostic
```

```

...
Global Diagnostic Data
  Unknown Connection log
Source address/port -> local port
    128.127.126.125/124 -> 8080  count: 3
    111.111.111.111/222 -> 3333  count: 4
# connection-reqs rejected: 0
# connection-reqs pending: 0
# sonewconn calls that fail: 0
...
Diagnostics:
  PRU_ Operations counters:
    PRU_ATTACH: 0
    PRU_DETACH: 0
    PRU_BIND: 1
    PRU_LISTEN: 1
    PRU_CONNECT: 0
    PRU_ACCEPT: 0
    PRU_DISCONNECT: 0
    PRU_SHUTDOWN: 0
    PRU_RCVD: 0
    PRU_SEND: 0
    PRU_ABORT: 0
    PRU_CONTROL: 0
    PRU_SENSE: 0
    PRU_RCVOOB: 0
    PRU_SENDOOB: 0
    PRU_SOCKADDR: 0
    PRU_PEERADDR: 0
    PRU_CONNECT2: 0
    PRU_FASTTIMO: 0
    PRU_SLOWTIMO: 0
    PRU_PROTORCV: 0
    PRU_PROTOSEND: 0
  Wildcard Matches: 2
  Rcv'd Packets after connection closed: 0
  Connect request rejected: 0
  Connect request approval pending 0
  New soconnect failed 0
  # Write-Wakeups: 0
  # Read wakeups 0
  # receives after close 0
  Retransmit timer: 0
  Persistence timer: 0
  Keepalive timer: 0

```

```

2MSL timer: 0
tcpDisconnect(s): 0
keep T/O pre-estab: 0
tcpkeepimeo_idle: 0
...
TCP Connection Event Log (most recent at bottom)
  TCPS_ELOG_PRU_ATTACH
  TCPS_ELOG_PRU_BIND

To display extensive information for IPv4 TCP statistics:

host1#show ip tcp statistics detailed
...
RST/SYN-Ack Protection is: ENABLED
  RSTs acked: 0
  ...Bogus RSTs: 0
  SYNs acked: 0
  ...Bogus SYNs: 0
  Data Insertions rejected: 0
PMTUD Information:      PMTUD: ENABLED
  Administrative Minimum MTU: 512
  Administrative Maximum MTU: none
  Timer 1: 10 minutes
  Timer 2: 2 minutes
  # ICMP TooBigs: 0
  # ICMP TooBigs for unk. connection: 0
  PMTU Increase Attempts: 17
  Black Hole Detect Threshold: 50 retransmissions
...
MTU/MSS Information
  ENABLED on this connection
  MSS in effect: 536
  Calculated MSS to peer: 536
  MSS received from peer: 0
  Application set MSS: 0
  Xmit Interface MSS: 0
  MSS Sent to Peer: 0
  "ICMP DestUn, Frag Req'd and DF Set" messages: 0
  Number of attempts to increase PMTU: 0
  Time to next increase attempt: 0 seconds
  Black Hole Detection State: none
...
Out-of-order Packet Queue Information
  Buffers Outstanding: 25
    High Water: 28
  Buffers discarded: 15
...
TCP-Paws is disabled

```

Meaning [Table 28 on page 134](#) lists the **show ip tcp statistics** command output fields.

Table 28: show ip tcp statistics Output Fields

Field Name	Field Description
TCP Global Statistics Connections	<ul style="list-style-type: none"> attempted—Number of outgoing TCP connections attempted accepted—Number of incoming TCP connections accepted established—Number of TCP connections established
TCP Global Statistics Rcvd	<ul style="list-style-type: none"> total pkts—Total number of packets received in-sequence pkts—Number of packets received in sequence bytes—Number of bytes received chksum err pkts—Number of checksum error packets received authentication err pkts—Number of authentication error packets received bad offset pkts—Number of bad offset packets received short pkts—Number of short packets received duplicate pkts—Number of duplicate packets received out of order pkts—Number of packets received out of order
TCP Global Statistics Sent	<ul style="list-style-type: none"> total pkts—Total number of packets sent data pkts—Number of data packets sent bytes—Number of bytes sent retransmitted pkts—Number of packets retransmitted retransmitted bytes—Number of bytes retransmitted
Global Diagnostic Data Unknown Connection log	<p>Includes the following global statistics:</p> <ul style="list-style-type: none"> Source address/port – local port—Shows the 32 most recent TCP connection attempts that were rejected, including the remote node's IP address and port, the local port for the connection attempt, and the number of identical attempts that have been received on that port in a row. The reason for rejection is not given. This information may be useful in tracking down DoS attacks. # connection-reqs rejected—Total number of connection attempts that have been rejected # connection-reqs pending—Current number of connection attempts that are pending, awaiting additional data from the peer # sonewconn calls that fail—Number of calls to sonewconn that have failed. This statistic often indicates that either a socket connection limit has been reached or that there was no memory to hold the socket data structures.

Table 28: show ip tcp statistics Output Fields (*continued*)

Field Name	Field Description
TCP Session Statistics	<ul style="list-style-type: none"> Local addr—Local address of the TCP connection Local port—Local port number of the TCP connection Remote addr—Remote address of the TCP connection Remote port—Remote port number of the TCP connection State—Current state of the TCP connection Authentication—Authentication status of the TCP connection
TCP Session Statistics Rcvd	<ul style="list-style-type: none"> total pkts—Total number of packets received on the TCP connection in-sequence pkts—Number of packets received in sequence on the TCP connection bytes—Number of bytes received on the TCP connection chksum err pkts—Number of checksum error packets received on the TCP connection bad offset pkts—Number of bad offset packets received on the TCP connection short pkts—Number of short packets received on the TCP connection duplicate pkts—Number of duplicate packets received on the TCP connection out of order pkts—Number of packets received out of order on the TCP connection
TCP Session Statistics Sent	<ul style="list-style-type: none"> total pkts—Total number of packets sent on the TCP connection data pkts—Number of data packets sent on the TCP connection bytes—Number of bytes sent on the TCP connection retransmitted pkts—Number of packets retransmitted on the TCP connection retransmitted bytes—Number of bytes retransmitted on the TCP connection
PRU_Operations counters	Number of calls for each of the indicated PRU_operations within the TCP service API. These are per-connection statistics.
Wildcard Matches	Number of packets received that matched this TCP connection due to wildcard matching. Matching is expected for listening server connections, such as Telnet, but is not expected for established connections. This is a per-connection statistic.

Table 28: show ip tcp statistics Output Fields (*continued*)

Field Name	Field Description
Rcv'd Packets after connection closed	Number of packets received on the connection after the connection has been closed (and before the data structure gets removed). This is a per-connection statistic.
Connect request rejected	Number of times an incoming connection request was not approved. This is a per-connection statistic.
Connect request approval pending	Number of times that an incoming connection request was held pending, waiting for a subsequent packet. This is a per-connection statistic.
New soconnect failed	Number of times a SONEWCONN() was tried on a listening connection and failed. This is a per-connection statistic.
# Write-Wakeups	Number of times a "write wakeup" occurred on the connection. This is a per-connection statistic.
# Read wakeups	Number of times a "read wakeup" occurred on the connection. This is a per-connection statistic.
# receives after close	Number of packets received with data after the connection entered the close-wait state. This is a per-connection statistic.
Retransmit timer	Current value of the retransmit timer
Persistence timer	Current value of the persistence timer
Keepalive timer	Current value of the keepalive timer
2MSL timer	Current value of the 2MSL (max segment lifetime) timer
tcpDisconnect()s	Number of times BsdTcp::tcpDisconnect() was called. This is a per-connection statistic.
keep T/O pre-estab	Number of times the keepalive timer expired before the connection reached the established state. This is a per-connection statistic.
tcpkeepimeo_idle	Number of times the keepalive timer popped, but no keepalive was sent because of connection idle-time considerations. This is a per-connection statistic.

Table 28: show ip tcp statistics Output Fields (*continued*)

Field Name	Field Description
TCP Connection Event Log (most recent at bottom)	<p>Event log for the TCP connection. It shows the last 32 events that occurred on the connection. The most recent event is at the bottom of the list. This is per-connection data.</p> <ul style="list-style-type: none"> • TCPS_ELOG_PRU_ATTACH • TCPS_ELOG_PRU_BIND <p>The following events can be recorded:</p> <ul style="list-style-type: none"> • Fast Timeout—Did a PRU_CONNECT • 2MSL Timeout—Did a PRU_CONNECT2 • Retransmit Timeout—Did a PRU_DISCONNECT • Persist Timeout—Did a PRU_ACCEPT • Received FIN packet—Did a PRU_SHUTDOWN • Received SYN packet—Did a PRU_RCVD • Received Retransmission—Did a PRU_SEND • Transmit a FIN packet—Did a PRU_ABORT • Transmit a SYN packet—Did a PRU_SENSE • Retransmit a packet—Did a PRU_RCVOOB • Did a PRU_ATTACH—Did a PRU_SENDOOB • Did a PRU_DETACH—Did a PRU_SOCKADDR • Did a PRU_BIND—Did a PRU_PEERADDR • Did a PRU_LISTEN—The keepalive timer popped. An 8-bit argument that describes how the timer was handled: <ul style="list-style-type: none"> • Ignored because the session was not established (that is, not in the OPEN state) • Ignored due to idle-timeout considerations • A packet was sent • Ignored because the connection did not have the keepalive option set OR the connection was in the process of closing

Table 28: show ip tcp statistics Output Fields (*continued*)

Field Name	Field Description
RST/SYN-Ack DoS Protection	<p>Specifies when this function is enabled:</p> <ul style="list-style-type: none"> RSTs acked—Number of RSTs received and then acknowledged by the TCP stack. <p>NOTE: This count is maintained even when the protection functions are disabled. The value indicates the count of packets that would have been acknowledged if the protections were enabled. Providing this information can help determine whether attacks are occurring.</p> <ul style="list-style-type: none"> Bogus RSTs—Number of RSTs that were judged to be invalid (that is, their timer expired) and therefore ignored SYNs acked—Number of SYNs received and then acknowledged by the TCP stack. <p>NOTE: This count is maintained even when the protection functions are disabled. The value indicates the count of packets that would have been acknowledged if the protections were enabled. Providing this information can help determine whether attacks are occurring.</p> <ul style="list-style-type: none"> Bogus SYNs—Number of RSTs that were judged to be invalid (that is, their timer expired) and therefore ignored Data Insertions rejected—Number of packets received and dropped because they are believed to have been inserted by an attacker <p>NOTE: This count is maintained even when the protection functions are disabled. The value indicates the count of packets that would have been rejected if the protections were enabled. Providing this information can help determine whether attacks are occurring.</p>

Table 28: show ip tcp statistics Output Fields (*continued*)

Field Name	Field Description
PMTUD information	<p>Information regarding path MTU discovery:</p> <ul style="list-style-type: none"> • PMTUD—Status of path MTU discovery on the virtual router: enabled or disabled • Administrative Minimum MTU—Minimum MTU that is enabled on any connection; a value of “none” indicates that the minimum is zero (0) • Administrative Maximum MTU—Maximum MTU that is enabled on any connection; a value of “none” indicates that the maximum is 65535 • Timer 1—Amount of time the virtual router waits after receiving an ICMP Too Big message before attempting to increase the path MTU • Timer 2—Amount of time the virtual router waits after successfully increasing the MTU before attempting to increase it more • # ICMP TooBigs—Number of ICMP Too Big messages that the router has received. When PMTU is disabled, this counter does not increase. • # ICMP TooBigs for unk. connection—Number of ICMP Too Big messages that the router has received for TCP connections that do not exist. When PMTU is disabled, this counter does not increase. • PMTU Increase Attempts—Number of attempts the router has made to increase the PMTU • Black Hole Detect Threshold—Number of successive transmissions that must occur on a connection before that connection treats retransmissions as indications that something is wrong • Override MSS—MSS that is advertised to peers, overriding the MSS that is derived from the interface MTU. This line does not appear in the output if you do not set the value.

Table 28: show ip tcp statistics Output Fields (*continued*)

Field Name	Field Description
MTU/MSS information	<p>Information regarding path MTU/MSS:</p> <ul style="list-style-type: none"> • PMTU—Status of MTU/MSS on this virtual router: enabled or disabled • MSS in effect—MSS currently being used for transmission to the peer. This number changes while various network events occur to cause the router to increase or decrease its estimate of the MSS. • Calculated MSS to peer—MSS that path MTU discovery has calculated (if PMTUD is enabled) to the peer • MSS received from peer—MSS that the peer received in a TCP MSS option. If no option is received, the value is zero (0). • Application set MSS—MSS that an application might have set for the connection • Xmit Interface MSS—MSS for the interface used to transmit packets to the peer; calculated as the interface MTU minus the size of the TCP and IP headers. • MSS Sent to Peer—MSS that has been advertised to the peer • “ICMP DestUn, Frag Req’d and DF Set” messages—Number of ICMP “Destination Unreachable: Fragmentation Required and DF set” messages that the router has received • Number of attempts to increase PMTU—Number of times the router has attempted to increase the PMTU by probing with a packet that is larger than the known MTU • Time to next increase attempt—Amount of time, in seconds, until the router retries to increase the MTU • Black Hole Detection State—State of the black hole detection mechanism: none, detecting, probable, or unknown
Out-of-Order Packet Queue Information	<p>Information regarding packet queue buffers:</p> <ul style="list-style-type: none"> • Buffers Outstanding—Number of buffers currently on the connection reordering queue • High Water—Most buffers that have ever been on the connection reordering queue • Buffers discarded—Number of buffers that were discarded because keeping them would have exceeded the connection maximum
TCP PAWS is [enabled/disabled]	Status of the TCP PAWS option; enabled indicates that PAWS is functioning normally (default mode) for TCP segments; disabled indicates that PAWS is disabled for TCP segments

- Related Documentation**
- [Enabling or Disabling the Transmission of ICMP Unreachable Messages for Static Routes on Null Interfaces on page 38](#)
 - [Configuring TCP for IP on page 49](#)
 - [Setting a Baseline for IP TCP Statistics on page 85](#)
 - `show tcp statistics`

Monitoring IP Traffic Statistics

Purpose Display statistics about IP traffic. You can use the `ipTraffic` log to show consumable IP traffic to the SRP module; the traffic is filterable per router and IP interface. You can show ICMP, TCP, and UDP traffic with the `icmpTraffic`, `udpTraffic`, and `tcpTraffic` logs.

Action To display statistics about IP traffic:

```
host1#show ip traffic
IP statistics: Router Id: 172.31.192.217
  Rcvd: 97833 total, 171059 local destination
    0 hdr errors, 0 addr errors
      167 unkn proto, 0 discards
    Frags: 4 reassembled, 30 reasm timed out, 8 reasm req
      0 reasm fails, 145 frag ok, 0 frag fail
      290 frag creates
  Sent: 15 forwarded, 25144 generated, 0 out disc
    0 no routes, 0 routing discards
  Route: 57680 routes in table
    0 timestamp req, 0 timestamp rpy
    0 addr mask req, 0 addr mask rpy
ICMP statistics:
  Rcvd: 561 total, 0 errors, 15 dst unreach
    0 time exceed, 0 param probs, 0 src quench
    0 redirects, 0 echo req, 0 echo rpy
    0 timestamp req, 0 timestamp rpy
    0 addr mask req, 0 addr mask rpy
  Sent: 463866 total, 0 errors, 163676 dest unreach
    0 time excd, 0 param prob, 0 src quench
    20 redirects, 463846 echo req, 0 echo rpy
    0 timestamp req, 0 timestamp rpy
    0 addr mask req, 0 addr mask rpy
UDP Statistics:
  Rcvd: 93326 total, 0 checksum errors, 90610 no port
  Sent: 0 total, 0 errors
TCP Global Statistics:
  Connections: 7358 attempted, 4 accepted, 7362 established
    0 dropped, 14718 closed
  Rcvd: 75889 total pkts, 53591 in-sequence pkts, 3120283 bytes
    0 chksum err pkts, 0 authentication err pkts, 0 bad offset
    0 short pkts, 0 duplicate pkts, 0 out of order pkts
  Sent: 82318 total pkts, 44381 data pkts, 656321 bytes
    34 retransmitted pkts, 487 retransmitted bytes
OSPF Statistics:
IGMP Statistics:
ARP Statistics:
```

Meaning [Table 29 on page 142](#) lists the `show ip traffic` command output fields.

Table 29: show ip traffic Output Fields

Field Name	Field Description
IP Statistics Rcvd	<ul style="list-style-type: none"> router Id—Router ID number total—Number of frames received local destination—Frames with this router as their destination hdr errors—Number of packets containing header errors addr errors—Number of packets containing addressing errors unkn proto—Number of packets received containing unknown protocols discards—Number of discarded packets
IP Statistics Frags	<ul style="list-style-type: none"> reassembled—Number of reassembled packets reasm timed out—Number of reassembled packets that timed out reasm req—Number of requests for reassembly reasm fails—Number of reassembly failures frag ok—Number of fragmented packets reassembled successfully frag fail—Number of fragmented packets reassembled unsuccessfully frag creates—Number of packets created by fragmentation
IP Statistics Sent	<ul style="list-style-type: none"> forwarded—Number of packets forwarded generated—Number of packets generated out disc—Number of outbound packets discarded no routes—Number of packets that could not be routed routing discards—Number of packets that could not be routed and were discarded
IP Statistics Route	<ul style="list-style-type: none"> routes in table—Number of routes in the routing table timestamp req—Number of requests for a timestamp timestamp rpy—Number of replies to timestamp requests addr mask req—Number of address mask requests addr mask rpy—Number of address mask replies

Table 29: show ip traffic Output Fields (*continued*)

Field Name	Field Description
ICMP Statistics Rcvd	<ul style="list-style-type: none"> • total—Total number of ICMP packets received • errors—Number of error packets received • dst unreachable—Number of packets received with destination unreachable • time exceed—Number of packets received with time-to-live exceeded • param probs—Number of packets received with parameter errors • src quench—Number of source quench packets received • redirects—Number of receive packet redirects • echo req—Number of echo request (ping) packets • echo rpy—Number of echo replies received • timestamp req—Number of requests for a timestamp • timestamp rpy—Number of replies to timestamp requests • addr mask req—Number of mask requests received • addr mask rpy—Number of mask replies received
ICMP Statistics Sent	<ul style="list-style-type: none"> • total—Total number of ICMP packets sent • errors—Number of error packets sent • dest unreachable—Number of packets sent with destination unreachable • time excd—Number of packets sent with time-to-live exceeded • param prob—Number of packets sent with parameter errors • src quench—Number of source quench packets sent • redirects—Number of send packet redirects • echo req—Number of echo request (ping) packets • echo rpy—Number of echo replies sent • timestamp req—Number of requests for a timestamp • timestamp rpy—Number of replies to timestamp requests • addr mask req—Number of address mask requests sent • addr mask rpy—Number of replies to address mask requests
UDP Statistics Rcvd	<ul style="list-style-type: none"> • total—Total number of UDP packets received • checksum—Number of checksum error packets received • no port—Number of packets received for which no E Series router application listener was listening on the destination port

Table 29: show ip traffic Output Fields (*continued*)

Field Name	Field Description
UDP Statistics Sent	<ul style="list-style-type: none"> total—Total number of UDP packets sent errors—Number of error packets sent
TCP Global Statistics Connections	<ul style="list-style-type: none"> attempted—Number of outgoing TCP connections attempted accepted—Number of incoming TCP connections accepted established—Number of TCP connections established dropped—Number of TCP connections dropped closed—Number of TCP connections closed currently established—Number of TCP connections currently established
TCP Global Statistics Rcvd	<ul style="list-style-type: none"> total pkts—Total number of TCP packets received in-sequence pkts—Number of packets received in sequence bytes—Number of bytes received chksum err pkts—Number of checksum error packets received authentication err pkts—Number of authentication error packets received bad offset pkts—Number of packets received with bad offsets short pkts—Number of short packets received duplicate pkts—Number of duplicate packets received out of order pkts—Number of packets received out of order
TCP Global Statistics Sent	<ul style="list-style-type: none"> total pkts—Total number of TCP packets sent data pkts—Number of data packets sent bytes—Number of bytes sent retransmitted pkts—Number of packets retransmitted retransmitted bytes—Number of retransmitted bytes
OSPF Statistics	Provides statistics on OSPF
IGMP Statistics	Provides statistics about queries, reports sent or received
ARP Statistics	Not supported for this version of the router

Related Documentation

- [Adding a Static Entry in the ARP Cache on page 22](#)
- [Identifying a Router Within an Autonomous System on page 36](#)

- [Enabling or Disabling the Transmission of ICMP Unreachable Messages for Static Routes on Null Interfaces on page 38](#)
- [Disabling the Forwarding of IP Packets on an SRP Ethernet Interface on page 59](#)
- [Setting a Baseline for IP Statistics on page 84](#)
- `show ip traffic`

Monitoring IP UDP Statistics

Purpose Display UDP statistics.

Action To display UDP statistics:

```
host1#show ip udp statistics
```

UDP Statistics:

```
Rcvd: 39196 total, 0 checksum errors, 29996 no port
Sent: 210 total, 0 errors
```

Meaning [Table 30 on page 145](#) lists the `show ip udp statistics` command output fields.

Table 30: show ip udp statistics Output Fields

Field Name	Field Description
UDP Statistics Rcvd	<ul style="list-style-type: none"> • total—Total number of UDP packets received • checksum—Number of checksum error packets received • no port—Number of packets received for which no E Series router application listener was listening on the destination port
UDP Statistics Sent	<ul style="list-style-type: none"> • total—Total number of UDP packets sent • errors—Number of error packets sent

Related Documentation

- [Setting a Baseline for IP UDP Statistics on page 85](#)
- `show ip udp statistics`

Monitoring an IP Profile

Purpose Display information about a specific IP profile.

Action To display information about a specific IP profile:

```
host1#show ip profile foo
```

IP profile : foo

IP address : none

Unnumbered interface : none

Router :

Directed Broadcast : Enabled

ICMP Redirects : Disabled

Access Route Addition : Enabled

```

Network Address Translation: Enabled, domain inside
Source-Address Validation  : Enabled
Ignore DF Bit              : Disabled
Administrative MTU         : 0
Auto Detect                : Disabled
Auto Configure             : Disabled
Auto Detect                : Disabled
IP FlowStats               : Enabled

```

Meaning [Table 31 on page 146](#) lists the **show ip profile** command output fields.

Table 31: show ip profile Output Fields

Field Name	Field Description
IP profile	Profile name
IP address	IP address and subnet mask of the interface or none if the interface is unnumbered
Unnumbered interface	Specifier for the unnumbered interface or none if the interface is numbered
Router	Router name
Directed Broadcast	Directed broadcast forwarding feature status: Enabled or disabled
ICMP Redirects	ICMP redirect feature status: Enabled or disabled
Access Route Addition	Access route feature status: Enabled or disabled
Network Address Translation	Enable or disable; domain location (inside or outside)
Source-Address Validation	Source address validation feature status: Enabled or disabled
Ignore DF Bit	Ignoring DF bit usage: Enabled or disabled
Administrative MTU	MTU size
Auto Detect	Router automatically detects packets that do not match any entries in the demultiplexer table; enabled or disabled
Auto Configure	Dynamic creation of subscriber interfaces on a primary IP interface; enabled or disabled
IP FlowStats	Enabled or disabled

Related Documentation

- [Configuring Profile Attributes for IP on page 18](#)
- `show ip profile`

Monitoring Profile Names

Purpose Display a list of all profile names.

Action To display a list of all profile names:

```
host1#show profile brief
Profile :
foo
trill
profile4
```

Meaning [Table 32 on page 147](#) lists the **show profile brief** command output fields.

Table 32: show profile brief Output Fields

Field Name	Field Description
Profile	Profile names

Related Documentation

- [Creating a Profile on page 17](#)
- show profile brief

Monitoring Route Map Details

Purpose Display configured route maps. The displayed information includes instances of each access list such as **match** and **set** commands.

Action To display configured route maps:

```
host1#show route-map westford
route-map 1, permit, sequence 10
Match clauses:
  match community 44
Set clauses:
  set local-pref 400
```

Related Documentation

- show route-map

CHAPTER 3

Configuring IPv6

This chapter describes how to configure IP version 6 (IPv6) routing on your E Series router; it contains the following sections:

- [IPv6 Overview on page 150](#)
- [IPv6 Addressing Overview on page 152](#)
- [IPv6 Tunnel Routing Tables Overview on page 156](#)
- [Indirect Next-Hop Overview on page 156](#)
- [IPv6 Platform Considerations on page 157](#)
- [Supported Management Applications for IPv6 on page 158](#)
- [IPv6 References on page 159](#)
- [Before You Configure IPv6 on page 159](#)
- [Configuring an IPv6 License on page 160](#)
- [IPv6 Profiles on page 160](#)
- [Enabling IPv6 Source Address Validation on page 164](#)
- [Establishing an IPv6 Static Route on page 165](#)
- [Understanding ICMPv6 Unreachable Messages for Static Routes Sent on Null Interfaces on page 165](#)
- [Enabling or Disabling the Transmission of ICMPv6 Unreachable Messages for Static Routes on Null Interfaces on page 167](#)
- [Configuring IPv6 Static Routes with Tags for Redistribution of Routes on page 168](#)
- [Redistributing a Specific IPv6 Static Route Based on the Tag Value on page 169](#)
- [Next-Hop Verification for IPv6 Static Routes Overview on page 170](#)
- [Specifying an IPv6 Hop-Count Limit on page 172](#)
- [Managing IPv6 Interfaces on page 173](#)
- [Shared IPv6 Interfaces on page 175](#)
- [Adding a Description to an IPv6 Interface or Subinterface on page 177](#)
- [Configuring TCP for IPv6 on page 178](#)
- [ECMP Load Sharing for IPv6 on page 185](#)
- [Removing an IPv6 Configuration on page 186](#)

- [Clearing IPv6 Routes on page 187](#)
- [Creating Static IPv6 Neighbors on page 187](#)
- [Clearing Static or Dynamic IPv6 Neighbors on page 188](#)

IPv6 Overview

IP version 6 (IPv6) is designed to eventually supersede IP version 4 (IPv4). The intent of this design change is not to take a radical step away from IPv4, but to enhance IP addressing and maintain other IPv4 functions that work well.

The differences between IPv4 and IPv6 include the following:

- Expanded addressing capabilities

IPv6 increases the size of the IP address from 32 bits to 128 bits. This increased size provides a larger address space and a much larger number of addressable nodes.

- Simplified header format

Reducing some common processing costs associated with packet handling and streamlining the bandwidth cost of the larger IPv6 header, some IPv4-specific header fields either no longer exist or are now optional in the IPv6 header.

- Traffic flow labeling capabilities

The ability to label packets for specific traffic flows exists in the IPv6 packet. These labels allow for nondefault quality of service (QoS) or the possibility of “real-time” services.

- Authentication capabilities

Authentication provides the ability to use extensions for some authentication and data integrity applications.

IPv6 continues to provide the basic packet delivery service for all TCP/IP networks. As a *connectionless* protocol, IPv6 does not exchange control information to establish an end-to-end connection before transmitting data. Instead, just like its IPv4 predecessor, IPv6 continues to rely on protocols in other layers to establish the connection if connection-oriented services are required and to provide error detection and error recovery.

In addition to supporting a revised header structure and an expanded addressing format, the E Series router supports the following IPv6 features:

- Static routes
- ICMPv6
- Ping
- Traceroute
- Routing policy (See *JunosE IP Services Configuration Guide* for details.)
- IPv6 B-RAS (See the *JunosE Broadband Access Configuration Guide* for details.)
- IPv6 tunnel routing tables

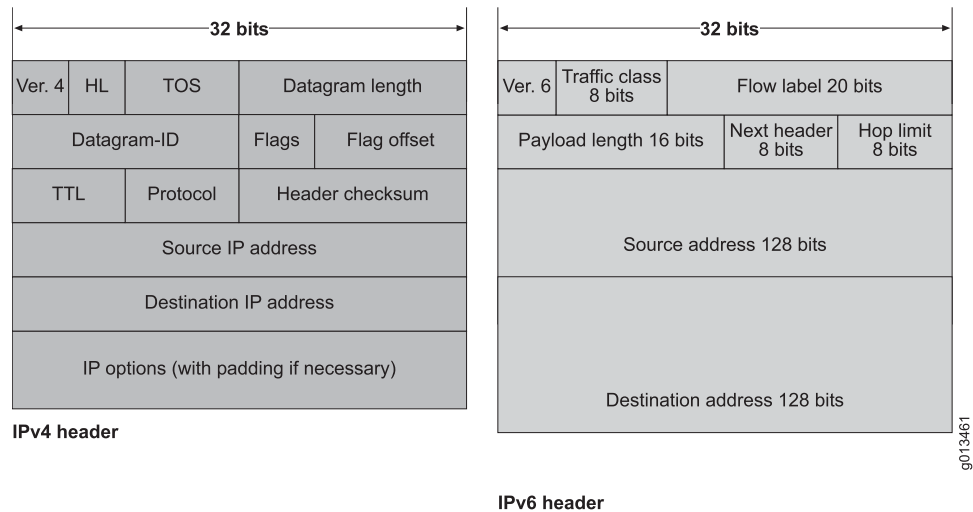
IPv6 Packet Headers

An IPv6 packet is a block of data that contains a header and a payload. The header is the information necessary to deliver the packet to a destination address; the payload is the data that you want to deliver. IPv6 packets can use a standard or an extended format.

IPv4 and IPv6 Header Differences

The main difference between IPv4 and IPv6 resides in their headers. [Figure 13 on page 151](#) provides a comparison between the two protocol versions.

Figure 13: IPv4 and IPv6 Header Comparison



Standard IPv6 Headers

IPv6 packet headers contain many of the fields found in IPv4 packet headers; some of these fields differ from IPv4. (See [Figure 13 on page 151](#).)

The 40-byte IPv6 header consists of the following eight fields:

- Version—Indicates the version of the Internet Protocol.
- Traffic class—Previously the type-of-service (ToS) field in IPv4, the traffic class field defines the class-of-service priority of the packet. However, the semantics for this field (for example, Differentiated Services (DiffServ) code points) are identical to IPv4.
- Flow label—The flow label identifies all packets belonging to a specific flow (that is, packet flows requiring a specific class of service (CoS)); routers can identify these packets and handle them in a similar fashion.
- Payload length—Previously the total length field in IPv4, the payload length field specifies the length of the IPv6 payload.
- Next header—Previously the protocol field in IPv4, the Next Header field indicates the next extension header to examine.

- Hop limit—Previously the time-to-live (TTL) field in IPv4, the hop limit indicates the maximum number of hops allowed.
- Source address—Identifies the address of the source node sending the packet.
- Destination address—Identifies the final destination node address for the packet.

Extension Headers

In IPv6, extension headers are used to encode optional Internet-layer information. Extension headers are placed between the IPv6 header and the upper-layer header in a packet.

IPv6 enables you to chain extension headers together by using the next header field. The next header field, located in the IPv6 header, indicates to the router which extension header to expect next. If there are no more extension headers, the next header field indicates the upper-layer header (TCP header, UDP header, ICMPv6 header, an encapsulated IP packet, or other items).

Related Documentation

- [IPv6 Addressing Overview on page 152](#)
- [IPv6 Tunnel Routing Tables Overview on page 156](#)
- [IPv6 Platform Considerations on page 157](#)
- [IPv6 References on page 159](#)
- [System Event Logs Used to Troubleshoot and Monitor IPv6 on page 192](#)

IPv6 Addressing Overview

IP version 6 (IPv6) increases the size of the IP address from the 32 bits found in IPv4 to 128 bits. This increased size provides for a broader range of addressing hierarchies and a much larger number of addressable nodes.

In addition to the increased size, IPv6 addresses can be of different scopes that categorize what types of applications are suitable for the address. IPv6 does not support broadcast addresses, but uses multicast addresses to serve this role. In addition, IPv6 also defines a new type of address called *anycast*.

This topic describes the following:

- [Address Representation on page 153](#)
- [Address Types on page 154](#)
- [Address Scope on page 155](#)
- [Address Structure on page 155](#)
- [ICMP Support on page 155](#)

Address Representation

IPv6 addresses consist of eight hexadecimal groups. Each hexadecimal group, separated by a colon (:), consists of a 16-bit hexadecimal value. The following is an example of the IPv6 format:

```
xxxx:xxxx:xxxx:xxxx:xxxx:xxxx:xxxx:xxxx
```

A group of xxxx represents the 16-bit hexadecimal value. Each individual x represents a 4-bit hexadecimal value. The following is an example of a possible IPv6 address:

```
4FDE:0000:0000:0002:0022:F376:FF3B:AB3F
```



NOTE: Hexadecimal letters in IPv6 addresses are not case sensitive.

This section explains the following:

- [IPv6 Address Compression on page 153](#)
- [IPv6 Address Prefix on page 153](#)

IPv6 Address Compression

IPv6 addresses often contain consecutive hexadecimal fields of zeros. To simplify address entry, you can use two colons (::) to represent the consecutive fields of zeros when typing the IPv6 address. [Table 33 on page 153](#) provides compressed IPv6 address format examples.

Table 33: Compressed IPv6 Formats

IPv6 Address Type	Full Format	Compressed Format
Unicast	10FB:0:0:0:C:ABC:1F0C:44DA	10FB::C:ABC:1F0C:44DA
Multicast	FF01:0:0:0:0:0:1F	FF01::1F
Loopback	0:0:0:0:0:0:1	::1
Unspecified	0:0:0:0:0:0:0	::



NOTE: You can use two colons (::) only once in an IPv6 address to represent hexadecimal fields of consecutive zeros.

IPv6 Address Prefix

An IPv6 address prefix is a combination of an IPv6 prefix (address) and a prefix length. The prefix takes the form *ipv6-prefix/prefix-length* and represents a block of address space (or a network). The *ipv6-prefix* variable follows general IPv6 addressing rules (see RFC 2373 for details). The */prefix-length* variable is a decimal value that indicates the

number of contiguous, higher-order bits of the address that make up the network portion of the address. For example, 10FA:6604:8136:6502::/64 is a possible IPv6 prefix.

Address Types

IPv6 can use several types of addresses:

- Unicast—Used to identify a single interface, this release of the E Series router product supports the following unicast address types:
 - Global aggregatable—Provides for aggregation of routing prefixes to limit the number of global routing table entries
 - Link-local—Eliminates the need for a globally unique prefix. Local-link addresses allow communications between devices on a local link.
 - Site-local—Used as private addresses to restrict communication to a domain portion.



NOTE: IPv6 routers must not forward packets that have site-local source or destination addresses outside the site.

- IPv4-compatible—Contains a standard IPv4 address in the lower-order 32 bits of the address and zeros in the higher-order 96 bits of the address. For example, the format of an IPv4-compatible IPv6 address is 0:0:0:0:0:A.B.C.D (or condensed as ::A.B.C.D). In other words, devices using IPv6 use the entire 128-bit IPv4-compatible IPv6 address, whereas IPv4 devices use the IPv4 address embedded within the lower-order 32-bits of the address. You would use IPv4-compatible IPv6 addresses for devices that must support both IPv4 and IPv6 protocols.
- Multicast—Used for sending packets to multiple destinations. A multicast transmission sends packets to all interfaces that are part of a multicast group. The group is represented by the IPv6 destination address of the packet.
- Anycast – Used for a set of interfaces on different nodes. An anycast transmission sends packets to only one of the interfaces associated with the address, not to all of the interfaces. This interface is typically the closest interface, as defined by the routing protocol.
- Loopback—Used by a node to send an IPv6 packet to itself. An IPv6 loopback address functions the same as an IPv4 loopback address.
- Unspecified—Indicates the absence of an IPv6 address. For example, newly initialized IPv6 nodes may use the unspecified address as the source address in their packets until they receive an IPv6 address.



NOTE: IPv6 does not use broadcast addresses; instead, IPv6 uses multicast addresses.

Address Scope

Some unicast and multicast IPv6 addresses contain a value known as *scope*. This value identifies the application suitable for the address.

Unicast addresses support two types of scope—global and local. In addition, there are two types of local scope—link-local addresses and site-local addresses.

Link-local unicast addresses, identified by the first ten bits of the prefix, function within a single network link. You cannot use link-local addresses outside a network link.

Site-local unicast addresses function within a site or an intranet. A site consists of multiple network links, and site-local addresses identify nodes inside the intranet. You cannot use site-local addresses outside the site.

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

Address Structure

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

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

11111111 | *flgs* | *scop* | *group ID*

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

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

ICMP Support

Internet Control Message Protocol (ICMP) provides a mechanism that enables a router or destination host to report an error in data traffic processing to the original source of the packet. For this release, the E Series router supports ICMP for use in the IPv6 **ping** and **traceroute** commands.

The **ping** and **traceroute** commands help you determine destination reachability within a network.

- Use the **ping ipv6** command to send an ICMP echo request packet. In the following example, the request packet is sent to address 1::1 with a data size of 200 and a timeout value of 10 seconds:

```
host1#ping ipv6 1::1 data-size 200 timeout 10
```

- Use the **traceroute ipv6** command to discover routes that router packets follow when traveling to their destination. In the following example, the trace destination address is 1::1, the maximum number of hops of the trace is 20, and the timeout value is 10 seconds:

```
host1#traceroute ipv6 1::1 hop-limit 20 timeout 10
```

**Related
Documentation**

- [IPv6 Overview on page 150](#)
- [IPv6 References on page 159](#)
- ping
- traceroute

IPv6 Tunnel Routing Tables Overview

The IP version 6 (IPv6) tunnel routing tables include IPv6 routes that point only to tunnels, such as MPLS tunnels. The tunnel routing table is not used for forwarding. Instead, protocols resolve next hops by looking up the routes that point to tunnels. The routes in the tunnel routing table cannot be redistributed. See *JunosE BGP and MPLS Configuration Guide* for more information.

**Related
Documentation**

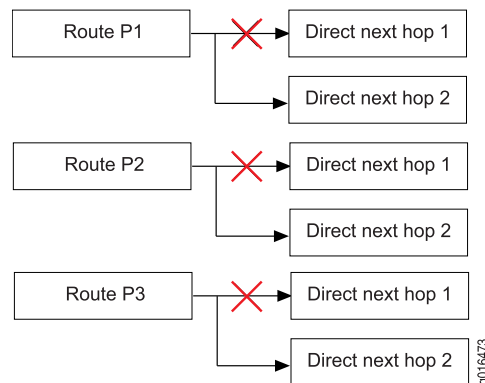
- [IPv6 Overview on page 150](#)
- [System Event Logs Used to Troubleshoot and Monitor IPv6 on page 192](#)
- [Monitoring the Current State of IPv6 Routing Tables on page 224](#)

Indirect Next-Hop Overview

The router uses indirect next hops to promote faster network convergence (for example, in BGP networks) by decreasing the number of routing table changes required when a change in the network topology occurs.

Direct next-hops point routes in the routing table toward individual, direct next-hop connections. (See [Figure 6 on page 15.](#))

Figure 14: Direct Next Hops

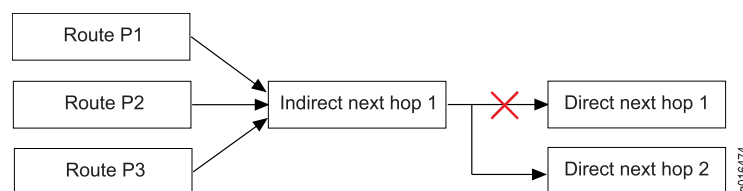


Indirect next hops enable multiple routes in the routing table to point to a single next hop, thereby accelerating convergence. (See [Figure 7 on page 15.](#))



NOTE: Indirect next hops are not limited to any number of levels. In other words, an indirect next hop can point to a direct next hop or another indirect next hop.

Figure 15: Indirect Next Hops



By using indirect next hops, if a topology change occurs in the network, only the indirect next hop is modified in the routing table, decreasing the number of state changes required to achieve convergence.

Related Documentation

- [Configuring IP Static Routes with Indirect Next Hops on page 39](#)
- [Configuring ECMP Round-Robin Load Sharing on page 64](#)
- [Enabling IPv6 Source Address Validation on page 164](#)
- [ECMP Fast Reroute Protection Overview on page 64](#)

IPv6 Platform Considerations

For information about modules that support IPv6 and Neighbor Discovery on the ERX7xx models, ERX14xx models, and the ERX310 Broadband Services Routers:

- See *ERX Module Guide, Table 1, Module Combinations* for detailed module specifications.
- See *ERX Module Guide, Appendix A, Module Protocol Support* for information about the modules that support IP.

For information about modules that support IP on the E120 and E320 Broadband Services 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 IP.

**Related
Documentation**

- [IPv6 Overview on page 150](#)
- [IPv6 References on page 159](#)

Supported Management Applications for IPv6

This section describes information about the management protocols and services that JunosE Software supports for IPv6 networks. All of the listed applications are supported for IPv4 networks.

The following management applications are supported in IPv6 topologies:

- FTP client
- HTTP redirect

The following management applications are not supported in IPv6 topologies:

- Access Node Control Protocol (ANCP)
- FTP server
- Network File System (NFS)
- Network Time Protocol (NTP)
- RADIUS
- Secure File Transfer Protocol (SFTP) client
- SNMP
- SSH
- Syslog
- TACACS
- Telnet client and Telnet server

**Related
Documentation**

- [IPv6 Overview on page 150](#)
- [IPv6 References on page 159](#)

IPv6 References

For more information about IPv6, consult the following resources:

- RFC 2373—IP Version 6 Addressing Architecture (July 1998)
- RFC 2460—Internet Protocol, Version 6 (IPv6) (December 1998)
- RFC 4861—Neighbor Discovery for IP Version 6 (IPv6) (September 2007)
- RFC 4862—IPv6 Stateless Address Autoconfiguration (September 2007)
- RFC 2463—Internet Control Message Protocol (ICMPv6) for the Internet Protocol Version 6 (IPv6) Specification (December 1998)
- RFC 2464—Transmission of IPv6 Packets over Ethernet Networks (December 1998)
- RFC 2465—Management Information Base for IP Version 6: Textual Conventions and General Group (December 1998)
- RFC 2466—Management Information Base for IP Version 6: ICMPv6 Group (December 1998)

You can access these and other Internet RFCs and drafts at the following URL:

<http://www.ietf.org>

Related Documentation

- [IPv6 Overview on page 150](#)
- [IPv6 Addressing Overview on page 152](#)
- [IPv6 Platform Considerations on page 157](#)

Before You Configure IPv6

Before you configure IPv6, you must create the lower-layer interfaces over which IPv6 traffic flows. For information about the modules that support IPv6:

- See *E120 and E320 Module Guide, Appendix A, IOA Protocol Support* for modules supported on E120 and E320 routers.
- See *ERX Module Guide, Appendix A, Module Protocol Support* for modules supported on the ERX310, ERX710, ERX1410, and ERX1440 routers.

For example, to configure an ATM interface:

```
host1(config)#interface atm 1/0
host1(config-if)#atm sonet stm-1
host1(config-if)#no loopback
host1(config-if)#atm clock internal chassis
host1(config-if)#interface atm 1/0.10
host1(config-if)#atm pvc 10 0 20 aal5snap
```

See *JunosE Link Layer Configuration Guide* for information about configuring an ATM interface. See *JunosE Physical Layer Configuration Guide* for information about configuring an Ethernet interface.

**Related
Documentation**

- [Enabling or Disabling an IPv6 Interface on page 173](#)
- [Associating the Shared IPv6 Interface with the Layer 2 Interface on page 176](#)
- [Example: Configuring Shared IPv6 Interfaces on page 176](#)
- [Adding a Description to an IPv6 Interface or Subinterface on page 177](#)

Configuring an IPv6 License

You must configure an IPv6 license before you can use any IPv6 routing protocol configuration commands on the E Series router. You can configure IPv6 policy settings, such as policy lists, classifier lists, and rate-limit profiles, and local address pools for IPv6 subscribers even without configuring an IPv6 license.



NOTE: Acquire the license from Juniper Networks Customer Services and Support or your Juniper Networks sales representative.

To specify an IPv6 license on the E Series router:

- Issue the **license ipv6** command in Global Configuration mode.

`host1(config)#license ipv6 license-value`

Use the **no** version to disable the license.

**Related
Documentation**

- [Monitoring the IPv6 License Key on the Router on page 233](#)
- [license ipv6](#)

IPv6 Profiles

You can create a profile, add IP version 6 (IPv6) characteristics to the profile, and assign the profile to IPv6 interfaces.

- [IPv6 Profiles Overview on page 160](#)
- [Creating a Profile on page 161](#)
- [Configuring Profile Attributes for IPv6 on page 161](#)
- [Assigning a Profile to an Interface on page 163](#)

IPv6 Profiles Overview

You can configure an IPv6 interface dynamically by creating a profile. A profile is a set of characteristics that acts as a pattern that can be dynamically assigned to an IPv6 interface. You can manage a large number of IPv6 interfaces efficiently by creating a

profile with a specific set of characteristics. In addition, you can create a profile to assign an IPv6 interface to a virtual router.

A profile can contain one or more of the following characteristics:

- **address**—Configures an IPv6 address on an interface
- **mld**—Configures the Multicast Listener Discovery (MLD) interface
- **mtu**—Configures the maximum transmission unit (MTU) for a network
- **nd**—Configures Neighbor Discovery router advertisement characteristics
- **policy**—Attaches (or removes) a policy to (or from) an interface
- **sa-validate**—Enables source address validation
- **unnumbered**—Configures IPv6 on this interface without a specific address
- **virtual-router**—Specifies a virtual router to which interfaces created by this profile will be attached



NOTE: You can also configure any of these IPv6 characteristics outside the profile configuration mode.

Creating a Profile

You can use the **profile** command from Global Configuration mode to create or edit a profile. You can specify a profile name with up to 80 characters.

To create a profile on the router:

- Issue the **profile** command in Global Configuration mode.

```
host1(config)#profile foo
```

Use the **no** version to remove a profile.

See *JunosE Link Layer Configuration Guide* for information about creating profiles and on other characteristics that can be applied to the profile.

Configuring Profile Attributes for IPv6

You can add a specific set of IPv6 characteristics to a created profile and assign the profile to many IPv6 interfaces.

To assign IPv6 characteristics to a profile:

1. Add an IPv6 address to the profile.

```
host1(config-profile)#ipv6 address 1::1/64
```



NOTE: You can use this command in Interface Configuration or Subinterface Configuration mode.

2. (Optional) Assign a virtual router to the profile. Dynamic interfaces created with the profile are assigned to this virtual router. You can configure a virtual router using RADIUS instead of adding one to the profile by using the **ipv6 virtual-router** command.

```
host1(config-profile)#ipv6 virtual-router VR6
```

3. (Optional) Set the MTU size of IPv6 packets sent on an interface to which the profile is assigned. The MTU size is in the range 128–10240.

```
host1(config-profile)#ipv6 mtu 1000
```

4. (Optional) Set up an unnumbered interface.

An unnumbered interface does not have an IPv6 address assigned to it. Unnumbered interfaces are often used in point-to-point connections where an IPv6 address is not required. The **ipv6 unnumbered** command enables IPv6 processing on an interface without you having to assign an explicit IPv6 address to the interface. You supply an interface location that is the type and number of another interface on which the router has an assigned IPv6 address. This interface cannot be another unnumbered interface.

```
host1(config-profile)#ipv6 unnumbered loopback 0
```

5. (Optional) Enable the IPv6 Neighbor Discovery process for the profile.

```
host1(config-profile)#ipv6 nd
```

6. (Optional) Set the “managed address configuration” flag in IPv6 router advertisements for the profile.

```
host1(config-profile)#ipv6 nd managed-config-flag
```

7. (Optional) Set the “other stateful configuration” flag in IPv6 router advertisements for the profile.

```
host1(config-profile)#ipv6 nd other-config-flag
```

8. (Optional) Specify the IPv6 prefix included in IPv6 router advertisements for the profile.

```
host1(config-profile)#ipv6 nd prefix-advertisement 4::4/64 300 400
```

9. (Optional) Configure the interval between IPv6 router advertisements for the profile.

```
host1(config-profile)#ipv6 nd ra-interval 500
```

10. (Optional) Configure the router advertisement lifetime for the profile.

```
host1(config-profile)#ipv6 nd ra-lifetime 800
```

11. (Optional) Configure the amount of time the router can reach an IPv6 node after a reachability confirmation event occurs.

```
host1(config-profile)#ipv6 nd reachable-time 7200000
```

12. (Optional) Disable router advertisement transmissions for the profile.

```
host1(config-profile)#ipv6 nd suppress-ra
```

13. (Optional) Enable source address validation for the profile.

```
host1(config-profile)#ipv6 sa-validate
```

Assigning a Profile to an Interface

You can assign a profile to a PPP interface using the **profile** command. The profile configuration is used to dynamically create an upper IP interface.

To assign a profile to an interface:

- Issue the **profile** command in Interface Configuration mode.

```
host1(config-if)#profile foo
```

Use the **no** version to remove the assignment from the interface.

Related Documentation

- [Monitoring Profile Names on page 147](#)
- [System Event Logs Used to Troubleshoot and Monitor IPv6 on page 192](#)
- [Monitoring General Information for IPv6 on page 193](#)
- [Monitoring Detailed or Summary Information for IPv6 Addresses on page 194](#)
- [Monitoring Detailed or Summary Information for IPv6 Interfaces on page 203](#)
- [Monitoring an IPv6 Profile on page 220](#)
- [Monitoring Received IPv6 Router Advertisements on page 226](#)
- [ipv6](#)
- [ipv6 address](#)
- [ipv6 mtu](#)
- [ipv6 nd](#)
- [ipv6 nd managed-config-flag](#)
- [ipv6 nd other-config-flag](#)
- [ipv6 nd prefix-advertisement](#)
- [ipv6 nd ra-interval](#)
- [ipv6 nd ra-lifetime](#)
- [ipv6 nd reachable-time](#)
- [ipv6 nd suppress-ra](#)
- [ipv6 sa-validate](#)
- [ipv6 unnumbered](#)
- [ipv6 virtual-router](#)
- [license ipv6](#)
- [profile](#)

Enabling IPv6 Source Address Validation

Source address validation verifies that a packet has been sent from a valid source address. When a packet arrives on an interface, the router performs a routing table lookup using the source address. The result from the routing table lookup is an interface to which packets destined for that address are routed. This interface must match the interface on which the packet arrived. If it does not match, the router drops the packet.



CAUTION: When the routing table lookup for a source address contains an ECMP route, the router returns a list of interfaces for multiple next-hops. One of the interfaces in this list must match the interface on which the packet arrived or the router drops the packet. If the ECMP route uses indirect next-hops, the returned list of interfaces does not include interfaces that are reachable by those indirect next-hops. For example, if a packet arrives on an interface with source address validation enabled, and the interface is represented only by an indirect next-hop, a match for that interface does not appear in the list of interfaces from the routing table lookup. The router drops the packet.



NOTE:

- You must configure an IPv6 license using the `license ipv6` command before using the IPv6 routing protocol configuration commands on the E Series router.
- All IPv6 routing protocol configurations are removed from the virtual router when you issue the `no ipv6` command.

To enable source address validation for the interface:

- Issue the **ipv6 sa-validate** command in Interface Configuration mode.

```
host1(config-if)#ipv6 sa-validate
```

Use the **no** version to disable source address validation.

Related Documentation

- [Indirect Next-Hop Overview on page 15](#)
- [Monitoring Detailed or Summary Information for IPv6 Addresses on page 194](#)
- [Monitoring Detailed or Summary Information for IPv6 Interfaces on page 203](#)
- `ipv6`
- `ipv6 sa-validate`
- `license ipv6`

Establishing an IPv6 Static Route

You can set a destination to receive and send traffic by a specific route through the network.

For null 0 interfaces, you can use the **reject** keyword to enable the sending of ICMP unreachable messages to the originator for discarded ping and traceroute packets that reach the null 0 interface with a static route. Alternatively, you can use the **discard** keyword to disable the sending of ICMP unreachable messages to the originator for such dropped packets.

You can assign optional route tags for IPv6 static routes. The route tag is a 32-bit number in the range 0-4294967295. The default tag value is 0.



NOTE:

- You must configure an IPv6 license using the **license ipv6** command before using the IPv6 routing protocol configuration commands on the E Series router.
- All IPv6 routing protocol configurations are removed from the virtual router when you issue the **no ipv6** command.

To establish an IPv6 static route:

- Issue the **ipv6 route** command in Global Configuration mode.

```
host1(config)#ipv6 route 7fff::0/16 1::1
```

Use the **no** version to remove a static route from the routing table.

Related Documentation

- [Understanding ICMPv6 Unreachable Messages for Static Routes Sent on Null Interfaces on page 165](#)
- [Configuring IPv6 Static Routes with Tags for Redistribution of Routes on page 168](#)
- [Monitoring the Current State of IPv6 Routing Tables on page 224](#)
- [Monitoring the Status of IPv6 Static Routes in the Routing Table on page 227](#)
- `ipv6`
- `ipv6 route`
- `license ipv6`

Understanding ICMPv6 Unreachable Messages for Static Routes Sent on Null Interfaces

You can handle undesired traffic by sending data packets to the null interface. The null interface is automatically created by the router, is always up, cannot be deleted, and acts as a data sink. The null interface cannot forward or receive traffic. However, the command-line interface (CLI) does enable you to access the null interface. You can

configure a static route using the **ip route** command and direct traffic to the null interface by specifying the **null 0** keyword with this command, instead of a next-hop or destination address. You can also use access control lists to filter undesired traffic.

When a ping or traceroute packet from a subscriber reaches the null 0 interface configured with a static route, it is discarded in the forwarding plane. You can configure the router to either send or not send Internet Control Message Protocol version 6 (ICMPv6) unreachable messages to the subscriber for such discarded packets. An advantage of this feature is that it enables synchronization of the RADIUS configuration of the client environment with the network topology.

You can use the **reject** keyword with the **ipv6 route** command to cause the router to send ICMPv6 unreachable messages to the originator from which ping and traceroute packets are received on the null 0 interface with a static route. The switch route processor (SRP) module drops these ping and traceroute packets destined for null 0 interface without further processing and sends ICMPv6 unreachable messages to the originator.

For ICMPv6 unreachable messages to be sent from the router for packets that are received from clients on the static routes configured on null 0 interfaces, you must configure the router to enable generation of ICMP unreachable messages for IPv6 (ping and traceroute) that the router cannot deliver using the **ip unreachable** command in Interface Configuration mode.

The option to send ICMPv6 unreachable messages is available for all IPv6 static routes in a virtual router that are configured with null 0 interface as the next-hop. The Denial of Service (DoS) protection feature can be enabled to monitor the ping and traceroute packets that are discarded from flooding the network. A new DoS type is used to apply a rate-control limit on these packets.

By default, generation of ICMP unreachable messages is enabled on an interface. If the capability to generate ICMP unreachable messages is disabled on the interface, you must enable this functionality using the **ip unreachable** command in Interface Configuration mode to send ICMP unreachables for packets that reached null 0 interfaces with static routes and were discarded. The IPv6 ICMP unreachable message packets are sent with a value of 6 (Reject Route to destination) in the Code field.

If you disable generation of ICMPv6 unreachable messages for null interfaces on the router using the **no ip unreachable** command, ICMPv6 unreachable messages are not sent for packets that are dropped or not processed by such interfaces, even if you configure static routes for such interfaces to send ICMP unreachables (using the **reject** keyword with the **ipv6 route** command).

To enable backward compatibility with versions of JunosE Software in which functionality is not available, the default behavior is to discard the IPv6 ping and traceroute packets destined for null 0 interfaces at the forwarding layer without the transmission of ICMP unreachable messages to the originator.

You can use the output of the **show ipv6 static** command to determine whether the sending of ICMP unreachable messages is enabled on each interface for which static routes are configured. The ICMP Unreach field in the output of these commands specifies

whether the **reject** or **discard** keyword is configured for each static route on the router interface.

Related Documentation

- [Establishing an IPv6 Static Route on page 165](#)
- [Enabling or Disabling the Transmission of ICMPv6 Unreachable Messages for Static Routes on Null Interfaces on page 167](#)
- `ip unreachable`
- `ipv6 route`
- `show ipv6 static`

Enabling or Disabling the Transmission of ICMPv6 Unreachable Messages for Static Routes on Null Interfaces

You can enable or disable the transmission of ICMP unreachable messages for IPv6 packets while configuring an IPv6 static route with null 0 interface as the next-hop points.



NOTE:

- You must configure an IPv6 license using the `license ipv6` command before using the IPv6 routing protocol configuration commands on the E Series router.
- All IPv6 routing protocol configurations are removed from the virtual router when you issue the `no ipv6` command.

To configure an IPv6 static route with a null 0 interface as the next-hop points:

- Issue the **ipv6 route** command in Global Configuration mode.

```
host1(config)#ipv6 route 2:1::/64 null0
```

In this example, the default behavior for packets reaching null 0 interfaces with static routers occurs, which is to discard the received packets and not send ICMPv6 unreachable messages to the originator.

To enable the transmission of ICMP unreachable messages for IPv6 packets that reach the null 0 interface configured with a static route and are discarded:

- Issue the **ipv6 route** command with the **reject** keyword in Global Configuration mode.

```
host1(config)#ipv6 route 2:1::/64 null0 reject
```

To disable the transmission of ICMP unreachable messages for IPv6 packets that reach the null 0 interface configured with a static route and are discarded:

- Issue the **ipv6 route** command with the **discard** keyword in Global Configuration mode.

```
host1(config)#ipv6 route 2:1::/64 null0 discard
```

Related Documentation

- [Understanding ICMPv6 Unreachable Messages for Static Routes Sent on Null Interfaces on page 165](#)
- [Monitoring Detailed or Summary Information for IPv6 Addresses on page 194](#)
- [Monitoring Detailed or Summary Information for IPv6 Interfaces on page 203](#)
- [Monitoring the Status of IPv6 Static Routes in the Routing Table on page 227](#)
- [Monitoring IPv6 Traffic Statistics on page 229](#)
- [ipv6](#)
- [ipv6 route](#)
- [license ipv6](#)

Configuring IPv6 Static Routes with Tags for Redistribution of Routes

You can assign optional route tags for IPv6 static routes. IPv6 static routes are configured to set a destination to receive and send traffic to and from a network or to use a specific route through the network. You can use the optional **tag** keyword to specify a value for the route tag. The route tag is a 32-bit number in the range 0-4294967295. The default value is 0. The configured tag value is stored in NVS; hence it will be available after SRP reload, HA, and ISSU. You can verify the configured parameters by using the **show** commands. The route tag can be used for route redistribution to routing protocols by using route maps similar to IPv4 static route redistribution. You can do this by configuring a route map with the route tags in it. This route map is applied to the redistribution command. You can assign a tag value to the IPv6 static route using the **ipv6 route** command as follows:



NOTE:

- You must configure an IPv6 license using the **license ipv6** command before using the IPv6 routing protocol configuration commands on the E Series router.
 - All IPv6 routing protocol configurations are removed from the virtual router when you issue the **no ipv6** command.
-

To assign a tag value to the IPv6 static route:

- Issue the **ipv6 route** command with the **tag** keyword in Global Configuration mode.

```
host1(config)#ipv6 route 55::/55 44::44 tag 1234
```

Use the **no** version to remove a static route from the routing table.

Related Documentation

- [Establishing an IPv6 Static Route on page 165](#)
- [Monitoring the Current State of IPv6 Routing Tables on page 224](#)
- [Monitoring the Status of IPv6 Static Routes in the Routing Table on page 227](#)

- ipv6
- ipv6 route
- license ipv6

Redistributing a Specific IPv6 Static Route Based on the Tag Value

To redistribute a specific IPv6 static route for BGP based on the tag value:

1. Enable an IPv6 instance on the router.

```
host1(config)#ipv6
```

2. Create an IPv6 static route with the tag value as 1234.

```
host1(config)#ipv6 route 55::/55 44::44 tag 1234
```

3. Create a route map and enter into Route Map Configuration mode.

```
host1(config)#route-map access
```

4. Assign a specific tag value to the route map.

```
host1(config-route-map)#set tag 1234
```

5. Exit from Route Map Configuration mode.

```
host1(config-route-map)#exit
```

6. Enter into Router Configuration mode to configure the BGP routing process.

```
host1(config)#router bgp 100
```

7. Configure the IPv6 address family on the BGP router.

```
host1 (config-router)#address-family ipv6
```

8. Configure the route redistribution using the route map.

```
host1 (config-router-af)#redistribute static route-map access
```

Related Documentation

- [Establishing an IPv6 Static Route on page 165](#)
- address-family
- ipv6 route
- redistribute
- route-map
- router bgp
- set tag

Next-Hop Verification for IPv6 Static Routes Overview

You can control the installation of IP version 6 (IPv6) static routes in the routing table using the Bidirectional Forwarding Detection (BFD) protocol. The static routes are installed in the routing table only when the next-hop neighbor for the static routes is reachable.

- [BFD Next-Hop Verification Overview for IPv6 Static Routes on page 170](#)
- [Enabling BFD on an IPv6 Static Route on page 171](#)
- [Configuring BFD Next-Hop Verification for IPv6 Static Routes on page 171](#)

BFD Next-Hop Verification Overview for IPv6 Static Routes

IPv6 static routes on E Series routers can use BFD to verify the availability of the next hop and obtain the state of the IPv6 service. For additional information about BFD, see *JunosE IP Services Configuration Guide*.

If you specify the **verify bfd-liveness-detection** keyword with a minimum interval, minimum receive interval, minimum transmit interval, or multiplier when you issue the **ipv6 route** command to establish a static route, the router verifies the next-hop status and installs the IPv6 static route in the routing table under the following conditions:

- You configure the static routes with the actual next hop address and not just interface details.
- The BFD protocol is operational on both ends of the verification.
- The next hop is adjacent to the router (that is, only one hop away).



NOTE: BFD next-hop verification does not currently function in a multi-hop configuration.

- The next hop to the specified IPv6 destination address is resolved.

The static route is removed from the routing table if the next hop is no longer reachable and reinstalled when the route becomes reachable again.

The BFD next-hop verification minimizes packet drop and improves network convergence in an IPv6 network by detecting the loss of connectivity to the next hop in the order of milliseconds. This quick detection allows the routing protocols to quickly recompute any available alternative paths for the data traffic.

Related Documentation

- [Enabling BFD on an IPv6 Static Route on page 171](#)
- [Configuring BFD Next-Hop Verification for IPv6 Static Routes on page 171](#)
- `ipv6 route`

Enabling BFD on an IPv6 Static Route

You can enable BFD on an IPv6 static route using the **ipv6 route** command with the **verify bfd-liveness-detection** keyword.

You can use the following optional keywords along with the **verify bfd-liveness-detection** keyword:

- The **minimum-interval** keyword to specify a minimum proposed transmit interval and required receive interval for BFD control packets. The range for the value is 100–65,535 milliseconds except for ES2 4G LM, for which it is 10–65,535 milliseconds. The default value is 300 milliseconds.
- The **minimum-receive-interval** keyword to specify a minimum required receive interval. The range for the value is 100–65,535 milliseconds except for ES2 4G LM, for which it is 10–65,535 milliseconds. The default value is 300 milliseconds.
- The **minimum-transmit-interval** keyword to specify a minimum proposed transmit interval. The range for the value is 100–65,535 milliseconds except for ES2 4G LM, for which it is 10–65,535 milliseconds. The default value is 300 milliseconds.
- The **multiplier** keyword to specify a multiplier number in the range 1–255. The default value is 3.

You can change parameters at any time without stopping or restarting the existing session. BFD automatically adjusts to the new parameter value. However, no changes to BFD parameters take place until the values resynchronize with each BFD peer.

To enable BFD on an IPv6 static route with:

- Next-hop address with the same value for receive and transmit intervals.

```
host1(config)#ipv6 route 3ffe::/32 2222::1 verify bfd-liveness-detection
minimum-interval 500 multiplier 2
```

- Next-hop address with different receive and transmit intervals.

```
host1(config)#ipv6 route 3ffe::/32 2222::1 verify bfd-liveness-detection
minimum-receive-interval 800 minimum-transmit-interval 400
```

Use the **no** version to remove the IPv6 static route from the routing table, thereby removing BFD from that static route.

Related Documentation

- [BFD Next-Hop Verification Overview for IPv6 Static Routes on page 170](#)
- [Configuring BFD Next-Hop Verification for IPv6 Static Routes on page 171](#)
- `ipv6 route`

Configuring BFD Next-Hop Verification for IPv6 Static Routes

This section describes how to configure BFD next-hop verification settings in two adjacent IPv6 peers for enabling BFD next-hop verification between the peers. To enable BFD next-hop verification between two adjacent IPv6 peers, you configure each peer as follows:

1. Configure peer A with the next-hop address as the IPv6 address of peer B's connected interface along with the desired intervals and keyword options.

```
host1(config)#ipv6 route 3ffe::/32 2222::1 verify bfd-liveness-detection
minimum-interval 500 multiplier 2
```

2. Configure peer B with the next-hop address as the IPv6 address of peer A's connected interface along with the desired intervals and keyword options.

```
host1(config)#ipv6 route 4ffe::/32 2222::2 verify bfd-liveness-detection
minimum-interval 500 multiplier 2
```

**Related
Documentation**

- [BFD Next-Hop Verification Overview for IPv6 Static Routes on page 170](#)
- [Enabling BFD on an IPv6 Static Route on page 171](#)
- `ipv6 route`

Specifying an IPv6 Hop-Count Limit

You can specify the maximum number of hops that the router can use in router advertisements and all IPv6 packets.



NOTE:

- You must configure an IPv6 license using the `license ipv6` command before using the IPv6 routing protocol configuration commands on the E Series router.
- All IPv6 routing protocol configurations are removed from the virtual router when you issue the `no ipv6` command.

To set the maximum number of hops that the router can use in router advertisements and all IPv6 packets:

- Issue the **ipv6 hop-limit** command in Global Configuration mode.

```
host1(config)#ipv6 hop-limit 50
```

Use the **no** version to set the hop limit for IPv6 packets to 255 hops and router advertisements to zero (0) hops (or “unspecified”).

**Related
Documentation**

- [Monitoring General Information for IPv6 on page 193](#)
- [Monitoring Received IPv6 Router Advertisements on page 226](#)
- `ipv6`
- `ipv6 hop-limit`
- `license ipv6`

Managing IPv6 Interfaces

You can manage IPv6 interfaces with the following tasks:



NOTE:

- You must configure an IPv6 license using the `license ipv6` command before using the IPv6 routing protocol configuration commands on the E Series router.
- All IPv6 routing protocol configurations are removed from the virtual router when you issue the `no ipv6` command.

- [Enabling or Disabling an IPv6 Interface on page 173](#)
- [Clearing IPv6 Interface Counters on page 173](#)
- [Sending Echo Request Packets to the IPv6 Address on page 173](#)
- [Discovering the Routes Followed by Router Packets when Traveling to the IPv6 Destination on page 174](#)

Enabling or Disabling an IPv6 Interface

You can enable or disable an IPv6 interface at any time.



NOTE:

- Before you configure IPv6, you must create the lower-layer interfaces over which IPv6 traffic flows.
- By default, an IPv6 interface is enabled when you first create it.

To enable an IPv6 interface:

- Issue the **ipv6 enable** command in Interface Configuration mode.

```
host1(config-if)#ipv6 enable
```

Use the **no** version to disable IPv6 on an interface or a subinterface.

Clearing IPv6 Interface Counters

To clear counters on a specified IPv6 interface:

- Issue the **clear ipv6 interface** command in Privileged Exec mode.

```
host1#clear ipv6 interface atm 2/0
```

Sending Echo Request Packets to the IPv6 Address

You can send an ICMP echo request packet to the specified IPv6 address for determining reachability by using the **ping** command.

You can use the **source interface** keywords to specify a source interface other than the one from which the probe originates. You can use the **source address** keywords to specify a source IPv6 address other than the one from which the probe originates.

The following characters can appear in the display after you issue the **ping** command:

- !—Reply received
- .—Timed out while waiting for a reply
- ?—Unknown packet type
- A—Admin unreachable
- b—Packet too big
- H—Host unreachable
- N—Network unreachable
- P—Port unreachable
- p—Parameter problem
- S—Source beyond scope
- t—Hop limit expired (TTL expired)

To send an ICMP echo request packet to the specific IPv6 address:

- Issue the **ping** command in Privileged Exec mode.

```
host1#ping ipv6 1::1
```

Discovering the Routes Followed by Router Packets when Traveling to the IPv6 Destination

You can discover the routes that router packets follow when traveling to their destination using the **traceroute** command. You can specify the following parameters in the **traceroute** command:

- Destination IPv6 address
- Source interface for each of the transmitted packets
- Source IPv6 address for each of the transmitted packets
- Maximum number of hops of the trace and a timeout value
- Size of the IPv6 packets (not the ICMP payload) in the range 0–64000 bytes sent with the **traceroute** command. Including a size might help locate any MTU problems that exist between your router and a particular device.
- Hop count in the range 1–255; the default is 32

You can also force transmission of the packets on a specified interface regardless of what the IPv6 address lookup indicates. To discover the routes that router packets follow when traveling to their destination:

- Issue the **traceroute** command in Privileged Exec mode.

```
host1#traceroute ipv6 1::1 timeout 10
```

Related Documentation

- [Before You Configure IPv6 on page 159](#)
- [Monitoring General Information for IPv6 on page 193](#)
- [Monitoring Detailed or Summary Information for IPv6 Addresses on page 194](#)
- [Monitoring Detailed or Summary Information for IPv6 Interfaces on page 203](#)
- `clear ipv6 interface`
- `ipv6`
- `ipv6 enable`
- `license ipv6`
- `ping`
- `traceroute`

Shared IPv6 Interfaces

You can create multiple shared IPv6 interfaces over the same layer 2 logical interface.



NOTE:

- Before you configure IPv6, you must create the lower-layer interfaces over which IPv6 traffic flows.
- You must configure an IPv6 license using the `license ipv6` command before using the IPv6 routing protocol configuration commands on the E Series router.
- All IPv6 routing protocol configurations are removed from the virtual router when you issue the `no ipv6` command.

This topic describes the following:

- [Creating a Shared IPv6 Interface on page 175](#)
- [Associating the Shared IPv6 Interface with the Layer 2 Interface on page 176](#)
- [Example: Configuring Shared IPv6 Interfaces on page 176](#)

Creating a Shared IPv6 Interface

You can create an IPv6 interface for interface sharing using the **interface ipv6** command. You should use the specified name to refer to the shared IPv6 interface; you cannot use the layer 2 interface to refer to them, because the shared interface can be moved.

To create an IPv6 interface for interface sharing:

- Issue the **interface ipv6** command in Global Configuration mode.

```
host1(config)#interface ipv6 si1
```

Use the **no** version to delete the IPv6 interface.

Associating the Shared IPv6 Interface with the Layer 2 Interface

You can specify the layer 2 interface used by a shared IPv6 interface. The command fails if the layer 2 interface does not yet exist. The command is not supported (that is, it fails) if you use an RSVP tunnel (for example, **tunnel mpls:1**) to identify the layer 2 interface.

After creating the shared IPv6 interface, you can configure it as you do any other IPv6 interface. The shared interface is operationally up when the layer 2 interface is operationally up. You can create operational shared IPv6 interfaces in the absence of a primary IPv6 interface.

To associate a shared IPv6 interface with a layer 2 interface:

- Issue the **ipv6 share-interface** command in Interface Configuration mode.

```
host1(config-if)#ipv6 share-interface atm 5/3.101
```

Use the **no** version to remove the association between the layer 2 interface and the shared IPv6 interface. You can delete shared and primary IPv6 interfaces independently.

Example: Configuring Shared IPv6 Interfaces

This example explains how to create a shared IPv6 interface over a layer 2 logical interface.

- [Requirements on page 176](#)
- [Overview on page 176](#)
- [Creating a Shared IPv6 Interface over a Layer 2 Logical Interface on page 176](#)

Requirements

This example uses the following software and hardware components:

- JunosE Release 7.1.0 or higher-numbered releases
- E Series router (ERX7xx models, ERX14xx models, the ERX310 router, the E120 router, or the E320 router)
- ASIC-based line modules that support Fast Ethernet or Gigabit Ethernet

Overview

You can create multiple *shared* IPv6 interfaces over the same layer 2 logical interface—for example, atm 5/3.101—enabling more than one IPv6 interface to share the same logical resources.

Creating a Shared IPv6 Interface over a Layer 2 Logical Interface

To share IPv6 interfaces:

1. Create a layer 2 interface.

```
host1(config)#interface atm 5/3
host1(config-if)#interface atm 5/3.101
```


2. (Optional) Create a primary IPv6 interface.

```
host1(config-if)#ipv6 address 1::1/64
host1(config-if)#exit
```

3. Create the shared IPv6 interface.

```
host1(config)#interface ipv6 si0
```

4. Associate the shared IPv6 interface with the layer 2 interface by the following method:

```
host1(config-if)#ipv6 share-interface atm 5/3.101
```

5. To fully configure the shared interface, assign an address (or make the interface unnumbered).

```
host1(config-if)#ipv6 address 1::1/64
```

Related Documentation

- [Monitoring General Information for IPv6 on page 193](#)
- [interface](#)
- [interface atm](#)
- [interface fastEthernet](#)
- [interface gigabitEthernet](#)
- [interface ipv6](#)
- [ipv6](#)
- [ipv6 address](#)
- [ipv6 share-interface](#)
- [license ipv6](#)

Adding a Description to an IPv6 Interface or Subinterface

The router enables you to add a text description or an alias to an IPv6 interface or subinterface. Adding a description helps you identify the interface and keep track of interface connections. The description or alias can be a maximum of 256 characters.



NOTE:

- Before you configure IPv6, you must create the lower-layer interfaces over which IPv6 traffic flows.
- You must configure an IPv6 license using the `license ipv6` command before using the IPv6 routing protocol configuration commands on the E Series router.
- All IPv6 routing protocol configurations are removed from the virtual router when you issue the `no ipv6` command.
- You can use this command in Subinterface Configuration mode.

To assign a text description or an alias to an IPv6 interface:

- Issue the **ipv6 description** command in Interface Configuration mode.

```
host1(config-if)#ipv6 description boston01 ipv6 interface
```

To assign a text description or an alias to an IPv6 subinterface:

- Issue the **ipv6 description** command in Subinterface Configuration mode.

```
host1(config-subif)#ipv6 description dallas05 ipv6 subinterface
```

Use the **no** version to remove the text description or alias.

Related Documentation

- [Monitoring Detailed or Summary Information for IPv6 Addresses on page 194](#)
- [Monitoring Detailed or Summary Information for IPv6 Interfaces on page 203](#)
- [ipv6](#)
- [ipv6 description](#)
- [license ipv6](#)

Configuring TCP for IPv6

IPv6 supports TCP configuration. You can use the same commands to configure TCP on IPv6 as you do to configure TCP on IPv4. This topic describes the following tasks:

- [Setting MSS for TCP Connections on page 178](#)
- [Configuring TCP PMTU Discovery for IPv6 on page 179](#)
- [Protecting Against TCP RST or SYN DoS Attacks on page 181](#)
- [Preventing TCP PAWS Timestamp DoS Attacks on page 182](#)
- [Protecting Against TCP Out-of-Order DoS Attacks on page 182](#)

Setting MSS for TCP Connections

MSS is used by TCP to define the maximum amount of data that a TCP interface can accept in any single packet (or segment size). The MSS value is typically negotiated during connection establishment and is not renegotiated.

By default, the router uses an MSS value of 1280 bytes and the advertised MSS is derived from the MTU of the transmitting interface. However, you can use the **tcp mss** command to set the MSS for TCP use.

You can use the *vrfName* variable to specify a VRF to which you want to assign the TCP MSS value.

**NOTE:**

- All IPv6 routing protocol configurations are removed from the virtual router when you issue the **no ipv6** command.
- The MSS value is equal to the MTU value minus the IPv6 and TCP headers, so the MSS value is generally 60 bytes less than the MTU.

To specify the MSS value for TCP to use:

- Issue the **tcp mss** command in Global Configuration mode.

```
host1(config)#tcp mss 1000
```

Use the **no** version to remove the MSS value so that the router uses the advertised MSS derived from the MTU of the output interface.

Configuring TCP PMTU Discovery for IPv6

IPv6 hosts transmit large amounts of data to other hosts using a series of IPv6 datagrams. To best use resources, increase performance, and avoid difficult reassembly, hosts try to send datagrams that are as large as possible without requiring fragmentation anywhere along the path from the source to the destination. This datagram size is referred to as the *path MTU (PMTU)*, and it is equal to the smallest MTU for each hop in the path.

PMTU discovery is the process of discovering the PMTU value and using that value when transmitting IP datagrams.



NOTE: All IPv6 routing protocol configurations are removed from the virtual router when you issue the **no ipv6** command.

You can configure TCP PMTU discovery for IPv6 with the following tasks:

- [Enabling TCP PMTU Discovery on page 179](#)
- [Limiting TCP PMTU Discovery Values on page 180](#)
- [Configuring Black Hole Thresholds for TCP PMTU on page 181](#)

Enabling TCP PMTU Discovery

You can enable PMTU discovery on the active virtual router using the **tcp path-mtu-discovery** command.

You can use the **age-timer** keyword to set the time (*minutes*) that TCP waits before attempting to increase the path MTU after receiving an ICMP Too Big message or after previously increasing the PMTU successfully (*minutes2*). The range of these two timers is 1–30 minutes. The timer defaults to 10 minutes.

You can use the **age-timer indefinite** keyword with the **tcp path-mtu-discovery** command to disable PMTU aging functions.

To enable and configure PMTU discovery on the virtual router:

- Issue the **tcp path-mtu-discovery** command in Global Configuration mode.

```
host1:VR1(config)#tcp path-mtu-discovery
```

To configure PMTU age timers:

- Set path MTU discovery age timers differently.

```
host1:VR1(config)#tcp path-mtu-discovery age-timer 20 15
```

- Set path MTU discovery age timers to the same value (5 minutes).

```
host1:VR1(config)#tcp path-mtu-discovery age-timer 5
```

- Disable path MTU discovery age timers.

```
host1:VR1(config)#tcp path-mtu-discovery age-timer indefinite
```

Use the **no** version with a keyword to return the values to their defaults. Use the **no** version without any keywords to disable path MTU discovery on the virtual router.

Limiting TCP PMTU Discovery Values

You can limit calculated PMTU values within a range by using the **tcp path-mtu-discovery** command with the **max-mtu** and **min-mtu** keywords.



NOTE: When specifying PMTU limits, keep the following in mind:

- If a PMTU discovery value is lower than the configured minimum MTU setting, PMTU discovery is disabled for that connection.
 - If a PMTU discovery value is larger than the configured maximum MTU setting, the configured maximum MTU setting is used.
 - The maximum MTU setting must be greater than the minimum MTU setting.
-

To limit the maximum MTU size used for the PMTU:

- Issue the **tcp path-mtu-discovery** command with the **max-mtu** keyword in Global Configuration mode.

```
host1:VR1(config)#tcp path-mtu-discovery max-mtu 512
```

To specify the minimum MTU value used for the PMTU:

- Issue the **tcp path-mtu-discovery** command with the **min-mtu** keyword in Global Configuration mode.

```
host1:VR1(config)#tcp path-mtu-discovery min-mtu 255
```

Use the **no** version to remove any limitation so that the virtual router uses the discovered path MTU value.

Configuring Black Hole Thresholds for TCP PMTU

Some domains might be configured not to generate certain ICMP messages (like an ICMP destination unreachable message) or to filter all ICMP messages. Under these conditions, the source of oversized ICMP packets never learns that it is sending oversized packets. The device continues sending oversized packets that never get through. This behavior is often referred to as a *black hole*.

A black hole threshold is a limit to the number of times a virtual router can retransmit identical sequences of datagrams before the retransmissions are identified as a problem.

To specify the number of permitted retransmissions before the retransmissions are determined to be a problem:

- Issue the **tcp path-mtu-discovery** command with the **black-hole-detect-threshold** keyword in Global Configuration mode.

```
host1:VR1(config)#tcp path-mtu-discovery black-hole-detect-threshold 200
```

Use the **no** version to disable black hole threshold detection.

Protecting Against TCP RST or SYN DoS Attacks

You can use the **tcp ack-rst-and-syn** command to help protect the router from DoS attacks.

Normally, when it receives an RST or SYN message for an existing connection, TCP attempts to shut down the TCP connection. This action is expected under normal conditions, but someone maliciously generating otherwise valid RST or SYN messages can cause problems for network applications and the network as a whole.

When you enable the **tcp ack-rst-and-syn** command, the router challenges any RST or SYN messages that it receives by sending an ACK message back to the expected source of the message. The source reacts in one of the following ways:

- If the source did send the RST or SYN message, it recognizes the ACK message to be spurious and resends another RST or SYN message. The second RST or SYN message causes the router to shut down the connection.
- If the source did not send the RST or SYN message, the source accepts the ACK message as part of an existing connection. As a result, the source does not send another RST or SYN message and the router does not shut down the connection.



NOTE: Enabling this command slightly modifies the way TCP processes RST or SYN messages to ensure that they are genuine.

To help protect the router from TCP RST and SYN DoS attacks:

- Issue the **tcp ack-rst-and-syn** command in Global Configuration mode.

```
host1(config)#tcp ack-rst-and-syn
```

Use the **no** version to disable this protection (the default mode).

Preventing TCP PAWS Timestamp DoS Attacks

The TCP PAWS number option works by including the TCP timestamp option in all TCP headers to help validate the packet sequence number.

Normally, in PAWS packets that have the timestamps option enabled, hosts use an internal timer to compare the value of the timestamp associated with incoming segments against the last valid timestamp the host recorded. If the segment timestamp is larger than the value of the last valid timestamp, and the sequence number is less than the last acknowledgement sent, the host updates its internal timer with the new timestamp and passes the segment on for further processing.

If the host detects a segment timestamp that is smaller than the value of the last valid timestamp or the sequence number is greater than the last acknowledgement sent, the host rejects the segment.

A remote attacker can potentially determine the source and destination ports and IP addresses of both hosts that are engaged in an active connection. With this information, the attacker might be able to inject a specially crafted segment into the connection that contains a fabricated timestamp value. When the host receives this fabricated timestamp, it changes its internal timer value to match. If this timestamp value is larger than subsequent timestamp values from valid incoming segments, the host determines the incoming segments as being too old and discards them. The flow of data between hosts eventually stops, resulting in a denial of service condition.



NOTE: Disabling PAWS does not disable other processing related to the TCP timestamp option. This means that even though you disable PAWS, a fabricated timestamp that already exists in the network can still pollute the database and result in a successful DoS attack. Enabling PAWS resets the saved timestamp state for all connections in the virtual router and stops any existing attack.

To disable the PAWS number option in TCP segments:

- Issue the **tcp paws-disable** command in Global Configuration mode.

```
host1(config)#tcp paws-disable
```

You can specify a VRF context for which you want PAWS disabled. You can use the **no** version to restore PAWS processing (the default mode).

Protecting Against TCP Out-of-Order DoS Attacks

You can use the group of **tcp resequence-buffers** commands to help protect the router from TCP out-of-order packet DoS attacks.

TCP guarantees that applications receive data in order. This means that TCP buffers any out-of-order packets it receives until ordered delivery can occur.

To prevent connections from consuming too many resources, TCP limits the amount of data it accepts to the number of data bytes that the receiver is willing to receive and buffer. TCP does not take into account the buffering scheme that the receiver uses. If the receiver uses a fixed-size receive buffer (that is, buffering all packets) regardless of length, a packet that contains only one data byte might consume many data bytes of buffer space, but only one byte of TCP space.

Under these conditions, an attacker can send a large number of 1-byte packets to an E Series router in which each packet is buffered, consuming an entire packet buffer and eventually consuming a large amount of resources.

To defend against this sort of attack, you can set defaults and limits on the number of outstanding buffers on reordering queues. You can configure these defaults and limits on a per-router, per-virtual router, or per-connection within the virtual router basis.

You can protect the router from TCP out-of-order packet DoS attacks with the following tasks:

- [Limiting TCP Resequencing Buffers per Router on page 183](#)
- [Limiting TCP Resequencing Buffers per Virtual Router on page 183](#)
- [Limiting TCP Resequencing Buffers per Connection on page 184](#)

Limiting TCP Resequencing Buffers per Router

To limit the number of outstanding buffers on the entire router:

- Issue the **tcp resequence-buffers global-maximum** command in Global Configuration mode.

```
host1(config)#tcp resequence-buffers global-maximum
```

You can specify a value of zero (0) to turn off the limit. You can use the **no** version to revert the global maximum buffer value to its default, 1000 buffers.

Limiting TCP Resequencing Buffers per Virtual Router

You can limit the number of outstanding buffers on existing or newly established virtual routers using the **tcp resequence-buffers vr-maximum** command and **tcp resequence-buffers default-vr-maximum** commands.

To specify the default buffer limit assigned to all virtual routers when the virtual router is established:

- Issue the **tcp resequence-buffers default-vr-maximum** command in Global Configuration mode.

```
host1(config)#tcp resequence-buffers default-vr-maximum 200
```

You can specify a value of zero (0) to turn off the limit assignment. You can use the **no** version to revert the virtual router maximum value to its default, 100 buffers.

To define the maximum number of buffers that the current or specified virtual router can use:

- Issue the **tcp resequence-buffers vr-maximum** command in Global Configuration mode.

```
host1(config)#tcp resequence-buffers vr-maximum
```

You can specify a value of zero (0) to turn off the limit assignment. You can use the **no** version to revert the virtual router maximum value to its default, 100 buffers.

Limiting TCP Resequence Buffers per Connection

You can limit the number of outstanding buffers on existing or newly established connections using the **tcp resequence-buffers connection-maximum** command and **tcp resequence-buffers default-connection-maximum** commands.

To define the maximum number of buffers that connections on the current or specified virtual router can use:

- Issue the **tcp resequence-buffers connection-maximum** command in Global Configuration mode.

```
host1(config)#tcp resequence-buffers connection-maximum 50
```

You can specify a value of zero (0) to turn off the connection maximum. You can use the **no** version to revert the connection maximum value to its default, 10 buffers.

To specify the default buffer limit assigned to all TCP connections on a virtual router unless a specific limit is set for the virtual router in which the connection is established.

- Issue the **tcp resequence-buffers default-connection-maximum** command in Global Configuration mode.

```
host1(config)#tcp resequence-buffers default-connection-maximum 100
```

You can specify a value of zero (0) to turn off the connection maximum. You can use the **no** version to revert the connection maximum value to its default, 10 buffers.

Related Documentation

- [Monitoring TCP Statistics for IPv6 on page 234](#)
- [Monitoring TCP PMTU Information on page 128](#)
- [Monitoring the Status of TCP Protection on page 128](#)
- [Monitoring TCP PAWS Status on page 129](#)
- [Monitoring the TCP Resequencing Buffer Management Functions on page 129](#)
- [ipv6](#)
- [tcp ack-rst-and-syn](#)
- [tcp mss](#)
- [tcp path-mtu-discovery](#)
- [tcp paws-disable](#)
- [tcp resequence-buffers connection-maximum](#)
- [tcp resequence-buffers default-connection-maximum](#)

- `tcp resequence-buffers default-vr-maximum`
- `tcp resequence-buffers global-maximum`
- `tcp resequence-buffers vr-maximum`

ECMP Load Sharing for IPv6

Equal-cost multipath (ECMP) sets are formed when the router finds routing table entries for the same destination with equal cost. The router then balances traffic across these sets of equal-cost paths by using hashed mode.

- [ECMP Hashed Mode Overview on page 185](#)
- [Defining the Maximum Parallel Routes Supported by the Routing Protocol on page 185](#)
- [ECMP Fast Reroute Protection Overview on page 185](#)

ECMP Hashed Mode Overview

Hashed mode uses hashing of source and destination addresses to determine which of the available paths in the ECMP set to use. Hashed mode is the default ECMP mode of operation.

Defining the Maximum Parallel Routes Supported by the Routing Protocol

You can add routing table entries manually (as static routes), or they are formed as routers discover their neighbors and exchange routing tables (via OSPF, BGP, and other routing protocols).

To control the maximum number of parallel routes that the routing protocol (BGP, IS-IS, OSPF, or RIP) can support:

- Issue the **maximum paths** command in Router Configuration mode.

```
host1(config-router)#maximum-paths 2
```

The maximum number of routes can be in the range 1–16 for BGP, IS-IS, OSPF, or RIP. Use the **no** version to restore the default value, 1 for BGP or 4 for IS-IS, OSPF, or RIP.

ECMP Fast Reroute Protection Overview

If a link goes down, ECMP uses fast reroute protection to shift packet forwarding to use operational links, thereby decreasing packet loss. Fast reroute protection updates ECMP sets for the interface without having to wait for the route table update process. When the next route table update occurs, a new ECMP set can be added with fewer links or the route might point to a single next hop.



CAUTION: To provide ECMP fast reroute functionality in the event of an interface failure, the members of an equal cost multipath must be resolved to corresponding interfaces. If the member is an indirect next hop, the interface is obtained by using the forwarding equivalence class (FEC) to which the

member points. This method of resolving members occurs only if the FEC, pointed to by the indirect next hop, is either an interface or a direct next hop.

An indirect next hop member is not resolved to an interface if it points to another indirect next hop or to an equal cost multipath. ECMP fast reroute functionality is not available if any interfaces that correspond to unresolved indirect next hop members go down.

If you modify an indirect next hop member to point to a different FEC (that is, a different interface, direct next hop, indirect next hop, or ECMP), the indirect next hop member is not resolved for the new changes.

-
- Related Documentation**
- [Indirect Next-Hop Overview on page 15](#)
 - [Establishing an IPv6 Static Route on page 165](#)
 - `maximum-paths`

Removing an IPv6 Configuration

You can remove all available IPv6 routing protocol-related configurations from the virtual router using the **no ipv6** command. The previously configured IPv6 policy settings, such as policy lists, classifier lists, and rate-limit profiles, and local address pools for IPv6 subscribers are not removed because these attributes can be configured without configuring an IPv6 license.



NOTE: You must configure an IPv6 license using the `license ipv6` command before using the IPv6 routing protocol configuration commands on the E Series router.

To remove an IPv6 configuration from the virtual router.

- Issue the **no ipv6** command in Global Configuration mode.

```
host1(config)#no ipv6
```



NOTE: The E Series router automatically starts IPv6 processing when you begin configuring an IPv6 interface. However, by issuing the `ipv6` command without using the `no` option, you can create an IPv6 processing instance with no IPv6 configuration.

-
- Related Documentation**
- [IPv6 Profiles on page 160](#)
 - `ipv6`
 - `license ipv6`

Clearing IPv6 Routes

You can clear dynamic IPv6 routes from the routing table, use the **clear ipv6 routes** command. You can specify the IPv6 prefix to clear the routes for a specific IPv6 network. You can use the * (asterisk) option to clear all dynamic IPv6 routes.



NOTE:

- You must configure an IPv6 license using the **license ipv6** command before using the IPv6 routing protocol configuration commands on the E Series router.
- All IPv6 routing protocol configurations are removed from the virtual router when you issue the **no ipv6** command.

To clear all dynamic IPv6 routes:

- Issue the **clear ipv6 routes** command with the * (asterisk) option in Global Configuration mode.

```
host1(config)#clear ipv6 routes *
```

Related Documentation

- [Monitoring the Current State of IPv6 Routing Tables on page 224](#)
- [Monitoring IPv6 Traffic Statistics on page 229](#)
- **clear ipv6 routes**
- **ipv6**
- **license ipv6**

Creating Static IPv6 Neighbors

You can create static IPv6 neighbors using the **ipv6 neighbor** command.



NOTE:

- You must configure an IPv6 license using the **license ipv6** command before using the IPv6 routing protocol configuration commands on the E Series router.
- All IPv6 routing protocol configurations are removed from the virtual router when you issue the **no ipv6** command.

To create static IPv6 neighbors:

- Issue the **ipv6 neighbor** command in Global Configuration mode.

```
host1(config)#ipv6 neighbor 1::10 fastEthernet 1/0 0002.7dfa.0034
```

Use the **no** version to delete the neighbor.

- Related Documentation**
- [Monitoring Static or Dynamic Entries of the IPv6 Neighbor Discovery Cache on page 218](#)
 - `ipv6`
 - `ipv6 neighbor`
 - `license ipv6`

Clearing Static or Dynamic IPv6 Neighbors

You can clear dynamic IPv6 neighbors using the **clear ipv6 neighbor** command. You can clear both dynamic neighbors and static neighbors using the **include-statics** keyword. You can clear only IPv6 static neighbors using the **statics-only** keyword.



NOTE:

- You must configure an IPv6 license using the `license ipv6` command before using the IPv6 routing protocol configuration commands on the E Series router.
- All IPv6 routing protocol configurations are removed from the virtual router when you issue the `no ipv6` command.

To clear all dynamic IPv6 neighbors:

- Issue the **clear ipv6 neighbors** command in Global Configuration mode.

```
host1(config)#clear ipv6 neighbors
```

- Related Documentation**
- [Monitoring Static or Dynamic Entries of the IPv6 Neighbor Discovery Cache on page 218](#)
 - `clear ipv6 neighbors`
 - `ipv6`
 - `license ipv6`

CHAPTER 4

Monitoring IPv6

This chapter describes how to monitor IP version 6 (IPv6) routing configurations on your E Series router; it contains the following sections:

- [Establishing a Baseline for IPv6 Statistics on page 189](#)
- [System Event Logs Used to Troubleshoot and Monitor IPv6 on page 192](#)
- [Commands Used to Monitor IPv6 on page 192](#)
- [Monitoring General Information for IPv6 on page 193](#)
- [Monitoring Detailed or Summary Information for IPv6 Addresses on page 194](#)
- [Monitoring IPv6 Forwarding Table Details for a Line Module on page 202](#)
- [Monitoring Detailed or Summary Information for IPv6 Interfaces on page 203](#)
- [Monitoring Static or Dynamic Entries of the IPv6 Neighbor Discovery Cache on page 218](#)
- [Monitoring an IPv6 Profile on page 220](#)
- [Monitoring Active IPv6 Protocols on page 221](#)
- [Monitoring the IPv6 Route Redistribution Policy on page 223](#)
- [Monitoring the Current State of IPv6 Routing Tables on page 224](#)
- [Monitoring Received IPv6 Router Advertisements on page 226](#)
- [Monitoring the Status of IPv6 Static Routes in the Routing Table on page 227](#)
- [Monitoring IPv6 Traffic Statistics on page 229](#)
- [Monitoring IPv6 UDP Statistics on page 233](#)
- [Monitoring the IPv6 License Key on the Router on page 233](#)
- [Monitoring TCP Statistics for IPv6 on page 234](#)
- [Monitoring the Configuration Details for IPv6 Local Address Pools on page 244](#)

Establishing a Baseline for IPv6 Statistics

IPv6 statistics are stored in system counters. The only way to reset the system counters is to reboot the system. You can, however, establish a baseline for IPv6 statistics by setting a group of reference counters to zero (0).

The router 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.

You can use the **delta** keyword with IPv6 **show** commands to specify that baselined statistics are to be shown.

You can establish a baseline for IPv6 statistics with the following tasks:

- [Setting a Baseline for IPv6 Statistics on page 190](#)
- [Setting a Baseline for IPv6 Interface Statistics on page 190](#)
- [Setting a Baseline for IPv6 Local Address Pool Statistics on page 191](#)
- [Setting a Baseline for IPv6 TCP Statistics on page 191](#)

Setting a Baseline for IPv6 Statistics

You can set a baseline for IPv6 statistics using the **baseline ipv6** command. You can use the **udp** keyword to set a baseline for UDP statistics.



NOTE:

- You must configure an IPv6 license using the **license ipv6** command before using the IPv6 routing protocol configuration commands on the E Series router.
 - All IPv6 routing protocol-related configurations are removed from the virtual router when you issue the **no ipv6** command.
-

To set a baseline for IPv6 statistics:

- Issue the **baseline ipv6** command in Privileged Exec mode.

```
host1#baseline ipv6
```

Setting a Baseline for IPv6 Interface Statistics

You can set a statistical baseline for a specified IPv6 interface using the **baseline ipv6 interface** command.



NOTE:

- You must configure an IPv6 license using the **license ipv6** command before using the IPv6 routing protocol configuration commands on the E Series router.
 - All IPv6 routing protocol-related configurations are removed from the virtual router when you issue the **no ipv6** command.
-

To set a statistical baseline for a specified IPv6 interface:

- Issue the **baseline ipv6 interface** command in Privileged Exec mode.

```
host1#baseline ipv6 interface atm 2/0.100
```

Setting a Baseline for IPv6 Local Address Pool Statistics

To set a baseline for IPv6 local address pool statistics used in DHCP prefix delegation:

- Issue the **baseline ipv6 local pool** command in Privileged Exec mode.

```
host1#baseline ipv6 local pool
```

Setting a Baseline for IPv6 TCP Statistics

You can use the **baseline tcp** command to set a statistics baseline for all (both IPv4 and IPv6) TCP statistics or for only IPv4 or IPv6 statistics.



NOTE:

- You must configure an IPv6 license using the **license ipv6** command before using the IPv6 routing protocol configuration commands on the E Series router.
- All IPv6 routing protocol-related configurations are removed from the virtual router when you issue the **no ipv6** command.

To set a statistics baseline for IPv6 TCP statistics:

- Issue the **baseline tcp** command with the **ipv6** keyword in Privileged Exec mode.

```
host1#baseline ipv6 tcp
```

To set a statistics baseline for all TCP statistics:

- Issue the **baseline tcp** command in Privileged Exec mode.

```
host1#baseline tcp
```

Related Documentation

- [Monitoring Detailed or Summary Information for IPv6 Interfaces on page 203](#)
- [Monitoring IPv6 Traffic Statistics on page 229](#)
- [Monitoring TCP Statistics for IPv6 on page 234](#)
- [Monitoring the Configuration Details for IPv6 Local Address Pools on page 244](#)
- **baseline ipv6**
- **baseline ipv6 interface**
- **baseline ipv6 local pool**
- **baseline tcp**
- **ipv6**
- **license ipv6**

System Event Logs Used to Troubleshoot and Monitor IPv6

To troubleshoot and monitor IPv6, use the following system event logs:

- `ipv6General`—IPv6 general information
- `ipv6Interface`—IPv6 interface events
- `ipv6ProfileMgr`—IPv6 profile manager events
- `ipv6RouteTable`—IPv6 routing table events
- `ipv6Traffic`—IPv6 frame transmit and receive events

For more information about using event logs, see the *JunosE System Event Logging Reference Guide*.

Related Documentation

- [IPv6 Overview on page 150](#)
- [IPv6 Profiles Overview on page 160](#)
- [IPv6 Tunnel Routing Tables Overview on page 156](#)

Commands Used to Monitor IPv6

You can monitor the following aspects of IPv6 using **show ipv6** commands:

To Display	Command
General IPv6 information	show ipv6
IPv6 addresses	show ipv6 address
IPv6 forwarding table	show ipv6 forwarding-table slot
IPv6 Interfaces	show ipv6 interface
IPv6 neighbors	show ipv6 neighbors
IPv6 profile information	show ipv6 profile
Active IPv6 protocol information	show ipv6 protocols
IPv6 route redistribution configuration	show ipv6 redistribute
IPv6 routes	show ipv6 route
IPv6 router advertisements received	show ipv6 routers
IPv6 static routes	show ipv6 static
IPv6 statistics/traffic	show ipv6 traffic

To Display	Command
IPv6 UDP information	show ipv6 udp statistics
IPv6 license string	show license
IPv6 TCP information	show tcp statistics
IPv6 local address pools	show ipv6 local pool

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 *JunosE System Basics Configuration Guide*, for details.

Related Documentation

- [Establishing a Baseline for IPv6 Statistics on page 189](#)

Monitoring General Information for IPv6

Purpose Display general IPv6 information.



NOTE:

- You must configure an IPv6 license using the **license ipv6** command before using the IPv6 routing protocol configuration commands on the E Series router.
- All IPv6 routing protocol-related configurations are removed from the virtual router when you issue the **no ipv6** command.

Action To display general IPv6 information:

```
host1#show ipv6
Ipv6 Unicast Routing: Enabled
Default hop limit: not specified
Number of interfaces: 2
Default interface source address/mask: fe80::90:1a00:210:fd0/128
```

Meaning [Table 34 on page 193](#) lists the **show ipv6** command output fields.

Table 34: show ipv6 Output Fields

Field Name	Field Description
Ipv6 Unicast Routing	Status of IPv6 unicast routing on the router: Enabled or Disabled
Default hop limit	Maximum number of hops that the router can use in router advertisements and all IPv6 packets

Table 34: show ipv6 Output Fields (*continued*)

Field Name	Field Description
Number of interfaces	Number of interfaces in which IPv6 processing is enabled
Default interface source address/mask	IPv6 address and mask of the default IPv6 interface

Related Documentation

- [Configuring Profile Attributes for IPv6 on page 161](#)
- [Specifying an IPv6 Hop-Count Limit on page 172](#)
- [Enabling or Disabling an IPv6 Interface on page 173](#)
- [Example: Configuring Shared IPv6 Interfaces on page 176](#)
- [ipv6](#)
- [license ipv6](#)
- [show ipv6](#)

Monitoring Detailed or Summary Information for IPv6 Addresses

Purpose Display detailed or summary interface information for a particular IPv6 address. You can use the **brief** keyword to display summary information about the interface for the specified IPv6 address. You can use the **detail** keyword to display detailed information about the interface for the specified IPv6 address.



NOTE:

- You must configure an IPv6 license using the **license ipv6** command before using the IPv6 routing protocol configuration commands on the E Series router.
- All IPv6 routing protocol-related configurations are removed from the virtual router when you issue the **no ipv6** command.

Action To display interface information for a particular IPv6 address:

```
host1#show ipv6 address 5:1::2
FastEthernet9/1.5 line protocol VlanSub is up, ipv6 is up
  Description: IPv6 interface in Virtual Router Hop5
  Network Protocols: IPv6
  Link local address: fe80::90:1a00:740:31ce
  Internet address: 5:1:1::2/64
  Operational MTU 1500 Administrative MTU 0
  Operational speed 100000000 Administrative speed 0
  Creation type Static
  ND reachable time is 3600000 milliseconds
  ND duplicate address detection attempts is 100
```

```

ND neighbor solicitation retransmission interval is 1000 milliseconds
ND proxy is enabled
ND RA source link layer is advertised
ND RA interval is 200 seconds, lifetime is 1800 seconds
ND RA managed flag is disabled, other config flag is disabled
ND RA advertising prefixes configured on interface

In Received Packets 12, Bytes 1260
  Unicast Packets 5, Bytes 588
  Multicast Packets 7, Bytes 672
In Total Dropped Packets 0, Bytes 0
  In Policed Packets 0
  In Invalid Source Address Packets 0
  In Error Packets 0
  In Discarded Packets 0

Out Forwarded Packets 21, Bytes 2352
  Unicast Packets 21, Bytes 2352
  Multicast Routed Packets 0, Bytes 0
Out Total Dropped Packets 8, Bytes 0
  Out Scheduler Dropped Packets 0, Bytes 0
  Out Policed Packets 0
  Out Discarded Packets 8

queue 0: traffic class best-effort, bound to ipv6 FastEthernet9/1.5
  Queue length 0 bytes
  Forwarded packets 4, bytes 680
  Dropped committed packets 0, bytes 0
  Dropped conformed packets 0, bytes 0
  Dropped exceeded packets 0, bytes 0

```

To display detailed interface information for a particular IPv6 address:

```

host1#show ipv6 address detail 5:1::2
FastEthernet9/1.5 line protocol VlanSub is up, ipv6 is up
  Description: IPv6 interface in Virtual Router Hop5
  Network Protocols: IPv6
  Link local address: fe80::90:1a00:740:31ce

  Internet address: 5:1::2/64
IPv6 statistics:
  Rcvd:  0 local destination
        0 hdr errors, 0 addr errors
        0 unkn proto, 0 discards
  Sent:  0 generated, 0 no routes, 0 discards

ICMPv6 statistics:
  Rcvd:  0 destination unreachable, 0 admin unreachable, 0 parameter problem
        0 time exceeded, 0 pkt too big, 0 echo requests
        3 echo replies
  Sent:  0 destination unreachable, 0 admin unreachable, 0 parameter problem
        0 time exceeded, 0 pkt too big, 5 echo requests
        0 echo replies

Operational MTU 1500 Administrative MTU 0
Operational speed 100000000 Administrative speed 0
Creation type Static
ND reachable time is 3600000 milliseconds
ND duplicate address detection attempts is 100
ND neighbor solicitation retransmission interval is 1000 milliseconds
ND proxy is enabled
ND RA source link layer is advertised
ND RA interval is 200 seconds, lifetime is 1800 seconds

```

```

ND RA managed flag is disabled, other config flag is disabled
ND RA advertising prefixes configured on interface

ICMPv6 statistics:
  Rcvd: 12 total, 0 errors
        0 rtr solicits, 7 rtr advertisements
        1 neighbor solicits, 1 neighbor advertisements
        Group membership: 0 queries, 0 responses, 0 reductions
        0 redirects
  Sent: 31 total, 0 errors
        0 rtr solicits, 16 rtr advertisements
        5 neighbor solicits, 5 neighbor advertisements
        Group membership: 0 queries, 0 responses, 0 reductions
        0 redirects

In Received Packets 12, Bytes 1260
  Unicast Packets 5, Bytes 588
  Multicast Packets 7, Bytes 672
In Total Dropped Packets 0, Bytes 0
  In Policed Packets 0
  In Invalid Source Address Packets 0
  In Error Packets 0
  In Discarded Packets 0

Out Forwarded Packets 22, Bytes 2480
  Unicast Packets 22, Bytes 2480
  Multicast Routed Packets 0, Bytes 0
Out Total Dropped Packets 8, Bytes 0
  Out Scheduler Dropped Packets 0, Bytes 0
  Out Policed Packets 0
  Out Discarded Packets 8

queue 0: traffic class best-effort, bound to ipv6 FastEthernet9/1.5
  Queue length 0 bytes
  Forwarded packets 4, bytes 680
  Dropped committed packets 0, bytes 0
  Dropped conformed packets 0, bytes 0
  Dropped exceeded packets 0, bytes 0

```

Meaning [Table 35 on page 196](#) lists the **show ipv6 address** command output fields.

Table 35: show ipv6 address Output Fields

Field Name	Field Description
Description	Optional description for the interface or address specified
Network Protocols	Network protocols configured on this interface
Link local address	Local IPv6 address of this interface
Internet address	External address of this interface

Table 35: show ipv6 address Output Fields (*continued*)

Field Name	Field Description
IPv6 statistics Rcvd	<ul style="list-style-type: none">• local destination—Frames with this router as their destination• hdr errors—Number of packets containing header errors• addr errors—Number of packets containing addressing errors• unkn proto—Number of packets received containing unknown protocols• discards—Number of discarded packets
IPv6 statistics Sent	<ul style="list-style-type: none">• generated—Number of packets generated• no routes—Number of packets that could not be routed• discards—Number of packets that could not be routed that were discarded <p>NOTE: If you configure the router to discard packets for static routes with null 0 interfaces as the next-hop points using the reject keyword with the ipv6 route command, the value displayed in this field also includes the packets that reached the null 0 interface and were dropped.</p>

Table 35: show ipv6 address Output Fields (*continued*)

Field Name	Field Description
ICMPv6 statistics Rcvd	<ul style="list-style-type: none"> total—Total number of received packets errors—Error packets received destination unreachable—Packets received with destination unreachable admin unreachable—Packets received because the destination was administratively unreachable (for example, the packet encountered a firewall filter) parameter problem—Packets received with parameter errors time exceeded—Packets received with time-to-live exceeded pkt too big—Number of packet-too-big messages received that indicate a packet was too large to forward because of the allowed MTU size redirects—Received packet redirects echo requests—Echo request (ping) packets echo replies—Echo replies received rtr solicits—Number of received router solicitations rtr advertisements—Number of received router advertisements neighbor solicits—Number of received neighbor solicitations neighbor advertisements—Number of received neighbor advertisements Group membership (queries, responses, reductions)—Number of queries, responses, and reduction requests received from within a group to which the interface is assigned

Table 35: show ipv6 address Output Fields (*continued*)

Field Name	Field Description
ICMPv6 statistics Sent	<ul style="list-style-type: none"> total—Total number of sent packets errors—Error packets sent destination unreachable—Packets sent with destination unreachable <p>NOTE: If you configure the router to discard packets for static routes with null 0 interfaces as the next-hop points using the reject keyword with the ipv6 route command, the value displayed in this field also includes the number of ICMPv6 unreachable messages sent out for packets that reached null 0 interfaces with static routes.</p> <ul style="list-style-type: none"> admin unreachable—Packets sent because the destination was administratively unreachable (for example, due to a firewall filter) parameter problem—Packets sent with parameter errors time exceeded—Packets sent with time-to-live exceeded pkt too big—Number of packet-too-big messages sent because a received packet was too large to forward because of the allowed MTU size redirects—Sent packet redirects echo requests—Echo request (ping) packets echo replies—Echo replies sent rtr solicits—Number of sent router solicitations rtr advertisements—Number of sent router advertisements neighbor solicits—Number of sent neighbor solicitations neighbor advertisements—Number of sent neighbor advertisements Group membership (queries, responses, reductions)—Number of queries, responses, and reduction requests sent to a group of which the interface is assigned
Operational MTU	Value of the MTU
Administrative MTU	Value of the MTU if it has been administratively overridden using the configuration
Operational speed	Speed of the interface
Administrative speed	Value of the speed if it has been administratively overridden using the configuration
Creation type	Method by which the interface was created (static or dynamic)

Table 35: show ipv6 address Output Fields (*continued*)

Field Name	Field Description
HTTP Redirect Url	URL to which a subscriber's initial Web browser session is redirected
ND reachable time	Amount of time (in milliseconds) that the neighbor is expected to remain reachable
ND duplicate address detection attempts	Number of times that the router attempts to determine a duplicate address
ND neighbor solicitation retransmission interval	Interval in which the router retransmits neighbor solicitations
ND proxy	Indicates whether the router will reply to solicitations on behalf of a known neighbor
ND RA source link layer	Indicates whether the RA includes the link layer
ND RA interval	Interval (in seconds) of the neighbor discovery router advertisement
ND RA lifetime	Lifetime (in seconds) of the neighbor discovery router advertisement
ND RA managed flag	State of the neighbor discovery router advertisement managed flag
ND RA other config flag	State of the neighbor discovery router advertisement other config flag
ND RA advertising prefixes	Configured advertisement prefixes for neighbor discovery router advertisement
In Packet Details	
In Received Packets, Bytes	Total number of packets and bytes received on this interface
Unicast Packets, Bytes	Unicast packets and bytes received on the IPv6 interface; link-local received multicast packets (non-multicast-routed frames) are counted as unicast packets
Multicast Packets, Bytes	Multicast packets and bytes received on the IPv6 interface which are then multicast-routed are counted as multicast packets
In Total Dropped Packets, Bytes	Total number of inbound packets and bytes dropped on this interface

Table 35: show ipv6 address Output Fields (*continued*)

Field Name	Field Description
In Policed Packets	Packets that were received and dropped on the interface for any of the following reasons: exceeding the token bucket limit, exceeding the rate limit, a drop action in a policy, discarded MAC validation packets, a destination address lookup failure, or when the destination address is an IP interface that has a route configured to the null 0 interface.
In Invalid Source Address Packets	Packets received with invalid source address (for example, spoofed packets)
In Error Packets	Number of packets received with errors
In Discarded Packets	Packets received that were discarded for reasons other than rate limits, errors, and invalid source address
Out Packet Details	
Out Forwarded Packets, Bytes	Total number of packets and bytes that were sent from this interface
Unicast Packets, Bytes	Unicast packets and bytes that were sent from this interface
Multicast Routed Packets, Bytes	Multicast packets and bytes that were sent from this interface
Out Total Dropped Packets	Total number of outbound packets and bytes dropped by this interface
Out Scheduler Dropped Packets, Bytes	Number of outbound packets and bytes dropped by the scheduler
Out Policed Packets, Bytes	Number of outbound packets and bytes dropped because of rate limits
Out Discarded Packets	Number of outbound packets that were discarded for reasons other than those dropped by the scheduler and those dropped because of rate limits
Queue Details	
queue, traffic class, bound to ipv6	Queue and traffic class bound to the specified IPv6 interface
Queue length	Number of bytes in queue
Dropped committed packets, bytes	Total number of committed packets and bytes dropped by this interface

Table 35: show ipv6 address Output Fields (*continued*)

Field Name	Field Description
Dropped conformed packets, bytes	Total number of conformed packets and bytes dropped by this interface
Dropped exceeded packets, bytes	Total number of exceeded packets and bytes dropped by this interface

Related Documentation

- [Configuring Profile Attributes for IPv6 on page 161](#)
- [Enabling IPv6 Source Address Validation on page 164](#)
- [Enabling or Disabling the Transmission of ICMPv6 Unreachable Messages for Static Routes on Null Interfaces on page 167](#)
- [Enabling or Disabling an IPv6 Interface on page 173](#)
- [Clearing IPv6 Interface Counters on page 173](#)
- [Adding a Description to an IPv6 Interface or Subinterface on page 177](#)
- [ipv6](#)
- [license ipv6](#)
- [show ipv6 address](#)

Monitoring IPv6 Forwarding Table Details for a Line Module

Purpose Display details on the forwarding table for a specific line module only when IPv6 is configured on the router. These details include the memory used by each virtual router configured on the line module and free memory available on the module.



NOTE:

- You must configure an IPv6 license using the `license ipv6` command before using the IPv6 routing protocol configuration commands on the E Series router.
- All IPv6 routing protocol-related configurations are removed from the virtual router when you issue the `no ipv6` command.

Action To display details on the forwarding table for a specific line module when IPv6 is configured on the router:

```
host1#show ipv6 forwarding-table slot 9
```

```
Free Memory = 32766 KB (99.99%)
```

Virtual Router	Memory(KB)	Load Errors	Status
default	-	-	Not Resident
1	2	0	Valid

Meaning Table 36 on page 203 lists the **show ipv6 forwarding-table slot** command output fields.

Table 36: show ipv6 forwarding-table slot Output Fields

Field Name	Field Description
Free Memory	Amount of routing table memory free on the line module, in kilobytes
Virtual Router	Name of the virtual routers configured on the line module
Memory (KB)	Amount of routing table memory consumed by the virtual router, in kilobytes
Load Errors	Count of errors made while loading the routing table on the line module. Records any failed routing table distribution attempt as an error. Attempts can fail for many reasons during normal operation; a failed attempt does not necessarily indicate a problem. It is normal to see many Load Errors per day.
Status	Indicates whether the routing table for the virtual router is valid. If does not indicate Valid, then the routing table distribution has failed constantly for that virtual router. It is normal and appropriate behavior to indicate Valid while the Load Error field increases daily.

- Related Documentation**
- [ipv6](#)
 - [license ipv6](#)
 - [show ipv6 forwarding-table slot](#)

Monitoring Detailed or Summary Information for IPv6 Interfaces

Purpose Display detailed or summary interface information for a particular interface or for all interfaces. You can use the **brief** keyword to display summary information for all interface types and all interfaces. You can use the **detail** keyword to display detailed information about the interface for all interfaces or the specified interface.



NOTE:

- You must configure an IPv6 license using the **license ipv6** command before using the IPv6 routing protocol configuration commands on the E Series router.
- All IPv6 routing protocol-related configurations are removed from the virtual router when you issue the **no ipv6** command.

Action To display information for all interfaces:

```
host1#show ipv6 interface
null0 line protocol IpLoopback is up, ipv6 is up
  Network Protocols: IPv6
  Link local address: fe80::90:1a00:740:1d44
  Unnumbered Interface: Corresponding Numbered Interface not specified or
removed
  Operational MTU 1500 Administrative MTU 0
  Operational speed 100000000 Administrative speed 0
  Creation type Static
  Neighbor Discovery is disabled

  In Received Packets 0, Bytes 0
    Unicast Packets 0, Bytes 0
    Multicast Packets 0, Bytes 0
  In Total Dropped Packets 0, Bytes 0
    In Policed Packets 0
    In Invalid Source Address Packets 0
    In Error Packets 0
    In Discarded Packets 0

  Out Forwarded Packets 0, Bytes 0
    Unicast Packets 0, Bytes 0
    Multicast Routed Packets 0, Bytes 0
  Out Total Dropped Packets 0, Bytes 0
    Out Scheduler Dropped Packets 0, Bytes 0
    Out Policed Packets 0
    Out Discarded Packets 0

FastEthernet9/1.5 line protocol VlanSub is up, ipv6 is up
  Description: IPv6 interface in Virtual Router Hop5
  Network Protocols: IPv6
  Link local address: fe80::90:1a00:740:31ce
  Internet address: 5:1:1::2/64
  Operational MTU 1500 Administrative MTU 0
  Operational speed 100000000 Administrative speed 0
  Creation type Static
  ND reachable time is 3600000 milliseconds
  ND duplicate address detection attempts is 100
  ND neighbor solicitation retransmission interval is 1000 milliseconds
  ND proxy is enabled

  In Received Packets 13, Bytes 1356
    Unicast Packets 5, Bytes 588
    Multicast Packets 8, Bytes 768
  In Total Dropped Packets 0, Bytes 0
    In Policed Packets 0
    In Invalid Source Address Packets 0
    In Error Packets 0
    In Discarded Packets 0

  Out Forwarded Packets 22, Bytes 2480
    Unicast Packets 22, Bytes 2480
    Multicast Routed Packets 0, Bytes 0
  Out Total Dropped Packets 8, Bytes 0
    Out Scheduler Dropped Packets 0, Bytes 0
    Out Policed Packets 0
    Out Discarded Packets 8

queue 0: traffic class best-effort, bound to ipv6 FastEthernet9/1.5
  Queue length 0 bytes
  Forwarded packets 4, bytes 680
  Dropped committed packets 0, bytes 0
```

```

Dropped conformed packets 0, bytes 0
Dropped exceeded packets 0, bytes 0
FastEthernet9/0.6 line protocol VlanSub is up, ipv6 is up
Description: IPv6 interface in Virtual Router Hop6
Network Protocols: IPv6
Link local address: fe80::90:1a00:740:31cd
Internet address: 6:1:1::1/64
Operational MTU 1500 Administrative MTU 0
Operational speed 1000000000 Administrative speed 0
Creation type Static
ND reachable time is 3600000 milliseconds
ND duplicate address detection attempts is 100
ND neighbor solicitation retransmission interval is 1000 milliseconds
ND proxy is enabled
ND RA source link layer is advertised
ND RA interval is 200 seconds, lifetime is 1800 seconds
ND RA managed flag is disabled, other config flag is disabled
ND RA advertising prefixes configured on interface

In Received Packets 0, Bytes 0
  Unicast Packets 0, Bytes 0
  Multicast Packets 0, Bytes 0
In Total Dropped Packets 0, Bytes 0
  In Policed Packets 0
  In Invalid Source Address Packets 0
  In Error Packets 0
  In Discarded Packets 0

Out Forwarded Packets 8, Bytes 768
  Unicast Packets 8, Bytes 768
  Multicast Routed Packets 0, Bytes 0
Out Total Dropped Packets 5, Bytes 0
  Out Scheduler Dropped Packets 0, Bytes 0
  Out Policed Packets 0
  Out Discarded Packets 5

queue 0: traffic class best-effort, bound to ipv6 FastEthernet9/0.6
Queue length 0 bytes
Forwarded packets 0, bytes 0
Dropped committed packets 0, bytes 0
Dropped conformed packets 0, bytes 0
Dropped exceeded packets 0, bytes 0

Loopback5 line protocol IpLoopback is up, ipv6 is up
Network Protocols: IPv6
Link local address: fe80::90:1a00:740:1d44
Internet address: 10:1:1:0:290:1aff:fe40:1d44/64 (eui-64)
Operational MTU 1500 Administrative MTU 0
Operational speed 1000000000 Administrative speed 0
Creation type Static
Neighbor Discovery is disabled

In Received Packets 0, Bytes 0
  Unicast Packets 0, Bytes 0
  Multicast Packets 0, Bytes 0
In Total Dropped Packets 0, Bytes 0
  In Policed Packets 0
  In Invalid Source Address Packets 0
  In Error Packets 0
  In Discarded Packets 0

Out Forwarded Packets 0, Bytes 0
  Unicast Packets 0, Bytes 0

```

```

Multicast Routed Packets 0, Bytes 0
Out Total Dropped Packets 0, Bytes 0
Out Scheduler Dropped Packets 0, Bytes 0
Out Policed Packets 0
Out Discarded Packets 0

IPv6 policy input ipv6InPol25
  rate-limit-profile Rlp2Mb classifier-group clgA entry 1
    Committed: 0 packets, 0 bytes
    Conformed: 0 packets, 0 bytes
    Exceeded: 0 packets, 0 bytes
  rate-limit-profile Rlp8Mb
    Committed: 0 packets, 0 bytes
    Conformed: 0 packets, 0 bytes
    Exceeded: 0 packets, 0 bytes
IPv6 policy output ipv6PolOut2
  rate-limit-profile RlpOutA classifier-group clgB entry 1
    Committed: 0 packets, 0 bytes
    Conformed: 0 packets, 0 bytes
    Exceeded: 0 packets, 0 bytes
  rate-limit-profile RlpOutB
    Committed: 0 packets, 0 bytes
    Conformed: 0 packets, 0 bytes
    Exceeded: 0 packets, 0 bytes
IPv6 policy local-input ipv6PolLocIn5
  rate-limit-profile Rlp1Mb classifier-group clgC entry 1
    Committed: 0 packets, 0 bytes
    Conformed: 0 packets, 0 bytes
    Exceeded: 0 packets, 0 bytes
  rate-limit-profile Rlp5Mb
    Committed: 0 packets, 0 bytes
    Conformed: 0 packets, 0 bytes
    Exceeded: 0 packets, 0 bytes
queue 0: traffic class best-effort, bound to ipv6 FastEthernet9/0.6
  Queue length 0 bytes
  Forwarded packets 0, bytes 0
  Dropped committed packets 0, bytes 0
  Dropped conformed packets 0, bytes 0
  Dropped exceeded packets 0, bytes 0

```

To display information for a particular interface:

```

host1#show ipv6 interface FastEthernet 9/0.6
FastEthernet9/0.6 line protocol VlanSub is up, ipv6 is up
Description: IPv6 interface in Virtual Router Hop6
Network Protocols: IPv6
Link local address: fe80::90:1a00:740:31cd
Internet address: 6:1:1::1/64
Operational MTU 1500 Administrative MTU 0
Operational speed 1000000000 Administrative speed 0
Creation type Static
ND reachable time is 3600000 milliseconds
ND duplicate address detection attempts is 100
ND neighbor solicitation retransmission interval is 1000 milliseconds
ND proxy is enabled
ND RA source link layer is advertised
ND RA interval is 200 seconds, lifetime is 1800 seconds
ND RA managed flag is disabled, other config flag is disabled
ND RA advertising prefixes configured on interface

In Received Packets 0, Bytes 0
  Unicast Packets 0, Bytes 0

```

```

    Multicast Packets 0, Bytes 0
In Total Dropped Packets 0, Bytes 0
  In Policed Packets 0
  In Invalid Source Address Packets 0
  In Error Packets 0
  In Discarded Packets 0

Out Forwarded Packets 8, Bytes 768
  Unicast Packets 8, Bytes 768
  Multicast Routed Packets 0, Bytes 0
Out Total Dropped Packets 5, Bytes 0
  Out Scheduler Dropped Packets 0, Bytes 0
  Out Policed Packets 0
  Out Discarded Packets 5

queue 0: traffic class best-effort, bound to ipv6 FastEthernet9/0.6
Queue length 0 bytes
Forwarded packets 0, bytes 0
Dropped committed packets 0, bytes 0
Dropped conformed packets 0, bytes 0
Dropped exceeded packets 0, bytes 0

IPv6 policy input ipv6InPol25
  rate-limit-profile Rlp2Mb classifier-group clgA entry 1
    Committed: 0 packets, 0 bytes
    Conformed: 0 packets, 0 bytes
    Exceeded: 0 packets, 0 bytes
  rate-limit-profile Rlp8Mb
    Committed: 0 packets, 0 bytes
    Conformed: 0 packets, 0 bytes
    Exceeded: 0 packets, 0 bytes
IPv6 policy output ipv6PolOut2
  rate-limit-profile RlpOutA classifier-group clgB entry 1
    Committed: 0 packets, 0 bytes
    Conformed: 0 packets, 0 bytes
    Exceeded: 0 packets, 0 bytes
  rate-limit-profile RlpOutB
    Committed: 0 packets, 0 bytes
    Conformed: 0 packets, 0 bytes
    Exceeded: 0 packets, 0 bytes
IPv6 policy local-input ipv6PolLocIn5
  rate-limit-profile Rlp1Mb classifier-group clgC entry 1
    Committed: 0 packets, 0 bytes
    Conformed: 0 packets, 0 bytes
    Exceeded: 0 packets, 0 bytes
  rate-limit-profile Rlp5Mb
    Committed: 0 packets, 0 bytes
    Conformed: 0 packets, 0 bytes
    Exceeded: 0 packets, 0 bytes
queue 0: traffic class best-effort, bound to ipv6 FastEthernet9/0.6
Queue length 0 bytes
Forwarded packets 0, bytes 0
Dropped committed packets 0, bytes 0
Dropped conformed packets 0, bytes 0
Dropped exceeded packets 0, bytes 0
Http Redirect Url: http://www.juniper.net

```

To display detailed information for all interfaces:

```

host1#show ipv6 interface detail
null0 line protocol IpLoopback is up, ipv6 is up
Network Protocols: IPv6
Link local address: fe80::90:1a00:740:1d44

```

Unnumbered Interface: Corresponding Numbered Interface not specified or removed

IPv6 statistics:

Rcvd: 0 local destination
0 hdr errors, 0 addr errors
0 unkn proto, 0 discards
Sent: 0 generated, 0 no routes, 0 discards

ICMPv6 statistics:

Rcvd: 0 destination unreachable, 0 admin unreachable, 0 parameter problem
0 time exceeded, 0 pkt too big, 0 echo requests
0 echo replies
Sent: 0 destination unreachable, 0 admin unreachable, 0 parameter problem
0 time exceeded, 0 pkt too big, 0 echo requests
0 echo replies

Operational MTU 1500 Administrative MTU 0

Operational speed 100000000 Administrative speed 0

Creation type Static

Neighbor Discovery is disabled

ICMPv6 statistics:

Rcvd: 0 total, 0 errors
0 rtr solicits, 0 rtr advertisements
0 neighbor solicits, 0 neighbor advertisements
Group membership: 0 queries, 0 responses, 0 reductions
0 redirects
Sent: 0 total, 0 errors
0 rtr solicits, 0 rtr advertisements
0 neighbor solicits, 0 neighbor advertisements
Group membership: 0 queries, 0 responses, 0 reductions
0 redirects

In Received Packets 0, Bytes 0

Unicast Packets 0, Bytes 0

Multicast Packets 0, Bytes 0

In Total Dropped Packets 0, Bytes 0

In Policed Packets 0

In Invalid Source Address Packets 0

In Error Packets 0

In Discarded Packets 0

Out Forwarded Packets 0, Bytes 0

Unicast Packets 0, Bytes 0

Multicast Routed Packets 0, Bytes 0

Out Total Dropped Packets 0, Bytes 0

Out Scheduler Dropped Packets 0, Bytes 0

Out Policed Packets 0

Out Discarded Packets 0

FastEthernet9/1.5 line protocol VlanSub is up, ipv6 is up

Description: IPv6 interface in Virtual Router Hop5

Network Protocols: IPv6

Link local address: fe80::90:1a00:740:31ce

Internet address: 5:1:1::2/64

IPv6 statistics:

Rcvd: 0 local destination
0 hdr errors, 0 addr errors
0 unkn proto, 0 discards
Sent: 0 generated, 0 no routes, 0 discards

ICMPv6 statistics:

Rcvd: 0 destination unreachable, 0 admin unreachable, 0 parameter problem


```

    0 time exceeded, 0 pkt too big, 0 echo requests
    3 echo replies
Sent: 0 destination unreachable, 0 admin unreachable, 0 parameter problem
    0 time exceeded, 0 pkt too big, 5 echo requests
    0 echo replies

Operational MTU 1500 Administrative MTU 0
Operational speed 1000000000 Administrative speed 0
Creation type Static
ND reachable time is 3600000 milliseconds
ND duplicate address detection attempts is 100
ND neighbor solicitation retransmission interval is 1000 milliseconds
ND proxy is enabled
ND RA source link layer is advertised
ND RA interval is 200 seconds, lifetime is 1800 seconds
ND RA managed flag is disabled, other config flag is disabled
ND RA advertising prefixes configured on interface

ICMPv6 statistics:
  Rcvd: 13 total, 0 errors
        0 rtr solicits, 8 rtr advertisements
        1 neighbor solicits, 1 neighbor advertisements
        Group membership: 0 queries, 0 responses, 0 reductions
        0 redirects
  Sent: 31 total, 0 errors
        0 rtr solicits, 16 rtr advertisements
        5 neighbor solicits, 5 neighbor advertisements
        Group membership: 0 queries, 0 responses, 0 reductions
        0 redirects

In Received Packets 13, Bytes 1356
  Unicast Packets 5, Bytes 588
  Multicast Packets 8, Bytes 768
In Total Dropped Packets 0, Bytes 0
  In Policed Packets 0
  In Invalid Source Address Packets 0
  In Error Packets 0
  In Discarded Packets 0

Out Forwarded Packets 22, Bytes 2480
  Unicast Packets 22, Bytes 2480
  Multicast Routed Packets 0, Bytes 0
Out Total Dropped Packets 8, Bytes 0
  Out Scheduler Dropped Packets 0, Bytes 0
  Out Policed Packets 0
  Out Discarded Packets 8

queue 0: traffic class best-effort, bound to ipv6 FastEthernet9/1.5
  Queue length 0 bytes
  Forwarded packets 4, bytes 680
  Dropped committed packets 0, bytes 0
  Dropped conformed packets 0, bytes 0
  Dropped exceeded packets 0, bytes 0

FastEthernet9/0.6 line protocol VlanSub is up, ipv6 is up
Description: IPv6 interface in Virtual Router Hop6
Network Protocols: IPv6
Link local address: fe80::90:1a00:740:31cd

Internet address: 6:1:1::1/64
IPv6 statistics:
  Rcvd: 0 local destination
        0 hdr errors, 0 addr errors

```

```
    0 unkn proto, 0 discards
Sent: 0 generated, 0 no routes, 0 discards

ICMPv6 statistics:
  Rcvd: 0 destination unreachable, 0 admin unreachable, 0 parameter problem
        0 time exceeded, 0 pkt too big, 0 echo requests
        0 echo replies
  Sent: 0 destination unreachable, 0 admin unreachable, 0 parameter problem
        0 time exceeded, 0 pkt too big, 0 echo requests
        0 echo replies

Operational MTU 1500 Administrative MTU 0
Operational speed 1000000000 Administrative speed 0
Creation type Static
ND reachable time is 3600000 milliseconds
ND duplicate address detection attempts is 100
ND neighbor solicitation retransmission interval is 1000 milliseconds
ND proxy is enabled
ND RA source link layer is advertised
ND RA interval is 200 seconds, lifetime is 1800 seconds
ND RA managed flag is disabled, other config flag is disabled
ND RA advertising prefixes configured on interface

ICMPv6 statistics:
  Rcvd: 0 total, 0 errors
        0 rtr solicits, 0 rtr advertisements
        0 neighbor solicits, 0 neighbor advertisements
        Group membership: 0 queries, 0 responses, 0 reductions
        0 redirects
  Sent: 13 total, 0 errors
        0 rtr solicits, 9 rtr advertisements
        2 neighbor solicits, 2 neighbor advertisements
        Group membership: 0 queries, 0 responses, 0 reductions
        0 redirects

In Received Packets 0, Bytes 0
  Unicast Packets 0, Bytes 0
  Multicast Packets 0, Bytes 0
In Total Dropped Packets 0, Bytes 0
  In Policed Packets 0
  In Invalid Source Address Packets 0
  In Error Packets 0
  In Discarded Packets 0

Out Forwarded Packets 8, Bytes 768
  Unicast Packets 8, Bytes 768
  Multicast Routed Packets 0, Bytes 0
Out Total Dropped Packets 5, Bytes 0
  Out Scheduler Dropped Packets 0, Bytes 0
  Out Policed Packets 0
  Out Discarded Packets 5

queue 0: traffic class best-effort, bound to ipv6 FastEthernet9/0.6
  Queue length 0 bytes
  Forwarded packets 0, bytes 0
  Dropped committed packets 0, bytes 0
  Dropped conformed packets 0, bytes 0
  Dropped exceeded packets 0, bytes 0

loopback5 line protocol IpLoopback is up, ipv6 is up
Network Protocols: IPv6
Link local address: fe80::90:1a00:740:1d44
```

```

Internet address: 10:1:1:0:290:1aff:fe40:1d44/64 (eui-64)
IPv6 statistics:
  Rcvd: 0 local destination
        0 hdr errors, 0 addr errors
        0 unkn proto, 0 discards
  Sent: 0 generated, 0 no routes, 0 discards

ICMPv6 statistics:
  Rcvd: 0 local destination
        0 hdr errors, 0 addr errors
        0 unkn proto, 0 discards
  Sent: 0 generated, 0 no routes, 0 discards

ICMPv6 statistics:
  Rcvd: 0 destination unreachable, 0 admin unreachable, 0 parameter problem
        0 time exceeded, 0 pkt too big, 0 echo requests
        0 echo replies
  Sent: 0 destination unreachable, 0 admin unreachable, 0 parameter problem
        0 time exceeded, 0 pkt too big, 0 echo requests
        0 echo replies

Operational MTU 1500 Administrative MTU 0
Operational speed 100000000 Administrative speed 0
Creation type Static
Neighbor Discovery is disabled

ICMPv6 statistics:
  Rcvd: 0 total, 0 errors
        0 rtr solicits, 0 rtr advertisements
        0 neighbor solicits, 0 neighbor advertisements
        Group membership: 0 queries, 0 responses, 0 reductions
        0 redirects
  Sent: 0 total, 0 errors
        0 rtr solicits, 0 rtr advertisements
        0 neighbor solicits, 0 neighbor advertisements
        Group membership: 0 queries, 0 responses, 0 reductions
        0 redirects

In Received Packets 0, Bytes 0
  Unicast Packets 0, Bytes 0
  Multicast Packets 0, Bytes 0
In Total Dropped Packets 0, Bytes 0
  In Policed Packets 0
  In Invalid Source Address Packets 0
  In Error Packets 0
  In Discarded Packets 0

Out Forwarded Packets 0, Bytes 0
  Unicast Packets 0, Bytes 0
  Multicast Routed Packets 0, Bytes 0
Out Total Dropped Packets 0, Bytes 0
  Out Scheduler Dropped Packets 0, Bytes 0
  Out Policed Packets 0
  Out Discarded Packets 0
IPv6 policy input ipv6InPol25
  rate-limit-profile Rlp2Mb classifier-group clgA entry 1
    Committed: 0 packets, 0 bytes
    Conformed: 0 packets, 0 bytes
    Exceeded: 0 packets, 0 bytes
  rate-limit-profile Rlp8Mb
    Committed: 0 packets, 0 bytes
    Conformed: 0 packets, 0 bytes
    Exceeded: 0 packets, 0 bytes

```

```

IPv6 policy output ipv6PolOut2
  rate-limit-profile RlpOutA classifier-group clgB entry 1
    Committed: 0 packets, 0 bytes
    Conformed: 0 packets, 0 bytes
    Exceeded: 0 packets, 0 bytes
  rate-limit-profile RlpOutB
    Committed: 0 packets, 0 bytes
    Conformed: 0 packets, 0 bytes
    Exceeded: 0 packets, 0 bytes
IPv6 policy local-input ipv6PolLocIn5
  rate-limit-profile Rlp1Mb classifier-group clgC entry 1
    Committed: 0 packets, 0 bytes
    Conformed: 0 packets, 0 bytes
    Exceeded: 0 packets, 0 bytes
  rate-limit-profile Rlp5Mb
    Committed: 0 packets, 0 bytes
    Conformed: 0 packets, 0 bytes
    Exceeded: 0 packets, 0 bytes
queue 0: traffic class best-effort, bound to ipv6 FastEthernet9/0.6
Queue length 0 bytes
Forwarded packets 0, bytes 0
Dropped committed packets 0, bytes 0
Dropped conformed packets 0, bytes 0
Dropped exceeded packets 0, bytes 0

```

To display summary information for all interfaces:

```
host1# show ipv6 interface brief
```

Interface	IPv6-Address	Status	Protocol	Description
nu110	Unnumbered	up	up	
FastEthernet9/1.5	5:1:1::2/64	up	up	IPv6 interface in Virtual Router Hop 5
FastEthernet9/0.6	6:1:1::1/64	up	up	IPv6 interface in Virtual Router Hop 6
loopback5	10:1:1:0:290:1aff:fe 40:1d44/64	up	up	

Meaning [Table 37 on page 212](#) lists the **show ipv6 interface** command output fields.

Table 37: show ipv6 interface Output Fields

Field Name	Field Description
Interface	Type of interface and interface specifier. For details about interface types and specifiers, see <i>Interface Types and Specifiers</i> in <i>JunosE Command Reference Guide</i>
Ipv6-Address	External address of the interface
Status	Status of the interface: up or down
Protocol	Status of the protocol on the interface: up or down
Description	Optional description for the interface or address specified

Table 37: show ipv6 interface Output Fields (*continued*)

Field Name	Field Description
Network Protocols	Network protocols configured on this interface
Link local address	Local IPv6 address of this interface
Internet address	External address of this interface
IPv6 statistics Rcvd	<ul style="list-style-type: none"> • local destination—Frames with this router as their destination • hdr errors—Number of packets containing header errors • addr errors—Number of packets containing addressing errors • unkn proto—Number of packets received containing unknown protocols • discards—Number of discarded packets
IPv6 statistics Sent	<ul style="list-style-type: none"> • generated—Number of packets generated • no routes—Number of packets that could not be routed • discards—Number of packets that could not be routed that were discarded <p>NOTE: If you configure the router to discard packets for static routes with null 0 interfaces as the next-hop points using the reject keyword with the ipv6 route command, the value displayed in this field also includes the packets that reached the null 0 interface and were dropped.</p>

Table 37: show ipv6 interface Output Fields (*continued*)

Field Name	Field Description
ICMPv6 statistics Rcvd	<ul style="list-style-type: none"> total—Total number of received packets errors—Error packets received destination unreachable—Packets received with destination unreachable admin unreachable—Packets received because the destination was administratively unreachable (for example, the packet encountered a firewall filter) parameter problem—Packets received with parameter errors time exceeded—Packets received with time-to-live exceeded pkt too big—Number of packet-too-big messages received that indicate a packet was too large to forward because of the allowed MTU size redirects—Received packet redirects echo requests—Echo request (ping) packets echo replies—Echo replies received rtr solicits—Number of received router solicitations rtr advertisements—Number of received router advertisements neighbor solicits—Number of received neighbor solicitations neighbor advertisements—Number of received neighbor advertisements Group membership (queries, responses, reductions)—Number of queries, responses, and reduction requests received from within a group to which the interface is assigned

Table 37: show ipv6 interface Output Fields (*continued*)

Field Name	Field Description
ICMPv6 statistics Sent	<ul style="list-style-type: none"> total—Total number of sent packets errors—Error packets sent destination unreachable—Packets sent with destination unreachable <p>NOTE: If you configure the router to discard packets for static routes with null 0 interfaces as the next-hop points using the reject keyword with the ipv6 route command, the value displayed in this field also includes the number of ICMPv6 unreachable messages sent out for packets that reached null 0 interfaces with static routes.</p> <ul style="list-style-type: none"> admin unreachable—Packets sent because the destination was administratively unreachable (for example, due to a firewall filter) parameter problem—Packets sent with parameter errors time exceeded—Packets sent with time-to-live exceeded pkt too big—Number of packet-too-big messages sent because a received packet was too large to forward because of the allowed MTU size redirects—Sent packet redirects echo requests—Echo request (ping) packets echo replies—Echo replies sent rtr solicits—Number of sent router solicitations rtr advertisements—Number of sent router advertisements neighbor solicits—Number of sent neighbor solicitations neighbor advertisements—Number of sent neighbor advertisements Group membership (queries, responses, reductions)—Number of queries, responses, and reduction requests sent to a group of which the interface is assigned
Operational MTU	Value of the MTU
Administrative MTU	Value of the MTU if it has been administratively overridden using the configuration
Operational speed	Speed of the interface
Administrative speed	Value of the speed if it has been administratively overridden using the configuration
Creation type	Method by which the interface was created (static or dynamic)

Table 37: show ipv6 interface Output Fields (*continued*)

Field Name	Field Description
HTTP Redirect Url	URL to which a subscriber's initial Web browser session is redirected
ND reachable time	Amount of time (in milliseconds) that the neighbor is expected to remain reachable
ND duplicate address detection attempts	Number of times that the router attempts to determine a duplicate address
ND neighbor solicitation retransmission interval	Interval in which the router retransmits neighbor solicitations
ND proxy	Indicates whether the router will reply to solicitations on behalf of a known neighbor
ND RA source link layer	Indicates whether the RA includes the link layer
ND RA interval	Interval (in seconds) of the neighbor discovery router advertisement
ND RA lifetime	Lifetime (in seconds) of the neighbor discovery router advertisement
ND RA managed flag	State of the neighbor discovery router advertisement managed flag
ND RA other config flag	State of the neighbor discovery router advertisement other config flag
ND RA advertising prefixes	Configured advertisement prefixes for neighbor discovery router advertisement
In Packet Details	
In Received Packets, Bytes	Total number of packets and bytes received on this interface
Unicast Packets, Bytes	Unicast packets and bytes received on the IPv6 interface; link-local received multicast packets (non-multicast-routed frames) are counted as unicast packets
Multicast Packets, Bytes	Multicast packets and bytes received on the IPv6 interface which are then multicast-routed are counted as multicast packets
In Total Dropped Packets, Bytes	Total number of inbound packets and bytes dropped on this interface

Table 37: show ipv6 interface Output Fields (*continued*)

Field Name	Field Description
In Policed Packets	Packets that were received and dropped on the interface for any of the following reasons: exceeding the token bucket limit, exceeding the rate limit, a drop action in a policy, discarded MAC validation packets, a destination address lookup failure, or when the destination address is an IP interface that has a route configured to the null 0 interface.
In Invalid Source Address Packets	Packets received with invalid source address (for example, spoofed packets)
In Error Packets	Number of packets received with errors
In Discarded Packets	Packets received that were discarded for reasons other than rate limits, errors, and invalid source address
Out Packet Details	
Out Forwarded Packets, Bytes	Total number of packets and bytes that were sent from this interface
Unicast Packets, Bytes	Unicast packets and bytes that were sent from this interface
Multicast Routed Packets, Bytes	Multicast packets and bytes that were sent from this interface
Out Total Dropped Packets	Total number of outbound packets and bytes dropped by this interface
Out Scheduler Dropped Packets, Bytes	Number of outbound packets and bytes dropped by the scheduler
Out Policed Packets, Bytes	Number of outbound packets and bytes dropped because of rate limits
Out Discarded Packets	Number of outbound packets that were discarded for reasons other than those dropped by the scheduler and those dropped because of rate limits
Queue Details	
queue, traffic class, bound to ipv6	Queue and traffic class bound to the specified IPv6 interface
Queue length	Number of bytes in queue
Dropped committed packets, bytes	Total number of committed packets and bytes dropped by this interface

Table 37: show ipv6 interface Output Fields (*continued*)

Field Name	Field Description
Dropped conformed packets, bytes	Total number of conformed packets and bytes dropped by this interface
Dropped exceeded packets, bytes	Total number of exceeded packets and bytes dropped by this interface
IPv6 Policy Details	
IPv6 policy	Type (input, output, local-input) and name of policy
rate-limit-profile	Name of profile
classifier-group entry	Entry index
Committed	Number of packets and bytes conforming to the committed access rate
Conformed	Number of packets and bytes that exceed the committed access rate but conform to the peak access rate
Exceeded	Number of packets and bytes exceeding the peak access rate

Related Documentation

- [Configuring Profile Attributes for IPv6 on page 161](#)
- [Enabling or Disabling the Transmission of ICMPv6 Unreachable Messages for Static Routes on Null Interfaces on page 167](#)
- [Enabling or Disabling an IPv6 Interface on page 173](#)
- [Clearing IPv6 Interface Counters on page 173](#)
- [Adding a Description to an IPv6 Interface or Subinterface on page 177](#)
- [Setting a Baseline for IPv6 Interface Statistics on page 190](#)
- `ipv6`
- `license ipv6`
- `show ipv6 interface`

Monitoring Static or Dynamic Entries of the IPv6 Neighbor Discovery Cache

Purpose Display IPv6 Neighbor Discovery cache information static entries, dynamic entries, or both:

- You can use the **static** keyword to display only static entries
- You can use the **dynamic** keyword to display only dynamic entries

- You can use the **summary** keyword to display summary information

**NOTE:**

- You must configure an IPv6 license using the **license ipv6** command before using the IPv6 routing protocol configuration commands on the E Series router.
- All IPv6 routing protocol-related configurations are removed from the virtual router when you issue the **no ipv6** command.

Action To display both static and dynamic entries from the IPv6 Neighbor Discovery cache:

```
host1# show ipv6 neighbors
```

Interface	IPv6-Address	Type	Hardware Addr	State	Age
FastEthernet4/1	1::1	dynamic	0090.1a40.05e5	reach	3

To display summary information of both static and dynamic entries from the IPv6 Neighbor Discovery cache:

```
host1# show ipv6 neighbors summary
```

```
Total IPv6 neighbors: 7
```

```
By type: 5 global, 2 link-local, 0 anycast, 0 unknown
```

```
By state: 5 reachable, 0 incomplete, 2 stale, 0 probe, 0 delay, 0 init
```

```
IPv6 address conflicts: 0 during DAD resolution, 0 after DAD resolution
```

Meaning [Table 38 on page 219](#) lists the **show ipv6 neighbors** command output fields.

Table 38: show ipv6 neighbors Output Fields

Field Name	Field Description
Interface	Neighbor interface
IPv6-Address	IPv6 address for the interface
Type	Type of interface (dynamic, static)
Hardware Addr	Layer 2 address of the interface
State	State of the interface (delay, incomplete, probe, reachable, stale)
Age	Amount of time (in seconds) since the router contacted the neighbor
Total IPv6 neighbors	Total number of IPv6 neighbors
By type	List by neighbor type (global, link-local, anycast, and unknown)

Table 38: show ipv6 neighbors Output Fields (*continued*)

Field Name	Field Description
By state	List by neighbor state (reachable, incomplete, stale, probe, delay, an init)
IPv6 address conflicts	Number of conflicts during or after duplicate address detection resolution

- Related Documentation**
- [Creating Static IPv6 Neighbors on page 187](#)
 - [Clearing Static or Dynamic IPv6 Neighbors on page 188](#)
 - [ipv6](#)
 - [license ipv6](#)
 - [show ipv6 neighbors](#)

Monitoring an IPv6 Profile

Purpose Display information about a specific IPv6 profile.

Action To display information about a specific IPv6 profile:

```
host1#show ipv6 profile foo
IPv6 profile : foo
Unnumbered interface on : loopback 0
Router : r1
Access Route Addition : Enabled
Source-Address Validation : Disabled
Administrative MTU : 0
```

Meaning [Table 39 on page 220](#) lists the **show ipv6 profile** command output fields.

Table 39: show ipv6 profile Output Fields

Field Name	Field Description
IPv6 profile	Profile name
Unnumbered interface on	Specifier for the unnumbered interface or none if the interface is numbered
Router	Router name
Access Route Addition	Status of access route addition (Enabled or disabled)
Source-Address Validation	Status of source address validation (Enabled or disabled)
Administrative MTU	MTU size

- Related Documentation**
- [Creating a Profile on page 17](#)
 - [Configuring Profile Attributes for IPv6 on page 161](#)
 - `ipv6`
 - `license ipv6`
 - `show ipv6 profile`

Monitoring Active IPv6 Protocols

Purpose Display detailed information about IPv6 protocols currently configured on the router.



NOTE:

- You must configure an IPv6 license using the `license ipv6` command before using the IPv6 routing protocol configuration commands on the E Series router.
- All IPv6 routing protocol-related configurations are removed from the virtual router when you issue the `no ipv6` command.

Action To display detailed information about IPv6 protocols currently configured on the router:

```
host1#show ipv6 protocols
Routing Protocol is " bgp 100"
  Local router ID 1.1.1.1, local AS 100
  Administrative state is Start
  Operational state is Up
  Shutdown in overload state is disabled
  Default local preference is 100
  IGP synchronization is enabled
  Default originate is disabled
  Auto summary is enabled
  Always compare MED is disabled
  Compare MED within confederation is disabled
  Advertise inactive routes is disabled
  Advertise best external route to internal peers is disabled
  Enforce first AS is disabled
  Missing MED as worst is disabled
  Route flap dampening is disabled
  Log neighbor changes is disabled
  Fast External Fallover is disabled
  No maximum received AS-path length
  BGP administrative distances are 20 (ext), 200 (int), and 200 (local)
  Client-to-client reflection is enabled
  Cluster ID is 1.1.1.1
  Route-target filter is enabled
  Default IPv4-unicast is enabled
  Local-RIB version 8. FIB version 8.
  Neighbor(s):
    No neighbors are configured
  Routing for Networks:
  Aggregate Generation for Unicast Routes:
```

To display only a list of currently configured protocols:

```
host1#show ipv6 protocols summary
bgp 100
```

Meaning [Table 40 on page 222](#) lists the **show ipv6 protocols** command output fields.

Table 40: show ipv6 protocols Output Fields

Field Name	Field Description
Local router ID	Router ID of the local router
Local AS	AS number of local router
Administrative state	Administrative state of the protocol
Operational state	Operational state of the protocol
Shutdown in overload state	Status of shutdown in an overload state
Default local preference	Default value for local preference
IGP synchronization	Indicates whether synchronization is enabled or disabled
Default originate	Indicates whether network 0.0.0.0 is redistributed into BGP
Auto summary	Status of autosummary
Always compare MED	Status of always compare MED
Compare MED within confederation	Status of compare MED within a confederation
Advertise inactive routes	Status of Advertise inactive routes
Advertise best external router to internal peers	Status of Advertise best external router to internal peers
Enforce first AS	Status of Enforce first AS
Missing MED as worst	Status of Missing MED as worst
Route flap dampening	Status of route dampening
Log neighbor changes	Status of Log neighbor changes
Fast External Fallover	Status of Fast External Fallover
Maximum received AS-path length	Maximum AS-path length received

Table 40: show ipv6 protocols Output Fields (*continued*)

Field Name	Field Description
BGP administrative distances	External, internal, and local BGP administrative distances
Client-to-client reflection	Whether client-to-client reflection is configured
Cluster ID	Cluster IDs
Route-target filter	Status of Route-target filter
Default IPv4-unicast	Status of Default IPv4-unicast
Local-RIB version	RIB version
Local-FIB version	FIB version
Neighbor(s)	BGP neighbors (if configured)
Networks for which routing is occurring	Networks for which routing is occurring
Aggregate Generation for Unicast Routes	Aggregate generation for unicast routes

- Related Documentation**
- [ipv6](#)
 - [license ipv6](#)
 - [show ipv6 protocols](#)

Monitoring the IPv6 Route Redistribution Policy

Purpose Display the configured route redistribution policy.



NOTE:

- You must configure an IPv6 license using the `license ipv6` command before using the IPv6 routing protocol configuration commands on the E Series router.
- All IPv6 routing protocol-related configurations are removed from the virtual router when you issue the `no ipv6` command.

Action To display the configured route redistribution policy:

```
host1#show ipv6 redistribute
To bgp, From static is enabled with route map foo
To bgp, From connected is enabled without a route map
```

Meaning Table 41 on page 224 lists the **show ipv6 redistribute** command output fields.

Table 41: show ipv6 redistribute Output Fields

Field Name	Field Description
To	Protocol that routes are distributed into
From	Protocol that routes are distributed from
status	Redistribution status
route map name	Name of the route map

- Related Documentation**
- [ipv6](#)
 - [license ipv6](#)
 - [show ipv6 redistribute](#)

Monitoring the Current State of IPv6 Routing Tables

Purpose Display the current state of the routing table, including routes not used for forwarding. You can display all routes, a specific route, detailed information about all or a specific route, or summary counters for the routing table.



NOTE:

- You must configure an IPv6 license using the **license ipv6** command before using the IPv6 routing protocol configuration commands on the E Series router.
- All IPv6 routing protocol-related configurations are removed from the virtual router when you issue the **no ipv6** command.

Action To display current state of all routes in the routing table:

```
host1#show ipv6 route
      Prefix/Length      Type  Dst/Met      Intf
-----
1::/16                  Connect  0/0      looback1
5::/64                  Connect  0/0      ATM4/0.15
6::/64                  Static   1/0      ATM4/0.15
2003::/16               Static   1/0      ATM4/0.15
```

To display summary information of all routes in the routing table:


```

host1#show ipv6 route summary
Unicast routes:
8 total routes, 576 bytes in route entries
0 isis routes
0 rip routes
3 static routes
2 connected routes
1 bgp routes
0 ospf routes
2 other internal routes
0 access routes
0 internally created access host routes

Last route added/deleted: 2::4/128 by BGP
At MON FEB 04 2008 14:18:25 UTC

Unicast routes used only for Multicast RPF check:
0 total routes, 0 bytes in route entries
0 isis routes
0 rip routes
0 staroughtic routes
0 connected routes
0 bgp routes
0 ospf routes
0 other internal routes
0 access routes
0 internally created access host routes
0 mbgp routes
0 dvmrp routes

Last route added/deleted: null by Invalid
At MON FEB 04 2008 14:18:04 UTC

MPLS tunnel routes (not used for forwarding):
3 total routes, 216 bytes in route entries
1 bgp tunnel routes
1 ldp tunnel routes
1 rsvp tunnel routes

Last route added/deleted: 2::4/128 by BGP Tunnel
At MON FEB 04 2008 14:18:26 UTC

To display the detailed information about the specific route:

host1#show ipv6 route 5::/64 detail
5::/64 Type: Static Distance: 1 Metric: 0 Tag: 1234 Class: 0
      NextHop: 1::2 IntfIndex 10007 Intf ATM4/0.15

```

Meaning [Table 42 on page 225](#) lists the **show ipv6 route** command output fields.

Table 42: show ipv6 route Output Fields

Field Name	Field Description
Prefix	IPv6 address prefix
Length	Prefix length
Type	Protocol type (possible route types include: Bgp, Connect, Idrp, Igrp, Invalid, Isis, Ndisc, Ospf, Other, Rip, Static)

Table 42: show ipv6 route Output Fields (*continued*)

Field Name	Field Description
Dst (or Distance)	Administrative distance for the route
Met (or Metric)	Number of hops
Intf	Interface type and interface specifier
Tag	Route tag assigned for the static route
NextHop	The configured next hop address for this interface
IfIndex	An autogenerated value for the next hop interface

Related Documentation

- [IPv6 Tunnel Routing Tables Overview on page 156](#)
- [Establishing an IPv6 Static Route on page 165](#)
- [Configuring IPv6 Static Routes with Tags for Redistribution of Routes on page 168](#)
- [ipv6](#)
- [license ipv6](#)
- [show ipv6 route](#)

Monitoring Received IPv6 Router Advertisements

Purpose Display IPv6 router advertisement information received. You can use the **conflicts** keyword to display router advertisements that differ from the advertisements configured.

Action To display IPv6 router advertisement information received:

```
host1#show ipv6 routers
```

```
Router FE80::83B3:60A4 on FastEthernet2/0, last update 3 min
  Hops 0, Lifetime 6000 sec, AddrFlag=0, OtherFlag=0
  Reachable time 0 msec, Retransmit time 0 msec
  Prefix 3FFE:C00:8007::800:207C:4E37/96 autoconfig
  Valid lifetime -1, preferred lifetime -1
```

```
Router FE80::290:27FF:FE8C:B709 on FastEthernet2/1, last update 0 min
  Hops 64, Lifetime 1800 sec, AddrFlag=0, OtherFlag=0
  Reachable time 0 msec, Retransmit time 0 msec
```

To display router advertisements that differ from the advertisements configured:

```
host1#show ipv6 routers conflicts
```

```
Router FE80::203:FDFE:FE34:7039 on FastEthernet1/0, last update 1 min, CONFLICT
  Hops 64, Lifetime 1800 sec, AddrFlag=0, OtherFlag=0
  Reachable time 0 msec, Retransmit time 0 msec
  Prefix 2003::/64 onlink autoconfig
  Valid lifetime -1, preferred lifetime -1
```

Meaning [Table 43 on page 227](#) lists the **show ipv6 routers** command output fields.

Table 43: show ipv6 routers Output Fields

Field Name	Field Description
Router	Router for which this information applies
Hops	Number of hops that the router uses in router advertisements
Lifetime	Lifetime (in seconds) of the neighbor discovery router advertisement
AddrFlag	State of the neighbor discovery router advertisement managed flag
OtherFlag	State of the neighbor discovery router advertisement other config flag
Reachable time	Amount of time (in milliseconds) that the neighbor is expected to remain reachable
Retransmit time	Interval in which the router retransmits neighbor solicitations
Prefix	IPv6 network number to include in router advertisements
Autoconfig	When present, indicates that local host links use the specified prefix for IPv6 autoconfiguration
Valid lifetime	Amount of time in seconds that the router advertises the IPv6 prefix as valid
preferred lifetime	Amount of time in seconds that the router advertises the specified IPv6 prefix as preferred

- Related Documentation**
- [Configuring Profile Attributes for IPv6 on page 161](#)
 - [Specifying an IPv6 Hop-Count Limit on page 172](#)
 - [Clearing IPv6 Routes on page 187](#)
 - [ipv6](#)
 - [license ipv6](#)
 - [show ipv6 routers](#)

Monitoring the Status of IPv6 Static Routes in the Routing Table

- Purpose** Display the status of static routes in the routing table. You can specify an IPv6 mask that filters specific routes.



NOTE:

- You must configure an IPv6 license using the `license ipv6` command before using the IPv6 routing protocol configuration commands on the E Series router.
- All IPv6 routing protocol-related configurations are removed from the virtual router when you issue the `no ipv6` command.

Action To display the status of static routes in the routing table:

```
host1# show ipv6 static
```

Prefix/Length	NextHop	Dst/Met	Tag	Interface	Verify	ICMP Unreach
6::/64	5::2	1/0	0	ATM4/0.15		
2003::/16	5::1	1/0	0	ATM4/0.15		
2:1::/64	::	1/0	0	null0		reject
3:1::/64	::	1/0	0	null0		discard
55::/55	44::44	1/0	1234	Unresolved		
3ffe::/32	2222::1	1/0	1	Unresolved	BFD up	

Meaning Table 44 on page 228 lists the `show ipv6 static` command output fields.

Table 44: show ipv6 static Output Fields

Field Name	Field Description
Prefix	IPv6 address prefix
Length	Prefix length
Next Hop	IPv6 address of the next hop
Dst	Administrative distance of the route
Met	Number of hops
tag	Route tag for IPv6 static route
Interface	Interface type and interface specifier
Verify	<p>Status of the BFD operation associated with the specified static route; this field is left empty if the verify bfd-liveness-detection keyword is not specified as part of the ipv6 route command. The display can include the following:</p> <ul style="list-style-type: none"> • BFD up/down—Current status of the associated BFD operation

Table 44: show ipv6 static Output Fields (*continued*)

Field Name	Field Description
ICMP Unreach	<p>Indicates whether the transmission of ICMPv6 unreachable messages to the originator is enabled for packets that are discarded from processing on each interface configured with a static route:</p> <ul style="list-style-type: none"> • reject—ICMPv6 unreachable messages are sent to the originator for packets that are received on the static route configured on the interface and are dropped from processing (reject keyword is specified with the ipv6 route command) • discard—ICMPv6 unreachable messages are not sent to the originator for packets that are received on the static route configured on the interface and are dropped from processing (discard keyword is specified with the ipv6 route command or the default mode of the ipv6 route command is in effect)

Related Documentation

- [Establishing an IPv6 Static Route on page 165](#)
- [Enabling or Disabling the Transmission of ICMPv6 Unreachable Messages for Static Routes on Null Interfaces on page 167](#)
- [Configuring IPv6 Static Routes with Tags for Redistribution of Routes on page 168](#)
- [Enabling BFD on an IPv6 Static Route on page 171](#)
- [ipv6](#)
- [ipv6 route](#)
- [license ipv6](#)
- [show ipv6 static](#)

Monitoring IPv6 Traffic Statistics

Purpose Display statistics about IPv6 traffic.



NOTE:

- You must configure an IPv6 license using the **license ipv6** command before using the IPv6 routing protocol configuration commands on the E Series router.
- All IPv6 routing protocol-related configurations are removed from the virtual router when you issue the **no ipv6** command.

Action To display statistics about IPv6 traffic:

```

host1#show ipv6 traffic
IPv6 statistics:
  Rcvd:  0 total, 0 local destination
        0 hdr errors, 0 addr errors
        0 unkn proto, 0 discards
  Sent:  0 forwarded, 0 generated
        0 out disc
  Mcast: 0 received 0 forwarded
  Routes: 7 in routing table

ICMPv6 statistics:
  Rcvd:  0 total, 0 errors
        0 destination unreachable, 0 admin unreachable, 0 parameter problem
        0 time exceeded, 0 pkt too big, 0 redirects
        0 echo requests, 0 echo replies
        0 rtr solicits, 0 rtr advertisements
        0 neighbor solicits, 0 neighbor advertisements
        Group membership: 0 queries, 0 responses, 0 reductions
  Sent:  3 total, 0 errors
        0 destination unreachable, 0 admin unreachable, 0 parameter problem
        0 time exceeded, 0 pkt too big, 0 redirects
        0 echo requests, 0 echo replies
        0 rtr solicits, 0 rtr advertisements
        2 neighbor solicits, 1 neighbor advertisements
        Group membership: 0 queries, 0 responses, 0 reductions

UDP Statistics:
  Rcvd: 0 total, 0 checksum errors, 0 no port
  Sent: 0 total, 0 errors

```

Meaning Table 45 on page 230 lists the **show ipv6 traffic** command output fields.

Table 45: show ipv6 traffic Output Fields

Field Name	Field Description
IPv6 statistics Rcvd	<ul style="list-style-type: none"> total—Total number of packets received local destination—Number of packets received with this router as their destination hdr errors—Number of packets containing header errors addr errors—Number of packets containing addressing errors unkn proto—Number of packets received containing unknown protocols discards—Number of discarded packets
IPv6 statistics Sent	<ul style="list-style-type: none"> forwarded—Number of packets forwarded generated—Number of packets generated out disc—Number of packets that could not be routed that were discarded
IPv6 statistics Mcast	<ul style="list-style-type: none"> received—Number of multicast packets received forwarded—Number of multicast packets forwarded
IPv6 statistics (Routes)	Number of routes currently in the routing table

Table 45: show ipv6 traffic Output Fields (*continued*)

Field Name	Field Description
ICMPv6 statistics Rcvd	<ul style="list-style-type: none"> • total—Total number of received packets • errors—Error packets received • destination unreachable—Packets received with destination unreachable • admin unreachable—Packets received because the destination was administratively unreachable (for example, the packet encountered a firewall filter) • parameter problem—Packets received with parameter errors • time exceeded—Packets received with time-to-live exceeded • pkt too big—Number of packet-too-big messages received that indicate a packet was too large to forward because of the allowed MTU size • redirects—Received packet redirects • echo requests—Echo request (ping) packets • echo replies—Echo replies received • rtr solicits—Number of received router solicitations • rtr advertisements—Number of received router advertisements • neighbor solicits—Number of received neighbor solicitations • neighbor advertisements—Number of received neighbor advertisements • Group membership (queries, responses, reductions)—Number of queries, responses, and reduction requests received from within a group to which the interface is assigned

Table 45: show ipv6 traffic Output Fields (*continued*)

Field Name	Field Description
ICMP statistics Sent	<ul style="list-style-type: none"> total—Total number of received packets errors—Error packets received destination unreachable—Packets received with destination unreachable admin unreachable—Packets sent because the destination was administratively unreachable (for example, due to a firewall filter) parameter problem—Packets received with parameter errors time exceeded—Packets received with time-to-live exceeded pkt too big—Number of packet-too-big messages sent because a received packet was too large to forward because of the allowed MTU size redirects—Received packet redirects echo requests—Echo request (ping) packets echo replies—Echo replies received rtr solicits—Number of sent router solicitations rtr advertisements—Number of sent router advertisements neighbor solicits—Number of sent neighbor solicitations neighbor advertisements—Number of sent neighbor advertisements Group membership (queries, responses, reductions)—Number of queries, responses, and reduction requests sent to a group to which the interface is assigned
UDP Statistics Rcvd	<ul style="list-style-type: none"> total—Total number of received packets checksum errors—Checksum error packets received no port—No port error packets received
UDP Statistics Sent	<ul style="list-style-type: none"> total—Total number of received packets errors—Error packets received

Related Documentation

- [Enabling or Disabling the Transmission of ICMPv6 Unreachable Messages for Static Routes on Null Interfaces on page 167](#)
- [Clearing IPv6 Routes on page 187](#)
- [Setting a Baseline for IPv6 Statistics on page 190](#)
- `ipv6`
- `license ipv6`
- `show ipv6 traffic`

Monitoring IPv6 UDP Statistics

Purpose Display IPv6 UDP statistics.



NOTE:

- You must configure an IPv6 license using the `license ipv6` command before using the IPv6 routing protocol configuration commands on the E Series router.
- All IPv6 routing protocol-related configurations are removed from the virtual router when you issue the `no ipv6` command.

Action To display IPv6 UDP statistics:

```
host1#show ipv6 udp statistics
UDP Statistics:
  Rcvd: 0 total, 0 checksum errors, 0 no port
  Sent: 0 total, 0 errors
```

Meaning [Table 46 on page 233](#) lists the `show ipv6 udp statistics` command output fields.

Table 46: show ipv6 udp statistics Output Fields

Field Name	Field Description
Rcvd	<ul style="list-style-type: none"> • total—Total number of received packets • checksum errors—Checksum error packets received • no port—No port error packets received
Sent	<ul style="list-style-type: none"> • errors—Error packets received • total—Total number of received packets

Related Documentation

- `ipv6`
- `license ipv6`
- `show ipv6 udp statistics`

Monitoring the IPv6 License Key on the Router

Purpose Display the IPv6 license key configured on the router.

Action To display the IPv6 license key configured on the router:

```
host1#show license ipv6
Ipv6 license is ipv6_license
```

Related Documentation

- [Configuring an IPv6 License on page 160](#)

- show license

Monitoring TCP Statistics for IPv6

Purpose Display all TCP statistics (both IPv4 and IPv6). The TCP statistics are displayed only for the connections that are active within the context of the virtual router:

- You can use the **ip** keyword to display only IPv4 statistics.
- You can use the **ipv6** keyword to display only IPv6 statistics.
- You can use the **brief** keyword to display summary information or the **detailed** keyword to display extensive information.
- You can use the **diagnostic** keyword to display diagnostic information collected on the TCP statistics in addition to the detailed information. This command shows information only for the connections that are active within the context of the virtual router in which you issue the command.



NOTE:

- You must configure an IPv6 license using the **license ipv6** command before using the IPv6 routing protocol configuration commands on the E Series router.
- All IPv6 routing protocol-related configurations are removed from the virtual router when you issue the **no ipv6** command.

Action To display TCP statistics for IPv6:

```
host1#show ipv6 tcp statistics
```

TCP Global Statistics:

```
Connections: 7358 attempted, 4 accepted, 7362 established
              0 dropped, 14718 closed
Rcvd: 75923 total pkts, 53608 in-sequence pkts, 3120303 bytes
      0 chksum err pkts, 0 authentication err pkts, 0 bad offset pkts
      0 short pkts, 0 duplicate pkts, 0 out of order pkts
Sent: 82352 total pkts, 44404 data pkts, 657095 bytes
      34 retransmitted pkts, 487 retransmitted bytes
```

TCP Session Statistics:

```
Local addr: 0.0.0.0, Local port: 23
Remote addr: 0.0.0.0, Remote port: 0
State: LISTEN Authentication: None
Rcvd: 4 total pkts, 0 in-sequence pkts, 0 bytes
      0 chksum err pkts, 0 bad offset pkts, 0 short pkts
      0 duplicate pkts, 0 out of order pkts
Sent: 0 total pkts, 0 data pkts, 0 bytes
      0 retransmitted pkts, 0 retransmitted bytes
```

```
Local addr: 192.168.1.250, Local port: 23
Remote addr: 10.10.0.77, Remote port: 2170
State: ESTABLISHED Authentication: None
Rcvd: 61 total pkts, 34 in-sequence pkts, 41 bytes
      0 chksum err pkts, 0 bad offset pkts, 0 short pkts
```

```

    0 duplicate pkts, 0 out of order pkts
Sent: 64 total pkts, 45 data
Local addr: 192.168.1.250, Local port: 23
Remote addr: 10.10.0.77, Remote port: 2170
State: ESTABLISHED Authentication: None
Rcvd: 61 total pkts, 34 in-sequence pkts, 41 bytes
    0 chksum err pkts, 0 bad offset pkts, 0 short pkts
    0 duplicate pkts, 0 out of order pkts
Sent: 64 total pkts, 45 data pkts, 2304 bytes
    0 retransmitted pkts, 0 retransmitted bytes
Local addr: 192.168.1.250, Local port: 23
Remote addr: 192.168.1.139, Remote port: 1038
State: ESTABLISHED Authentication: None
Rcvd: 295 total pkts, 159 in-sequence pkts, 299 bytes
    0 chksum err pkts, 0 bad offset pkts, 0 short pkts
    0 duplicate pkts, 0 out of order pkts
Sent: 281 total pkts, 210 data pkts, 3089 bytes
    0 retransmitted pkts, 0 retransmitted bytes

```

To display diagnostic information for all TCP statistics (both IPv4 and IPv6):

```

host1#show tcp statistics diagnostic
...
Global Diagnostic Data
  Unknown Connection log
Source address/port -> local port
    128.127.126.125/124 -> 8080   count: 3
    111.111.111.111/222 -> 3333   count: 4
# connection-reqs rejected: 0
# connection-reqs pending: 0
# sonewconn calls that fail: 0
...
Diagnostics:
  PRU_ Operations counters:
    PRU_ATTACH: 0
    PRU_DETACH: 0
    PRU_BIND: 1
    PRU_LISTEN: 1
    PRU_CONNECT: 0
    PRU_ACCEPT: 0
    PRU_DISCONNECT: 0
    PRU_SHUTDOWN: 0
    PRU_RCV: 0
    PRU_SEND: 0
    PRU_ABORT: 0
    PRU_CONTROL: 0
    PRU_SENSE: 0
    PRU_RCVOOB: 0
    PRU_SENDOOB: 0
    PRU_SOCKADDR: 0
    PRU_PEERADDR: 0
    PRU_CONNECT2: 0
    PRU_FASTTIMO: 0
    PRU_SLOWTIMO: 0
    PRU_PROTORCV: 0
    PRU_PROTOSEND: 0
  Wildcard Matches: 2
  Rcv'd Packets after connection closed: 0
  Connect request rejected: 0
  Connect request approval pending 0
  New soconnect failed 0

```

```
# Write-Wakeups: 0
# Read wakeups 0
# receives after close 0
Retransmit timer: 0
Persistence timer: 0
Keepalive timer: 0
2MSL timer: 0
tcpDisconnect(): 0
keep T/O pre-estab: 0
tcpkeepimeo_idle: 0
...
TCP Connection Event Log (most recent at bottom)
  TCPS_ELOG_PRU_ATTACH
  TCPS_ELOG_PRU_BIND
```

To display extensive information for all TCP statistics (both IPv4 and IPv6):

```
host1#show tcp statistics detailed
...
RST/SYN-Ack Protection is: ENABLED
  RSTs acked: 0
  ...Bogus RSTs: 0
  SYNs acked: 0
  ...Bogus SYNs: 0
  Data Insertions rejected: 0
PMTUD Information:      PMTUD: ENABLED
  Administrative Minimum MTU: 512
  Administrative Maximum MTU: none
  Timer 1: 10 minutes
  Timer 2: 2 minutes
  # ICMP TooBigs: 0
  # ICMP TooBigs for unk. connection: 0
  PMTU Increase Attempts: 17
  Black Hole Detect Threshold: 50 retransmissions
...
MTU/MSS Information
  ENABLED on this connection
  MSS in effect: 536
  Calculated MSS to peer: 536
  MSS received from peer: 0
  Application set MSS: 0
  Xmit Interface MSS: 0
  MSS Sent to Peer: 0
  "ICMP DestUn, Frag Req'd and DF Set" messages: 0
  Number of attempts to increase PMTU: 0
  Time to next increase attempt: 0 seconds
  Black Hole Detection State: none
...
Out-of-order Packet Queue Information
  Buffers Outstanding: 25
    High Water: 28
  Buffers discarded: 15
...
TCP-Paws is disabled
```

Meaning [Table 47 on page 237](#) lists the **show ipv6 tcp statistics** command output fields.

Table 47: show ipv6 tcp statistics Output Fields

Field Name	Field Description
TCP Global Statistics Connections	<ul style="list-style-type: none"> attempted—Number of outgoing TCP connections attempted accepted—Number of incoming TCP connections accepted established—Number of TCP connections established
TCP Global Statistics Rcvd	<ul style="list-style-type: none"> total pkts—Total number of packets received in-sequence pkts—Number of packets received in sequence bytes—Number of bytes received chksum err pkts—Number of checksum error packets received authentication err pkts—Number of authentication error packets received bad offset pkts—Number of bad offset packets received short pkts—Number of short packets received duplicate pkts—Number of duplicate packets received out of order pkts—Number of packets received out of order
TCP Global Statistics Sent	<ul style="list-style-type: none"> total pkts—Total number of packets sent data pkts—Number of data packets sent bytes—Number of bytes sent retransmitted pkts—Number of packets retransmitted retransmitted bytes—Number of bytes retransmitted
Global Diagnostic Data Unknown Connection log	<p>Includes the following global statistics:</p> <ul style="list-style-type: none"> Source address/port – local port—Shows the 32 most recent TCP connection attempts that were rejected, including the remote node's IP or IPv6 address and port, the local port for the connection attempt, and the number of identical attempts that have been received on that port in a row. The reason for rejection is not given. This information may be useful in tracking down DoS attacks. # connection-reqs rejected—Total number of connection attempts that have been rejected # connection-reqs pending—Current number of connection attempts that are pending, awaiting additional data from the peer # sonewconn calls that fail—Number of calls to sonewconn that have failed. This statistic often indicates that either a socket connection limit has been reached or that there was no memory to hold the socket data structures.

Table 47: show ipv6 tcp statistics Output Fields (*continued*)

Field Name	Field Description
TCP Session Statistics	<ul style="list-style-type: none"> Local addr—Local address of the TCP connection Local port—Local port number of the TCP connection Remote addr—Remote address of the TCP connection Remote port—Remote port number of the TCP connection State—Current state of the TCP connection Authentication—Authentication status of the TCP connection
TCP Session Statistics Rcvd	<ul style="list-style-type: none"> total pkts—Total number of packets received on the TCP connection in-sequence pkts—Number of packets received in sequence on the TCP connection bytes—Number of bytes received on the TCP connection chksum err pkts—Number of checksum error packets received on the TCP connection bad offset pkts—Number of bad offset packets received on the TCP connection short pkts—Number of short packets received on the TCP connection duplicate pkts—Number of duplicate packets received on the TCP connection out of order pkts—Number of packets received out of order on the TCP connection
TCP Session Statistics Sent	<ul style="list-style-type: none"> total pkts—Total number of packets sent on the TCP connection data pkts—Number of data packets sent on the TCP connection bytes—Number of bytes sent on the TCP connection retransmitted pkts—Number of packets retransmitted on the TCP connection retransmitted bytes—Number of bytes retransmitted on the TCP connection
PRU_Operations counters	Number of calls for each of the indicated PRU_operations within the TCP service API. These are per-connection statistics.
Wildcard Matches	Number of packets received that matched this TCP connection due to wildcard matching. Matching is expected for listening server connections, such as Telnet, but is not expected for established connections. This is a per-connection statistic.

Table 47: show ipv6 tcp statistics Output Fields (*continued*)

Field Name	Field Description
Rcv'd Packets after connection closed	Number of packets received on the connection after the connection has been closed (and before the data structure gets removed). This is a per-connection statistic.
Connect request rejected	Number of times an incoming connection request was not approved. This is a per-connection statistic.
Connect request approval pending	Number of times that an incoming connection request was held pending, waiting for a subsequent packet. This is a per-connection statistic.
New soconnect failed	Number of times a SONEWCONN() was tried on a listening connection and failed. This is a per-connection statistic.
# Write-Wakeups	Number of times a "write wakeup" occurred on the connection. This is a per-connection statistic.
# Read wakeups	Number of times a "read wakeup" occurred on the connection. This is a per-connection statistic.
# receives after close	Number of packets received with data after the connection entered the close-wait state. This is a per-connection statistic.
Retransmit timer	Current value of the retransmit timer
Persistence timer	Current value of the persistence timer
Keepalive timer	Current value of the keepalive timer
2MSL timer	Current value of the 2MSL (max segment lifetime) timer
tcpDisconnect()s	Number of times BsdTcp::tcpDisconnect() was called. This is a per-connection statistic.
keep T/O pre-estab	Number of times the keepalive timer expired before the connection reached the established state. This is a per-connection statistic.
tcpkeepimeo_idle	Number of times the keepalive timer popped, but no keepalive was sent because of connection idle-time considerations. This is a per-connection statistic.

Table 47: show ipv6 tcp statistics Output Fields (*continued*)

Field Name	Field Description
TCP Connection Event Log (most recent at bottom)	<p>Event log for the TCP connection. It shows the last 32 events that occurred on the connection. The most recent event is at the bottom of the list. This is per-connection data.</p> <ul style="list-style-type: none"> • TCPS_ELOG_PRU_ATTACH • TCPS_ELOG_PRU_BIND <p>The following events can be recorded:</p> <ul style="list-style-type: none"> • Fast Timeout—Did a PRU_CONNECT • 2MSL Timeout—Did a PRU_CONNECT2 • Retransmit Timeout—Did a PRU_DISCONNECT • Persist Timeout—Did a PRU_ACCEPT • Received FIN packet—Did a PRU_SHUTDOWN • Received SYN packet—Did a PRU_RCVD • Received Retransmission—Did a PRU_SEND • Transmit a FIN packet—Did a PRU_ABORT • Transmit a SYN packet—Did a PRU_SENSE • Retransmit a packet—Did a PRU_RCVOOB • Did a PRU_ATTACH—Did a PRU_SENDOOB • Did a PRU_DETACH—Did a PRU_SOCKADDR • Did a PRU_BIND—Did a PRU_PEERADDR • Did a PRU_LISTEN—The keepalive timer popped. An 8-bit argument that describes how the timer was handled: <ul style="list-style-type: none"> • Ignored because the session was not established (that is, not in the OPEN state) • Ignored due to idle-timeout considerations • A packet was sent • Ignored because the connection did not have the keepalive option set OR the connection was in the process of closing

Table 47: show ipv6 tcp statistics Output Fields (*continued*)

Field Name	Field Description
RST/SYN-Ack DoS Protection	<p>Specifies when this function is enabled:</p> <ul style="list-style-type: none"> RSTs acked—Number of RSTs received and then acknowledged by the TCP stack. <p>NOTE: This count is maintained even when the protection functions are disabled. The value indicates the count of packets that would have been acknowledged if the protections were enabled. Providing this information can help determine whether attacks are occurring.</p> <ul style="list-style-type: none"> Bogus RSTs—Number of RSTs that were judged to be invalid (that is, their timer expired) and therefore ignored SYNs acked—Number of SYNs received and then acknowledged by the TCP stack. <p>NOTE: This count is maintained even when the protection functions are disabled. The value indicates the count of packets that would have been acknowledged if the protections were enabled. Providing this information can help determine whether attacks are occurring.</p> <ul style="list-style-type: none"> Bogus SYNs—Number of RSTs that were judged to be invalid (that is, their timer expired) and therefore ignored Data Insertions rejected—Number of packets received and dropped because they are believed to have been inserted by an attacker <p>NOTE: This count is maintained even when the protection functions are disabled. The value indicates the count of packets that would have been rejected if the protections were enabled. Providing this information can help determine whether attacks are occurring.</p>

Table 47: show ipv6 tcp statistics Output Fields (*continued*)

Field Name	Field Description
PMTUD information	<p>Information regarding path MTU discovery:</p> <ul style="list-style-type: none"> • PMTUD—Status of path MTU discovery on the virtual router: enabled or disabled • Administrative Minimum MTU—Minimum MTU that is enabled on any connection; a value of “none” indicates that the minimum is zero (0) • Administrative Maximum MTU—Maximum MTU that is enabled on any connection; a value of “none” indicates that the maximum is 65535 • Timer 1—Amount of time the virtual router waits after receiving an ICMP Too Big message before attempting to increase the path MTU • Timer 2—Amount of time the virtual router waits after successfully increasing the MTU before attempting to increase it more • # ICMP TooBigs—Number of ICMP Too Big messages that the router has received. When PMTU is disabled, this counter does not increase. • # ICMP TooBigs for unk. connection—Number of ICMP Too Big messages that the router has received for TCP connections that do not exist. When PMTU is disabled, this counter does not increase. • PMTU Increase Attempts—Number of attempts the router has made to increase the PMTU • Black Hole Detect Threshold—Number of successive transmissions that must occur on a connection before that connection treats retransmissions as indications that something is wrong • Override MSS—MSS that is advertised to peers, overriding the MSS that is derived from the interface MTU. This line does not appear in the output if you do not set the value.

Table 47: show ipv6 tcp statistics Output Fields (*continued*)

Field Name	Field Description
MTU/MSS information	<p>Information regarding path MTU/MSS:</p> <ul style="list-style-type: none"> • PMTU—Status of MTU/MSS on this virtual router: enabled or disabled • MSS in effect—MSS currently being used for transmission to the peer. This number changes while various network events occur to cause the router to increase or decrease its estimate of the MSS. • Calculated MSS to peer—MSS that path MTU discovery has calculated (if PMTUD is enabled) to the peer • MSS received from peer—MSS that the peer received in a TCP MSS option. If no option is received, the value is zero (0). • Application set MSS—MSS that an application might have set for the connection • Xmit Interface MSS—MSS for the interface used to transmit packets to the peer; calculated as the interface MTU minus the size of the TCP and IP headers. • MSS Sent to Peer—MSS that has been advertised to the peer • “ICMP DestUn, Frag Req’d and DF Set” messages—Number of ICMP “Destination Unreachable: Fragmentation Required and DF set” messages that the router has received • Number of attempts to increase PMTU—Number of times the router has attempted to increase the PMTU by probing with a packet that is larger than the known MTU • Time to next increase attempt—Amount of time, in seconds, until the router retries to increase the MTU • Black Hole Detection State—State of the black hole detection mechanism: none, detecting, probable, or unknown
Out-of-Order Packet Queue Information	<p>Information regarding packet queue buffers:</p> <ul style="list-style-type: none"> • Buffers Outstanding—Number of buffers currently on the connection reordering queue • High Water—Most buffers that have ever been on the connection reordering queue • Buffers discarded—Number of buffers that were discarded because keeping them would have exceeded the connection maximum
TCP PAWS is [enabled/disabled]	Status of the TCP PAWS option; enabled indicates that PAWS is functioning normally (default mode) for TCP segments; disabled indicates that PAWS is disabled for TCP segments

- Related Documentation**
- [Configuring TCP for IPv6 on page 178](#)
 - [Setting a Baseline for IPv6 TCP Statistics on page 191](#)
 - `ipv6`
 - `license ipv6`
 - `show tcp statistics`

Monitoring the Configuration Details for IPv6 Local Address Pools

- Purpose** Display information on IPv6 local address pools, such as prefix delegation parameters and attributes that control the assignment of prefixes to requesting routers.
- You can specify the pool name to limit the display to a specific IPv6 local pool.
 - You can specify the **statistics** keyword to display IPv6 local address pool statistics for prefix delegation.
 - You can use the optional **delta** keyword with the **show ipv6 local pool** command to specify that baseline-relative statistics are to be shown. You must use the **baseline ipv6 local pool** command to set a baseline.



NOTE:

- You must configure an IPv6 license using the `license ipv6` command before using the IPv6 routing protocol configuration commands on the E Series router.
- All IPv6 routing protocol-related configurations are removed from the virtual router when you issue the `no ipv6` command.

- Action** To display information on all IPv6 local address pools:

```
host1#show ipv6 local pool
```

IPv6 Local Address Pools		
Pool	Start	End
example	2002:2002::/48	2002:2002:ffff::/48
example	3003:3003::/56	3003:3003:0:1000::/56
example	4004:4004:0:ff00::/64	4004:4004:0:ffff::/64
example	5005:5005::/48	5005:5005:ffff::/48
test	6006:6006:ffff::/60	6006:6006:ffff:fff0::/60

Pool	Total	In Use
example	65536	0
example	17	0
example	256	0
example	65536	0

```
test                4096        0
```

To display prefix delegation details for a particular IPv6 local address pool configured on a virtual router:

```
host1#show ipv6 local pool example
```

```
Pool : example
```

```
Utilization : 0
```

Start	End	Total	In Use	Exclude	Util
2002:2002::/48	2002:2002:ffff::/48	65536	0	0	0
3003:3003::/56	3003:3003:0:1000::/56	17	0	0	0
4004:4004:0:ff00::/64	4004:4004:0:ffff::/64	256	0	0	0
5005:5005::/48	5005:5005:ffff::/48	65536	0	10	0

Start	Preferred Lifetime	Valid Lifetime
2002:2002::/48	1 day	1 day
3003:3003::/56	1 day	1 day
4004:4004:0:ff00::/64	1 day	1 day
5005:5005::/48	infinite	infinite

Exclude 5005:5005:1::/48
5005:5005:2::/48 - 5005:5005:a::/48

Dns Servers 3001::1
3001::2

Domain Search List test1.com
test2.com
test3.com
test4.com

To display IPv6 local address pool statistics used for DHCP prefix delegation to requesting routers:

```
host1#show ipv6 local pool statistics
```

```
IPv6 Local Address Pool Statistics
```

Statistic	Value
Allocations	0
Allocation Errors	0
Releases	0
Release Errors	0

Meaning Table 48 on page 245 lists the **show ipv6 local pool** command output fields.

Table 48: show ipv6 local pool Output Fields

Field Name	Field Description
IPv6 Local Address Pools Details	
Pool	Name of IPv6 local address pools configured on the virtual router or for which prefix delegation details are displayed
Start	Starting prefix of the range of prefixes configured in a particular pool

Table 48: show ipv6 local pool Output Fields (*continued*)

Field Name	Field Description
End	Ending prefix of the range of prefixes configured in a particular pool
Total	Number of prefixes available for allocation to clients from a particular pool
In Use	Number of prefixes in a pool that are currently used by DHCPv6 clients
Utilization	Percentage of IPv6 prefixes allocated to clients from the local address pool
Preferred Lifetime	Amount of time for which the prefix remains preferred for the requesting router to use
Valid Lifetime	Amount of time for which the prefix remains valid for the requesting router to use
Exclude	Prefix length or prefix range excluded from allocation to the requesting router
Dns Servers	List of IPv6 addresses of DNS servers to be sent to clients in the DHCPv6 responses
Domain Search List	List of domain names configured in the IPv6 local pool for DNS resolution
IPv6 Local Address Pool Statistics Details	
Allocations	Number of prefixes allocated to DHCPv6 clients from the local address pool
Allocation Errors	Number of errors encountered during the allocation of prefixes
Releases	Number of prefixes released by the requesting router or client to be made available to the IPv6 local pool for the delegating router to reassign them to other clients
Release Errors	Number of errors encountered during the process of release of previously assigned prefixes by the requesting router

Related Documentation

- [Setting a Baseline for IPv6 Local Address Pool Statistics on page 191](#)
- [Configuring DHCP Local Address Pools](#)
- [ipv6](#)

- license ipv6
- show ipv6 local pool

CHAPTER 5

Configuring Neighbor Discovery

This chapter describes how to configure Neighbor Discovery (ND) on your E Series router; it contains the following sections:

- [Understanding Neighbor Discovery on page 249](#)
- [Neighbor Discovery Platform Considerations on page 250](#)
- [Neighbor Discovery References on page 250](#)
- [Configuring Neighbor Discovery on page 251](#)
- [Configuring Proxy Neighbor Advertisements on page 254](#)
- [Duplicate Address Detection Attempts Overview on page 255](#)
- [Monitoring Neighbor Discovery on page 255](#)

Understanding Neighbor Discovery

Though not a true protocol, routers and hosts (nodes) use Neighbor Discovery (ND) messages to determine the link-layer addresses of neighbors that reside on attached links and to overwrite invalid cache entries. Hosts also use ND to find neighboring routers that can forward packets on their behalf.

In addition, nodes use ND to actively track the ability to reach neighbors. When a router (or the path to a router) fails, nodes actively search for alternatives to reach the destination.

IPv6 Neighbor Discovery corresponds to a number of the IPv4 protocols — ARP, ICMP Router Discovery, and ICMP Redirect. However, Neighbor Discovery provides many improvements over the IPv4 set of protocols. These improvements address the following:

- Router discovery—How a host locates routers residing on an attached link.
- Prefix discovery—How a host discovers address prefixes for destinations residing on an attached link. Nodes use prefixes to distinguish between destinations that reside on an attached link and those destinations that it can reach only through a router.
- Parameter discovery—How a node learns various parameters (link parameters or Internet parameters) that it places in outgoing packets.
- Address resolution—How a node uses only a destination IPv6 address to determine a link-layer address for destinations on an attached link.

- Next-hop determination—The algorithm that a node uses for mapping an IPv6 destination address into a neighbor IPv6 address (either the next router hop or the destination itself) to which it plans to send traffic for the destination.
- Neighbor unreachability detection—How a node determines that it can no longer reach a neighbor.
- Duplicate address detection—How a node determines whether an address is already in use by another node.

**Related
Documentation**

- [Neighbor Discovery Platform Considerations on page 250](#)
- [Neighbor Discovery References on page 250](#)
- [Configuring Neighbor Discovery on page 251](#)
- [Monitoring Neighbor Discovery on page 255](#)

Neighbor Discovery Platform Considerations

For information about modules that support Neighbor Discovery on the ERX7xx models, ERX14xx models, and the ERX310 Broadband Services Routers:

- See *ERX Module Guide, Table 1, Module Combinations* for detailed module specifications.
- See *ERX Module Guide, Appendix A, Module Protocol Support* for information about the modules that support Neighbor Discovery.

For information about modules that support Neighbor Discovery on the E120 and E320 Broadband Services 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 Neighbor Discovery.

**Related
Documentation**

- [Understanding Neighbor Discovery on page 249](#)
- [Neighbor Discovery References on page 250](#)

Neighbor Discovery References

For more information about Neighbor Discovery, consult the following resource:

- RFC 4861—Neighbor Discovery for IP Version 6 (IPv6) (September 2007)

You can access these and other Internet RFCs and drafts at the following URL:

<http://www.ietf.org>

**Related
Documentation**

- [Understanding Neighbor Discovery on page 249](#)

- [Neighbor Discovery Platform Considerations on page 250](#)

Configuring Neighbor Discovery

This topic includes the following tasks:

- [Before You Configure Neighbor Discovery on page 251](#)
- [Configuring Neighbor Discovery on page 251](#)
- [Using IPv6 Profiles and RADIUS to Configure Neighbor Discovery Route Advertisements on page 252](#)

Before You Configure Neighbor Discovery

Before you configure Neighbor Discovery, you must configure IPv6. For information about configuring IPv6, see [“Configuring IPv6” on page 149](#).

Configuring Ethernet interfaces to function with IPv6 requires Neighbor Discovery configuration for the interface.



NOTE: IPv6 Neighbor Discovery is fully supported when configured on broadcast interfaces. IPv6 neighbor discovery supports only router advertisement characteristics when configured on PPP interfaces.

Configuring Neighbor Discovery

To configure Neighbor Discovery:

1. Access an IPv6 interface.

```
host1(config)#interface fastEthernet 3/0
host1(config-if)#
```

2. Configure the current IPv6 interface to send neighbor solicitations and to respond with neighbor advertisements.

```
host1(config-if)#ipv6 nd
```



NOTE: This command is redundant when configuring Neighbor Discovery over Ethernet, because router advertisements are automatically sent on Ethernet interfaces. However, unless explicitly enabled, IPv6 router advertisements are not sent on other types of interfaces.

3. (Optional) Configure the interface to retry sending neighbor solicitations using a specified interval.

```
host1(config-if)#ipv6 nd ns-interval 500
```

4. (Optional) Configure the interface to assume that a neighbor is reachable for a specified time after a reachable confirmation event.

host1(config-if)#ipv6 nd reachable-time 30000

5. (Optional) Configure the interface to suppress router advertisements, as well as replies to router solicitations.

host1(config-if)#ipv6 nd suppress-ra

6. (Optional) Configure the interface to suppresses the source link-layer option in IPv6 router advertisement transmissions. This action forces neighbors to solicit the router link layer explicitly, and may prove necessary when enabling inbound load sharing across multiple link-layer addresses.

host1(config-if)#ipv6 nd suppress-ra-source-link-layer

7. (Optional) Configure the interface to send router advertisements at a specified interval.

host1(config-if)#ipv6 nd ra-interval 500

8. (Optional) Configure the router advertisement lifetime in seconds.

host1(config-if)#ipv6 nd ra-lifetime 900

9. (Optional) Configure the router advertisement to list a specified prefix, for a valid lifetime and preferred lifetime. The following example also advertises the prefix as reachable on link and that the router can use it as part of the stateless address configuration.

**host1(config-if)#ipv6 nd prefix-advertisement 2002:1::/64 60000 45000 onlink
autoconfig**

10. (Optional) Configure the router advertisement to contain the “managed address configuration” flag.

host1(config-if)#ipv6 nd managed-config-flag

11. (Optional) Configure the router advertisement to contain the “other stateful configuration” flag.

host1(config-if)#ipv6 nd other-config-flag

12. (Optional) Enable active solicitations.

host1(config-if)#ipv6 nd active-solicitations

Using IPv6 Profiles and RADIUS to Configure Neighbor Discovery Route Advertisements

In addition to the CLI-based configuration of Neighbor Discovery, you can also use IPv6 profiles to configure Neighbor Discovery route advertisements for dynamically configured interfaces. You can also use RADIUS to configure the prefix in Neighbor Discovery route advertisements for dynamically configured interfaces.

When you configure either a profile-based or RADIUS-based Neighbor Discovery router advertisement, the following considerations apply:

- You can advertise one IPv6 prefix per interface.
- The router advertisement must have a prefix length of 64. For the Ipv6-NdRa-Prefix attribute, the prefix length is in the following format, in which 0040 indicates the prefix length of 64.

0x 0040 xxxx xxxx xxxx xxxx



NOTE: If both an IPv6 profile and RADIUS are configured for Neighbor Discovery router advertisement, the prefix value returned in RADIUS VSA 26-129 takes precedence over the prefix specified in the IPv6 profile configuration.

In addition to the CLI-based configuration of Neighbor Discovery, you can also use the following tasks:

- [IPv6 Profile-Based Configuration on page 253](#)
- [RADIUS-Based Configuration on page 254](#)

IPv6 Profile-Based Configuration

The JunosE Software enables you to use profiles to dynamically configure IPv6 interfaces. When you create an IPv6 profile, you can also include Neighbor Discovery route advertisement characteristics, which are then configured on the dynamically-created IPv6 interfaces.

You can include the following commands in IPv6 profiles to configure Neighbor Discovery route advertisement characteristics.

Command	Description
<code>ipv6 nd</code>	Enables Neighbor Discovery on an interface
<code>ipv6 nd managed-config-flag</code>	Sets the “managed address configuration” flag in IPv6 router advertisements
<code>ipv6 nd other-config-flag</code>	Sets the “other stateful configuration” flag in IPv6 router advertisements
<code>ipv6 nd prefix-advertisement</code>	Specifies which IPv6 prefixes are included in IPv6 router advertisements
<code>ipv6 nd ra-interval</code>	Configures the interval between IPv6 router advertisements
<code>ipv6 nd ra-lifetime</code>	Configures the router advertisement lifetime
<code>ipv6 nd reachable-time</code>	Configures the amount of time the router can reach an IPv6 node after a reachability confirmation event occurs
<code>ipv6 nd suppress-ra</code>	Disables router advertisement transmissions

For additional information about using IPv6 profiles to configure dynamic interfaces, see [“IPv6 Profiles” on page 160](#) and *JunosE Link Layer Configuration Guide*.

RADIUS-Based Configuration

You can use RADIUS attribute Ipv6-NdRa-Prefix (VSA 26-129) to configure the prefix used in IPv6 Neighbor Discovery route advertisements. RADIUS then includes the VSA in Access-Accept messages. For information about the Ipv6-NdRa-Prefix RADIUS attribute, see *Configuring RADIUS Attributes* and *RADIUS Attribute Descriptions* in the *JunosE Broadband Access Configuration Guide*.

Related Documentation

- [Understanding Neighbor Discovery on page 249](#)
- [Monitoring Neighbor Discovery on page 255](#)
- `ipv6 nd`
- `ipv6 nd active-solicitations`
- `ipv6 nd managed-config-flag`
- `ipv6 nd ns-interval`
- `ipv6 nd other-config-flag`
- `ipv6 nd prefix-advertisement`
- `ipv6 nd ra-interval`
- `ipv6 nd ra-lifetime`
- `ipv6 nd reachable-time`
- `ipv6 nd suppress-ra`
- `ipv6 nd suppress-ra-source-link-layer`

Configuring Proxy Neighbor Advertisements

Much like proxy ARP, proxy Neighbor Discovery is a means by which one interface responds to a Neighbor Discovery query on behalf of another interface.

To configure proxy Neighbor Discovery:

1. Access an IPv6 interface.

```
host1(config)#interface fastEthernet 0/0
host1(config-if)#
```

2. Enable Neighbor Discovery on the current interface.

```
host1(config-if)#ipv6 nd
```



NOTE: This command is redundant when configuring Neighbor Discovery over Ethernet, because neighbor solicitations and advertisements are automatically sent on Ethernet interfaces.

3. Enable IPv6 neighbor proxy.

host1(config-if)#ipv6 nd proxy

- Related Documentation**
- [Understanding Neighbor Discovery on page 249](#)
 - [Configuring Neighbor Discovery on page 251](#)
 - [Monitoring Neighbor Discovery on page 255](#)
 - **ipv6 nd proxy**

Duplicate Address Detection Attempts Overview

The duplicate address detection feature helps to verify that a new unicast IPv6 address is unique in the network. The router sends the IPv6 address in its neighbor solicitation messages. However, the router relies on the receiving device to understand the address duplication and does not prompt a conflict if the address already exists.

The CLI allows you to specify the number of consecutive neighbor solicitation messages that the router sends from the IPv6 interface.

- Related Documentation**
- [Understanding Neighbor Discovery on page 249](#)
 - [Configuring Neighbor Discovery on page 251](#)
 - [Monitoring Neighbor Discovery on page 255](#)
 - **ipv6 nd dad attempts**

Monitoring Neighbor Discovery

Neighbor Discovery-specific output appears in the output of various IPv6 **show** commands. For detailed information about IPv6 **show** commands and their output, see “[Monitoring Detailed or Summary Information for IPv6 Addresses](#)” on page 194, “[Monitoring Detailed or Summary Information for IPv6 Interfaces](#)” on page 203, “[Monitoring Static or Dynamic Entries of the IPv6 Neighbor Discovery Cache](#)” on page 218, and “[Monitoring Received IPv6 Router Advertisements](#)” on page 226.

- Related Documentation**
- [Understanding Neighbor Discovery on page 249](#)
 - [Configuring Neighbor Discovery on page 251](#)

PART 2

Internet Protocol Routing

- [Configuring RIP on page 259](#)
- [Configuring OSPF on page 293](#)
- [Configuring IS-IS on page 377](#)

CHAPTER 6

Configuring RIP

This chapter describes how to configure the Routing Information Protocol (RIP) on your E Series router; it contains the following sections:

- [Overview on page 259](#)
- [Platform Considerations on page 260](#)
- [References on page 260](#)
- [Features on page 261](#)
- [Before You Run RIP on page 264](#)
- [Configuration Tasks on page 264](#)
- [Enabling RIP on Dynamic IP Interfaces on page 276](#)
- [Clearing Dynamic RIP Interfaces on page 277](#)
- [Using RIP Routes for Multicast RPF Checks on page 277](#)
- [Configuring the BFD Protocol for RIP on page 278](#)
- [Remote Neighbors on page 279](#)
- [Monitoring RIP on page 282](#)

Overview

RIP is an interior gateway protocol (IGP) typically used in small, homogeneous networks. RIP uses distance-vector routing to route information through IP networks.

Distance-vector routing requires that each router simply inform its neighbors of its routing table. For each network path, the receiving router picks the neighbor advertising the lowest metric, then adds this entry into its routing table for readvertisement.

Any host that uses RIP is assumed to have interfaces to one or more networks. These networks are considered to be directly connected networks. RIP relies on access to certain information about each of these networks. The most important information is the network's metric.

RIP Metric

RIP uses the hop count as the metric (also known as cost) to compare the value of different routes. The hop count is the number of routers that data packets must traverse between RIP networks. Metrics range from 0 for a directly connected network to 16 for

an unreachable network. This small range prevents RIP from being useful for large networks.

RIP Messages

RIP exchanges routing information via User Datagram Protocol (UDP) data packets. Each RIP router sends and receives datagrams on UDP port number 520, the RIP version 1/RIP version 2 port. All communications intended for another router's RIP process area are sent from the RIP port.

Every RIP message contains a RIP header that consists of a command and a version number. The router supports RIP version 1 (RIPv1) and RIP version 2 (RIPv2) extensions.

RIP employs the following message types:

- Request—A request for the responding router to send all or part of its routing table.
- Response—A message containing all or part of the sender's routing table. This message is sent in response to a request or is an unsolicited routing update generated by the sender.

The RIP request and response messages also contain a list of route entries. Each route entry contains the following:

- Address Entry Identifier—The type of address
- Destination IP address—The destination address of the message
- Cost to reach the destination—A value between 1 and 15, which specifies the current metric for reaching the destination

Platform Considerations

For information about modules that support RIP on the ERX7xx models, ERX14xx models, and the ERX310 Broadband Services Router:

- See *ERX Module Guide, Table 1, Module Combinations* for detailed module specifications.
- See *ERX Module Guide, Appendix A, Module Protocol Support* for information about the modules that support RIP.

For information about modules that support RIP on the E120 and E320 Broadband Services 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 RIP.

References

For more information about RIP, consult the following resources:

- RFC 1058—Routing Information Protocol (June 1998)
- RFC 2453—RIP Version 2 (November 1998)

Features

Some of the major RIP features supported by the router include:

• authentication	• RIP version 1
• BFD liveness detection	• RIP version 2
• equal-cost multipath	• route summarization
• multicast addressing	• route tags
• next hop	• split horizon
• poison reverse	• subnet masks
• remote neighbors	

Route Tags

A route tag is a field in a RIP message that allows boundary routers in an autonomous system (AS) to exchange information about external routes. Route tags provide a method of separating internal RIP routes (routes within the RIP routing domain) from external RIP routes, which may have been imported from an EGP (exterior gateway protocol) or another IGP (interior gateway protocol).

Routers supporting protocols other than RIP should be configurable to allow the route tags to be configured for routes imported from different sources. For example, routes imported from BGP should be able to have their route tags set to the number of the ASs from which the routes were learned.

Authentication

RIPv1 does not support authentication. If you are sending and receiving RIPv2 packets, you can enable RIP authentication on an interface.

The router provides the simple authentication scheme for RIPv2. Because authentication is a per message function and only one 2-octet field is available in the RIP message header, authentication uses the space of an entire RIP message.

The first 20-byte entry in a RIP authentication message contains an address family identifier value of 0xffff and a route tag value of 2. If the 0xffff address family is present in the RIP message, the remaining 16 octets of the entry contain a plain text password. If the password is fewer than 16 octets, it must be left-justified and padded to the right with nulls (0x00).

Authentication is applied per RIP interface. You can specify either **text** or **MD5** authentication. Text authentication uses a simple password that must be shared by the

neighbors receiving updates or requests. If they do not have this password, the neighbors reject all updates or requests from the router. MD5 authentication uses a shared key to encrypt the RIP message. The neighbors must have the MD5 key to decrypt the message and encrypt a response.



NOTE: Do not use text authentication when security is important, because the router sends the unencrypted password in every RIP packet it sends.

Example 1 The following example shows how to use password authentication:

```
host1(config)#interface fastEthernet 0/0
host1(config-if)#ip rip send version 2
host1(config-if)#ip rip authentication mode text
host1(config-if)#ip rip authentication key ke6G72mV
```

Example 2 The following example shows how to use MD5 authentication:

```
host1(config)#interface fastEthernet 0/0
host1(config-if)#ip rip send version 2
host1(config-if)#ip rip authentication mode md5 8
host1(config-if)#ip rip authentication key sf43nBScE9
```

Subnet Masks

The Subnet Mask field of a RIP message contains the subnet mask that is applied to the IP address to set the nonhost portion of the address. If the subnet mask field in a RIP message contains a zero, then no subnet mask was included for the entry.

On an interface where a RIPv1 router may hear and operate on information in a RIPv2 routing entry, the following rules apply:

- Information internal to one network must never be advertised into another network.
- Information about a more specific subnet may not be advertised where RIPv1 routers would consider it a host route.
- Supernet routes (routes where a netmask is less specific than the natural network mask) must not be advertised where they could be misinterpreted by RIPv1 routers.

Next Hop

The Next Hop field in a RIP message contains the next IP address where a packet is sent. A value of zero in this field indicates that the next address the packet should be sent to is the router that originally sent the RIP message.

Multicasting

To reduce unnecessary load on hosts that are not listening to RIPv2 messages, an IP multicast address is used for periodic broadcast messages. The IP multicast address is 224.0.0.9.

Route Summaries

You can summarize routes reported by RIP to reduce the size of the routing table and the amount of traffic resulting from RIP updates. Configuring a RIP summary will cause that prefix to be advertised with the associated metric regardless of the presence of more-specific prefixes. Any more-specific prefixes will not be advertised when they are covered by the summary. You can choose the degree of summarization by using a prefix tree to specify the number of bits to report for routes matching a route map. Alternatively, you can explicitly specify routes for RIP to summarize.

Prefix Tree Example The following example shows how to configure a 16-bit route summary:

1. Specify a route map for RIP in Router Configuration mode.

```
host1#configure t
Enter configuration commands, one per line. End with CNTL/Z.
host1(config)#router rip
host1(config-router)#route-map 1
host1(config-router)#exit
```

2. Define a route map associated with a prefix tree.

```
host1(config)#
host1(config)#route-map 1
host1(config-route-map)#match-set
host1(config-route-map)#match-set summary prefix-tree boston
host1(config-route-map)#exit
host1(config)#
```

3. Set the conditions for summarization in the prefix tree, including which routes are summarized and how many bits of the network addresses are preserved as the network prefix.

```
host1(config)#ip prefix-tree boston permit 2.1.0.0/16
```

This example summarizes routes for networks addressed by 2.1.x.x. The first 16 bits of the network address are preserved in the summary. For example, routes 2.1.3.0, 2.1.2.0, and 2.1.1.0 would all be summarized as 2.1.0.0.

Static Summary Example You can use the **ip summary-address** command to specify routes that RIP will summarize.

```
host1(config-router)#ip summary-address 4.4.0.0 255.255.0.0 5
host1(config-router)#ip summary-address 4.3.0.0 255.255.0.0 6
```

Split Horizon

Split horizon is a mechanism to aid in preventing routing loops when distance-vector routing protocols such as RIP are employed in broadcast networks. When split horizon is enabled, the router cannot advertise information about routes on an interface from which the information originates. Split horizon is enabled by default on the router.

You can disable split horizon and enable poison reverse routing updates that advertise routes originating on the interface, but for each of these routes the metric is set to infinity to explicitly advertise that these networks are not reachable.

Equal-Cost Multipath

RIP supports equal-cost multipath (ECMP) and installs into the routing table multiple entries for paths to the same destination. Each of these multiple paths to a given destination must have the same cost as the others, but a different next hop.

Applying Route Maps

You can apply a policy to redistributed routes with the **route-map** command. See *JunosE IP Services Configuration Guide*, for more information about route maps. You can use the **table-map** command to apply a route map to RIP routes that are about to be added to the IP routing table.

Before You Run RIP

At least one IP address must be configured on your router for RIP to run.

Configuration Tasks

To configure RIP:

1. Create a RIP process by enabling RIP.

```
host1(config)#router rip
```

2. (Optional) Configure the global RIP version. RIPv1 is used by default.

```
host1(config-router)#version 2
```

3. (Optional) Do one of the following:

- Associate a network with a RIP routing process and optionally configure RIP for the network.

```
host1(config-router)#network 10.2.1.0 255.255.255.0
host1(config-if)#ip rip
host1(config-if)#ip rip receive version 1
host1(config-if)#ip rip send version 2
host1(config-if)#ip rip authentication mode text
host1(config-if)#ip rip authentication key klaatu42
```

- Associate the RIP routing process with an interface specified by an IP address or with an unnumbered interface, and configure RIP for the interface.

```
host1(config-router)#address 10.2.1.1
host1(config-router)#address 10.2.1.1 receive version 1
host1(config-router)#address 10.2.1.1 send version 2
host1(config-router)#address 10.2.1.1 authentication mode text
host1(config-router)#address 10.2.1.1 authentication key 31barada
```

Each configuration step is optional, and includes the following:

- (Optional) Specify a RIP receive version for an interface. By default, RIP interfaces on your router receive both RIPv1 and RIPv2.
- (Optional) Specify a RIP send version for an interface. By default, RIP interfaces on your router send only RIPv1.

- (Optional) Specify an authentication mode and authentication password or key.
This step is permitted only if both receive version and send version are set to RIPv2.
- 4. (Optional) Enable RIP to advertise a default route.
`host1(config-router)#default-information originate`
- 5. (Optional) Specify a default metric for redistributed routes on all subsequently created interfaces.
`host1(config-router)#default-metric 5`
- 6. (Optional) Set the administrative distance for advertised routes.
`host1(config-router)#distance 150`
- 7. (Optional) Control the dynamic distribution of routes caused by changes to an associated route map.
`host1(config-router)#disable-dynamic-redistribute`
- 8. (Optional) Adjust RIP timers.
`host1(config-router)#timers update 20`
`host1(config-router)#timers invalid 60`
`host1(config-router)#timers holddown 60`
`host1(config-router)#timers flush 90`
- 9. (Optional) Specify maximum number of ECMP paths.
`host1(config-router)#maximum-paths 2`
- 10. (Optional) Summarize routes.

Use a prefix tree to specify the number of bits to report for routes matching a route map:

```
host1(config)#ip prefix-tree boston permit 10.10.2.0/24
host1(config-router)#route-map 4
host1(config-route-map)#match-set summary prefix-tree boston
```



NOTE: For information about the `ip prefix-tree` command, see *JunosE IP Services Configuration Guide*.

Alternatively, explicitly specify routes for RIP to summarize:

```
host1(config-router)#ip summary-address 4.4.0.0 255.255.0.0 5
host1(config-router)#ip summary-address 4.3.0.0 255.255.0.0 6
```

- 11. (Optional) Redistribute routes from other protocols into RIP, or from RIP to other protocols.
`host1(config-router)#redistribute rip 5`
`host1(config-router)#route-map 4`
`host1(config-router)#redistribute bgp 100 route-map 4`
- 12. (Optional) Enable unicast communication with RIP neighbors.
`host1(config-router)#neighbor 10.10.21.100`
`host1(config-router)#passive-interface atm atm 2/0.16`

13. (Optional) Set the debounce time for interfaces brought down by some event.

```
host1(config-router)#debounce-time 30
```

14. (Optional) Prevent RIP from purging the routing table for interfaces brought down by some event.

```
host1(config-router)#interface-event-disable
```

15. (Optional) Prevent RIP from sending a more-specific route if a less-specific route has a better metric.

```
host1(config-router)#send-more-specific-routes-disable
```

16. (Optional) Prevent RIP from sending triggered updates.

```
host1(config-router)#triggered-update-disable
```

17. (Optional) Apply a table map to modify route distance.

```
host1(config-router)#table-map dist1
```

Relationship Between **address** and **network** Commands

If you use the **network** command to configure a RIP network, use the **ip rip** commands to configure the RIP attributes for that network. Do not use the **address** commands.

If you use the **address** command to configure a RIP network, use the **address** commands to configure the RIP attributes for that network. Do not use the **ip rip** commands.



NOTE: The **network** and **ip rip** commands are maintained for industry compatibility. You can configure all your RIP interfaces with the **address** commands. You cannot configure unnumbered interfaces with the **network** and **ip rip** commands.

address

- Use to configure RIP to run on the interface specified by the IP address or on an unnumbered interface. Use the **address** commands to configure RIP attributes on the network.
- Configures RIP with the default values: Send version is RIPv1, receive version is RIPv1 and RIPv2, authentication is not enabled.
- Example

```
host1(config-router)#address 10.2.1.1
```

- Use the **no** version to delete the RIP interface.
- See **address**

address authentication key

- Use to specify either the simple password for text authentication or the encryption/decryption key for MD5 authentication. The key is a string of up to 16 alphanumeric characters and can be mixed uppercase and lowercase.
- You can specify whether the key is entered in unencrypted or encrypted format. If you do not specify which, the string is assumed to be unencrypted.
- Example
`host1(config-router)#address 10.2.1.1 authentication key ke6G72mV`
- Use the **no** version to clear all authentication keys.
- See address authentication key

address authentication mode

- Use to specify the authentication mode.
- Specify **text** to send a simple text password to neighbors. If a neighbor does not have the same password, requests and updates from this router are rejected.
- Specify **md5** *keyID* to send an MD5 hash to neighbors. Neighbors must share the MD5 key to decrypt the message and encrypt the response.
- Example
`host1(config-router)#address 10.2.1.1 authentication mode text`
- Use the **no** version to remove authentication from all RIP interfaces.
- See address authentication mode

address receive version

- Use to restrict the RIP version that the router can receive on an interface. The default is to receive both RIPv1 and RIPv2.
- Example
`host1(config-router)#address 10.2.1.1 receive version 1`
- Use the **no** version to restore the default value, 1 2.
- See address receive version

address send version

- Use to restrict the RIP version that the router can send on an interface. The default is to send only RIPv1.
- Example
`host1(config-router)#address 10.2.1.1 send version 2`
- Use the **no** version to restore the default value, 1.
- See address send version

clear ip rip redistribution

- Use to clear all the routes that have previously been redistributed into RIP.
- Example

```
host1#clear ip rip redistribution
```
- There is no **no** version.
- See clear ip rip redistribution

debounce-time

- Use to control the interval RIP waits before bringing back up an interface that was brought down by some event.
- The interval can be in the range 0–60 seconds.
- Example

```
host1(config-router)#debounce-time 30
```
- Use the **no** version to restore the default value, 10 seconds.
- See debounce-time

default-information originate

- Use to enable RIP to advertise a default route (0.0.0.0/0) if the default route exists in the IP routing table.
- If the default route does not exist, you must configure it using the **ip route** command, or specify the **always** keyword. The **always** keyword causes RIP to always advertise the default route, and creates it if it is not present in the IP routing table.
- Example

```
host1(config-router)#default-information originate
```
- Use the **no** version to disable advertisement of the default route.
- See default-information originate

default-metric

- Use to configure RIP to apply this metric for redistributed routes on all subsequently created interfaces.
- Configuring a default metric lowers the priority of the routes.
- Use a metric in the range 1 – 16.
- Example

```
host1(config-router)#default-metric 5
```
- Use the **no** version to restore the default value, 0.
- See default-metric

disable

- Use to disable RIP processing.
- Example

```
host1(config-router)#disable
```
- Use the **no** version to enable RIP processing.
- See disable

disable-dynamic-redistribute

- Use to halt the dynamic redistribution of routes that are initiated by changes to a route map.
- Dynamic redistribution is enabled by default.
- Example

```
host1(config-router)#disable-dynamic-redistribute
```
- Use the **no** version to reenab le dynamic redistribution.
- See disable-dynamic-redistribute

distance

- Use to set the administrative distances for routes.
- Example

```
host1(config-router)#distance 150
```
- Use the **no** version to restore the default value, 120.
- See distance

distribute-list

- Use to apply a specific access list to incoming or outgoing RIP route updates.
- An IP access list acts as a filter. Refer to access-list in the *JunosE Command Reference Guide* for more information.
- Example

```
host1(config-router)#distribute-list 5 incoming
```
- Use the **no** version to stop application of the distribute list.
- See distribute-list

interface-event-disable

- Use to configure RIP to purge the routing table for interfaces that were brought down by some event.
- Example

```
host1(config-router)#interface-event-disable
```

- Use the **no** version to restore the default condition, wherein RIP does not automatically purge the routing table for down interfaces.
- See interface-event-disable

ip rip

- Use to configure RIP on the network interface specified with the **network** command.
- Configures RIP with the default values: Send version is RIPv1, receive version is RIPv1 and RIPv2, authentication is not enabled.
- Example

```
host1(config-if)#ip rip
```
- Use the **no** version to delete the RIP interface.
- See ip rip

ip rip authentication key

- Use to specify either the simple password for text authentication or the encryption/decryption key for MD5 authentication. The key is a string of up to 16 alphanumeric characters and can be mixed uppercase and lowercase.
- You can specify whether the key is entered in unencrypted or encrypted format. If you do not specify which, the string is assumed to be unencrypted.
- Example

```
host1(config-if)#ip rip authentication key ke6G72mV
```
- Use the **no** version to clear all authentication keys.
- See ip rip authentication key

ip rip authentication mode

- Use to specify the authentication mode.
- Specify **text** to send a simple text password to neighbors. If a neighbor does not have the same password, requests and updates from this router are rejected.
- Specify **md5** *keyID* to send an MD5 hash to neighbors. Neighbors must share the MD5 key to decrypt the message and encrypt the response.
- Example

```
host1(config-if)#ip rip authentication mode text
```
- Use the **no** version to remove authentication from all RIP interfaces.
- See ip rip authentication mode

ip rip receive version

- Use to restrict the RIP version that the router can receive on an interface. The default is both RIPv1 and RIPv2.
- Example

```
host1(config-if)#ip rip receive version 1
```

- Use the **no** version to restore the default value, 1 2.
- See ip rip receive version

ip rip send version

- Use to restrict the RIP version that the router can send on an interface. The default is RIPv1.
- Example

```
host1(config-if)#ip rip send version 2
```

- Use the **no** version to restore the default value, 1.
- See ip rip send version

ip split-horizon

- Use to configure the split horizon feature and poison reverse features for the interface. Enabled by default, split horizon prevents the RIP router from advertising routes from the originating interface.
- Poison reverse routing updates are disabled by default; when enabled, they set the metric for routes originating on the interface to infinity, thus explicitly advertising that the network is not reachable. This helps to prevent routing loops.
- In most configurations, you will want to accept the default condition.
- Example

```
host1(config-if)#no ip split-horizon
```

- Use the **no** version to disable split horizon and enable poison reverse routing updates.
- See ip split-horizon

ip summary-address

- Use to specify an IP address and network mask to identify which routes to summarize.
- You can optionally specify a metric associated with the summary address. The default metric is 1.
- Example

```
host1(config-router)#ip summary-address 4.4.0.0 255.255.0.0 5
host1(config-router)#ip summary-address 4.3.0.0 255.255.0.0 6
```

- Use the **no** version to stop summarization for the specified routes.
- See ip summary-address

match-set summary prefix-tree

- Use to specify a prefix tree that summarizes routes for a particular route map.
- Use the **ip prefix-tree** command to set the conditions of the prefix tree, including which routes to summarize and how many bits of the network address to preserve.

- Example

```
host1(config-route-map)#match-set summary prefix-tree boston
```

- Use the **no** version to disable the use of the prefix tree by the route map.
- See match-set summary prefix-tree

maximum-paths

- Use to control the maximum number of parallel routes that RIP can support.
- RIP installs multiple equal-cost paths to a given destination only if each has a different next hop.
- The maximum number of routes can be in the range 1–16.
- Example

```
host1(config-router)#maximum-paths 2
```

- Use the **no** version to restore the default value, 4.
- See maximum-paths

neighbor

- Use to specify a RIP neighbor to which the router sends unicast messages.
- You must also use the **passive-interface** command to specify the interface as passive, thereby restricting the interface to unicast RIP messages.
- Example

```
host1(config-router)#neighbor 10.10.21.100
```

- Use the **no** version to remove the neighbor.
- See neighbor

network

- Use to associate a network with a RIP routing process. Use the **ip rip** commands to configure RIP attributes on the network.
- You supply a network mask to the new address so that RIP runs on that specific network.
- If you do not specify an interface's network, the network is not advertised in any RIP updates.
- You can specify the standard subnet mask with this command.
- Example

```
host1(config-router)#network 10.2.1.0 255.255.255.0
```

- Use the **no** version to disable RIP on the specified interface.
- See network

passive-interface

- Use to disable the transmission of multicast RIP messages on the interface.
- RIP messages are unicast to a RIP neighbor on the interface if the interface is present in the IP routing table as the next-hop interface to the configured neighbor.
- Example

```
host1(config-router)#passive-interface atm atm 2/0.16
```
- Use the **no** version to reenale the transmission of RIP multicast messages on the specified interface.
- See passive-interface

redistribute

- Use to redistribute information from a routing domain other than RIP into the RIP domain.
- Specify the source protocol from which routes are being redistributed. It can be one of the following keywords: **bgp**, **isis**, **ospf**, **static** [ip], and **connected**. Use the **static** keyword to redistribute IP static routes; optionally add the **ip** keyword when redistributing into IS-IS. The keyword **connected** refers to routes that are established automatically by virtue of having enabled IP on an interface. For routing protocols such as OSPF and IS-IS, these routes will be redistributed as external to the AS.
- Use the **route-map** keyword to interrogate the route map to filter the importation of routes from the source routing protocol to the current routing protocol. If you do not specify the route-map option, all routes are redistributed. If you specify the route-map option, but no route map tags are listed, no routes will be imported.
- Use to redistribute routes from RIP into other non-RIP routing domains.
- Example 1

```
host1(config)#router rip 5
host1(config-router)#redistribute bgp 100 route-map 4
```
- Example 2

```
host1(config)#router bgp 100
host1(config-router)#redistribute rip 5
```
- Use the **no** version to disable redistribution.
- See redistribute.

route-map

- Use to specify a route map for RIP.
- Example

```
host1(config)#router rip
host1(config-router)#route-map 4
```
- Use the **no** version to delete the route map. If you do not specify an interface, it removes the global route map if it exists.
- See route-map

router rip

- Use to enable RIP routing protocol and specify a RIP process for IP, or to access Router Configuration mode.
- Specify only one RIP process per router.
- Example

```
host1(config)#router rip
```
- Use the **no** version to delete the RIP process and removes the configuration from your router.
- See router rip

send-more-specific-routes-disable

- Use to configure RIP to send a less-specific route in preference to a more-specific route if the less-specific route has a metric.
- Example

```
host1(config-router)#send-more-specific-routes-disable
```
- Use the **no** version to restore the default condition, wherein RIP always sends a more-specific route in preference to a less-specific route, even if the less-specific route has a metric.
- See send-more-specific-routes-disable

table-map

- Use to apply a policy to modify distance, metric, or tag values of RIP routes about to be added to the IP routing table.
- The new route map is applied to all routes currently in and those subsequently placed in the forwarding table. Previously redistributed routes are redistributed with the changes caused by the route map.
- To remove from the forwarding table any old routes that are now disallowed by the specified route map, you must refresh the IP routing table with the **clear ip routes *** command.
- Example

```
host1(config)#route-map dist1 permit 5
host1(config-route-map)#match community boston42
host1(config-route-map)#set distance 33
host1(config-route-map)#exit
host1(config)#router rip 100
host1(config-router)#table-map dist1
host1(config-router)#exit
host1(config)#exit
host1#clear ip routes *
```
- Use the **no** version to halt application of the route map.
- See table-map

timers

- Use to configure RIP timers.
- The router supports the following RIP timers:
 - **update**—Interval in seconds at which routing updates are sent. The default is 30 seconds.
 - **invalid**—Interval in seconds after which a route is declared invalid (null). Set this value to at least three times the update value. The default is 180 seconds.
 - **holddown**—Interval in seconds during which routing information about better paths is suppressed. Set this value to at least three times the update value. The default is 120 seconds.
 - **flush**—Interval in seconds that must pass before a route is removed from the routing table. Set this value greater than the invalid value. The default is 300 seconds.
- Example


```
host1(config-router)#timers update 20
host1(config-router)#timers invalid 60
host1(config-router)#timers holddown 60
host1(config-router)#timers flush 90
```
- Use the **no** version to restore the default values, 30 180 120 300.
- See timers

triggered-update-disable

- Use to prevent RIP from sending triggered routing updates.
- Example


```
host1(config-router)#triggered-update-disable
```
- Use the **no** version to restore the default condition, wherein RIP does send triggered routing updates.
- See triggered-update-disable

version

- Use to specify the global RIP version. The default is RIPv1.
- To change the RIP version on a specific interface, use the **ip rip receive version** and the **ip rip send version** commands, or the **address receive version** and **address send version** commands.
- Example


```
host1(config-router)#version 2
```
- Use the **no** version to revert to the default value, 1.
- See version

Enabling RIP on Dynamic IP Interfaces

You can use the **ip rip copy-to-dynamic** command to enable RIP on dynamic, unnumbered IP interfaces. This command allows the dynamic interfaces, as they are created, to copy RIP settings from a numbered IP interface to which the interfaces refer for their source address.



CAUTION: RIP transmits a complete set of routing updates at each update interval. This can result in a very large number of RIP updates. When configuring RIP over dynamic interfaces, we strongly recommend that you configure an output policy on the reference interface to limit the amount of routing information that RIP transmits to each peer.

ip rip copy-to-dynamic

- Use to enable RIP on dynamic, unnumbered IP interfaces. This command allows the dynamic interfaces to copy RIP settings from the numbered IP interface to which the interfaces refer for their source address.
- Once created, the dynamic RIP interfaces do not track configuration changes on the numbered interface from which they originally inherited the configuration. To reinherit RIP settings, use the `clear ip rip dynamic-interfaces` command.



CAUTION: Issuing the **ip rip copy-to-dynamic** command enables RIP on all dynamic unnumbered interfaces that reference the interface and become active after issuing the command. This may unintentionally include dynamic interfaces created on MPLS tunnels or subscriber interfaces where you would not want to enable RIP. To avoid this possible misconfiguration, take care to reference dynamic interfaces where RIP is not required to another numbered interface on which RIP is not enabled.

- Example

```
host1(config-if)#ip rip copy-to-dynamic
```

- Use the **no** version to stop the use of RIP configuration on any new, dynamic, unnumbered IP interfaces. The **no** version does not remove all existing, active RIP interfaces that were created after issuing this command. To remove all existing, active RIP interfaces, use the **no ip rip copy-to-dynamic** command to stop the use of RIP on any new, dynamic interfaces, and then use the `clear ip rip dynamic-interfaces` command to clear any existing RIP dynamic interfaces.
- See `ip rip copy-to-dynamic`

Clearing Dynamic RIP Interfaces

You can use the **clear ip rip dynamic-interfaces** to clear any existing dynamic RIP interfaces that were created by the **ip rip copy-to-dynamic** command. If the router is still using the **ip rip copy-to-dynamic** command, when the router recreates the dynamic interfaces, they use the RIP attributes from the interface to which they refer. If the router no longer uses the **ip rip copy-to-dynamic** command, any newly created dynamic interfaces do not use the RIP attributes from the reference interface.

clear ip rip dynamic-interfaces

- Use to clear all existing dynamic, unnumbered interfaces that were created since issuing the **ip rip copy-to-dynamic** command.
- Example

```
host1#clear ip rip dynamic-interfaces
```
- There is no **no** version.
- See `clear ip rip dynamic-interfaces`

Using RIP Routes for Multicast RPF Checks

You can use the **ip route-type** command to specify whether RIP routes are available for only unicast forwarding protocols or only multicast reverse path forwarding (RPF) checks. Routes available for unicast forwarding appear in the unicast view of the routing table, whereas routes available for multicast RPF checks appear in the multicast view of the routing table.

ip route-type

- Use to specify whether RIP routes are available only for unicast forwarding, only for multicast reverse path forwarding checks, or for both.
- Use the **show ip route** command to view the routes available for unicast forwarding.
- Use the **show ip rpf-routes** command to view the routes available for multicast reverse path forwarding checks.
- By default, RIP routes are available for both unicast forwarding and multicast reverse path forwarding checks.
- Example

```
host1(config)#router rip
host1(config-router)#ip route-type unicast
```
- Use the **no** version to restore the default value, both.
- See `ip route-type`

Configuring the BFD Protocol for RIP

The **address bfd-liveness-detection** command or the **ip rip bfd-liveness-detection** command configures the Bidirectional Forwarding Detection (BFD) protocol for RIP. The BFD protocol uses control packets and shorter detection time limits to more rapidly detect failures in a network. Also, because they are adjustable, you can modify the BFD timers for more or less aggressive failure detection.

Without BFD, when a RIP peer goes down, the routes learned from that peer are purged only after each route times out. The timeout is configurable with the **timers invalid** command. By default, the timeout is 180 seconds after each route was received or refreshed. Consequently routes are purged successively over varying time periods rather than all at once.

In contrast, when a BFD session exists between RIP peers, a peer that goes down is detected quickly. RIP simultaneously purges all routes learned from that peer and starts the hold-down timer for each peer.

When you issue the **address bfd-liveness-detection** command or the **ip rip bfd-liveness-detection** command on a RIP peer, the peer establishes BFD liveness detection with all BFD-enabled RIP peers. When the local peer receives an update from a remote RIP peer—if BFD is enabled and if the session is not already present—the local peer attempts to create a BFD session to the remote peer.

Each adjacent pair of peers negotiates an acceptable transmit interval for BFD packets. The negotiated value can be different on each peer. Each peer then calculates a BFD liveness detection interval. When a peer does not receive a BFD packet within the detection interval, it declares the BFD session to be down and purges all routes learned from the remote peer.



NOTE: Before the router can use the **address bfd-liveness-detection** command or the **ip rip bfd-liveness-detection** command, you must specify a BFD license key. To view an already configured license, use the **show license bfd** command.

For general information about configuring and monitoring the BFD protocol, see *JunosE IP Services Configuration Guide*.

address bfd-liveness-detection

ip rip bfd-liveness-detection

- Use to enable BFD (bidirectional forwarding detection) and define BFD values to more quickly detect RIP data path failures.
- Use the **address bfd-liveness-detection** command when you have used the **address** command to configure the RIP network. Use the **ip rip bfd-liveness-detection** command when you have used the **network** command to configure the RIP network.

- The peers in a RIP adjacency use the configured values to negotiate the actual transmit intervals for BFD packets.
 - You can use the **minimum-transmit-interval** keyword to specify the interval at which the local peer proposes to transmit BFD control packets to the remote peer. The default value is 300 milliseconds.
 - You can use the **minimum-receive-interval** keyword to specify the minimum interval at which the local peer must receive BFD control packets from the remote peer. The default value is 300 milliseconds.
 - You can use the **minimum-interval** keyword to specify the same value for both of those intervals. Configuring a minimum interval has the same effect as configuring the minimum receive interval and the minimum transmit interval to the same value. The default value is 300 milliseconds.
- You can use the **multiplier** keyword to specify the detection multiplier value. The calculated BFD liveness detection interval can be different on each peer. The multiplier value is roughly equivalent to the number of packets that can be missed before the BFD session is declared to be down. The default value is 3.
- For details on liveness detection negotiation, see *JunosE IP Services Configuration Guide*.
- You can change the BFD liveness detection parameters at any time without stopping or restarting the existing session; BFD automatically adjusts to the new parameter value. However, no changes to BFD parameters take place until the values resynchronize with each peer.
- Example


```
host1(config-if)#ip rip bfd-liveness-detection minimum-interval 800
or
host1(config-router)#address bfd-liveness-detection minimum-interval 800
```
- Use the **no** version to disable BFD on the RIP interface.
- See address bfd-liveness-detection
- See ip rip bfd-liveness-detection

Remote Neighbors

You can create RIP remote neighbors to enable the router to establish neighbor adjacencies through unidirectional interfaces, such as MPLS tunnels, rather than the standard practice of using the same interface for receipt and transmission of RIP packets. The remote neighbor can be more than one hop away through intermediate routes that are not running RIP. RIP uses the interface associated with the best route to the remote neighbor to reach the neighbor. A best route to the neighbor must exist in the IP routing table.

You must explicitly configure remote neighbors on the RIP routers to specify the remote neighbor with which the router will form an adjacency and the source IP address the router will use for RIP packets destined to its peer remote neighbor.

To form an adjacency with its remote neighbor, the router sends all RIP packets to the remote neighbor as unicast packets with the destination IP address equal to the source IP address of the remote neighbor. The loopback interface associated with the source IP address for the remote neighbor acts as a logical RIP interface for the neighbor.

To prevent routing loops, you can disable split horizon and enable poison reverse routing updates.

The **remote-neighbor** command to specify the remote neighbors is mandatory. Configuration of all other remote-neighbor attributes is optional.

authentication-key

- Use to specify the password for text authentication and the key for MD5 authentication for RIP remote-neighbor interface.
- This command is supported only in RIPv2. Authentication is disabled by default.
- Example

```
host1(config-router-rn)#authentication key 0 jun27ior
```
- Use the **no** version to clear the key for the remote-neighbor interface.
- See authentication-key

authentication mode

- Use to specify the authentication mode for the remote neighbor interface.
- Specify **text** to send a simple text password to remote neighbors. If a remote neighbor does not have the same password, requests and updates from this router are rejected.
- Specify **md5 keyID** to send an MD5 hash to remote neighbors. Remote neighbors must share the MD5 key to decrypt the message and encrypt the response.
- This command is supported only in RIPv2. Authentication is disabled by default.
- Example

```
host1(config-router-rn)#authentication mode text
```
- Use the **no** version to remove authentication from the RIP remote-neighbor interface.
- See authentication mode

distribute-list

- Use to apply a specific access list to either incoming or outgoing RIP route updates on the RIP remote-neighbor interface.
- An IP access list acts as a filter. Refer to access-list in the *JunosE Command Reference Guide* for more information.
- Example

```
host1(config)#distribute-list 5 in
```
- Use the **no** version to stop application of the distribute list.
- See distribute-list

exit-remote-neighbor

- Use to exit from the Remote Neighbor Configuration mode and return to Router Configuration mode.
- Example

```
host1(config-router-rn)#exit-remote-neighbor
```
- There is no **no** version.
- See exit-remote-neighbor

receive version

- Use to restrict the RIP version that the router can receive on a RIP remote-neighbor interface. The default is to receive both RIPv1 and RIPv2.
- The **off** keyword overrides any other specified option; for example, configuring both **1** and **off** or both **2** and **off** has the same result as configuring only **off**.
- Example

```
host1(config-router-rn)#receive version 1
```
- Use the **no** version to restore the default value, 1 2.
- See receive version

remote-neighbor

- Use to configure a RIP remote neighbor.
- Example

```
host1(config-router)#remote-neighbor 10.25.100.14
```
- Use the **no** version to remove the remote neighbor and any attributes configured for the remote neighbor.
- See remote-neighbor

send version

- Use to restrict the RIP version that the router can send on an interface. The default is to send only RIPv1.
- Example

```
host1(config-router-rn)#send version 1
```
- Use the **no** version to restore the default value, 1.
- See send version

split-horizon

- Use to configure the split horizon and poison reverse features for RIP remote neighbors.
- Split horizon is enabled by default; poison reverse routing updates are disabled by default.

- Poison reverse routing updates set the metric for routes originating on the interface to infinity, thus explicitly advertising that the network is not reachable. This helps to prevent routing loops.
- Example

```
host1(config-router-rn)#no split-horizon
```
- Use the **no** version to disable the split horizon and enable poison reverse routing updates.
- See split-horizon

time-to-live

- Use to configure a hop count by setting the value of the time-to-live field used by packets sent to a RIP remote neighbor.
- Example

```
host1(config-router-rn)#time-to-live 12
```
- Use the **no** version to restore the default value, 16.
- See time-to-live

update-source

- Use to specify the RIP interface whose local address is used as the source address for the RIP connection to a remote neighbor.
- The source address assigned to a remote neighbor must be unique. If you configure a RIP router to form neighbor adjacencies with two RIP remote neighbors, then the RIP router must have two unique local source IP addresses, one for each of its remote neighbors.
- Example

```
host1(config-router-rn)#update-source atm 2/0.17
```
- Use the **no** version to delete the source address from the connection to the remote neighbor.
- See update-source

Monitoring RIP

Two sets of commands enable you to monitor RIP operation on your router: the debug and the show commands. Both sets of commands provide information about your router's RIP state and configuration.

The task you are performing with each of these monitoring commands is basically the same for each command; that is, you are requesting information. The results of this request may vary. For instance, the debug commands provide information about problems with the network or the router, whereas the show commands provide information about the actual state and configuration of your router.

debug Commands

The debug commands provide information about the following RIP items:

- General events, such as creating a RIP process or removing RIP from an interface
- Routing events, such as when two RIP routers exchange routes

debug ip rip

- Use to display information about selected RIP events. This command has many keywords that allow you to specify a variety of RIP events.
- You can set the level of severity for the events you want displayed; specify the desired descriptive term or a corresponding number (0–7).
- You can set the verbosity of the messages you want displayed: low, medium, high.
- Example

```
host1#debug ip rip events
```

- Use the **no** version to cancel the display of any information about the designated variable.
- See debug ip rip

undebg ip rip

- Use to cancel the display of information about a selected event.
- The same RIP variables can be designated as in the debug ip rip command.
- Example

```
host1#undebg ip rip events
```

- There is no **no** version.
- See undebg ip rip

show Commands

Use the show commands to monitor the following types of RIP information:

- Configuration
- IP-related information
- Global counters
- Counters for a specified network
- Statistics

You can set a statistics baseline for RIP interfaces by using the **baseline ip rip** command.

You can specify a VRF instance for the **show ip rip** commands. 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 *JunosE System Basics Configuration Guide*, for details.

baseline ip rip

- Use to set a statistics baseline for RIP interfaces.
- The router 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.
- Use the optional **delta** keyword with the **show ip rip statistics** command to specify that baselined statistics are to be shown.

- Example

```
host1#baseline ip rip
```

- There is no **no** version.
- See baseline ip rip

show ip rip

- Use to display RIP information.
- Specify **vrf** *vrfName* to limit the display to a specific VRF.
- Use the **ifconfig** keyword to display address and interface configuration information instead of the default operational data.
- Field descriptions
 - Router Information Protocol Fields
 - Router Administrative State—Displays the RIP state. Enable means the router is allowed to send and receive updates. Disable means that RIP might be configured but it is not allowed to run yet.
 - System version RIP1—RIP versions allowed for sending and receiving RIP updates. The router version is currently set to RIP1, which sends RIPv1 but will receive RIPv1 or RIPv2. If it is set to RIP2, it will send and receive RIPv2 only. The default is configured for RIP1.
 - Incoming filters—Access list applied to incoming route updates
 - Outgoing filters—Access list applied to outgoing route updates
 - Global route map—Route map that specifies all RIP interfaces on the router
 - Default metric—Value for redistributed routes. The default is 1. This global value is superseded by metrics applied to a RIP interface.
 - Distance—Value added to RIP routes added to the IP routing table. The default is 120.

- Number of route changes—Number of times the router has been told to route changes by its peers
- Number of route queries—Number of times the router has received route requests from other routers
- Update interval—Current setting of the update timer (in seconds)
- Invalid interval—Current setting of the invalid timer (in seconds)
- Hold down time—Current setting of the hold-down timer (in seconds)
- Flush interval—Current setting of the flush timer (in seconds)
- Route Type—Whether RIP routes are available only for unicast forwarding, only for multicast reverse path forwarding checks, or for both
- Max Ecmp Paths—Number of parallel routes that RIP can support
- Default-Information originate always—Ability (enabled or disabled) of RIP to advertise a default route (0.0.0.0/0) if the default route exists in the IP routing table
- Triggered Updates—Ability (enabled or disabled) of RIP to send triggered updates
- Purge Routes on Interface Down Event—Ability (enabled or disabled) of RIP to purge the routing table for interfaces that were brought down by some event
- Send More Specific Routes—Ability (enabled or disabled) of RIP to send a less-specific route in preference to a more-specific route if the less-specific route has a metric
- Debounce Time—Debounce time for interfaces brought down by some event
- Default-Information originate—Ability (enabled or disabled) of RIP to advertise a default route (0.0.0.0/0) if the default route exists in the IP routing table
- route-map—Name of the route map specified for RIP
- Summary Address—Route that RIP summarizes
- Network—IP address of a network on which RIP is running
- Netmask—Network mask applied to the network address
- Neighbor—Configured neighbor information
- Address Operational Data
 - Unnumbered status—Status of the unnumbered interface
 - Received bad packet—Number of bad packets received
 - Received bad routes—Number of bad routes received

- Triggered updates sent—Number of triggered updates sent; triggered updates are sent before the entire RIP routing table is sent; triggered by events such as adding a new RIP route or redistribution
 - Received updates—Number of updates received
 - Numbered status—Status of the numbered interface from which this interface obtains its configuration
 - Send version—Version of RIP used for sending updates
 - Receive version—Version of RIP accepted in received updates
 - Authentication mode—Password or MD5 authentication, or none
 - Default metric—Metric value applied to the RIP interface. The default is 1.
 - BFD minimum receive interval(msec)—Configured minimum interval requested between BFD control packets sent by the remote RIP peer; used with RIP peers to negotiate a detection interval for BFD session failure. The default is 300 milliseconds.
 - BFD minimum transmit interval(msec)—Configured minimum interval between BFD control packets sent by the local RIP peer; used with RIP peers to negotiate a detection interval for BFD session failure. The default is 300 milliseconds.
 - BFD multiplier—Multiplied by the negotiated BFD minimum receive interval to determine the interval between packets permitted before the BFD session is declared down. Also, the number of BFD control packets that the RIP local peer can miss before the BFD session is declared down. The default is 3.
 - Passive Interface—Whether or not the interface is passive, thereby restricting the interface to unicast RIP messages
 - Passive Interface—Whether or not the interface is passive, thereby restricting the interface to unicast RIP messages
 - Access-list applied to outgoing route—Name of the access list applied to outgoing routes
 - Access-list applied to incoming route—Name of the access list applied to incoming routes
 - Route-map applied to outgoing route—Name of the route map applied to outgoing routes
- Example 1

```
host1#show ip rip
Routing Information Protocol
Router Administrative State = enable
System version RIP2: send = 2, receive = 2
No filter is applied to outgoing route update for all interfaces
No filter is applied to incoming route update for all interfaces
```

```

No global route map
No table map
Default metric = 1
Distance = 120
Number of route changes = 3
Number of route queries = 0
Update interval = 30 (secs)
Invalid interval = 180 (secs)
Hold down time = 120 (secs)
Flush interval = 300 (secs)
Route Type      = both unicast and multicast
Max Ecmp Paths = 4
Default-Information originate always = enabled
Triggered Updates = enabled
Purge Routes on Interface Down Event = enabled
Send More Specific Routes = enabled
Debounce Time = 10
Default-Information originate : disabled
    route-map : none
    Summary Address: None
Network      netmask
Neighbor
    No Configured Neighbors

```

*** Address Operational Data ***

```

Unnumbered, Rip is up, ATM2/1.18
    Dynamic creation and inherits configuration from loopback1
    Received bad packet = 0
    Received bad routes = 0
    Triggered updates sent = 0
    Received updates = 9
1.1.1.1, Rip is up, loopback1
    Send version = 2
    Receive version = 2
    Authentication mode = none
    Default metric = 1
    Passive Interface = No
    Access-list applied to outgoing route = none
    Access-list applied to incoming route = none
    Route-map applied to outgoing route = none
    Copy configuration to dynamic interfaces
    Received bad packet = 0
    Received bad routes = 0
    Triggered updates sent = 0
    Received updates = 0

```

- Example 2

```

host1#show ip rip ifconfig
Routing Information Protocol
Router Administrative State = enable
System version RIP2: send = 2, receive = 2
No filter is applied to outgoing route update for all interfaces
No filter is applied to incoming route update for all interfaces
No global route map
No table map
Default metric = 1
Distance = 120
Number of route changes = 17
Number of route queries = 2
Update interval = 30 (secs)
Invalid interval = 180 (secs)

```

```

Hold down time = 120 (secs)
Flush interval = 300 (secs)
Route Type      = both unicast and multicast
Max Ecmp Paths = 4
Default-Information originate always = enabled
Triggered Updates = enabled
Purge Routes on Interface Down Event = enabled
Send More Specific Routes = enabled
Debounce Time = 10
Default-Information originate : disabled
    route-map : none
    Summary Address: None
    Network      netmask
    Neighbor
    No Configured Neighbors

```

*** Interface Configuration Data***

```

loopback1
    Send version = def
    Receive version = def
    Authentication mode = none
    Default metric = default
    Passive Interface = No
    Access-list applied to outgoing route = none
    Access-list applied to incoming route = none
    Route-map applied to outgoing route = none
    Copy configuration to dynamic interfaces

```

*** Address Configuration Data ***

```

Unnumbered, Rip is up, ATM2/1.18
    Dynamic creation and inherits configuration from loopback1
    Received bad packet = 0
    Received bad routes = 0
    Triggered updates sent = 0
    Received updates = 3
1.1.1.1, Rip is up, loopback1
    Send version = def
    Receive version = def
    Authentication mode = none
    Default metric = default
    Passive Interface = No
    Access-list applied to outgoing route = none
    Access-list applied to incoming route = none
    Route-map applied to outgoing route = none
    Received bad packet = 0
    Received bad routes = 0
    Triggered updates sent = 0
    Received updates = 0

```

- Example 3—Interface configuration data excerpt showing BFD information.

```

host1#show ip rip ifconfig
*** Interface Configuration Data***
FastEthernet1/0
    Send version = def
    Receive version = def
    Authentication mode = none
    Default metric = default
    BFD minimum receive interval(msec) = 400
    BFD minimum transmit interval(msec)= 500
    BFD multiplier = 2

```



```

Passive Interface = No
Access-list applied to outgoing route = none
Access-list applied to incoming route = none
Route-map applied to outgoing route = none...

```

- See `show ip rip`

show ip rip brief

- Use to display limited RIP information.
- Specify **vrf** *vrfName* to limit the display to a specific VRF.
- Field descriptions
 - IP Address—IP address of the interface where RIP is running
 - Tx—Transmit version of RIP on this interface, which can override the router configuration
 - Rx—Receive version of RIP on this interface
 - Auth—Type of authentication, password (text) or MD5
 - Met—Current value is the same as the router one (the default metric). Based on MIB 2 for RIP, the interface's route metric can be set individually.
 - AccList O/I—Access list applied to outgoing/incoming RIP route updates
 - RtMap—Identifier for the route map that specifies a summary of RIP routes
 - Status—Status of RIP, either up or down
 - Intf—Interface type on which RIP is running
- Example

```

host1#show ip rip brief
IP Address Tx  Rx  Auth  Met  AccList O/I  RtMap  Status Intf
10.2.1.32  1   1,2 none  1   no/no   no   up    fastEthernet0/0
10.10.1.2   1   1,2 none  1   no/no   no   up    serial5:1/1:1

```

- See `show ip rip`

show ip rip database

- Use to display the route entries in the RIP routing table.
- Specify **vrf** *vrfName* to limit the display to a specific VRF.
- Specify the **active** keyword to limit the display to active routes learned via RIP updates.
- Specify the **inactive** keyword to limit the display to routes that the router will discard in the immediate future.
- Field descriptions
 - Prefix—IP address prefix
 - Length—Prefix length

- **ttl**—(Time to live) Indicates how many seconds the specific route remains in the routing table. If an entry reaches 0, it is removed from the routing table.
- **Met**—Metric that RIP uses to rate the value of different routes (hop count). The hop count is the number of routers that can be traversed in a route.
- **Next Hop**—Next IP address where a packet is sent. A value of zero in this field indicates that the next address the packet should be sent to is the router that originally sent the RIP message.
- **Intf**—Interface that the route has learned

- **Example**

```
host1#show ip rip database
Prefix/Length: ttl  Met:  Next Hop      Intf:
3.0.0.0/8        0    1    72.30.100.2   tm2/1.100
9.20.0.0/17      0    2    172.30.100.1  tm2/1.100
10.2.1.0/24      0    2    172.30.100.1  tm2/1.100
```

- See `show ip rip database`

show ip rip network

- Use to display the networks associated with the RIP routing process.
- Specify **vrf** *vrfName* to limit the display to a specific VRF.
- Field descriptions
 - **network**—IP address of a network on which RIP is running
 - **netmask**—Network mask applied to the network address

- **Example**

```
host1#show ip rip network
Network      netmask
10.2.1.0     255.255.255.0
172.30.100.0 255.255.255.0
172.30.200.0 255.255.255.0
```

- See `show ip rip network`

show ip rip peer

- Use to display limited information about each RIP neighbor.
- Specify **vrf** *vrfName* to limit the display to a specific VRF.
- Field descriptions
 - **Time since last update received**—Time in seconds since an update was received from this peer
 - **Peer version**—Version of IS-IS running on the peer
 - **Bad packets received**—Number of bad packets received from the peer

- Bad routes received—Number of bad routes received from the peer
- BFD—State of the BFD session with the peer, Up or Down
- Example

```

host1#show ip rip peer
192.168.1.102
    Time since last update received = 24
    Peer version = 1
    Bad packet received = 0
    Bad routes received = 0
    BFD Up

192.168.1.151
    Time since last update received = 24
    Peer version = 1
    Bad packet received = 0
    Bad routes received = 0
    BFD Down

192.168.1.250
    Time since last update received = 7
    Peer version = 2
    Bad packet received = 0
    Bad routes received = 0
    BFD Up

```

- See `show ip rip peer`

show ip rip statistics

- Use to display global and session statistics counters for RIP. If you specify an IP address, statistics for that interface are displayed in addition to the global RIP statistics.
- Specify **vrf** *vrfName* to limit the display to a specific VRF.
- Use the optional **delta** keyword to specify that baselined statistics are to be shown. You must use the **baseline ip rip** command to set a baseline.
- Field descriptions
 - Number of route changes—Number of times the router has been told to route changes by its peers
 - Number of route queries—Number of times the router has received route requests from other routers
 - Received bad packets—Number of bad packets received from the peer
 - Received bad routes—Number of bad routes received from the peer
 - Triggered updates sent—Number of triggered updates sent; triggered updates are sent before the entire RIP routing table is sent; triggered by events such as adding a new RIP route or redistribution
 - Received updates—Number of updates received
- Example 1

```
host1#show ip rip statistics
Number of route changes = 23
Number of route queries = 0
```

- Example 2

```
host1#show ip rip statistics 10.2.1.32
Number of route changes = 901
Number of route queries = 0
```

```
fastEthernet 0/0, 10.2.1.32
Received bad packet = 0
Received bad routes = 0
Triggered updates sent = 2
Received updates = 41
```

- See show ip rip statistics

show ip rip summary-address

- Use to display the specified summary address or all summary addresses for RIP.
- Field descriptions
 - Summary Address—Address summarizing RIP routes
 - Mask—Network mask specified in the **ip summary-address** command to identify which routes to summarize
 - Metric—Metric advertised with the summary RIP prefix
- Example

```
host1#show ip rip summary-address
Summary Address Mask      Metric
4.3.0.0          255.255.0.0      3
4.4.0.0          255.255.0.0      5
```

- See show ip rip summary-address

CHAPTER 7

Configuring OSPF

This chapter provides information for configuring the Open Shortest Path First (OSPF) routing protocol on your E Series router; it contains the following sections:

- [Overview on page 294](#)
- [Platform Considerations on page 297](#)
- [References on page 298](#)
- [Features on page 298](#)
- [OSPF Configuration Tasks on page 303](#)
- [Starting OSPF on page 303](#)
- [Aggregating OSPF Networks on page 308](#)
- [Configuring OSPF Interfaces on page 309](#)
- [Configuring OSPF Areas on page 318](#)
- [Optimizing the Cost to Reach a Range of OSPF Routers Within an Area on page 322](#)
- [Configuring Authentication on page 323](#)
- [Configuring the BFD Protocol for OSPF on page 328](#)
- [Configuring Additional Parameters on page 329](#)
- [Configuring OSPF for NBMA Networks on page 339](#)
- [Traffic Engineering on page 340](#)
- [Using OSPF Routes for Multicast RPF Checks on page 342](#)
- [OSPF and BGP/MPLS VPNs on page 343](#)
- [Remote Neighbors on page 343](#)
- [Configuring OSPF Graceful Restart on page 347](#)
- [Disabling and Reenabling Incremental SPF on page 349](#)
- [Configuring OSPF Traps on page 350](#)
- [Configuring OSPFv3 Traps on page 350](#)
- [Neighbor Uptime Tracking on page 352](#)
- [Monitoring OSPF on page 353](#)

Overview

OSPF is an interior gateway protocol (IGP) that runs within a single autonomous system (AS). Exterior gateway protocols (EGPs), such as Border Gateway Protocol (BGP), exchange routing information between ASs.

OSPF is a link-state routing protocol, similar to the Intermediate System–to–Intermediate System (IS-IS) routing protocol. It advertises the states of its local network links. This link advertisement distinguishes OSPF from some IGPs, such as Routing Information Protocol (RIP). A distance vector protocol, such as RIP, advertises the distances (that is, the number of hops) to each known destination within the network.

Each participating OSPF router within the AS has an identical database describing the AS's topology. Each individual piece of this database is a particular router's local state. From this database, OSPF calculates a routing table by constructing a shortest-path tree.

OSPF learns the best routes to reachable destinations. It can quickly detect changes in the topology of an AS and, after a short convergence period, calculate new loop-free routes. This protocol has been designed expressly for the TCP/IP Internet environment, including explicit support for classless interdomain routing (CIDR) and the tagging of externally derived routing information.

This chapter provides direction for customizing basic OSPF settings if you need to do so. For detailed information about the OSPF commands, see the *JunosE Command Reference Guide*.

OSPF Terms

Table 49 on page 294 defines commonly used OSPF terms.

Table 49: OSPF-Related Terms

Term	Meaning
adjacency	The relationship between selected neighboring routers for exchanging routing information. Not every pair of neighboring routers is adjacent.
area	A collection of network segments interconnected by routers. It is a region in an OSPF routing domain.
area border router (ABR)	A router that sits on the edge of an OSPF area and routes link-state advertisements (LSAs) between areas.
area ID	A unique number that identifies an area. Typically, formatted as an IP address.
authentication	A process whereby a user or data source proves that it is what it claims to be.

Table 49: OSPF-Related Terms (*continued*)

Term	Meaning
authentication type	The method by which authentication is achieved—null (or none), simple, or MD5. For example, simple authentication requires a 64-bit password in each OSPF packet.
autonomous system (AS)	A set of networks or IP prefixes within a single routing policy domain.
autonomous system boundary router (AS boundary router)	An OSPF router that redistributes routing information from other routing protocol sources.
classless interdomain routing (CIDR)	An addressing method that replaces the traditional class structure of IP addresses. In CIDR, the boundary between the network and host portions of an IP address can be on any bit boundary. CIDR addresses have no class restrictions, enabling more efficient use of the IP address space. CIDR addresses are represented by a prefix and a notation that indicates the IP address and mask; for example, 10.12.8.3/16.
designated router	A designated device (OSPF router) with which other routers form adjacencies, reducing the number of adjacencies required on a broadcast or NBMA network.
domain	A collection of routers that use a common interior gateway protocol.
flooding	The distribution and synchronization of the link-state database between OSPF routers.
hello protocol	A protocol that establishes and maintains neighbor relationships and that communication between neighbors is bidirectional. The hello protocol also dynamically discovers neighboring routers on broadcast or point-to-point networks.
interior gateway protocol (IGP)	A routing protocol that routers within an AS use to exchange information.
link-state advertisement (LSA)	A unit of data that describes the local state of a router or network. LSAs are flooded throughout their respective flooding domains. For example, router LSAs are flooded within the area to which the router belongs, summary LSAs are flooded to other areas through the backbone, and external LSAs are flooded throughout the OSPF domain.

Table 49: OSPF-Related Terms (*continued*)

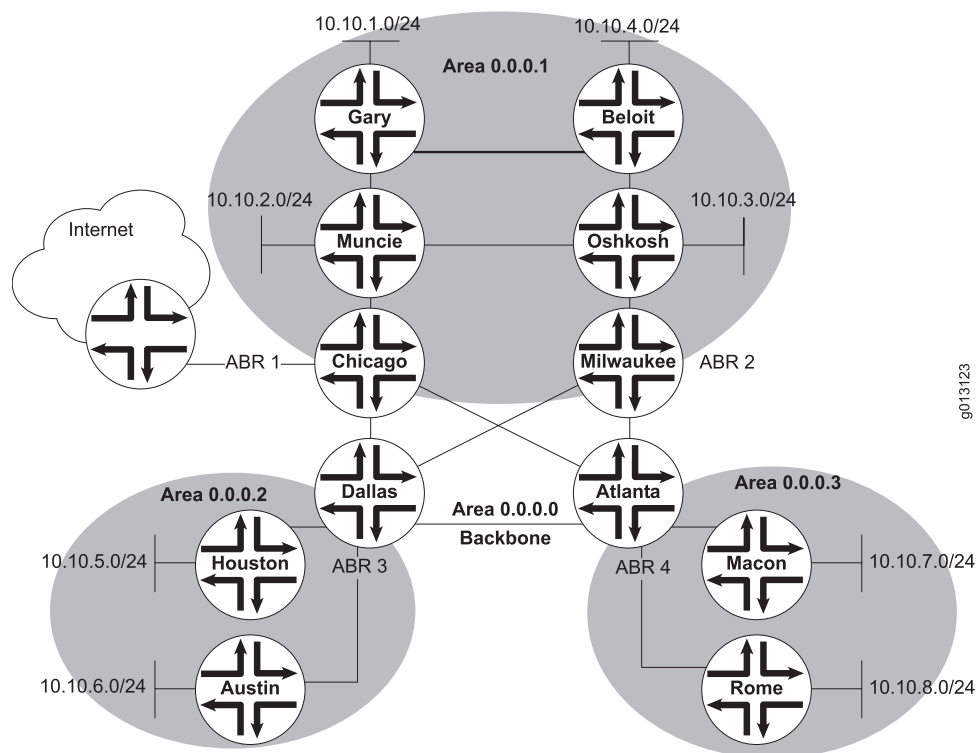
Term	Meaning
LSA types	<p>OSPF LSAs are categorized into the following types:</p> <ul style="list-style-type: none"> • Type 1—LSAs generated by an OSPF router for each area that it belongs to. Type 1 LSAs are flooded to only a single area. These LSAs carry information about directly connected links. Also known as router LSA. • Type 2—LSAs generated by an OSPF designated router to describe the set of routers in a network. Type 2 LSAs are flooded to the area that contains that network. Also known as network LSA. • Type 3—LSAs generated by an ABR to describe inter-area routes to networks outside of that area and internal to the AS; used for route summarization. Also known as inter-area prefix LSA. • Type 4—LSAs generated by an ABR to describe inter-area routes to ASBRs outside of that area and internal to the AS; used for route summarization. Also known as inter-area router LSA. • Type 5—LSAs generated by an ASBR to describe links that are external to the AS. Type 5 LSAs are reflooded from other protocols into OSPF, and are flooded by OSPF throughout the routing domain to all area types other than stub areas. OSPF sets the forwarding address for a type 5 LSA when the next hop is directly connected to the OSPF interface. Also known as AS-external LSA. • Type 6—Not supported. • Type 7—LSAs generated by an ASBR to describe routes that are external to an NSSA. Type 7 LSAs are flooded only to NSSAs. • Type 8—Not supported. • Type 9—Opaque LSA with a link-local scope. Type 9 LSAs are not flooded beyond the local network (local link). • Type 10—Opaque LSA with an area-local scope. Type-10 LSAs are not flooded beyond the borders of their associated area. • Type 11—Opaque LSA flooded throughout the AS. Type 11 LSAs are flooded throughout all transit areas, are not flooded into stub areas from the backbone, and are not originated by routers into their connected stub areas. Any type 11 LSA received in a stub area from a neighboring router within the stub area is rejected. • Link LSA—OSPFv3 LSA that Provides the router's link-local address to all other routers attached to the link; informs other routers attached to the link of a list of IPv6 prefixes to associate with the link; enables the router to assert a collection of options bits in the network LSA to be originated for the link • Intra-area prefix LSA—OSPFv3 LSA that associates a list of IPv6 address prefixes with a transit network link by referencing a network LSA, or associates a list of IPv6 address prefixes with a router by referencing a router LSA. The intra-area prefix LSA includes the IPv6 prefix information that OSPFv2 includes in type 1 and type 2 LSAs.
neighboring routers	Routers that have interfaces to a common network.
nonbroadcast network	A network that has no broadcast capability but supports more than two routers.
Not-so-stubby area (NSSA)	Similar to a stub area, but can also import selected external LSAs.

Table 49: OSPF-Related Terms (*continued*)

Term	Meaning
router ID	A 32-bit number that uniquely identifies a router within an AS; for example, 10.10.1.5.
stub area	An area that does not get flooded with external LSAs but does carry intra-area and interarea routes and a default route.
Totally stubby area	A stub area that also blocks type 3 summary LSAs from flowing into the area; however, type 3 LSAs carrying default route information alone are injected into the area.
virtual link	A logical link between two backbone routers for which the link tunnels through a nonbackbone area.

Figure 16 on page 297 illustrates the topology of an OSPF routing domain.

Figure 16: OSPF Topology



Platform Considerations

For information about modules that support OSPF on the ERX7xx models, ERX14xx models, and the ERX310 Broadband Services Router:

- See *ERX Module Guide, Table 1, Module Combinations* for detailed module specifications.

- See *ERX Module Guide, Appendix A, Module Protocol Support* for information about the modules that support OSPF.

For information about modules that support OSPF on the E120 and E320 Broadband Services 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 OSPF.

References

If you need more information about the OSPF protocol, see the following documents:

- *JunosE Release Notes, Appendix A, System Maximums*—See the Release Notes corresponding to your software release for information about maximum values.
- OSPFv3 Graceful Restart—draft-ietf-ospf-ospfv3-graceful-restart-04.txt (November 2006 expiration)
- RFC 2328—OSPF Version 2 (April 1998)
- RFC 2370—The OSPF Opaque LSA Option (July 1998)
- RFC 2740—OSPF for IPv6
- RFC 3623—Graceful OSPF Restart (November 2003)
- RFC 3630—Traffic Engineering (TE) Extensions to OSPF Version 2 (September 2003)



NOTE: IETF drafts are valid for only 6 months from the date of issuance. They must be considered works in progress. Please refer to the IETF Web site at <http://www.ietf.org> for the latest drafts.

For information about the OSPF protocol working group, see <http://www.ietf.org/html.charters/ospf-charter.html>.

Features

The following sections provide brief descriptions of key OSPF features supported in our implementation of OSPF.

Intra-area, Interarea, and External Routes

You can split up an OSPF AS into areas. Doing this reduces the size of the link-state database (LSDB). Each OSPF area runs as a separate network and maintains its own LSDB. OSPF computes routes only to destinations within the area, and does not flood routes beyond the area boundaries.

Routing Priority

OSPF areas receive routes based on priority. [Table 50 on page 299](#) describes the routing priority.

Table 50: Routing Priority

Priority	Type	Description
1 (highest)	Intra-area	Intra-area routing. Refers to routing within a single OSPF area.
2	Interarea	Interarea routing. Refers to routing between OSPF areas within a single OSPF routing domain.
3	External	<p>External type 1. Refers to routing from other protocols that can be imported into the OSPF domain and readvertised by OSPF as type 1 external.</p> <p>Type 1 metric is comparable to the link-state metric; the cost is equal to the sum of the internal costs plus the external cost.</p>
4 (lowest)	External	<p>External type 2. Refers to routing from other protocols that can be imported into the OSPF domain and readvertised by OSPF as type 2 external.</p> <p>Type 2 metric is much larger than the cost of any intra-AS path; the cost is equal to the external cost. This is the OSPF default.</p>

If you use the **redistribute** command to import routes from other protocols or sources, the routes default to external type 2. You can specify a route map with the **redistribute** command to modify the type. Alternatively, you can use the **metric-type** keyword with the **redistribute** command to specify the type.

Virtual Links

Each OSPF area must be directly connected to the backbone area. The backbone is responsible for distributing routing information between nonbackbone areas. All routers in the backbone must be contiguous, but they need not be physically adjacent. You can configure backbone routers to be logically adjacent by creating OSPF virtual links.

Authentication

OSPF supports three modes of authentication:

- Null authentication—Implies that no authentication is in use.
- Simple password authentication—Requires a 64-bit unencrypted password in each OSPF packet.
- Cryptographic authentication—Uses a shared secret key that is configured on each router on a network. RFC 2328 defines the use of OSPF cryptographic authentication with the MD5 algorithm.

Opaque LSAs

OSPF opaque LSAs provide a generalized way of extending OSPF. The router generates opaque LSAs to carry traffic engineering information, accepts them from other routers, and floods them accordingly. OSPF uses the traffic engineering information to build a database from which paths can be computed for MPLS label-switched paths.

Route Leakage

Routes can be leaked into OSPF or from OSPF as follows:

- Route leakage into OSPF—When another routing protocol adds a new route to the routing table, or when a static route is added to the routing table, OSPF can be informed through the redistribute commands. When OSPF learns the new route, it floods the information into the routing domain by using external LSAs.
- Route leakage from OSPF—OSPF adds routing information to the routing table, which is used in forwarding IP packets.

Equal-Cost Multipath

OSPF inherently supports equal-cost multipath (ECMP). When building the shortest-path tree, OSPF calculates all paths of equal cost to a given destination. If equal-cost paths exist, OSPF inserts into the routing table the next hops for all equal-cost paths to a destination.

OSPF MIB

See the compressed software image bundle that you downloaded from the Juniper Networks website for complete information about the OSPF Management Information Base (MIB) supported by your router. The MIBs folder contains information about all supported standard and Juniper Networks E Series enterprise (proprietary) MIBs. OSPF does not act as a host within the router and therefore does not support the ospfIfMetric and ospfHost tables.

Interacting with Other Routing Protocols

OSPF interacts seamlessly with the following routing protocols:

- IS-IS—OSPF was developed originally from an early version of the IS-IS intradomain routing protocol. OSPF can import IS-IS routing information. See [“Configuring IS-IS” on page 377](#).
- RIP—E Series routers can simultaneously run OSPF and RIP. When doing so, OSPF routes are preferred over RIP. In general, use of the OSPF protocol is preferred because of its robustness, responsiveness, and decreased bandwidth requirements. See [“Configuring RIP” on page 259](#).
- BGP—The default expectation is that your routing environment is an AS running OSPF and exchanging BGP routes with other ASs. See *JunosE BGP and MPLS Configuration Guide*.

Implementing OSPF for IPv6

OSPF version 3 (OSPFv3) specifies IPv6 support in the OSPF protocol. Compared with OSPF version 2, the fundamental mechanisms for OSPF remain unchanged. These mechanisms include the following:

- OSPF designated router/border designated router election
- OSPF adjacency maintenance
- OSPF interface states, events, and interface state machine
- OSPF flooding mechanism
- OSPF LSA management
- SPF calculation

Understanding the OSPFv3 Difference

OSPFv3 changes the way it describes the network topology. All addressing semantics have been removed from the LSA header and from router-LSAs and network-LSAs. These two LSAs now describe the topology of the routing domain in a network-protocol-independent manner (using interface identifiers and router identifiers). New LSAs have been added to distribute IPv6 address information and data required for next-hop resolution.

In addition to the obvious address and processing modifications to handle IPv6 addressing, changes in OSPFv3 include the following:

- Authentication-related information is removed from the OSPF packet headers. Instead, OSPFv3 uses an authentication header in IPv6.
- OSPFv3 requires that each OSPF interface attached to a link be assigned a link-local unicast address.
- The option field for hello packets, database description (DD) packets, and LSAs has been expanded from 8 bits to 24 bits. In addition, two new LSA types have been added—link LSAs and intra-area prefix LSAs.
- The LSA flooding scope is more explicit in OSPFv3 and now appears in the LS type field. The LS type field also encodes a specific action to take for unknown LS types, allowing OSPF to function with unknown LS types instead of simply discarding them.
- The flooding process is modified to manage unrecognized LSAs and the new LSA flooding scope.
- The route calculation has been updated to handle modifications in the LSA database.

Supported LSA Types

OSPFv3 supports the following LSA types:

- Router LSA—Describes link state and costs of router links to the area; flooded within an area only
- Network LSA—Originated by the designated router for every broadcast or nonbroadcast multiaccess (NBMA) link having two or more attached routers; lists all routers attached to the link
- Interarea prefix LSA—Known as the type-3 summary LSA in OSPFv2; describes a prefix external to the area, yet internal to the AS
- Interarea router LSA—Called type 4 summary-LSAs in OSPFv2; describes a path to a destination OSPF router (that is, an AS boundary router) that is external to the area, yet internal to the AS
- AS-external LSA—Describes a path to a prefix external to the AS
- Link LSA (new for OSPFv3)—Provides the router's link-local address to all other routers attached to the link; informs other routers attached to the link of a list of IPv6 prefixes to associate with the link; enables the router to assert a collection of options bits in the Network-LSA to be originated for the link
- Intra-area prefix LSA (new for OSPFv3)—Associates a list of IPv6 address prefixes with a transit network link by referencing a network LSA, or associates a list of IPv6 address prefixes with a router by referencing a router LSA

An LSA in OSPFv3 is still identified by its type, link-state ID, and the advertising router ID. However, the link-state ID (for all LSA types) no longer carries IP address information. Instead, the LSA carries either an arbitrarily assigned number or an interface ID.

The link-state ID always has a fixed length of 4 bytes. The LS type field is extended to 16 bits and encodes LSA flooding scope and specific actions to take when the router encounters unrecognized LS types.

An IPv6 address, if it is specified in an LSA, is represented by its prefix length, prefix options, and prefix address.



NOTE: If an OSPF interface receives a hello packet whose IP address is the same as the IP address of the neighbor interface, the hello packet is not processed and the OSPF neighbor adjacency is brought down.

Unsupported OSPF Components

This release does not support the following OSPF components when implementing OSPF for IPv6:

- Virtual link
- Not-so-stubby-area (NSSA)
- Nonbroadcast multiaccess (NBMA)
- Remote neighbor

- Traffic engineering extensions
- Features specified in “OSPF as the PE/CE Protocol in BGP/MPLS IP VPNs” (draft-ietf-l3vpn-ospf-2547)

OSPF Configuration Tasks

Configuring OSPF requires careful coordination among a variety of routing devices:

- Routers internal to a single area
- Routers that link multiple areas within a single routing domain; these routers are called area border routers (ABRs)
- Routers that link multiple routing domains; these routers are called autonomous system boundary routers (AS boundary routers)

To minimally configure OSPF, you must:

1. Enable OSPF.
2. Configure and aggregate network ranges.
3. Create the router's OSPF network interfaces.
4. Define the OSPF areas attached to the router.

The following sections describe how to perform these tasks.

Starting OSPF

You enable OSPFv2 and OSPFv3 differently. When you enable OSPFv2 on your router, you can create either a range of OSPFv2 interfaces or a single OSPFv2 interface. When enabling OSPFv3, you create the OSPFv3 interface and assign the interface to an area.

Enabling OSPFv2

You can create OSPFv2 interfaces in the following ways:

- You can issue the **network area** command, which creates OSPF interfaces for all IP interfaces with IP addresses within the specified range.
- You can issue the **address area** command, which creates an OSPF interface in the specified area that sits on top of the IP interface at the given IP address (or on the unnumbered interface, if that is specified).



NOTE: Do not enable OSPF on any unidirectional interfaces (such as an MPLS tunnel), because it can never form an adjacency.

You can delete OSPFv2 interfaces in the following ways:

- You can issue the **no network area** command, which deletes all OSPF interfaces within the specified range.

- If the OSPF interface was created with the **address area** command, you can issue the **no address area** command to delete the specified interface.
- You can issue the **no ip address** command to delete the IP interface associated with the OSPF interface and also the OSPF interface itself.



NOTE: If an OSPF interface is configured on top of an IP interface and you delete the IP interface, the corresponding OSPF interface is also deleted. The previously configured network range, however, is not deleted. You must issue the **no network area** command to delete the range.

Enabling OSPFv3



NOTE: Before you can enable OSPFv3, you must specify an IPv6 license key. For additional information about configuring an IPv6 license key, see [“Configuring an IPv6 License” on page 160](#).

OSPFv3 provides IPv6 support in the OSPF protocol. To enable OSPFv3:

1. Issue the **ipv6 router ospf** command, and specify a process ID.
2. Use the **router id** command to specify a router ID for OSPFv3.
See [“Specifying an OSPF Router ID” on page 307](#).
3. Issue the **ipv6 ospf area** command (in interface configuration mode) to create an OSPFv3 interface under an area ID.

You can delete OSPFv3 interfaces in the following ways:

- You can issue the **no ipv6 router ospf** command, which deletes OSPFv3.
- You can issue the **no ipv6 ospf area** command to remove the OSPF interface from a specific area.

Creating a Range of OSPF Interfaces

To create a range of OSPFv2 interfaces:

1. Create an OSPF routing process.
2. Create the range of IP addresses associated with the routing process and the corresponding OSPF interfaces.
3. Assign an area ID associated with each range of IP addresses.

Each router running OSPFv2 has a database describing a map of the routing domain. This map needs to be identical in all participating routers.

network area

- Use to configure a range of OSPFv2 interfaces and their related area.
- If the specified range matches one or more of the IP addresses configured for IP interfaces, one or more corresponding OSPF interfaces are created and placed in the specified area.
- Create address ranges that do not overlap; you can attach only the same range of interfaces to a single area.
- You cannot use this command for unnumbered interfaces.
- If the range specified by this command includes an address on an interface that is being referred to by unnumbered interfaces, all of the unnumbered interfaces begin trying to form adjacencies. If this behavior is not intended, you must reevaluate the interface assignment or the range specified by the command.
- Example 1—shows the creation of one OSPF interface in the backbone area

```
host1(config-if)#ip address 2.2.2.1 255.255.0.0
host1(config-if)#ip address 2.2.1.1 255.255.0.0 secondary
host1(config)#router ospf 2
host1(config-router)#network 2.2.2.0 0.0.0.255 area 0
```

- Example 2—shows the creation of two OSPF interfaces, one in the backbone area and one in a non-backbone area

```
host1(config-if)#ip address 2.2.2.1 255.255.255.0
host1(config-if)#ip address 2.2.1.1 255.255.255.0 secondary
host1(config)#router ospf 2
host1(config-router)#network 2.2.2.0 0.0.0.255 area 0
host1(config-router)#network 2.2.1.0 0.0.0.255 area 1
```

This sequence of commands creates two OSPF ranges (2.2.2.0/24 and 2.2.1.0/24), with each range belonging to a different area. Area 0 is configured for 2.2.2.0/24, and area 1 is configured for 2.2.1.0/24. This sequence also creates two OSPF interfaces: one in the backbone area (area 0) using IP address 2.2.2.1, the second in a nonbackbone area (area 1) using IP address 2.2.1.1. This command also creates the two areas if they do not already exist.

- Use the **no** version to delete OSPF interfaces, ranges, and areas.



NOTE: Until you activate the configured network range for summaries by issuing the **area range** command, the range is not active for summarization; the network range is summarized through area summaries—for ABRs only. (See [“Aggregating OSPF Networks” on page 308](#).) The only range that is active by default if you do not issue the **area range** command is the network that matches the IP interface’s network exactly. (In other words, by default the exact network of the IP interface is going to be summarized into other areas.)

- See **network area**

ospf enable

- Use to enable OSPF on the router.
- OSPF is enabled by default.
- Example
`host1(config-router)#ospf enable`
- The **no** version of this command is deprecated and may be removed in a future release. Use the **ospf shutdown** command to disable OSPF on the router.
- See ospf enable

router ospf

ipv6 router ospf

- Use to set an OSPF process ID.
- The process ID can be any positive integer in the range 1–65535.
- You must assign a unique ID for the OSPF routing process.
- From a virtual router context you can specify a VRF name (OSPFv2 only). Doing so changes the context to that of the specified VRF and remains so until you exit from the OSPFv2 router context.
- Example 1
`host1(config)#router ospf 5`
- Example 2
`host1(config)#ipv6 router ospf 5`
- Use the **no** version to end the designated OSPF routing process.
- See router ospf
- See ipv6 router ospf

Creating a Single OSPFv2 Interface

To create a single OSPFv2 interface:

1. Create an OSPF routing process.
2. Create the OSPF interface associated with the IP interface at the specified address.

Each router running OSPF has a database describing a map of the routing domain. This map needs to be identical in all participating routers.

address area

- Use to create an interface in an area on which OSPFv2 runs, on top of the IP interface at the specified IP address.
- You can specify either an IP address or an unnumbered interface.
- Configures OSPFv2 with the default values. You can configure the interface with a nondefault value by using the other **address** commands. You must first issue the

address area command before issuing any other **address** commands. See [“Configuring OSPF Interfaces” on page 309](#) for more information.

- Example

```
host1(config-router)#address 10.10.32.100 area 0.0.0.0
```
- Use the **no version** to delete the OSPFv2 interface.
- See **address area**

ospf enable

- Use to enable OSPF on the router.
- OSPF is enabled by default.
- Example

```
host1(config-router)#ospf enable
```
- The **no** version of this command is deprecated and might be removed in a future release. Use the **ospf shutdown** command to disable OSPF on the router.
- See **ospf enable**

router ospf

- Use to set an OSPF process ID.
- The process ID can be any positive integer in the range 1–65535.
- You must assign a unique ID for each OSPF routing process.
- Example

```
host1(config)#router ospf 5
```
- Use the **no** version to end the designated OSPF routing process.
- See **router ospf**

Specifying an OSPF Router ID

The router ID is typically derived by each router from its interface IP addresses. However, you can use the **router-id** command to specify a different router ID for OSPF.



NOTE: You must specify a router ID to enable OSPFv3.

Although you can specify the router IP address using the **ip router-id** command in Global Configuration mode for OSPFv2 interfaces, use the **router-id** command in Router Configuration mode to enable the router to use a different IP address as the OSPF router ID rather than the address used for other IP routing protocols.

router-id

- Use to specify a different IP address for the router to use as the OSPF router ID.
- Example

```
host1(config-router)#router-id 192.168.50.5
```
- Use the **no** version to force OSPF to use the previous OSPF router ID behavior.
- See router-id

Aggregating OSPF Networks

You can aggregate OSPF networks at the border of an OSPF area by using the **area range** command. You can also aggregate OSPF networks when entering the border of the OSPF domain by using the **summary-address** command for IP routes and the **summary-prefix** command for IPv6 routes.

To create an area range:

1. Configure the interface's IP addresses using the **ip address** command.
2. Enable OSPF using the **router ospf** command.
3. Configure the network area with the **network area** command.
4. Configure the area range with the **area range** command.

area range

- Use to aggregate OSPF routes at an OSPF area border.
- Use only for ABRs.
- You can configure multiple instances of the area range command for a single OSPF area.
- By default, the range of configured networks is advertised in type 3 (summary) LSAs.
- Use the **advertise** keyword (IPv6 only) to specify advertisement of configured networks.
- Use the **do-not-advertise** keyword to prevent advertisement of configured networks.
- Use the **cost** keyword (IPv6 only) to define the cost value (0–16777215) for the specified range of networks.
- Use the command **no area area-id** (with no other keywords) to remove the specified area from the configuration.
- Use the **summary-address** or **summary-prefix** command to summarize external routes being redistributed into OSPF.
- Example

```
host1(config-if)#ip address 2.2.10.1 255.255.255.0
host1(config-if)#ip address 2.2.11.1 255.255.255.0 secondary
host1(config)#router ospf 2
host1(config-router)#network 2.2.0.0 0.0.255.255 area 0
```

At this point, the OSPF process is configured with two OSPF interfaces. If your router is an ABR, two networks must be summarized: 2.2.10.0/24 and 2.2.11.0/24.

```
host1(config-router)#area 0 range 2.2.0.0 255.255.0.0
```

After you enter this **area range** command, only the aggregated range 2.2.0.0/16 is going to be summarized.

- Use the **no** version to disable the aggregation of routes at the OSPF area border.
- See area range

summary-address

summary-prefix

- Use to aggregate external routes at the border of the OSPF routing domain.
- Use the **summary-address** command for IP routes. Use the **summary-prefix** command for IPv6 routes.
- Use only for AS boundary routers.
- The AS boundary router advertises one external route as an aggregate for all redistributed routes that are covered by the address.
- For OSPF, these commands summarize only routes from other routing protocols that are being redistributed into OSPF.
- With these commands, you can reduce the load of advertising many OSPF external routes by specifying a range that includes some (or all) of these external routes.
- Example

```
host1(config-router)#summary-address 10.1.0.0 255.255.0.0
```

- Use the area range command for route summarization between OSPF areas.
- Use the **no** version to restore the default.
- See summary-address
- See summary-prefix

Configuring OSPF Interfaces

You can configure OSPF attributes for either a single OSPF network by using the **address** commands, or for all OSPF networks on a particular media interface by using the **ip ospf** commands.

The size of the OSPF maximum transmission unit (MTU) is negotiated rather than configured. OSPF database description exchange uses the interface MTU to signal the largest OSPF MTU that can be sent over an OSPF interface without fragmentation.

Configuring OSPF attributes for OSPF networks includes setting the following:

- Cost
- Dead interval

- Hello interval
- Router priority
- Retransmit interval
- Transmit delay



NOTE: Before using the **address** or **ip ospf** commands, see “[Precedence of Commands](#)” on page 317 for information about the relationship between these commands.

address Commands

You can use the **address area** command to create a new OSPF interface. Use the other **address** commands to configure parameters for OSPF interfaces that already exist.

The **address** commands configure OSPF attributes for a single OSPF network. The **ip ospf** commands configure OSPF attributes for all OSPF networks in the given interface context—for example, in a multinet environment where multiple IP networks sit on top of an Ethernet interface.



NOTE: You must first issue the **address area** command before issuing any other **address** command.

address area

- Use to create a new OSPF interface and configure the area ID.
- The interface can have an IP address, or it can be unnumbered.
- Example

```
host1(config-router)#address 10.12.10.2 area 3
```

- You must first issue the **address area** command before issuing any other **address** commands.
- Use the **no** version to delete the area ID from the specified interface.
- See address area

address cost

- Use to specify the cost metric for the interface. The cost is used in calculating the SPF routing table and can be in the range 0–65535.
- The interface can have an IP address, or it can be unnumbered.
- Example

```
host1(config-router)#address unnumbered atm 4/0.1 area 3  
host1(config-router)#address unnumbered atm 4/0.1 cost 50
```

- Use the **no** version to reset the path cost to the default value, 1.
- See address cost

address dead-interval

- Use to specify the time period for the router's neighbors to wait without seeing hello packets from the router before they declare the router to be down.
- The dead interval can be in the range 0–2147483647 seconds, and is advertised by the router's hello packets.
- For the OSPF routers to become adjacent, the dead interval must be identical on each router.
- The interface can have an IP address, or it can be unnumbered.
- Example


```
host1(config-router)#address 192.168.10.32 area 6
host1(config-router)#address 192.168.10.32 dead-interval 60
```
- Use the **no** version to reset the dead interval to the default value, 40 seconds.
- See address dead-interval

address hello-interval

- Use to specify the interval between hello packets that the router sends on the interface.
- The hello interval can be in the range 1–65535 seconds.
- The interface can have an IP address, or it can be unnumbered.
- Example


```
host1(config-router)#address 192.168.1.1 area 5
host1(config-router)#address 192.168.1.1 hello-interval 25
```
- Use the **no** version to reset the hello interval to the default value, 10 seconds.
- See address hello-interval

address passive-interface

- Use to disable the transmission of routing updates on the interface, meaning that OSPF routing information is neither sent by nor received through the interface.
- The interface can have an IP address, or it can be unnumbered.
- Example


```
host1(config-router)#address 192.168.100.20 area 5
host1(config-router)#address 192.168.100.20 passive-interface
```
- Use the **no** version to reenables the transmission of routing updates.
- See address passive-interface

address priority

- Use to specify the router priority, an 8-bit number in the range 1–255. Used in determining the designated router for the particular network.
- Applies only to nonbroadcast multiaccess (NBMA) networks. Every broadcast and NBMA network has a designated router.
- The interface can have an IP address, or it can be unnumbered.
- Example

```
host1(config-router)#address unnumbered loopback 0 area 6
host1(config-router)#address unnumbered loopback 0 priority
```
- Use the **no** version to restore the default value, 1.
- See address priority

address retransmit-interval

- Use to specify the time between LSA retransmissions for the interface when an acknowledgment for the LSA is not received.
- Specify an interval in the range 0–3600 seconds; the default value is 5.
- The interface can have an IP address, or it can be unnumbered.
- Example

```
host1(config-router)#address 192.168.10.200 area 6
host1(config-router)#address 192.168.10.200 retransmit-interval 500
```
- Use the **no** version to restore the default value, 5 seconds.
- See address retransmit-interval

address transmit-delay

- Use to specify the estimated time it takes to transmit a link-state update packet on the interface.
- Specify an interval in the range 0–3600 seconds; the default value is 1.
- The interface can have an IP address, or it can be unnumbered.
- Example

```
host1(config-router)#address 10.100.25.38 area 7
host1(config-router)#address 10.100.25.38 transmit-delay 30
```
- Use the **no** version to restore the default value, 1 second.
- See address transmit-delay

ip ospf and ipv6 ospf Commands

The **ip ospf** commands have two effects on interface configuration. These effects apply to all **ip ospf** commands:

- Configuration per logical IP interface (for example, Fast Ethernet 0/1.3 or ATM 5/0.1):

The **ip ospf** command configures the specified OSPF parameters for all networks configured on the given IP interface—for example, all multinetted addresses on an interface.

The **no** version of the command resets the specified parameters to *unspecified*.

If the **no** version of the command takes effect for a specified IP interface, there is no default value for the specified parameters. The parameter is set back to unspecified values. However, the value of the specified parameter for the OSPF interface is set back to the default value or the value previously specified by the **address** command.



NOTE: The **ip ospf** commands configure OSPF attributes for all OSPF networks in the given interface context—for example, in a multinet environment where multiple IP networks sit on top of an Ethernet interface. The **address** commands configure OSPF attributes for a single OSPF interface.

- Configuration per OSPF interface:

The **ip ospf** command configures the specified OSPF parameters for each OSPF interface that sits on top of the IP interface.

The **no** version of the command restores the specified parameters to the default values.



NOTE: We recommend using **address** commands to set attributes of OSPF interfaces created using the **address area** command.

ipv6 ospf area

- Use to create an OSPFv3 interface under the specified area ID or move the OSPFv3 interface from its current area to the specified area.
- Specify an optional process ID in the range 1–65535.
- Example

```
host1(config)#interface fastethernet 0/0
host1(config-if)#ipv6 ospf area 50
```

- Use the **no** version to remove this interface from the specified area.
- See **ipv6 ospf area**

ip ospf cost

ipv6 ospf cost

- Use to configure the cost of sending a packet on the network.
- Cost is a metric value in the range 0–65535; the default value is 1.
- The router LSA advertises the link-state metric as the link cost.
- For the IPv6 command, you can specify an optional process ID in the range 1–65535.

- Example 1

```
host1(config)#interface fastethernet 0/0
host1(config-if)#ip ospf cost 50
```

- Example 2

```
host1(config)#interface fastethernet 0/0
host1(config-if)#ipv6 ospf cost 50
```

- Use the **no** version to reset the path cost to the default value, 1.
- See ip ospf cost
- See ipv6 ospf cost

ip ospf dead-interval

ipv6 ospf dead-interval

- Use to configure the interval since the last hello packet was seen.
- Specify an interval in the range 0–2147483647 seconds; the default value is 40 seconds.
- For the OSPF routers to become adjacent, the dead interval must be identical on each router.
- The router's hello packets advertise this interval.
- For the IPv6 command, you can specify an optional process ID in the range 1–65535.
- Example 1

```
host1(config-if)#ip ospf dead-interval 60
```

- Example 2

```
host1(config-if)#ipv6 ospf dead-interval 60
```

- Use the **no** version to restore the default value, 40 seconds.
- See ip ospf dead-interval
- See ipv6 ospf dead-interval

ip ospf hello-interval

ipv6 ospf hello-interval

- Use to configure the interval between hello packets.
- Specify an interval in the range 1–65535 seconds; the default value is 10 seconds.
- For the OSPF routers to become adjacent, the hello interval must be identical on each router.
- For the IPv6 command, you can specify an optional process ID in the range 1–65535.
- Example 1

```
host1(config-if)#ip ospf hello-interval 8
```

- Example 2

```
host1(config-if)#ipv6 ospf hello-interval 8
```

- Use the **no** version to restore the default value, 10 seconds.
- See `ip ospf hello-interval`
- See `ipv6 ospf hello-interval`

ipv6 ospf mtu-ignore

- Use to specify that the interface disregard the MTU size contained in the data description packet.
- When enabled, the interface accepts data description packets from its neighbor even if it has a different MTU size (the MTU size must be less than 18000).
- Specify an optional process ID in the range 1–65535.
- Example


```
host1(config-if)#ipv6 ospf mtu-ignore
```
- Use the **no** version to reset the default: that the neighbor MTU size must match the MTU size of the OSPFv3 interface from which the packet is received.
- See `ipv6 ospf mtu-ignore`

ipv6 ospf network

- Use to configure the OSPF network type for an interface.
- Specify a network type (broadcast or point-to-point) for the interface.
- Example


```
host1(config)#interface fastethernet 0/0
host1(config-if)#ipv6 ospf network broadcast
```
- Use the **no** version to revert the network type to the default for the interface.
- See `ipv6 ospf network`

ip ospf priority

ipv6 ospf priority

- Use to configure the router's priority.
- Select a priority level in the range 0–255; the default value is 1.
- This setting determines the designated router for the particular network.
- A router whose priority is set to 0 cannot be a designated router.
- A higher priority value for an OSPF interface signifies a greater likelihood of that router becoming the designated router. A value of 1 means that the router has the least chance of becoming a designated router.
- Configure priority only for interfaces to multiaccess networks.
- For the IPv6 command, you can specify an optional process ID in the range 1–65535.
- Example 1


```
host1(config-if)#ip ospf priority 2
```

- Example 2

```
host1(config-if)#ipv6 ospf priority 2
```

- Use the **no** version to restore the default value, 1.
- See ip ospf priority
- See ipv6 ospf priority

ip ospf retransmit-interval

ipv6 ospf retransmit-interval

- Use to configure the time interval between retransmission of an LSA.
- Specify an interval in the range 0–3600 seconds; the default value is 5 seconds.
- For the IPv6 command, you can specify an optional process ID in the range 1–65535.
- Example 1

```
host1(config-if)#ip ospf retransmit-interval 10
```

- Example 2

```
host1(config-if)#ipv6 ospf retransmit-interval 10
```

- Use the **no** version to return to the default value, 5 seconds.
- See ip ospf retransmit-interval
- See ipv6 ospf retransmit-interval

ip ospf transmit-delay

ipv6 ospf transmit-delay

- Use to configure the time it takes to transmit a link-state update on the interface.
- This is the time between transmissions of LSAs.
- Specify an interval in the range 0–3600 seconds; the default value is 1 second.
- In setting the time, consider the interface's transmission and propagation delays.
- For the IPv6 command, you can specify an optional process ID in the range 1–65535.
- Example 1

```
host1(config-if)#ip ospf transmit-delay 4
```

- Example 2

```
host1(config-if)#ipv6 ospf transmit-delay 4
```

- Use the **no** version to return to the default value, 1 second.
- See ip ospf transmit-delay
- See ipv6 ospf transmit-delay

Comparison Example

In the following example you configure a range of OSPF interfaces with the **network area** command.

```
host1(config)#interface fastEthernet 0/0
host1(config-if)#ip address 1.1.1.1 255.255.255.0
host1(config-if)#ip address 2.2.2.2 255.255.255.0 secondary
host1(config-if)#exit
host1(config)#router ospf 1
host1(config-router)#network 1.1.0 0.0.0.255 area 0
host1(config-router)#network 2.2.0 0.0.0.255 area 0
```

If you want to specify the cost, you can do so for both interfaces simultaneously.

```
host1(config)#interface fastEthernet 0/0
host1(config-if)#ip ospf cost 30
```

You can use **address** commands to create a third OSPF interface over the Ethernet interface. When you specify a cost, you set it for only that interface.

```
host1(config)#interface fastEthernet 0/0
host1(config-if)#ip address 3.3.3.3 255.255.255.0 secondary
host1(config-if)#exit
host1(config)#router ospf 1
host1(config-router)#address 3.3.3.3 area 0
host1(config-router)#address 3.3.3.3 cost 25
```

Precedence of Commands

For a single OSPF interface, when you modify the same OSPF attribute by issuing both the **ip ospf** command and the **address** command, the value configured with the **address** command takes precedence. In other words, the most specific command for a single OSPF interface takes precedence.

Consider the following example. Suppose you have a numbered IP interface with an IP address of 10.10.1.1/24 sitting on top of Fast Ethernet interface 0/0. Configure a single OSPF interface on top of the IP interface.

```
host1(config)#router ospf 100
host1(router-config)#address 10.10.1.1 area 0
```

The default cost for this OSPF interface is 10. Change the cost for this OSPF interface by using the **address cost** command.

```
host1(router-config)#address 10.10.1.1 cost 45
```

The cost for OSPF interface 10.10.1.1 is now 45.

Now use the **ip ospf cost** command to change the cost for this OSPF interface.

```
host1(config)#int fastEthernet 0/0
host1(config-if)#ip ospf cost 23
```

The cost of OSPF interface 10.10.1.1 does *not* change. The previously issued **address cost** command is more specific for the interface and takes precedence over the **ip ospf cost**

command. You must use the **address cost** command if you want to change the cost again.

```
host1(router-config)#address 10.10.1.1 cost 23
```

Configuring OSPF Areas

You can divide your OSPF routing domain into OSPF areas. Dividing into areas provides the following benefits:

- Reduces resource demands placed on routers and links
- Reduces the router CPU usage by the OSPF routing calculation
- Reduces the amount of memory used for link-state databases
- Hides subnets within areas from the rest of the routing domain
- Increases routing security within the area

You must attach each area in your routing domain to an area called the backbone area (0.0.0.0).

Disadvantages of using OSPF areas include the following:

- Areas hide information, which can result in less-than-optimal data paths.
- Creating areas complicates the task of configuring OSPF routing domains.

You can optionally define an area to be a stub area, totally stubby area, or a not-so-stubby area. You can configure virtual links for areas that are not directly connected to a backbone area.

area default-cost

- Use to configure the cost for the default summary route sent into a stub area.
- Cost is a metric value in the range 1–65535; the default value is 1.
- Use only on an ABR attached to a stub area.
- Provides the metric for the summary default route that the ABR generates into the stub area.
- Example

```
host1(config-router)#area 47.0.0.0 default-cost 1
```

- Use the **no** version to remove the configured default route cost.
- See area default-cost

area nssa

- Use to configure the area as an NSSA.
- You must configure each router in a stub area as belonging to the stub area.
- An NSSA is like a stub area, but it can also import external AS routes in a limited way.

- To cause NSSA border routers to generate a type 7 default LSA in the OSPF database if there is a default route in the routing table, you must specify the **default-information-originate** option.
- You can specify a metric cost, metric type, or a route map to be applied to the generated type 7 default LSAs.
- Use the **no-summary** keyword to create a “totally stubby area” and restrict type 3 summary LSAs from flowing into the area. However, type 3 default-route LSAs can continue to flow into the area and a type 3 default-route LSA is advertised into the NSSA.



NOTE: We recommend that you do not use the **default-information-originate** keyword with the **no-summary** keyword for an NSSA.

- Example

```
host1(config-router)#area 35.0.0.0 nssa
```
- Use the **no** version to remove the NSSA designation from the area, to stop the generation of type 7 default LSAs, to reinitiate type 3 summary LSAs into the area (with the **no-summary** keyword), or to stop the application of the specified metric cost, metric type, or a route map to the type 7 default LSAs.
- See area nssa

area stub

- Use to configure a stub area. Stub areas do not get flooded with external LSAs but do carry a default route, intra-area routes, and interarea routes. The lack of flooding in stub areas reduces the size of the OSPF database for the area and decreases memory usage for external routers in the stub area.
- You must configure each router in a stub area as belonging to the stub area.
- You cannot configure virtual links across a stub area.
- Stub areas cannot contain AS boundary routers.
- Use the **no-summary** keyword to create a “totally stubby area” and restrict type 3 summary LSAs from entering the stub area. However, type 3 default-route LSAs can continue to flow into the area.
- Example

```
host1(config-router)#area 47.0.0.0 stub
```
- Use the **no** version to disable this function.
- See area stub

area virtual-link

- Use to configure an OSPF virtual link.
- A virtual link is used for areas that do not have a direct connection to the backbone area.
- To have configured virtual links, the router itself must be an ABR.
- Virtual links are identified by the router ID of the other endpoint, which is also an ABR.
- The two endpoint routers must be attached to a common area, called the virtual link's transit area.
- Virtual links are part of the backbone and behave as if they were unnumbered point-to-point networks between the two routers.
- A virtual link uses the intra-area routing of its transit area to forward packets.
- Example

```
host1(config-router)#area 27.0.0.0 virtual-link 27.8.4.2
```
- Use the **no** version to remove an OSPF virtual link.
- See area virtual-link

area virtual-link dead-interval

- Use to set the time in seconds to wait before declaring a neighbor down after not receiving packets from that neighbor.
- Specify an interval in the range 0–2147483647 seconds; the default value is 40 seconds.
- Example

```
host1(config-router)#area 27.0.0.0 virtual-link 27.8.4.2 dead-interval 10
```
- Use the **no** version to remove the virtual link's dead interval.
- See area virtual-link dead-interval

area virtual-link hello-interval

- Use to configure the hello interval on an OSPF virtual link.
- Specify an interval in the range 1–65535 seconds; the default value is 10 seconds.
- The hello interval is the time between the transmission of hello packets.
- The hello interval must be the same for all routers attached to a common network.
- Example

```
host1(config-router)#area 27.0.0.0 virtual-link 27.8.4.2 hello-interval 10
```
- Use the **no** version to remove the virtual link's hello interval.
- See area virtual-link hello-interval

area virtual-link retransmit-interval

- Use to configure the retransmission interval on an OSPF virtual link.
- The retransmit interval is the time between retransmissions of link-state advertisements for adjacencies belonging to the interface.
- Specify an interval in the range 0–3600 seconds; the default value is 5 seconds.
- Set the value greater than the expected round-trip delay.
- Example


```
host1(config-router)#area 27.0.0.0 virtual-link 27.8.4.2 retransmit-interval 6
```
- Use the **no** version to remove the interface's retransmit interval.
- See area virtual-link retransmit-interval

area virtual-link transmit-delay

- Use to configure the estimated time it takes to transmit a link-state update packet on the virtual link.
- Specify an interval in the range 0–3600 seconds; the default value is 1 second.
- Example


```
host1(config-router)#area 27.0.0.0 virtual-link 27.8.4.2 transmit-delay 1
```
- Use the **no** version to remove the interface's transmit delay.
- See area virtual-link transmit-delay

automatic-virtual-link

- Use to enable an automatic virtual link configuration.
- If this feature is enabled, then backbone connectivity is ensured by the automatic creation of a virtual link between this backbone router that has an interface to a common nonbackbone area and other backbone routers that have interfaces to a common nonbackbone area.
- Example


```
host1(config-router)#automatic-virtual-link
```
- Use the **no** version to disable an automatic virtual link.
- See automatic-virtual-link

no area

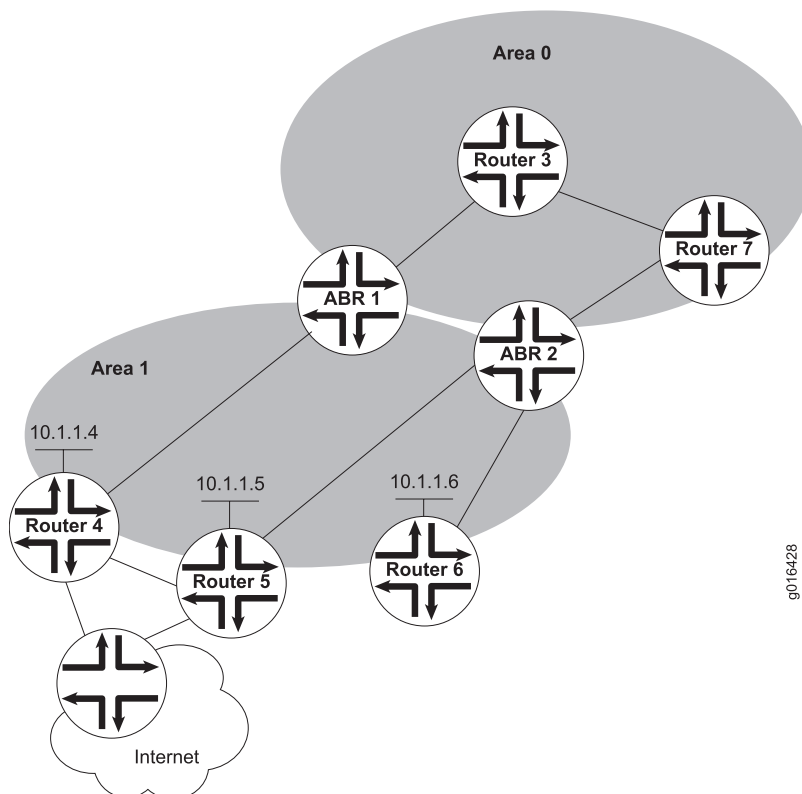
- Use to remove the specified area only if no OSPF interfaces are configured in the area.
- Example


```
host1(config-router)#no area 47.0.0.0
```
- There is no affirmative version of this command; there is only a **no** version.
- See no area

Optimizing the Cost to Reach a Range of OSPF Routers Within an Area

OSPF automatically calculates a cost for an area based on the individual costs from an area border router to each OSPF router within that area. The highest individual cost is advertised by the area border router as the aggregate cost for routers in an adjacent area to reach any router within the first area. Consider the topology shown in [Figure 17 on page 322](#).

Figure 17: Optimizing OSPF Area Aggregate Costs



In this example, the router IDs of the OSPF routers in area 1 are announced by OSPF into area 0. ABR 1 and ABR 2 aggregate the 10.1.1.x networks in area 1 at the border. Each individual OSPF link has a cost of 1.

ABR 1 calculates the following costs:

- A cost of 5 to reach Router 6:
ABR 1-->Router 4-->Router 5--> ABR 2-->Router 6
- A cost of 3 to reach Router 5:
ABR 1-->Router 4-->Router 5
- A cost of 2 to reach Router 4:
ABR 1->Router 4

The highest individual cost is 5. ABR 1 subsequently advertises a cost of 5 for the aggregate 10.1.1.0 to be announced into area 0.

ABR 2 calculates the following costs:

- A cost of 2 to reach Router 6:
ABR 2-->Router 6
- A cost of 2 to reach Router 5:
ABR 2-->Router 5
- A cost of 3 to reach Router 4:
ABR 2-->Router 5-->Router 4

The highest individual cost is 3. ABR 2 subsequently calculates a cost of 3 for the aggregate 10.1.1.0 to be announced into area 0.

When Router 3 sends traffic to Router 4, it routes the traffic via ABR 2 because ABR 2 advertises a lower cost than does ABR 1. However, this path is not optimal, because the traffic must traverse Router 3-->Router 7-->ABR 2--> Router 5-->Router 4. The path through ABR 1, Router 3-->ABR 1-->Router 4 is a better path, even though ABR 1 advertised a higher aggregate cost.

You can avoid this kind of suboptimal routing by manually configuring a cost for the aggregate. The summary LSA then announces the configured cost instead of the automatically calculated cost. Use the **cost** keyword with the **area range** command to specify a cost for a range of OSPF networks aggregated at an area boundary.

Configuring Authentication

The router supports the following authentication capabilities:

- Null authentication
- Simple password authentication
- MD5 authentication

The MD5 algorithm takes as input a message of arbitrary length and produces a 128-bit *fingerprint* or *message digest* of the input. MD5 is used to create digital signatures. It is a one-way *hash* function, meaning that it takes a message and converts it into a fixed string of digits, called a message digest.

When using a one-way hash function, you can compare a calculated message digest with the message digest that is decrypted by using a public key (password). The key verifies that the message has not been tampered with. This comparison process is called a hashcheck.



NOTE: You must first issue the **address area** command before issuing any other **address** command.

Authentication Requirements

If you configure either simple password or MD5 authentication, the password or authentication key must be the same on both sides of an adjacency. When you change the password or key on one side of an established adjacency, you must also change it on the other side within the dead interval. Doing this enables a hello packet that has the latest authentication information to be sent before the dead interval expires. If the packet is not sent within the dead interval, the adjacency breaks down and is not reestablished until both sides of the adjacency have the same password or key.

address authentication-key

- Use to assign a password used by neighboring routers for OSPF simple password authentication.
- The interface can have an IP address, or it can be unnumbered.
- You can specify whether the key is entered in unencrypted or encrypted format. If you do not specify which, the string is assumed to be unencrypted.
- The password, or key, is a character string up to 8 characters long.
- Example

```
host1(config-router)#address 10.12.10.2 authentication-key 9rdf7
```
- Use the **no** version to delete the password from the specified interface.
- See address authentication-key

address authentication message-digest

- Use to specify that MD5 authentication is used for the OSPF interface.
- You must configure the MD5 key ID and password with the **address message-digest-key md5** command.
- Switching between authentication types does not delete a configured MD5 key ID or password; only using the **no** version of that configuration command can delete the MD5 key ID and password.
- Example

```
host1(config-router)#address 10.12.10.2 authentication message-digest
```
- Use the **no** version to set authentication for the interface to none without removing any configured MD5 key. You can subsequently apply MD5 authentication to the interface without having to reconfigure the key.
- See address authentication message-digest

address authentication-none

- Use to disable authentication on the interface.
- The interface can have an IP address, or it can be unnumbered.
- Example

```
host1(config-router)#address 192.168.10.32 authentication-none
```

- The **no** version has no effect.
- See address authentication-none

address message-digest-key md5

- Use to enable OSPF MD5 authentication and configure the MD5 key.
- The MD5 key is a character string up to 16 characters long. You must also specify a key identifier and whether the key is entered in unencrypted or encrypted format. If you do not specify which, the string is assumed to be unencrypted.
- Configures an interface already created, or creates a new OSPF interface and configures the MD5 key. The interface can have an IP address, or it can be unnumbered.
- Example

```
host1(config-router)#address 10.1.1.1 message-digest-key 1 md5 0 9mwk6gdr76
```

- Use the **no** version to delete the MD5 key.
- See address message-digest-key md5

area virtual-link authentication-key

- Use to configure a simple password for a virtual link.
- You can specify whether the key is entered in unencrypted or encrypted format. If you do not specify which, the string is assumed to be unencrypted.
- The password can be up to eight characters long.
- Example

```
host1(config-router)#area 27.0.0.0 virtual-link 27.3.4.5 authentication-key sadsa29c
```

- Use the **no** version to remove the password.
- See area virtual-link authentication-key

area virtual-link authentication message-digest

- Use to specify that MD5 authentication is used for the particular virtual link.
 - You must configure the MD5 key ID and password with the **area virtual-link message-digest-key md5** command.
 - Switching between authentication types does not delete a configured MD5 key ID or password; only using the **no** version of that configuration command can delete the MD5 key ID and password.
 - Example
- ```
host1(config-router)#area 27.0.0.0 virtual-link 27.2.3.4 authentication message-digest
```
- Use the **no** version to set authentication for the virtual link to none without removing any configured MD5 key. You can subsequently apply MD5 authentication to the virtual link without having to reconfigure the key.
  - See area virtual-link authentication message-digest

***area virtual-link authentication-none***

- Use to specify that no authentication is used for the particular virtual link.
- Example

```
host1(config-router)#area 27.0.0.0 virtual-link 27.2.3.4 authentication-none
```
- The **no** version has no effect.
- See area virtual-link authentication-none

***area virtual-link message-digest-key md5***

- Use to enable MD5 authentication and to configure MD5 keys for virtual links.
- The MD5 key is a character string up to 16 characters long. You must also specify a key identifier and whether the key is entered in unencrypted or encrypted format. If you do not specify which, the string is assumed to be unencrypted.
- Example

```
host1(config-router)#area 27.0.0.0 virtual-link 327.3.4.5 message-digest-key 2 md5
rc45lsm2c
```
- Use the **no** version to remove the password.
- See area virtual-link message-digest-key md5

***ip ospf authentication-key***

- Use to configure a type 1 authentication (a simple password) on the interface.
- Neighboring OSPF routers use the password to access the router's interface.
- Use the same password on all neighboring routers on the same network.
- Use this password only when you enable authentication for the interface.
- You can specify whether the key is entered in unencrypted or encrypted format. If you do not specify which, the string is assumed to be unencrypted.
- Use a password that is a continuous string up to 8 characters long.
- Example

```
host1(config-if)#ip ospf authentication-key yourpwd
```
- Use the **no** version to remove the password on the interface.
- See ip ospf authentication-key

***ip ospf authentication message-digest***

- Use to specify the authentication method for the interface as MD5.
- You must configure the MD5 key ID and password with the **ip ospf message-digest-key md5** command.
- Switching between authentication types does not delete a configured MD5 key ID or password; only using the **no** version of that configuration command can delete the MD5 key ID and password.

- Example

```
host1(config-if)#ip ospf authentication message-digest
```

- Use the **no** version to set authentication for the interface to none without removing any configured MD5 key. You can subsequently apply MD5 authentication to the interface without having to reconfigure the key.
- See ip ospf authentication message-digest

#### *ip ospf authentication-none*

- Use to specify that no authentication is used for the OSPF interface.
  - Example
- ```
host1(config-if)#ip ospf authentication-none
```
- The **no** version has no effect.
 - See ip ospf authentication-none

ip ospf message-digest-key md5

- Use to enable MD5 authentication on the OSPF interface and configure the MD5 key.



NOTE: If all the MD5 keys have been deleted, the authentication type is still MD5, but you need to configure MD5 keys.

- The MD5 key is a character string up to 16 characters long. You must also specify a key identifier and whether the key is entered in unencrypted or encrypted format. If you do not specify which, the string is assumed to be unencrypted.



NOTE: To display the password only in encrypted text, use the **service password-encryption** command.

- Example

```
host1(config-if)#ip ospf message-digest-key 3 md5 0 tre987is
```

- Use the **no** version to delete an MD5 key from the OSPF interface.



NOTE: To disable MD5 authentication for the interface, use the **ip ospf authentication-none** command.

- See ip ospf message-digest-key md5

Configuring the BFD Protocol for OSPF

The **ip ospf bfd-liveness-detection** and **ipv6 ospf bfd-liveness-detection** commands configure the Bidirectional Forwarding Detection (BFD) protocol for OSPFv2 and OSPFv3 (respectively). The BFD protocol uses control packets and shorter detection time limits to more rapidly detect failures in a network. Also, because they are adjustable, you can modify the BFD timers for more or less aggressive failure detection.

When you issue the **ip ospf bfd-liveness-detection** or **ipv6 ospf bfd-liveness-detection** command on an OSPF peer, the peer establishes BFD liveness detection with all BFD-enabled OSPF peers. When the local peer receives an update from a remote OSPF peer—if BFD is enabled and if the session is not already present—the local peer attempts to create a BFD session to the remote peer.

Each adjacent pair of peers negotiates an acceptable transmit interval for BFD packets. The negotiated value can be different on each peer. Each peer then calculates a BFD liveness detection interval. When a peer does not receive a BFD packet within the detection interval, it declares the BFD session to be down and purges all routes learned from the remote peer.



NOTE: Before the router can use the **ip ospf bfd-liveness-detection** or **ipv6 ospf bfd-liveness-detection** command, you must specify a BFD license key. To view an already configured license, use the **show license bfd** command.

For general information about configuring and monitoring the BFD protocol, see *JunosE IP Services Configuration Guide*.

ip ospf bfd-liveness-detection

ipv6 ospf bfd-liveness-detection

- Use to enable BFD (bidirectional forwarding detection) and define BFD values to more quickly detect OSPFv2 or OSPFv3 data path failures.
- The peers in an OSPF adjacency use the configured values to negotiate the actual transmit intervals for BFD packets.
 - You can use the **minimum-transmit-interval** keyword to specify the interval at which the local peer proposes to transmit BFD control packets to the remote peer. The default value is 300 milliseconds.
 - You can use the **minimum-receive-interval** keyword to specify the minimum interval at which the local peer must receive BFD control packets from the remote peer. The default value is 300 milliseconds.
 - You can use the **minimum-interval** keyword to specify the same value for both of those intervals. Configuring a minimum interval has the same effect as configuring the minimum receive interval and the minimum transmit interval to the same value. The default value is 300 milliseconds.

- You can use the **multiplier** keyword to specify the detection multiplier value. The calculated BFD liveness detection interval can be different on each peer. The multiplier value is roughly equivalent to the number of packets that can be missed before the BFD session is declared to be down. The default value is 3.
- For details on liveness detection negotiation, see *JunosE IP Services Configuration Guide*.
- You can change the BFD liveness detection parameters at any time without stopping or restarting the existing session; BFD automatically adjusts to the new parameter value. However, no changes to BFD parameters take place until the values resynchronize with each peer.
- Example 1 (OSPFv2)
`host1(config)#ip ospf bfd-liveness-detection minimum-interval 800`
- Example 2 (OSPFv3)
`host1(config)#ipv6 ospf bfd-liveness-detection minimum-interval 800`
- Use the **no** version to disable BFD on the OSPF interface.
- See `ip ospf bfd-liveness-detection`
- See `ipv6 ospf bfd-liveness-detection`

Configuring Additional Parameters

The commands presented in this section include both OSPF-specific commands and routing protocol-independent commands that are not limited to OSPF. You can use these commands to perform the tasks listed in [Table 51 on page 329](#).

Table 51: Additional Configuration Tasks

Filter and apply policy to routes.	Set the maximum paths.
Set a baseline for statistics.	Enable automatic cost calculation.
Clear statistics for access lists, counters, redistributed routes, or processes.	Enable logs for OSPF neighbor changes.
Set the redistribution routes.	Set SPF hold time.
Set the distance for OSPF routes.	Set a default metric.
Administratively disable OSPF.	Enable use of the configured bandwidth for OSPF cost calculation.

access-list

route-map

- Use the **access-list** command to create a standard or extended access list.
- Use the **route-map** command to create a route map.

- For detailed information about configuring access lists and route maps, see *JunosE IP Services Configuration Guide*.

- Example

1. Configure three static routes.

```
host1(config)#ip route 20.20.20.0 255.255.255.0 192.168.1.0
host1(config)#ip route 20.20.21.0 255.255.255.0 192.168.1.0
host1(config)#ip route 20.21.0.0 255.255.255.0 192.168.1.0
```

2. Configure an access list with filters on routes 20.20.20.0/24 and 20.20.21.0/24.

```
host1(config)#access-list boston permit 20.20.0.0 0.0.255.255
```

3. Configure a route map that matches the previous access list and applies a metric type 1 (OSPF).

```
host1(config)#route-map boston
host1(config-route-map)#match ip address boston
host1(config-route-map)#set metric-type type-1
```

4. Configure redistribution of the static routes into OSPF with route map boston.

```
host1(config)#router ospf 2
host1(config-router)#redistribute static route-map boston
```

5. Use the **show ip ospf database** command to verify the effect of the redistribution (that the two static routes matching the route map are redistributed as external type 1).

```
host1#show ip ospf database
      OSPF Database
        Router Link States (Area 0.0.0.0)
Link ID      ADV Router    Age      Seq#          Checksum
192.168.1.250 192.168.1.250    3        0x80000006    0x39a1
192.168.254.7 192.168.254.7   220      0x80000169    0xd2b5
      Network Link States (Area 0.0.0.0)
Link ID      ADV Router    Age      Seq#          Checksum
192.168.1.214 192.168.254.7   220      0x80000001    0xe0f2
      AS External Link States
Link ID      ADV Router    Age      Seq#          Checksum
20.20.20.0   192.168.1.250    3        0x80000001    0x6045
20.20.21.0   192.168.1.250    3        0x80000001    0x554f
```

- Use the **no** version of the **access-list** command to remove the access list or the specified entry in the access list.
- Use the **no** version of the **route-map** command to remove an entry.
- See access-list
- See route-map

auto-cost reference-bandwidth

ospf auto-cost reference-bandwidth

- Use to calculate the OSPFv2 or OSPFv3 interface cost according to bandwidth.
- Sets the OSPF metric for an interface according to the bandwidth specified.

- Affects OSPF metrics for existing OSPFv2 interfaces and OSPFv2 interfaces created after the execution of this command.
- Affects OSPF metrics for only OSPFv3 interfaces created after the execution of this command.
- This command's value overrides the cost resulting from the command.
- If you want this command to apply to OSPF interfaces already configured, you need to bounce the existing interfaces: Use the `no network` and then the `network` command for the selected OSPF interfaces.
- For OSPFv3, the **auto-cost reference-bandwidth** *refBw* command requires an interface flap (for example, by entering the shutdown/no shutdown command sequence in Interface Configuration mode) to take effect. However, for OSPFv2, it is not necessary to flap the interfaces for the **ospf auto-cost reference-bandwidth** *refBw* command to become effective.

- Example 1—OSPFv2

```
host1(config-router)#ospf auto-cost reference-bandwidth 1000
```

- Example 2—OSPFv3

```
host1((config-router)#)#auto-cost reference-bandwidth 1000
```

- When you issue this command, the metric is calculated as follows:

OSPF metric = bandwidth*1,000,000/link speed

For the previous example, a 64K link yields a metric of 15625, whereas a T1 link yields a metric of 647. The minimum value for the metric is 1.

- If you never issue the **ospf auto-cost reference-bandwidth** command, OSPF calculates the cost as 108/link speed.
- Use the **no** version to assign cost based only on the interface type.
- See auto-cost reference-bandwidth
- See ospf auto-cost reference-bandwidth

baseline ip ospf

baseline ipv6 ospf

- Use to set a baseline for OSPF statistics and counters.
- The following example first displays the output of the **show ip ospf** command, which is shown before you run the **baseline ip ospf** command; then it displays the execution of the **baseline ip ospf** command; and finally, it displays the **show ip ospf** command run after you execute the **baseline ip ospf** command.
 - The output of the **show ip ospf** command run before the **baseline ip ospf** command reflects the up-to-date packet counters.
 - The output of the **show ip ospf delta** command run after you run the **baseline ip ospf** command reflects the baseline set for OSPF statistics and counters.
- Example

```
host1#show ip ospf
```

```
Routing Process OSPF 1 with Router ID 5.106.7.1
OSPF Statistics:
  Rcvd: 217935 total, 0 checksum errors
        8987 hello, 8367 database desc, 188 link state req
        159898 link state updates, 40484 link state acks
  Sent: 265026 total, 0 pkts dropped
        8927 hello, 8341 database desc, 53 link state req
        158571 link state updates, 89134 link state acks
Supports only single TOS(TOS0) routes
SPF schedule delay 0 secs, Hold time between two SPFs 3 secs
Maximum path splits 1
Area BACKBONE(0.0.0.0)
  Area is a transit area
  SPF algorithm executed 425 times
  ABR count 0
  ASBR count 1
  LSA Count 12
  Number of interfaces in this area is 24
  Area ranges are:
Number of active areas in this router is 1
1 normal, 0 stub, 0 NSSA.
```

```
host1#baseline ip ospf
```

```
host1#show ip ospf delta
```

```
Routing Process OSPF 1 with Router ID 5.106.7.1
OSPF Statistics:
  Rcvd: 0 total, 0 checksum errors
        0 hello, 0 database desc, 0 link state req
        0 link state updates, 0 link state acks
  Sent: 0 total, 0 pkts dropped
        0 hello, 0 database desc, 0 link state req
        0 link state updates, 0 link state acks
Supports only single TOS(TOS0) routes
SPF schedule delay 0 secs, Hold time between two SPFs 3 secs
Maximum path splits 1
Area BACKBONE(0.0.0.0)
  Area is a transit area
  SPF algorithm executed 425 times
  ABR count 0
  ASBR count 1
  LSA Count 12
  Number of interfaces in this area is 24
  Area ranges are:
Number of active areas in this router is 1
1 normal, 0 stub, 0 NSSA.
```

- There is no **no** version.
- See `baseline ip ospf`
- See `baseline ipv6 ospf`

clear ipv6 ospf counters

- Use to clear all OSPF IPv6 statistical counters for the virtual router.
- Example

```
host1#clear ipv6 ospf counters
```

- There is no **no** version.
- See clear ipv6 ospf counters

clear ipv6 ospf process

- Use to clear the OSPF IPv6 process on the virtual router.
- Example

```
host1#clear ipv6 ospf process
```
- There is no **no** version.
- See clear ipv6 ospf process

clear ip ospf database

- Use to delete all entries from the OSPF link-state database and to reset all adjacencies.
- Example

```
host1#clear ip ospf database
```
- There is no **no** version.

clear ip ospf neighbor

- Use to clear an IP OSPF neighbor by specifying the IP address.



NOTE: When OSPF is configured and running over an NBMA network, do not issue the **clear ip ospf neighbor** command simultaneously on both ends of the OSPF link. Doing so brings the OSPF link down completely. In this event, you must do one of the following on both sides of the link to bring the link back up:

- Reconfigure the OSPF neighbors on the NBMA interface with the neighbor command.
- Issue the **clear ip ospf database** command to clear and reset the OSPF adjacencies.
- Issue the **shutdown** command followed by the **no shutdown** command on the interface.

- Example

```
host1#clear ip ospf neighbor neighborAddress
```
- There is no **no** version.
- See clear ip ospf neighbor

clear ip ospf redistribution

clear ipv6 ospf redistribution

- Use to clear and readvertise all of the routes that have been previously redistributed into OSPF.



CAUTION: Using this command purges all external LSAs and reoriginates.

- Example 1

```
host1#clear ip ospf redistribution
```

- Example 2

```
host1#clear ipv6 ospf redistribution
```

- There is no **no** version.
- See clear ip ospf redistribution
- See clear ipv6 ospf redistribution

default-information originate

- Use to generate a default route into an OSPF routing domain.
- When you use this command to redistribute routes into an OSPF routing domain, the router automatically becomes an AS boundary router.
- An AS boundary router, however, does not, by default, generate a default route into the OSPF routing domain. The software must have a default route before it generates one, except when you have specified the **always** keyword.
- You can specify a metric for the route or specify that the route be OSPF external type 1 or 2.
- Example

```
host1(config)#router ospf 1
host1(config-router)#default-information originate route-map 5
```
- Use the **no** version to disable this feature.
- See default-information originate

disable-dynamic-redistribute

- Use to halt the dynamic redistribution of routes that are initiated by changes to a route map.
- Dynamic redistribution is enabled by default.
- Example

```
host1(config-router)#disable-dynamic-redistribute
```
- Use the **no** version to reenale dynamic redistribution.
- See disable-dynamic-redistribute

distance

- Use to configure the administrative distance for OSPF routes.
- Example


```
host1(config-router)#distance ospf external 60
```
- Default settings:
 - Intra-area routes—110
 - Interarea routes—112
 - External routes—114
- Use the **no** version to restore the default values.
- See distance

ip ospf shutdown

ipv6 ospf shutdown

- Use to disable OSPF on the interface.
- Example 1


```
host1(config-if)#ip ospf shutdown
```
- Example 2


```
host1(config-if)#ipv6 ospf shutdown
```
- Use the **no** version to enable OSPF on the interface.
- See ip ospf shutdown
- See ipv6 ospf shutdown

log-adjacency-changes

ospf log-adjacency-changes

- Use to configure the router to send a log message when the state of an OSPF neighbor changes.
- Use the **log-adjacency-changes** command for OSPFv3 interfaces; use the **ospf log-adjacency-changes** command for OSPFv2 interfaces.
- Example 1


```
host1(config-router)#log-adjacency-changes severity 3 verbosity low
```
- Example 2


```
host1(config-router)#ospf log-adjacency-changes severity 3 verbosity low
```
- Use the **no** version to halt logging of neighbor changes.
- See log-adjacency-changes
- See ospf log-adjacency-changes

maximum-paths

- Use to control the maximum number of parallel routes that OSPF can support.
- The maximum number of routes can be in the range 1–16.
- The default for OSPF is 4 paths.
- To enable equal-cost multipath (ECMP) for OSPF, you need to specify a value for maximum paths greater than 1.
- Example
`host1(config-router)#maximum-paths 2`
- Use the **no** version to restore the default value, 4.
- See maximum-paths

ospf bandwidth

- Use to direct the router to use the bandwidth configured on an OSPF interface as part of its calculation of the OSPF interface cost.
- The router uses various methods and precedence rules for the commands to calculate the OSPF interface cost. For information on the precedence based on the commands you use, see [“Methods for Calculating OSPF Interface Cost” on page 338](#).
- Example
`host1(config-router)#ospf bandwidth`
- Use the **no** version to disable the use of the configured bandwidth for OSPF interface cost calculation.
- See ospf bandwidth

ospf shutdown

- Use to administratively disable OSPF on the router.
- Example
`host1(config-router)#ospf shutdown`
- Use the **no** version to reenabling OSPF on the interface.
- See ospf shutdown

passive-interface

- Use to disable the transmission of routing updates on the interface, meaning that OSPFv2 or OSPFv3 routing information is neither sent by nor received through the interface.
- The specified interface appears as a stub network in the OSPF domain.
- By default, OSPF is enabled on a configured OSPF interface.
- Example
`host1(config-router)#passive-interface ethernet 1/0`

- Use the **no** version to reenale the transmission of OSPF routing updates on the specified interface.
- See `passive-interface`

redistribute

- Use to redistribute information from a routing domain other than OSPF into the OSPF domain.
- You can set the OSPF metric type—type 1 or type 2—and set a metric for all redistributed routes.
- If you do not specify **route-map**, all routes are redistributed. By default, all routes are imported as external type 2 routes.
- If you specify **route-map** but do not list any route map tags, no routes are imported.
- Use to redistribute routes from OSPF into other non-OSPF routing domains.
- Example 1

```
host1(config)#router ospf 5
host1(config-router)#redistribute bgp route-map 4
```

- Example 2

```
host1(config)#router bgp 100
host1(config-router)#redistribute ospf 5
```

- Use the **no** version to disable redistribution.
- See `redistribute`.

table-map

- Use to apply a policy to modify distance, metric, metric type, route type, or tag values of OSPF routes about to be added to the IP routing table.
- The new route map is applied to all routes currently in and those subsequently placed in the forwarding table. Previously redistributed routes are redistributed with the changes caused by the route map.
- To remove from the forwarding table any old routes that are now disallowed by the specified route map, you must refresh the IP routing table with the **clear ip routes *** command.
- Example

```
host1(config)#route-map dist1 permit 5
host1(config-route-map)#match community boston42
host1(config-route-map)#set distance 33
host1(config-route-map)#exit
host1(config)#router ospf 100
host1(config-router)#table-map dist1
host1(config-router)#exit
host1(config)#exit
host1#clear ip routes *
```

- Use the **no** version to halt application of the route map.
- See table-map

timers spf

- Use to configure the time between two consecutive SPF calculations.
- Set the time (in seconds) in the range 1–5; the default value is 3 seconds.
- If you set the hold time to 0, there is no delay between two consecutive SPF calculations. They can be done one immediately after the other.
- Example

```
host1(config-router)#timers spf 2
```
- Use the **no** version to return to the default value, 3 seconds.
- See timers spf

Methods for Calculating OSPF Interface Cost

The router uses the methods and precedence listed in [Table 52 on page 338](#) to calculate the OSPF interface cost.

Table 52: Methods and Precedence for Calculating OSPF Interface Cost

Cost Calculation Method	Precedence
Issuing address cost command	Takes the highest precedence. The router uses the cost configured on the OSPF interface for cost calculation.
Issuing ip ospf cost command	Takes precedence if you do not use the address cost command to configure the interface cost. The router uses the cost configured on the OSPF interface for cost calculation.
Using actual bandwidth configured on OSPF interface	If you issue the ospf bandwidth command to enable use of the configured bandwidth for OSPF interface cost calculation, and do not use either the address cost command or the ip ospf cost command to configure the interface cost, the router uses the actual bandwidth configured on the OSPF interface for cost calculation.
Issuing auto-cost reference-bandwidth command	Takes the lowest precedence. The router uses the reference bandwidth configured on the OSPF interface for cost calculation.



NOTE: If you do not use any of the preceding methods to configure the OSPF interface cost, the router uses the interface speed to calculate the interface cost.

Default Metrics

Although the router does not support a **default-metric** command, the **redistribute** command provides two ways to set a default metric for redistributed routes.

You can simply configure a metric with the **redistribute** command to apply to all routes redistributed from the specified source protocol:

```
host1(config)#router ospf 5
host1(config-router)#redistribute bgp metric 5
```

Alternatively, you can create one or more route maps that set the metric and apply them selectively to redistributed routes:

```
host1(config)#access-list 1 permit any any
host1(config)#route-map defmetric
host1(config-route-map)#match ip address 1
host1(config-route-map)#set metric 10
host1(config-route-map)#exit
host1(config)#router ospf 5
host1(config-router)#redistribute bgp route-map defmetric
host1(config-router)#redistribute isis route-map defmetric
```

See *JunosE IP Services Configuration Guide*, for information about configuring route maps.

Configuring OSPF for NBMA Networks

You can configure OSPF nonbroadcast multiaccess (NBMA) networks. You can configure your OSPF network type as NBMA, regardless of the default medium. This configuration is useful when, for example, you have routers in your network that do not support multicast addressing.

You must use the **neighbor** command to specify the router's OSPF neighbors.

To configure OSPF for an NBMA network:

1. Configure an interface network type as NBMA for OSPF.

```
host1(config-subif)#ip ospf network non-broadcast
```

2. Exit Interface Configuration mode. Enter Global Configuration mode.

```
host1(config-subif)#exit
```

3. Configure an OSPF routing process, and enter Router Configuration mode.

```
host1(config)#router ospf 5
```

4. Specify an OSPF neighbor, and optionally assign a priority number or poll interval to the neighbor.

```
host1(config-router)#neighbor 10.12.14.1 priority 5 poll-interval 180
```

5. Repeat Step 4 for each neighbor in the OSPF network.

If you want to configure the network type for a specific interface or OSPF area, rather than for all OSPF interfaces, you can use the **address network** command rather than the **ip ospf network** command.

address network

- Use to configure the network type on a specific OSPF interface or for a specific OSPF area to a type other than the default for the medium.
- You must first issue the **address area** command before issuing the **address network** command.
- Example

```
host1(config-router)#address 10.12.10.2 network broadcast
```
- Use the **no** version to restore the default value for the medium.
- See address network

ip ospf network

- Use to configure the network type on all OSPF interfaces on the OSPF network to a type other than the default for the medium.
- Example

```
host1(config-if)#ip ospf network broadcast
```
- Use the **no** version to restore the default value for the medium.
- See ip ospf network

neighbor

- Use to configure OSPF neighbors on the NBMA network.
- Specify priority and poll interval only for routers that are eligible to become the designated router or backup designated router—that is, a router with a nonzero router priority value. The default priority value is 0, and the default polling interval is 120 seconds.
- Example

```
host1(config-router)#neighbor 10.12.11.5 priority 100
```
- Use the **no** version to remove the neighbor or restore the default values 0 and 120.
- See neighbor

Traffic Engineering

Traffic engineering enables more effective use of network resources by providing for the setup of explicitly routed Multiprotocol Label Switching (MPLS) label-switched paths (LSPs) that satisfy resource and administrative constraints. You can use OSPF to exchange link resource and traffic-engineering administrative information between routers. OSPF uses this information to calculate paths in the network that satisfy the

administrative constraints. MPLS can then set up LSPs along these paths. See *JunosE BGP and MPLS Configuration Guide* for a detailed discussion of MPLS.

Configuring OSPF for Traffic Engineering

For OSPF to support traffic engineering, you must issue both of the following commands:

- **mpls traffic-eng area**—Enables the router to flood traffic engineering resource and administrative information in the specified area using type 10 opaque LSAs. These LSAs have an area-wide scope and therefore are flooded only within the indicated area.
- **mpls traffic-eng router-id**—Designates a router as traffic engineering capable and specifies the address of a stable router interface as the router ID of the node for traffic engineering purposes. The traffic engineering router ID serves as the tunnel endpoint for tunnels terminating at the node. Each node advertises its traffic engineering router ID in type 10 LSAs.

By default, OSPF always uses the MPLS tunnel to reach the MPLS endpoint. Best paths determined by SPF calculations are not considered. You can enable the consideration of best paths by issuing the **mpls spf-use-any-best-path** command. As a result, OSPF considers metrics for IGP paths and the tunnel metric, and might forward traffic along a best path, through the MPLS tunnel, or both.

You can use the **show ip ospf database opaque-area** command to display information about traffic engineering opaque LSAs.

For OSPF routes to use established MPLS tunnels as next hops—so that traffic can be mapped to use these tunnels—you must configure the tunnels with the **tunnel mpls autoroute announce ospf** command. See *JunosE BGP and MPLS Configuration Guide*, for information about configuring MPLS on a router.

mpls spf-use-any-best-path

- Use to enable SPF calculations to consider the IGP (OSPF) best paths as well as the MPLS tunnel for forwarding traffic to the MPLS endpoint.
- By default, the MPLS tunnel is always selected for traffic to the tunnel endpoint; IGP paths are not considered. For traffic beyond the endpoint, the tunnel is considered equally with any other path.
- Example


```
host1(config-router)#mpls spf-use-any-best-path
```
- Use the **no** version to disable the use of IGP best paths.
- See *mpls spf-use-any-best-path*

mpls traffic-eng area

- Use to enable flooding of MPLS traffic engineering link information into the specified OSPF area. Flooding is disabled by default.
- Example

```
host1(config-router)#mpls traffic-eng area 0
```

- Use the **no** version to disable flooding.
- See mpls traffic-eng area

mpls traffic-eng router-id

- Use to specify a stable interface to be used as a router ID for MPLS traffic engineering. Typically you specify a loopback interface to provide the greatest stability, because this is flooded to all nodes. The interface acts as the destination node for tunnels originating at other nodes.

- Example

```
host1(config-router)#mpls traffic-eng router-id loopback 0
```

- Use the **no** version to remove the interface as a router ID.
- See mpls traffic-eng router-id

Using OSPF Routes for Multicast RPF Checks

You can use the **ip route-type** or **ipv6 route-type** command to specify whether OSPF routes are available for only unicast forwarding protocols or only multicast reverse-path-forwarding (RPF) checks. Routes available for unicast forwarding appear in the unicast view of the routing table, whereas routes available for multicast RPF checks appear in the multicast view of the routing table.

To enable a multicast protocol and MPLS traffic engineering (TE) to interoperate on a router running OSPF, use the **mpls traffic-eng multicast-intact** command.

ip route-type

ipv6 route-type

- Use to specify whether OSPF routes are available only for unicast forwarding, only for multicast RPF checks, or for both.
- Use the **show ip route** or **show ipv6 route** command to view the routes available for unicast forwarding.
- Use the **show ip rpf-routes** or **show ipv6 rpf-routes** command to view the routes available for multicast RPF checks.
- By default, OSPF routes are available for both unicast forwarding and multicast RPF checks.

- Example 1

```
host1(config)#router ospf
host1(config-router)#ip route-type unicast
```

- Example 2

```
host1(config)#router ospf
host1((config-router)#)#ipv6 route-type unicast
```

- Use the **no** version to restore the default value, both.
- See ip route-type
- See ipv6 route-type

mpls traffic-eng multicast-intact

- Use to enable a multicast protocol and MPLS traffic engineering (TE) to interoperate on a router running OSPF.
- Example

```
host1(config-router)#mpls traffic-eng multicast-intact
```
- Use the **no** version to disable interoperability between a multicast protocol and MPLS-TE when running on an OSPF router.
- See mpls traffic-eng multicast-intact

OSPF and BGP/MPLS VPNs

Some network topologies use OSPF as the routing protocol between CE and PE routers in BGP/MPLS VPNs. See *JunosE BGP and MPLS Configuration Guide*, for information about configuring OSPF for this purpose.

Remote Neighbors

You can create OSPF remote neighbors to enable the router to establish neighbor adjacencies through unidirectional interfaces, such as MPLS tunnels, rather than the standard practice of using the same interface for receipt and transmission of OSPF packets. The remote neighbor can be more than one hop away through intermediate routers that are not running OSPF. OSPF uses the interface associated with the best route to reach the remote neighbor. A best route to the neighbor must exist in the IP routing table.

You must explicitly configure a remote neighbor on an OSPF router. You must specify the remote neighbor with which the router forms an adjacency and the source IP address the router uses for OSPF packets destined to its peer remote neighbor.

To form an adjacency with its remote neighbor, all OSPF packets are sent to the remote neighbor as unicast packets with the destination IP address equal to the source IP address of the remote neighbor. Use the **update-source loopback** command to assign the source IP address to a remote neighbor.

The connection between two remote neighbors is treated as an unnumbered point-to-point link that resides in the same area as that to which the pair of remote neighbors belongs.

The rules of OSPF adjacency must be followed for remote neighbors to form an adjacency with each other; for example, the neighbors must be in the same OSPF area and have the same hello interval and dead interval, and so on.

After you have used the **remote-neighbor** command to specify the remote neighbors and the **update-source** loopback to assign the source IP address, you must set a TTL value with the **tll** command, because a remote neighbor can be more than one hop away. Configuration of all other remote-neighbor attributes is optional.

authentication-key

- Use to enable simple password authentication and assign a password for communication with OSPF remote neighbors.
- Example

```
host1(config-router-rn)#authentication-key 0 br549hee
```
- Use the **no** version to delete the password.
- See authentication-key

authentication message-digest

- Use to specify that MD5 authentication is to be used on the OSPF remote neighbor interface.
- Example

```
host1(config-router-rn)#authentication message-digest
```
- There is no **no** version.
- See authentication message-digest

authentication-none

- Use to specify that no authentication is to be used on the OSPF remote neighbor interface.
- Example

```
host1(config-router-rn)#authentication-none
```
- There is no **no** version.
- See authentication-none

cost

- Use to specify a cost metric for the OSPF remote-neighbor interface; the metric is used in the calculation of the SPF routing table.
- The default value is 10 if there is no route to the remote neighbor; otherwise, the default is calculated based on the bandwidth of the physical interface used to reach the remote neighbor and the OSPF autocost reference bandwidth.
- Example

```
host1(config-router-rn)#cost 235
```
- Use the **no** version to restore the default value.
- See cost

dead-interval

- Use to set the time period, in seconds, that the OSPF router waits without receiving hello packets from a remote neighbor before declaring the neighbor to be down.
- Example

```
host1(config-router-rn)#dead-interval 180
```
- Use the **no** version to restore the default value, 40 seconds.
- See dead-interval

hello-interval

- Use to set the time interval between hello packets that the router sends on the OSPF remote-neighbor interface.
- Specify a value in the range 1–65535 seconds; the default value is 40 seconds.
- Example

```
host1(config-router-rn)#hello-interval 15
```
- Use the **no** version to restore the default value, 40 seconds.
- See hello-interval

message-digest-key md5

- Use to enable MD5 authentication for the OSPF remote-neighbor interface and configure the MD5 key.
- If you delete all MD5 keys, MD5 authentication is still enabled; you must either configure an MD5 key or disable MD5 authentication with the **authentication-none** command.
- Example

```
host1(config-router-rn)#message-digest-key 42 md5 0 sal29ute
```
- Use the **no** version to delete the MD5 key.
- See message-digest-key md5

remote-neighbor

- Use to configure an OSPF remote neighbor.
- Use the **update-source** command to configure source IP address for packets sent to the remote neighbor. We recommend that you do not leave the update source unconfigured for a remote neighbor.
- Example

```
host1(config-router)#remote-neighbor 10.25.100.14 area 35672
```
- Use the **no** version to remove the remote neighbor and any attributes configured for the remote neighbor.
- See remote-neighbor

retransmit-interval

- Use to set the time between LSA retransmissions for the OSPF remote-neighbor interface when an acknowledgment for the LSA is not received.
- Specify a value in the range 1–3600 seconds; the default value is 5 seconds.
- Example

```
host1(config-router-rn)#retransmit-interval 10
```
- Use the **no** version to restore the default value, 5 seconds.
- See retransmit-interval

transmit-delay

- Use to set the estimated time it takes to transmit a link-state update packet on the OSPF remote-neighbor interface.
- Specify a value in the range 0–3600 seconds; the default value is 1 second.
- Example

```
host1(config-router-rn)#transmit-delay 3
```
- Use the **no** version to restore the default value, 1 second.
- See transmit-delay

ttl

- Use to configure a hop count by setting the value of the time-to-live field used by packets sent to an OSPF remote neighbor.
- Specify a value in the range 1–255 seconds; the default value is 1 second.
- Example

```
host1(config-router-rn)#ttl 35
```
- Use the **no** version to restore the default value, 1 second.
- See ttl

update-source

- Use to specify the loopback interface whose local IP address is used as the source address for the OSPF connection to a remote neighbor.
- We recommend that you do not leave the update source unconfigured for a remote neighbor.
- Example

```
host1(config-router-rn)#update-source loopback 1
```
- Use the **no** version to delete the source address from the connection to the remote neighbor.
- See update-source

Remote Neighbors and Sham Links

You can configure OSPF remote neighbors to act as sham links for BGP/MPLS VPNs. See *JunosE BGP and MPLS Configuration Guide*, for more information.

Configuring OSPF Graceful Restart

E Series routers support OSPF graceful restart extensions as defined in RFC 3623 (Graceful OSPF Restart). Graceful restart enables a router to continue forwarding OSPF traffic based on routing information it receives prior to an unplanned restart, while the E Series router switches from the primary SRP to the secondary SRP module.

Graceful restart helps to avoid interruptions in traffic forwarding and network-wide route changes when a route processor restarts or switches over to a redundant route processor.

To accomplish OSPF graceful restart, communication must take place between the router that is restarting and its OSPF neighbors. These neighboring routers must cooperate with (or help) the restarting router by keeping it in the forwarding path while it is restarting.

The restarting router sends a grace LSA (a link-local LSA) to inform its neighbors that it is restarting. After receiving this grace LSA, the neighbors act as if the router still exists in the network topology and continue forwarding traffic through the restarting router (for the specified grace period as defined in the grace LSA). If the restarting router does not become fully adjacent with the helper router before the grace period expires, the helper abandons the helper role and determines its adjacency with the restarting router to be down. Also, based on your configuration, the helper can abandon a restart if it detects a topology change before the restart is complete.

After the router restarts, the restarting router purges the grace LSA from the OSPF domain.

To configure the router as a graceful restart helper, use the graceful restart helper commands. These commands include **graceful-restart helper** and **graceful-restart helper-abort-topology-change**.

To configure the router for a restart scenario, use the graceful restart commands. These commands include **graceful-restart**, **graceful-restart notify-time**, and **graceful-restart restart-time**.



NOTE: We recommend that you always enable stateful SRP switchover on routers that you have configured with OSPF graceful restart—not doing so renders OSPF graceful restart configuration ineffective.



NOTE: Graceful restart mode and the OSPF graceful restart helper mode are supported for both OSPFv2 and OSPFv3 routers.



NOTE: For information about configuring hold timers for OSPF graceful restart in scaled environments, see the *Configuring Hold Timers for Successful Graceful Restart in Scaled Scenarios* section in the *JunosE BGP and MPLS Configuration Guide*.

graceful-restart

- Use to enable OSPF graceful restart on the OSPFv2 or OSPFv3 router.
- Example

```
host1(config-router)#graceful-restart
```
- Use the **no** version to disable OSPF graceful restart capability on the router.
- See graceful-restart

graceful-restart helper

- Use to configure the OSPFv2 or OSPFv3 router to function as an OSPF graceful restart helper router.
- Example

```
host1(config-router)#graceful-restart helper
```
- Use the **no** version to disable OSPF graceful restart helper mode capability on the router.
- See graceful-restart helper

graceful-restart helper-abort-topology-change

- Use to specify conditions under which the OSPFv2 or OSPFv3 router abandons its role as an OSPF graceful restart helper router.
- Use the **any** keyword to abandon the helper role when any LSA changes during the restart. Use the **non-externals** keyword to abandon the helper role only when any nonexternal LSA changes during the restart.
- Example

```
host1(config-router)#graceful-restart helper-abort-topology-change any
```
- Use the **no** version to return the router to its default behavior of helping a restarting OSPF router during topology changes.
- See graceful-restart helper-abort-topology-change

graceful-restart notify-time

- Use to specify the time (in the range 1–3600 seconds) expected for the OSPFv2 or OSPFv3 router to remove grace LSAs over all interfaces.
- The restarting router sends the sum of the restart duration and notify duration as the *grace period* to the helping neighbors in the grace LSA. Receiving a maximum-aged grace LSA is an indication to the helper that the restart has been successfully completed on the restarting router.

- If the grace period on the helper router expires before the receipt of max-aged grace LSAs, the helper router stops the restart process and does not respond to the restarting router. The helper router then originates its own LSAs with the real current state of the adjacency with the restarting router reflected in them.
- If the inactivity timer is exceeded (which is the interval during which a test is performed to verify whether the interface is active) on an OSPFv2 helper router during the time when the grace period is still active, the graceful restart process is not terminated. Also, if the restart process takes longer than the normal period of up to 30 minutes on the helper router, the grace period extends when the restarting router receives a new grace link-local LSA.
- Example

```
host1(config-router)#graceful-restart notify-time 500
```
- Use the **no** version to return the notify duration to its default value, 15 seconds.
- See graceful-restart notify-time

graceful-restart restart-time

- Use to specify the time (in the range 1–3600 seconds) expected for the OSPFv2 or OSPFv3 router to reacquire OSPF neighbors that were fully operational prior to the restart.
- When this timer expires, the restarting router exits the restart procedure, originates any LSAs that were suppressed during the restart, removes any self-originated LSAs that it received from helping neighbors, runs SPF, and updates any routes in the routing table.
- Example

```
host1(config-router)#graceful-restart restart-time 350
```
- Use the **no** version to return the restart duration to its default value, 180 seconds.
- See graceful-restart restart-time

Disabling and Reenabling Incremental SPF

By default, when changes occur to a type 5 or type 7 LSA, OSPF recalculates new, loop-free routes for only the LSAs that change. When a subset of LSAs in the external link-state database change, a full recalculation is not necessary. However, through the CLI, you can disable incremental SPF so the router can perform a full SPF on all external LSAs in the link-state database.

disable-incremental-external-spf

- Use to disable incremental external SPF on the router. When issued, this command results in a full SPF when an event occurs to trigger an external SPF.
- Example

```
host1(config-router)#disable-incremental-external-spf
```

- Use the **no** version to reenables incremental SPF on this router.
- See `disable-incremental-external-spf`

Configuring OSPF Traps

You can use the **traps** command to specify OSPF traps. This command enables you to specify all or any number of the following trap settings:

- `virtIfStateChange`—To indicate any state change on an OSPF virtual interface
- `nbrStateChange`—To indicate any state change on a nonvirtual OSPF neighbor
- `virtNbrStateChange`—To indicate any state change on a virtual OSPF neighbor
- `ifConfigError`—To indicate any configuration mismatch with a nonvirtual neighbor
- `virtIfConfigError`—To indicate any configuration mismatch with a virtual neighbor
- `ifAuthFailure`—To indicate any authentication failure on a nonvirtual interface
- `virtIfAuthFailure`—To indicate any authentication failure on a virtual interface
- `ifRxBadPkt`—To indicate the receipt of a packet that the router cannot parse
- `virtIfRxBadPkt`—To indicate the receipt of a packet on a virtual interface that the router cannot parse
- `txRetransmit`—To indicate the retransmission of a packet on a nonvirtual interface
- `virtTxRetransmit`—To indicate the retransmission of a packet on a virtual interface
- `originateLsa`—To indicate the origination of a new LSA by this router
- `maxAgeLsa`—To indicate that an LSA in this router LSDB has reached its maximum age value
- `ifStateChange`—To indicate a state change on an OSPF interface

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.
- See `traps`

Configuring OSPFv3 Traps

You can use the **traps** command to specify OSPFv3 traps. This command enables you to specify all or any number of the following trap settings:

- `ospfv3IfStateChange`—To indicate a state change on a nonvirtual OSPFv3 interface
- `ospfv3VirtIfStateChange`—To indicate a state change on an OSPFv3 virtual interface



NOTE: This trap is not supported because virtual links are not supported for OSPFv3. A warning message is displayed when this trap is enabled.

- ospfv3NbrStateChange—To indicate a state change on a nonvirtual OSPFv3 neighbor
- ospfv3VirtNbrStateChange—To indicate a state change on a virtual OSPFv3 neighbor



NOTE: This trap is not supported because virtual links are not supported for OSPFv3. A warning message is displayed when this trap is enabled.

- ospfv3IfConfigError—To indicate that a packet has been received on a nonvirtual interface from a neighboring router whose configuration parameters conflict with that of the router containing the nonvirtual interface
- ospfv3VirtIfConfigError—To indicate that a packet has been received on a virtual interface from a neighboring router whose configuration parameters conflict with that of the router containing the virtual interface



NOTE: This trap is not supported because virtual links are not supported for OSPFv3. A warning message is displayed when this trap is enabled.

- ospfv3IfRxBadPacket—To indicate that an OSPFv3 packet that cannot be parsed has been received on a nonvirtual interface
- ospfv3VirtIfRxBadPacket—To indicate that an OSPFv3 packet that cannot be parsed has been received on a virtual interface



NOTE: This trap is not supported because virtual links are not supported for OSPFv3. A warning message is displayed when this trap is enabled.

- ospfv3LsdbOverflow—To indicate that the number of LSAs in the router's link state database has exceeded ospfv3ExtAreaLsdbLimit
- ospfv3LsdbApproachingOverflow—To indicate that the number of LSAs in the router's link state database has exceeded ninety percent of ospfv3ExtAreaLsdbLimit
- ospfv3NssaTranslatorStatusChange—To indicate a change in the router's ability to translate OSPFv3 NSSA LSAs into OSPFv3 External LSAs
- ospfv3RestartStatusChange—To indicate a change in the graceful restart state of the router
- ospfv3NbrRestartHelperStatusChange—To indicate a change in the graceful restart helper state of the neighbor
- ospfv3VirtNbrRestartHelperStatusChange—To indicate a change in the graceful restart helper state of the virtual neighbor



NOTE: This trap is not supported because virtual links are not supported for OSPFv3. A warning message is displayed when this trap is enabled.

traps

- You can use the **traps** command to specify traps for OSPFv3.
- Example:

```
host1(config-router-rn)#traps all
```
- Use the **no** version to delete the specified trap, group of traps, or all traps.



NOTE: The following traps are not supported because virtual links are not supported by OSPFv3:

- ospfv3VirtIfStateChange
- ospfv3VirtNbrStateChange
- ospfv3VirtIfConfigError
- ospfv3VirtIfRxBadPacket
- ospfv3VirtNbrRestartHelperStatusChange

A warning message is displayed when these traps are enabled.

- See traps

Neighbor Uptime Tracking

You can use the **history** keyword with the **show ip ospf neighbors** command to display a history of up to 10 events for all OSPF neighbors or a specific OSPF neighbor. This history can aid in troubleshooting network problems related to neighbor flapping. The history includes the interface for the neighbor, a timestamp for the event, whether the neighbor transition is seen (up) or down, and the cause of down events.

You can track up to 50 neighbors; when that number is exceeded, the history of the least recently tracked neighbor is overwritten. Similarly, when a neighbor's events exceed 10, the oldest event is overwritten, because no more than 10 events can be tracked per neighbor. Neighbor uptime tracking is not available for OSPFv3. See "[show ip ospf neighbors](#)" on page 370 for output field definitions.

host1#show ip ospf neighbors history

Transition log for neighbor 10.10.8.2:

Interface	Event	Cause	Time
ATM2/0.8	Seen	NA	WED DEC 14 07:02:27


```

Transition log for neighbor 10.10.12.2:
Interface      Event Cause      Time
=====
ATM2/0.12      Seen   NA              WED DEC 14 07:09:12
ATM2/0.12      DOWN  Interface down   WED DEC 14 07:05:47
ATM2/0.12      Seen   NA              WED DEC 14 07:02:32

```

Monitoring OSPF

Two sets of commands enable you to monitor OSPF operation on your router: the debug and the show commands. Both sets of commands provide information about your router's OSPF state and configuration.

The task you are performing with each of these monitoring commands is basically the same for each command; that is, you are requesting information. The results of this request can vary. For instance, the **debug** commands provide information (some of which is dynamically obtained from router logs) about problems with the network or the router, whereas the **show** commands provide information about the actual state and configuration of your router.

debug Commands

The debug commands provide information about the following OSPF items:

- Adjacencies
- Designated router
- General events
- Link-state advertisements
- Neighbors
- Packets received
- Packets sent
- Route events
- SPF events

debug ip ospf

debug ipv6 ospf

- Use to display information about selected OSPF events. This command has many keywords so you can specify a variety of OSPF events.
- You can set the level of severity for the events you want displayed: 0–7.
- You can set the verbosity of the messages you want displayed: low, medium, high.

- Example 1

```
host1#debug ip ospf adj
```

- Example 2

```
host1#debug ipv6 ospf lsa
```

- Use the **no** version to cancel the display of any information about the designated variable.
- See `debug ip ospf`
- See `debug ipv6 ospf`

ospf log-adjacency-changes

- Use to enable the logging of changes in the state of an OSPF neighbor.
- Example
`host1(config-router)#ospf log-adjacency-changes`
- Use the **no** version to disable the logging of changes in the state of an OSPF neighbor.
- See `ospf log-adjacency-changes`

undebg ip ospf

undebg ipv6 ospf

- Use to cancel the display of information about a selected event.
- The same OSPF variables can be designated as in the **debug ip ospf** or **debug ipv6 ospf** commands.
- Example 1
`host1#undebg ip ospf adj`
- Example 2
`host1#undebg ipv6 ospf lsa`
- There is no **no** version.
- See `undebg ip ospf`
- See `undebg ipv6 ospf`

show Commands

The show commands provide information about the following OSPFv2 and OSPFv3 items:

- Routing processes
- Border routers
- Database
- Interfaces
- Neighbors
- Traffic
- Virtual links

- Internal statistics
- MPLS tunnels and opaque LSAs

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 *JunosE System Basics Configuration Guide*, for details.

show ip ospf

show ipv6 ospf

- Use to display general information about OSPF routing processes.
- Field descriptions
 - Routing Process—Process ID, router ID, domain ID
 - OSPF administrative state—Enabled or disabled
 - OSPF operational state—Enabled or disabled
 - Incremental External SPF—On or off
 - Graceful Restart Capability—On or off
 - Time limit to complete graceful restart—Amount of time (in seconds) during which the router can reacquire OSPF neighbors that were fully operational prior to the restart
 - Time limit to flush grace LSAs—Amount of time (in seconds) during which the router can remove grace LSAs over all interfaces
 - Graceful Restart Helper Capability—On or off
 - Graceful Restart Help:
 - Not Aborted On Topology Change
 - Aborted On Any Topology Change
 - Aborted On Any Non-External Topology Change
 - OSPF set trap field—Enabled or disabled
 - Router—Router types: internal, area border, or autonomous system boundary routers
 - OSPF Statistics—Packets received and sent; LSA discard count
 - TOS type—Number of types of service supported
 - SPF timers—Timers configured on the router
 - Maximum path splits—Maximum equal-cost paths supported
 - Areas—Areas configured and their parameters
 - Number of areas—Number of areas in the router

- Example 1

```
host1#show ip ospf
```

```
Routing Process OSPF 1 with Router ID, 0.0.0.0, Domain ID 0.0.0.0
OSPF administrative state is enabled
OSPF operational state is disabled
Incremental External SPF is ON
Graceful Restart Capability is ON
Time limit to complete graceful restart 180 seconds
Time limit to flush grace LSAs 15 seconds
Graceful Restart Helper Capability is OFF
Graceful Restart Help Not Aborted On Topology Change
Ospf set trap field disabled
OSPF Statistics:
Rcvd: 0 total, 0 checksum errors
0 hello, 0 database desc, 0 link state req
0 link state updates, 0 link state acks
Sent: 0 total, 0 pkts dropped
0 hello, 0 database desc, 0 link state req
0 link state updates, 0 link state acks
LSA discard count: 0
Supports only single TOS(TOS0) routes
SPF schedule delay 0 secs, Hold time between two SPFs 3 secs
Maximum path splits 4
Number of active areas in this router is 0
0 normal, 0 stub, 0 NSSA.
```

- Example 2

```
host1#show ip ospf
```

```
Routing Process OSPF 4 with Router ID, 10.0.0.1, Domain ID 0.0.0
OSPF administrative state is enabled
OSPF operational state is enabled
Incremental External SPF is ON
Graceful Restart Capability is OFF
Graceful Restart Helper Capability is OFF
Graceful Restart Help Not Aborted On Topology Change
Ospf set trap field disabled
OSPF Statistics:
  Rcvd: 0 total, 0 pkts dropped, 0 checksum errors
        0 hello, 0 database desc, 0 link state req
        0 link state updates, 0 link state acks
  Sent: 1 total, 0 pkts dropped
        1 hello, 0 database desc, 0 link state req
        0 link state updates, 0 link state acks
  LSA discard count: 0
Supports only single TOS(TOS0) routes
SPF schedule delay 0 secs, Hold time between two SPFs 3 secs
Maximum path splits 4
Area BACKBONE(0.0.0.0)
  SPF algorithm executed 5 times
  ABDR count 0
  ASBDR count 0
  LSA Count 1
  Number of interfaces in this area is 1
  Area ranges are:
Area 0.0.0.1
  Area is a stub area
  Type-3 summary is filtered
  SPF algorithm executed 5 times
  ABDR count 0
```

```

ASBDR count 0
LSA Count 0
Number of interfaces in this area is 0
Area ranges are:
Area 0.0.0.2
Area is nssa
Type-3 summary is filtered
SPF algorithm executed 4 times
ABDR count 0
ASBDR count 0
LSA Count 0
Number of interfaces in this area is 0
Area ranges are:
Area 0.0.0.5
Area is nssa
SPF algorithm executed 3 times
ABDR count 0
ASBDR count 0
LSA Count 0
Number of interfaces in this area is 0
Area ranges are:
Number of active areas in this router is 4
1 normal, 1 stub, 2 NSSA.

```

- Example 3

```

host1#show ipv6 ospf
Routing Process OSPFv3 1 with Router ID 10.1.1.1
  OSPFv3 administrative state is enabled
  OSPFv3 operational state is enabled
  Incremental External SPF is OFF
  Graceful Restart capability is OFF
  Graceful Restart helper capability is OFF
  OSPFv3 traps currently enabled: ospfv3IfStateChange ospfv3NbrStateChange
  ospfv3RestartStatusChange
  SPF schedule delay 2 secs, Hold time between two SPFs 3 secs
  Maximum path splits 4
  Area BACKBONE(0.0.0.0)
  SPF algorithm executed 13 times
  ABDR count 1
  ASBDR count 1
  LSA Count 117
  Number of interfaces in this area is 3
  Area ranges are:
  Number of active areas in this router is 1
  1 normal, 0 stub, 0 NSSA.

```

- See show ip ospf
- See show ipv6 ospf

show ip ospf border-routers

show ipv6 ospf border-routers

- Use to display a list of OSPF border routers.
- Field descriptions
 - Destination—Destination's router ID
 - NEXT HOP—Next hop toward the destination

- Interface—Interface for which you are obtaining the information
- Router Type—Router type of the destination: either an ABR or AS boundary router, or both
- Route Type—Type of this route: either an intra-area or interarea route
- Area—Area ID of the area from which this route is learned

• Example 1

host1#show ip ospf border-routers

Destination	NEXT_HOP	Interface	Router Type	Route Type	Area
5.5.0.250	5.5.6.250	fastethernet0	ABR/ASBR	INTRA	0.0.0.0
5.5.0.250	4.4.4.250	fastethernet0	ABR/ASBR	INTRA	0.0.0.1
6.6.6.250	4.4.4.13	fastethernet0	ABR	INTRA	0.0.0.1

• Example 2

host1#show ipv6 ospf border-routers

OSPF Area Border Routers

Destination	NEXT_HOP	Interface	RouteType	Area
10.0.0.10	FE80::3	ATM4/1.39	INTRA	0.0.0.0
10.0.0.11	FE80::4	ATM4/0.41	INTRA	0.0.0.0
10.0.0.11	FE80::5	ATM4/1.48	INTRA	100.0.0.1

OSPF Autonomous System Border Routers

Destination	NEXT_HOP	Interface	RouteType	Area
10.1.1.4	FE80::3	ATM4/1.39	INTER	0.0.0.0
10.1.1.5	FE80::4	ATM4/0.41	INTER	0.0.0.0

- See show ip ospf border-routers
- See show ipv6 ospf border-routers

show ip ospf database

show ipv6 ospf database

- Use to display the full IP OSPF database, a summary of the database, or LSAs specific to the given area.
- Field descriptions
 - Link ID—Link-state ID of the LSA; for OSPFv2:
 - For router links, set to the router's OSPF router ID
 - For network links, set to the IP interface address of the network's designated router
 - For type 3 summary LSAs, set to an IP network number
 - For type 4 summary LSAs, set to an AS boundary router ID
 - For type 5 externals, set to an IP network number
 - Link ID—Link-state ID of the LSA; for OSPFv3:
 - For link LSAs, set to the interface ID
 - For network links, set to the interface ID

- For router links, set to integer
- For intra-area prefix links, set to integer
- For interarea prefix links, set to integer
- For interarea router links, set to integer
- For external links, set to integer
- For grace links, set to integer
- ADV Router—ID of the advertising router
- Age—Link-state age
- Seq#—Link-state sequence number (detects old or duplicate LSAs)
- Checksum—Fletcher checksum of the complete contents of the LSA
- Area—Area for which data is displayed
- Router—Number of router LSAs
- Network—Number of network LSAs
- Intra-Prefix—Number of intra-prefix LSAs
- Inter-Prefix—Number of inter-prefix LSAs
- Inter-Router—Number of inter-router LSAs
- Link LSAs—Number of link LSAs
- Grace LSAs—Number of graceful restart LSAs
- External LSAs—Number of external LSAs
- MaxAge—Number of LSAs that have reached the maximum age
- Area—Area for this LSA
- LS age—LSA age
- Options—Optional capabilities supported by this router
- LS Type—LSA type
- Link State ID—Link-state ID of the link local LSA
- Length—Length of the LSA (in bytes)
- Bit set—Bit set used by this LSA type
- Link connected to—Type of network to which the link connects

- Neighboring router's Router ID—Router ID of the neighboring router
- Neighboring router's Interface ID—Interface ID of the neighboring router
- Local Interface ID—Local interface ID
- Metric—Cost of this interface
- Attached Router—Addresses of any attached routers
- Router Priority—Priority value configured for the router
- Link Local Address—Originating router's link-local interface address on the link
- Prefixes—Prefixes associated with this LSA
- Number of Prefixes—Number of prefixes associated with this LSA
- Referenced LSA Type—Router LSA or network LSA with which the IPv6 address prefixes should be associated
- Referenced LSA Advertising Router—Router LSA or network LSA with which the IPv6 address prefixes should be associated
- Referenced LSA ID—Router LSA or network LSA with which the IPv6 address prefixes should be associated
- asbr—Address of the AS boundary router
- LS Seq Number—Sequence number of the LSA
- TLVs—Type of TLV included in LSA
 - 1(Restart duration)—Duration of the restart, in seconds
 - 2(Restart Reason)—Reason that the peer restarted: Unknown, Software Restart, Software Reload, Software Upgrade, Switch to redundant control processor
 - 3(Unknown)—Any recognized type is listed as type 3, unknown; consequently the meaning and units of the value are unknown as well
- length—Length of the TLV; varies according to the TLV
- Value—Value of the TLV; varies according to TLV
- Example 1—OSPFv2 output

```
host1#show ip ospf database
OSPF Database
```

```
Router Link States (Area 0.0.0.0)
```

Link ID	ADV Router	Age	Seq#	Checksum
5.1.101.1	5.1.101.1	932	0x80000069	0x102f
192.168.1.13	192.168.1.13	1763	0x80000099	0xaa4e
192.168.1.10	192.168.1.10	285	0x80000087	0xada6
192.168.1.11	192.168.1.11	401	0x80000087	0xaba5
192.168.24.6	192.168.24.6	622	0x800005bf	0x6087

Network Link States (Area 0.0.0.0)

Link ID	ADV Router	Age	Seq#	Checksum
56.56.56.220	5.6.6.1	499	0x80000069	0x26a0
192.168.1.12	192.168.254.6	622	0x8000009e	0xebc2

Summary Link States (Area 0.0.0.0)

Link ID	ADV Router	Age	Seq#	Checksum
4.4.4.0	5.5.0.250	497	0x8000005a	0x2ca6
4.4.4.0	192.168.1.13	528	0x80000059	0x 45d

AS Summary Link States (Area 0.0.0.0)

Link ID	ADV Router	Age	Seq#	Checksum
5.5.0.250	192.168.1.13	491	0x80000002	0xe9d4

AS External Link States

Link ID	ADV Router	Age	Seq#	Checksum
8.8.8.0	5.5.0.250	502	0x8000005f	0x2d67

Router Link States (Area 0.0.0.1)

Link ID	ADV Router	Age	Seq#	Checksum
5.5.0.250	5.5.0.250	498	0x80000067	0xdec1
192.168.1.13	192.168.1.13	505	0x800000a5	0x3b32

Network Link States (Area 0.0.0.1)

Link ID	ADV Router	Age	Seq#	Checksum
4.4.4.13	192.168.1.13	505	0x80000001	0x410b
5.1.0.0	192.168.1.13	940	0x80000059	0x82c4
5.2.0.0	5.5.0.250	495	0x80000001	0x51bf
5.2.0.0	192.168.1.13	932	0x80000059	0x76cf
5.3.0.0	5.5.0.250	495	0x80000001	0x45ca
5.3.0.0	192.168.1.13	932	0x80000059	0x6ada
56.56.56.0	5.5.0.250	495	0x80000062	0xc469

AS Summary Link States (Area 0.0.0.1)

Link ID	ADV Router	Age	Seq#	Checksum
5.5.0.250	5.5.0.250	496	0x800000001	0x51c0

• Example 2—OSPFv3 general output

```
host1#show ipv6 ospf database
```

```
OSPF Database
```

V3 Router Link States (Area 0.0.0.0)

Link ID	ADV Router	Age	Seq#	Checksum
0.0.0.0	2.2.2.2	167	0x80000003	0xa9e3
0.0.0.0	3.3.3.3	168	0x80000002	0x2c63

V3 Inter-Area Net Link States (Area 0.0.0.0)

Link ID	ADV Router	Age	Seq#	Checksum
0.0.0.1	2.2.2.2	33	0x80000004	0x5288

V3 Inter-Area Router Link States (Area 0.0.0.0)

Link ID	ADV Router	Age	Seq#	Checksum
0.0.0.1	2.2.2.2	33	0x80000001	0x a0f

V3 Intra-Area Prefix Link States (Area 0.0.0.0)

Link ID	ADV Router	Age	Seq#	Checksum
0.0.0.1	2.2.2.2	167	0x80000003	0xc8ba
0.0.0.1	3.3.3.3	168	0x80000003	0xdc9e

V3 Link Link States (Area 0.0.0.0)

Link ID	ADV Router	Age	Seq#	Checksum
50.0.0.10	2.2.2.2	178	0x80000001	0xb51d
50.0.0.13	3.3.3.3	178	0x80000001	0x8c3e

V3 Router Link States (Area 0.0.0.1)

Link ID	ADV Router	Age	Seq#	Checksum
0.0.0.0	1.1.1.1	40	0x80000003	0xf7a4
0.0.0.0	2.2.2.2	168	0x80000003	0x7825

V3 Inter-Area Net Link States (Area 0.0.0.1)

Link ID	ADV Router	Age	Seq#	Checksum
0.0.0.2	2.2.2.2	33	0x80000004	0x6a4f

V3 Intra-Area Prefix Link States (Area 0.0.0.1)

Link ID	ADV Router	Age	Seq#	Checksum
0.0.0.1	1.1.1.1	169	0x80000003	0x911a
0.0.0.1	2.2.2.2	168	0x80000003	0xa5fd

V3 Link Link States (Area 0.0.0.1)

Link ID	ADV Router	Age	Seq#	Checksum
50.0.0.6	1.1.1.1	180	0x80000001	0x44b7
50.0.0.9	2.2.2.2	178	0x80000001	0x1bd8

V3 External Link States

Link ID	ADV Router	Age	Seq#	Checksum
0.0.0.1	1.1.1.1	40	0x80000001	0xe5a0

- Example 3—OSPFv3 database summary information

```
host1:v2#show ipv6 ospf database database-summary
```

Area	Router	Network	Intra-Prefix	Inter-Prefix	Inter-Router
-----	-----	-----	-----	-----	-----
0.0.0.0	2	1	3	0	0
Area	MaxAge				
-----	-----				
0.0.0.0	0				

```
Link LSAs: 2, Max age: 0
Grace LSAs: 1, Max age: 0
External LSAs: 0, Max age: 0
```

- Example 4—OSPFv3 LSA output (router)

```
host1#show ipv6 ospf database router
```

```
V3 Router Link States (Area 0.0.0.0)
LS age: 433
Options: ( V6-Bit , R-Bit , ExternalRoutingCapability, No Nssa-LSA)
LS Type: Router Links
Link State ID: 0.0.0.0
Advertising Router: 1.1.1.1
LS Seq Number: 0x80000002
Checksum: 0x c90
Length: 40
Bit E set
Link connected to: a Point To Point Network
Neighboring router's Router Id: 2.2.2.2
Neighboring router's Interface Id: 0x3200000a
Local Interface ID : 0x32000006
Metric 1
```

```

LS age: 432
Options: ( V6-Bit , R-Bit , ExternalRoutingCapability, No Nssa-LSA)
LS Type: Router Links
Link State ID: 0.0.0.0
Advertising Router: 2.2.2.2
LS Seq Number: 0x80000002
Checksum: 0x8519
Length: 40

Link connected to: a Point To Point Network
Neighboring router's Router Id: 1.1.1.1
Neighboring router's Interface Id: 0x32000006
Local Interface ID : 0x3200000a
Metric 1

```

- Example 5—OSPFv3 LSA output (network)

```

host1#show ipv6 ospf database network
(Area 0.0.0.1)
LS Type: Network LSA
Link State ID: 0.0.0.14
Advertising Router: 3.3.3.3
LS age: 131
LS Seq Number: 0x80000001
Checksum: 0x6c69
Length: 32
Options: V6-bit set, ExternalRoutingCapability, R-bit set
Attached Router: 3.3.3.3
Attached Router: 2.2.2.2

```

- Example 6—OSPFv3 LSA output (link)

```

host1#show ipv6 ospf database link
V3 Link Link States (Area 0.0.0.0)

```

Link ID	ADV Router	Age	Seq#	Checksum
LS age: 280				
LS Type: Link				
Link State ID: 0x32000006				
Advertising Router: 1.1.1.1				
LS Seq Number: 0x80000001				
Checksum: 0x44b7				
Length: 56				
Router Priority 0				
Link Local Address fe80::90:1a00:200:670				
Prefixes				
1:1:1:1000:: / 60	options 0		metric 0	
LS age: 282				
LS Type: Link				
Link State ID: 0x3200000a				
Advertising Router: 2.2.2.2				
LS Seq Number: 0x80000001				
Checksum: 0x11e1				
Length: 56				
Router Priority 0				
Link Local Address fe80::90:1a00:300:670				
Prefixes				
1:1:1:1000:: / 60	options 0		metric 0	

- Example 7—OSPFv3 LSA output (intra-area-prefix)

host1#show ipv6 ospf database intra-area-prefix

```

    V3 Intra Area Prefix Link States (Area 0.0.0.0)
    LS age: 162
    LS Type: Intra Area Prefix Links
    Link State ID: 0.0.0.1
    Advertising Router: 1.1.1.1
    LS Seq Number: 0x80000003
    Checksum: 0x911a
    Length: 44
    Number of Prefixes 1
    Referenced LSA Type 0x    2001
    Referenced LSA Advertising Router 1.1.1.1
    Referenced LSA ID 0
    Prefixes
      1:1:1:1000:: / 60          options 0          metric 1

    LS age: 161
    LS Type: Intra Area Prefix Links
    Link State ID: 0.0.0.1
    Advertising Router: 2.2.2.2
    LS Seq Number: 0x80000003
    Checksum: 0xa5fd
    Length: 44
    Number of Prefixes 1
    Referenced LSA Type 0x    2001
    Referenced LSA Advertising Router 2.2.2.2
    Referenced LSA ID 0
    Prefixes
      1:1:1:1000:: / 60          options 0          metric 1

```

- Example 8—OSPFv3 LSA output (interarea router)

host1#show ipv6 ospf database inter-area-router

```

    V3 Inter-Area-Router Link States (Area 0.0.0.0)
    LS age: 304
    LS Type: Inter Area Net Links
    Link State ID: 0.0.0.1
    Advertising Router: 2.2.2.2
    LS Seq Number: 0x80000001
    Checksum: 0x a0f
    Length: 32
    Metric: 1
    Options: 19
    asbr: 1.1.1.1

```

- Example 9—OSPFv3 LSA output (graceful restart helper)

host1#show ipv6 ospf database grace

```

    V3 Grace Link States (Area 0.0.0.1)
    LS age: 3
    LS Type: Grace
    Link State ID: 0x00000002
    Advertising Router: 2.2.2.2
    LS Seq Number: 0x80000001
    Checksum: 0x8409
    Length: 44
    TLVs
    Type: 1(Restart duration), length: 4, Value: 150
    Type: 2(Restart Reason), length: 1, Value: 2(Software Reload)
    Type: 3(Unknown), length: 4, Value: 33686018

```

- See `show ip ospf database`
- See `show ipv6 ospf database`

show ip ospf database link-local

- Use to display OSPF database link local states.
- Field descriptions
 - Interface—Interface for which you are obtaining link-local LSA
 - LS age—Age of LSA
 - LS Type—Type of LSA (Link Local)
 - Link State ID—Link-state ID of the link local LSA
 - Advertising Router—Router ID of the router that originated the LSA
 - LS Seq Number—Link-state sequence number to identify duplicate or old LSIDs
 - Checksum—Checksum of the complete contents of the LSA
 - Length—Length of the LSA in bytes
 - Opaque LSA Type—Type of opaque LSA
 - Neighbor—Neighbor IP address
 - Grace Period—Helper grace period in seconds
 - Restart Reason—Reason for restart; Planned Restart or Unplanned Restart
- Example

```
host1#show ip ospf database link-local
Link-Local States

Interface : ATM1/3.80
LS age: 17
LS Type: Link Local
Link State ID: 3.0.0.0
Advertising Router: 100.1.1.67
LS Seq Number: 0x80000002
Checksum: 0xac91
Length: 36
Opaque LSA Type : Restart Grace
Neighbor 0.0.0.0
Grace Period 90 seconds
Restart Reason : Unplanned Restart
```

- See `show ip ospf database`

show ip ospf database opaque-area

- Use to display lists of information about the TE opaque LSAs.
- The TE router address LSA describes a stable IP address on the originating router that can be used for TE purposes—such as setting up TE LSPs to this address.

- The TE link LSA describes TE information about an interface on the originating router.
- Field descriptions
 - LS age—Age of LSA
 - Options—Optional capabilities supported by the described portion of the routing domain
 - LS Type—Type of LSA; opaque area TE router address or opaque area TE link LSA
 - Link State ID—Link-state ID of the opaque LSA
 - Advertising Router—Router ID of the router that originated the LSA
 - LS Seq Number—Link-state sequence number to identify duplicate or old LSIDs
 - Checksum—Checksum of the complete contents of the LSA
 - Length—Length of the LSA in bytes
 - TE Router-ID—Traffic engineering router ID of the originating router
 - Link Type—Point-to-point or multiaccess
 - Link ID—For point-to-point interfaces, this is the router ID of the router at the remote end; for multiaccess interfaces, this is the address of the DR
 - Local Address—IP address of the local interface for the link
 - Remote Address—IP address of the remote (neighbor's) interface for the link
 - TE Metric—Link metric for traffic engineering purposes; can be different from the standard OSPF link
 - Max BW—Maximum bandwidth that can be used on this link in this direction
 - Max Reservable BW—Maximum bandwidth that can be reserved on this link; can exceed the maximum bandwidth in the event of oversubscription
 - Max Unreserved BW—Amount of bandwidth not yet reserved at each of the eight priority levels; each value is less than or equal to the maximum reservable bandwidth
 - Color—Bitmask that specifies the administrative group membership for this link; a link that is a member of more than one group will have multiple bits set
- Example

```
host1#show ip ospf database opaque-area
```

```
Opaque-area Link States (Area 0.0.0.0)
```

```
LS age: 914
```

```
Options: (TOS-capable, No Type7-LSA, ExternalRoutingCapability, No  
Multicast Capability, No External Attributes LSA)
```

```
LS Type: Opaque-Area (TE Router Address)
```

```
Link State ID: 1.0.0.0(Instance)
```

```
Advertising Router: 100.1.1.1
```

```

LS Seq Number: 0x80000003
Checksum: 0xd293
Length: 28
TE Router-ID: 100.1.1.1

LS age: 919
Options: (TOS-capable, No Type7-LSA, ExternalRoutingCapability, No
Multicast Capability, No External Attributes LSA)
LS Type: Opaque-Area (TE Links)
Link State ID: 1.0.0.1(Instance)
Advertising Router: 100.1.1.1
LS Seq Number: 0x80000003
Checksum: 0xf66e
Length: 124
Link Type: P2P
Link ID: 1744896257
Local Address 14.1.1.2
Remote Address 14.1.1.1
TE Metric 0
Max BW 1000 kb/sec (125000 Bps)
Max Reservable BW 1000 kb/sec (125000 Bps)
Max Unreserved BW : pri 0 1000 kb/sec (125000 Bps)
Max Unreserved BW : pri 1 1000 kb/sec (125000 Bps)
Max Unreserved BW : pri 2 1000 kb/sec (125000 Bps)
Max Unreserved BW : pri 3 1000 kb/sec (125000 Bps)
Max Unreserved BW : pri 4 1000 kb/sec (125000 Bps)
Max Unreserved BW : pri 5 1000 kb/sec (125000 Bps)
Max Unreserved BW : pri 6 1000 kb/sec (125000 Bps)
Max Unreserved BW : pri 7 1000 kb/sec (125000 Bps)
Color 0

```

- See show ip ospf database

show ip ospf interface

show ipv6 ospf interface

- Use to display a list of OSPFv2 or OSPFv3 interfaces.
- Use the optional *areaid* or *areaidint* values to specify an OSPF area ID in either IP or decimal format.
- Field descriptions
 - Interface value (fastEthernet)—Status of the physical link and the operational status of the protocol
 - Internet Address—Interface IP address
 - Area—Area identifier: IP address
 - Network type—Broadcast, NBMA, Point-to-Point, or Point-to-Multipoint
 - Authentication type—None, simple, or MD5
 - Cost—Metric for OSPF transmission
 - Transmit Delay—Time between transmissions from the specified interface
 - Interface State—Current state of the specified interface

- Priority—Router's priority on the specified interface
- Designated Router—Designated router ID and respective interface IP address
- Backup Designated Router—Designated router ID and respective interface IP address of the backup router
- Timer intervals—Configuration of timer intervals: Hello, Dead, Wait, and Retransmit
- Neighbor Count—Number of neighbors and their state; adjacent neighbors
- LDP is configured through LDP autoconfig—Indicates whether LDP is configured on the interface by means of autoconfiguration; supported only for OSPFv2
- LDP-IGP Synchronization—Status of synchronization, Achieved or Pending; supported only for OSPFv2
- Example 1

```
host1#show ip ospf interface
FastEthernet0 is up, OSPF line protocol is up
OSPF interface configuration:
  Internet Address 192.168.1.250, Area 0.0.0.0
  Network type BROADCAST, No authentication
  Cost: 1
  Transmit Delay is 1 sec, Interface State DROTHER, Priority 1
  Designated Router (Interface address) 192.168.1.107
  Backup Designated Router (Interface address) 192.168.1.214
  Timer intervals configured, Hello 10, Dead 40, Wait 120, Retransmit 5
  Neighbor Count is 2, Adjacent neighbor count is 2
  Adjacent with neighbor 192.168.1.107 (Designated Router)
  Adjacent with neighbor 192.168.254.7 (Backup Designated Router)
  LDP is configured through LDP autoconfig
  LDP-IGP Synchronization: Achieved
```

- Example 2

```
host1#show ipv6 ospf interface
ATM4/0.12 is up, OSPFv3 line protocol is up
Area 0.0.0.0, Intf ID: 0x320004, Instance ID: 0
Link Local Address: fe80::90:1a00:100:80
Interface is active
Network type POINT-TO-POINT
Interface State POINT-TO-POINT
Cost: 1, Priority 1
No designated router on this network
No backup designated router on this network
Timer intervals configured:
Hello 10, Dead 40, Wait 40
Transmit Delay is 1 sec(s)
Retransmit interval is 5 secs
Neighbor Count is 1
  FULL Adjacent neighbor count is 1
  Adjacent with neighbor 11.0.0.2

FastEthernet0/0 is up, OSPFv3 line protocol is up
OSPF interface configuration:
  Interface ID 0.0.1.1
  IPv6 link-local address FE80::3/128
  IPv6 prefix address 3000::1/64, Area 0.0.0.0
```



```

Network type BROADCAST
Cost: 1
Transmit Delay is 1 sec, Interface State BACKUPDR, Priority 1
Designated Router's router ID 1.1.1.1
Backup Designated Router's router ID 2.2.2.2
Timer intervals configured, Hello 10, Dead 40, Retransmit 5
Neighbor Count is 1, Adjacent neighbor count is 1
  Adjacent with neighbor 3.3.3.3 (Designated Router)

```

- See `show ip ospf interface`
- See `show ipv6 ospf interface`

show ip ospf internal-statistics

show ipv6 ospf internal-statistics

- Use to display internal OSPFv2 or OSPFv3 statistics, such as allocation failures for different OSPF components.
- Use the **delta** keyword to display statistics relative to the current baseline.
- Field descriptions
 - LSA bytes allocated—Number of bytes allocated for LSAs
 - Router LSA bytes allocated—Number of bytes allocated for router LSAs
 - Summary bytes allocated—Number of bytes allocated for summary LSAs
 - Neighbor RTX bytes allocated—Number of bytes allocated for neighbor retransmissions
 - Timers bytes allocated—Number of bytes allocated for OSPF timers
 - Ospf total bytes free—Total number of bytes free
 - Ospf heap total bytes allocated—Total number of bytes allocated from the OSPF heap
 - Neighbor allocation failures—Number of neighbor allocation failures
 - LSA allocation failures—Number of LSA allocation failures
 - LSA HDR allocation failures—Number of LSA header allocation failures
 - DB Request allocation failures—Number of database request allocation failures
 - RTX allocation failures—Number of neighbor retransmission allocation failures
 - LS Ack allocation failures—Number of LSA acknowledgment packet allocation failures
 - DD pkt allocation failures—Number of database description packet allocation failures
 - OSPF interface allocation failures—Number of interface allocation failures
 - OSPF general packet allocation failures—Number of general packet allocation failures

- Example 1

```
host1#show ip ospf internal-statistics
Routing Process OSPF 1 with Router ID 5.72.3.1
Internal OSPF Statistics, bytes allocated/free:
  LSA bytes allocated:216
  Router LSA bytes allocated:936
  Summary bytes allocated:0
  Neighbor RTX bytes allocated:0
  Timers bytes allocated:352
  Ospf total bytes free:824368
  Ospf heap total bytes allocated:1048576
Internal OSPF Statistics, allocation failures:
  Neighbor allocation failures:0
  LSA allocation failures:0
  LSA HDR allocation failures:0
  DB Request allocation failures:0
  RTX allocation failures:0
  LS Ack allocation failures:0
  DD pkt allocation failures:0
  OSPF interface allocation failures:0
  OSPF general packet allocation failures:0
```

- Example 2

```
host1#show ipv6 ospf internal-statistics
Routing Process OSPFv3 1 with Router ID 1.1.1.1
Internal OSPF Statistics, bytes allocated/free:
  LSA bytes allocated:          39
  Router LSA bytes allocated:   1314774
  Summary bytes allocated:      0
  Timers bytes allocated:       96
  Ospf total bytes free:        16
  Ospf heap total bytes allocated: 1000
Internal OSPF Statistics, allocation failures:
  Neighbor allocation failures:  0
  LSA allocation failures:       0
  LSA HDR allocation failures:   0
  DB Request allocation failures: 0
  RTX allocation failures:       0
  LS Ack allocation failures:    0
  DD pkt allocation failures:    0
  OSPF interface allocation failures: 0
  OSPF general packet allocation failures: 0
```

- See show ip ospf internal-statistics
- See show ipv6 ospf internal-statistics

show ip ospf neighbors

- See show ip ospf neighbors

show ipv6 ospf neighbors

- Use to display information about OSPF neighbors on a per-interface basis.
- Use the optional *areald* or *arealdInt* values, in the **show ipv6 ospf neighbors** command, to specify an OSPFv3 area ID in either IP or decimal format.

- You can use the **history** keyword with the **show ip ospf neighbors** command to display a history of up to 10 events for all OSPF neighbors or a specific OSPF neighbor. This neighbor uptime tracking feature is not available for OSPFv3. For more information, see [“Neighbor Uptime Tracking” on page 352](#).
- Field descriptions
 - Neighbor ID—Neighbor’s router ID
 - Pri—Router priority of neighbor
 - State—OSPF neighbor’s state
 - DR—Designated router
 - BDR—Backup designated router
 - DR Other—Neighbor to a designated router or a backup designated router
 - Dead Time—Interval since last hello packet from neighbor
 - Address—IP address of the neighbor’s interface
 - Intf ID—Interface ID of the neighbor’s interface
 - Interface—Name of the specified interface and its port number
 - Transition log—List of transitions events for a neighbor
 - Interface—Interface for the neighbor
 - Event—Transition event
 - Cause—Cause of transition event
 - Time—Time stamp for the event in *day month date HH : MM : SS* format

• Example 1

```
host1# show ip ospf neighbors
Neighbor ID Pri State Dead Time Address Interface
10.0.8.1 1 TWO-WAY/DR Other 00:00:39 10.0.76.1 fastEthernet11/0
10.0.71.1 1 FULL/DR 00:00:42 10.0.76.2 fastEthernet11/0
10.0.96.1 1 FULL/BDR 00:00:28 10.0.76.4 fastEthernet11/0
```

• Example 2

```
host1# show ipv6 ospf neighbors
Neighbor ID Pri State Dead Time Intf ID Interface
1.1.1.1 1 TWO-WAY/DROTHER 00:00:40 0x3200042a FastEthernet13/1.172
3.3.3.3 1 FULL/BDR 00:00:40 0x32000494 FastEthernet13/1.172
4.4.4.4 1 FULL/DR 00:00:40 0x320004c9 FastEthernet13/1.172
```

• Example 3

```
host1#show ip ospf neighbors history
Transition log for neighbor 10.10.8.2:
Interface Event Cause Time
=====
ATM2/0.8 Seen NA WED DEC 14 07:02:27
```

```

Transition log for neighbor 10.10.12.2:
Interface          Event Cause          Time
=====
ATM2/0.12          Seen   NA               WED DEC 14 07:09:12
ATM2/0.12          DOWN  Interface down      WED DEC 14 07:05:47
ATM2/0.12          Seen   NA               WED DEC 14 07:02:32

```

- See `show ipv6 ospf neighbors`

show ip ospf remote-neighbor interface

- Use to display all interfaces that are associated with OSPF remote neighbors.
- Field descriptions
 - OSPF remote-neighbor—Remote neighbor address for this interface
 - Update-source—Update source for this interface
 - Remote-neighbor reachable—Reachable status of the remote neighbor, yes or no
 - Area—Area of this interface
 - Network type—Network type for this interface
 - Cost—Cost value for this interface
 - Transmit Delay—Transmit delay for this interface, in seconds
 - Interface State—Interface state
 - Priority—Priority value for this interface
 - Designated router—Designated router on this network, if any
 - Backup designated router—Backup designated router on this network, if any
 - Hello—Hello timer value, in seconds
 - Dead—Dead interval timer value, in seconds
 - Wait—Wait interval timer value, in seconds
 - Retransmit—Retransmit interval timer value, in seconds
 - Neighbor Count—Number of neighbors to this interface
 - Adjacent neighbor count—Number of adjacent neighbors to this interface
 - Adjacent with neighbor—Address of the neighbor adjacent to this interface
- Example

```

host1#show ip ospf remote-neighbor interface
OSPF remote-neighbor 221.221.221.221 interface configuration:
  Update-source loopback0
  Remote-neighbor reachable: yes
  Area 0.0.0.0
  Network type POINT-TO-POINT, No authentication
  Cost: 1

```

```

Transmit Delay is 1 sec, Interface State POINT-TO-POINT, Priority 1
No designated router on this network
No backup designated router on this network
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
Neighbor Count is 1, Adjacent neighbor count is 1
Adjacent with neighbor 221.221.221.221

```

- See `show ip ospf remote-neighbor interface`

show ip ospf spf-log

- Use to display how often and why the router has run a full SPF calculation.
- Field descriptions
 - Intra SPF log—Log for SPF calculations run to compute intra-area LSAs
 - Inter SPF log—Log for SPF calculations run to compute interarea LSAs
 - External SPF log—Log for SPF calculations run to compute routes outside the OSPF routing domain
 - When—Amount of time since a full SPF calculation took place, in *hours:minutes:seconds*; the previous 20 calculations are logged
 - Duration—Number of milliseconds to complete this SPF run; the elapsed time is in actual clock time, not CPU time
 - LSA Router Id—Whenever a full SPF calculation is triggered by a new LSA, the router ID is stored in the router
 - Triggers—List of reasons that triggered a full SPF calculation
- Example

host1#**show ip ospf spf-log**

Intra SPF log

When	Duration	LSA Router Id	Triggers
00:04:42	0.000	23.23.23.3	Protocol Off
00:04:38	0.000	23.23.23.3	LSA Add
00:04:34	0.000	12.12.12.2	LSA Add
00:04:30	0.010	23.23.23.3	LSA Update
00:03:51	0.000	23.23.23.3	Protocol Off
00:03:47	0.000	23.23.23.3	LSA Add
00:03:43	0.000	12.12.12.2	LSA Add
00:03:39	0.000	23.23.23.3	LSA Update

Inter SPF log

When	Duration	LSA Router Id	Triggers
00:04:46	0.010	23.23.23.3	Protocol Off
00:04:42	0.000	23.23.23.3	LSA Add
00:04:38	0.000	12.12.12.2	LSA Add
00:04:34	0.000	23.23.23.3	LSA Update
00:03:55	0.000	23.23.23.3	Protocol Off
00:03:51	0.000	23.23.23.3	LSA Add
00:03:47	0.000	12.12.12.2	LSA Add
00:03:43	0.000	23.23.23.3	LSA Update

External	SPF log		
When	Duration	LSA Router Id	Triggers
00:04:47	0.000	23.23.23.3	Protocol Off
00:04:43	0.000	23.23.23.3	LSA Add
00:04:39	0.000	12.12.12.2	LSA Add
00:04:35	0.010	23.23.23.3	LSA Update
00:03:56	0.000	23.23.23.3	Protocol Off
00:03:52	0.000	23.23.23.3	LSA Add
00:03:48	0.000	12.12.12.2	LSA Add
00:03:44	0.000	23.23.23.3	LSA Update

- See `show ip ospf spf-log`

show ipv6 ospf summary-prefix

- Use to display summary prefixes configured to summarize externals.
- Example

```
host1#show ipv6 ospf summary-prefix
Summary Prefixes
4:: / 64
5:: / 64
```

- See `show ipv6 ospf summary-prefix`

show ipv6 ospf traffic

- Use to display OSPFv3 packet statistics.
- Use the **delta** keyword to display statistics relative to the current baseline.
- Field descriptions
 - Rcvd
 - total—Total number of packets received
 - checksum errors—Total number of packets received that contained checksum errors
 - hello—Total number of hello packets received
 - database desc—Total number of database description packets received
 - link state req—Total number of link-state request packets received
 - link state updates—Total number of link-state update packets received
 - link state acks—Total number of link-state acknowledge packets received
 - Sent
 - total—Total number of sent packets
 - pkts dropped—Total number of packets dropped
 - hello—Total number of hello packets sent
 - database desc—Total number of database description packets sent

- link state req—Total number of link-state request packets sent
- link state updates—Total number of link-state update packets sent
- link state acks—Total number of link-state acknowledge packets sent
- LSA discard count—Total number of packets discarded
- Example


```
host1#show ipv6 ospf traffic
OSPFv3 Statistics:
  Rcvd: 249 total, 0 checksum errors
        242 hello, 2 database desc, 1 link state req
        4 link state updates, 1 link state acks
  Sent: 251 total, 0 pkts dropped
        242 hello, 3 database desc, 1 link state req
        4 link state updates, 1 link state acks
  LSA discard count: 0
```
- See show ipv6 ospf traffic

show ip ospf virtual-links

- Use to display the parameters and the current state of OSPF virtual links.
- Field descriptions
 - Virtual link to router—OSPF neighbor and the current state of the virtual link
 - Transmit Delay—Time (in seconds) between transmissions from the specified interface
 - Timer intervals—Timer intervals (in seconds) configured for the link: Hello, Dead, and Retransmit
- Example


```
host1#show ip ospf virtual-links
Virtual link to router 192.168.1.13 in state POINT-TO-POINT
Transmit Delay is 1 sec
Timer intervals configured, Hello 10 sec, Dead 40 sec, Retransmit 5 sec
```
- See show ip ospf virtual-links

CHAPTER 8

Configuring IS-IS

This chapter describes how to configure Intermediate System–to–Intermediate System (IS-IS) routing on your E Series router; it contains the following sections:

- [Overview on page 377](#)
- [Platform Considerations on page 391](#)
- [References on page 391](#)
- [Features on page 392](#)
- [Before You Run IS-IS on page 393](#)
- [Configuration Tasks on page 393](#)
- [Enabling IS-IS for IP Routing on page 393](#)
- [Enabling and Configuring IS-IS for IPv6 Routing on page 395](#)
- [Configuring IS-IS Interface-Specific Parameters on page 398](#)
- [Configuring Global IS-IS Parameters on page 408](#)
- [Configuring IS-IS for MPLS on page 436](#)
- [Using IS-IS Routes for Multicast RPF Checks on page 437](#)
- [Configuring the BFD Protocol for IS-IS on page 438](#)
- [Disabling the IS-IS Protocol on page 439](#)
- [Monitoring IS-IS on page 439](#)

Overview

IS-IS is a dynamic routing protocol developed by the International Organization for Standardization (ISO) and commonly referred to as ISO 10589. IS-IS was originally developed at Digital Equipment Corporation for Phase V DECnet. The motivation to standardize IS-IS, however, was through the efforts of the American National Standards Institute (ANSI) X3S3.3 Network and Transport Layers Committee.

Similar to the Open Shortest Path First (OSPF) routing protocol, IS-IS is a link-state protocol. It builds a complete and consistent picture of a network's topology by sharing link-state information across all network Intermediate System (IS) devices.

The IS-IS routing protocol provides routing for pure Open Systems Interconnection (OSI) environments. IS-IS as implemented on the E Series router supports IP networks and

enables you to configure IS-IS as an IP routing protocol only. In IS-IS, networks are partitioned into routing domains, which are further divided into areas. A two-level hierarchical routing design is used. With this model, routing is referred to as level 1, level 2, or both level 1 and level 2.

IS-IS Terms

OSI internetworking has its own terminology. A number of terms used in IS-IS routing discussions are defined in [Table 53 on page 378](#).

Table 53: IS-IS Terms

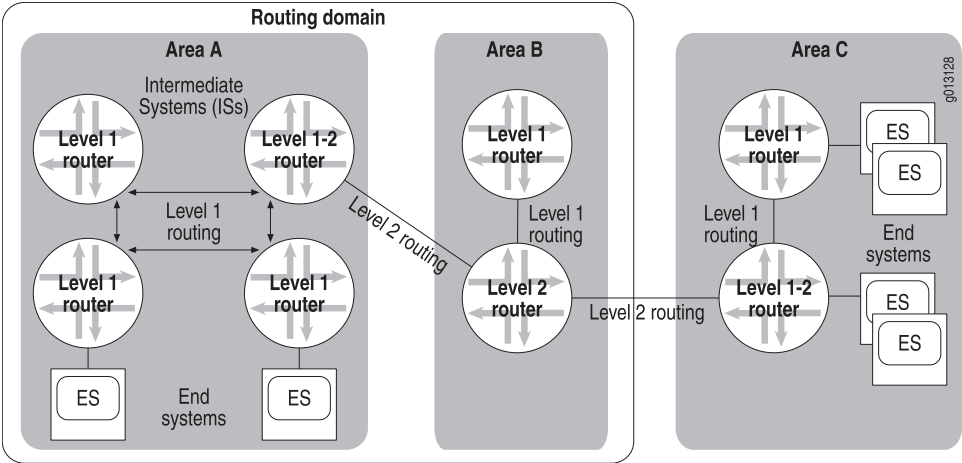
Term	Meaning
area	A group of contiguous networks and their attached hosts. Area boundaries are normally assigned by a network administrator.
complete sequence number PDU (CSNP)	PDU sent by designated router to ensure database synchronization
Connectionless Network Protocol (CLNP)	An OSI network layer protocol used by CLNS to handle data at the transport layer; the OSI equivalent of IP
Connectionless Network Service Protocol (CLNS)	An OSI network layer service that enables data transmission without establishing a circuit and that routes messages independently of any other messages.
end system (ES)	Any nonrouting network node or host
intermediate system (IS)	A router
level 1 routing	<ul style="list-style-type: none"> Routing <i>within</i> an area Level 1 routers (or intermediate systems) track all the individual links, routers, and end systems within a level 1 area. Level 1 routers do not know the identity of routers or destinations outside their area. A level 1 router forwards all traffic for destinations outside its area to the nearest level 2 router within its area.
level 2 routing	<ul style="list-style-type: none"> Routing <i>between</i> areas Level 2 routers know the level 2 topology and know which addresses are reachable via each level 2 router. Level 2 routers track the location of each level 1 area. Level 2 routers are not concerned with the topology within any level 1 area (for example, the details internal to each level 1 area). Level 2 routers can identify when a level 2 router is also a level 1 router within the same area. Only a level 2 router can exchange packets with external routers located outside its routing domain.
link-state PDU (LSP)	PDU broadcast by link-state protocols that contains information about neighbors and path costs; used to maintain routing tables; also known as link-state advertisement

Table 53: IS-IS Terms (continued)

Term	Meaning
network entity title (NET)	ISO network addresses used by CLNS networks; an identifier of a network entity in an end system or intermediate system. A NET consists of an area address (routing domain), system identifier, and selector.
network service access point (NSAP)	Hierarchical network address that specifies the point at which network services are made available to a transport layer entity in the OSI reference model. A valid NSAP address is unique and unambiguously identifies a single system.
partial sequence number PDU (PSNP)	PDU sent by designated router to acknowledge and request link-state information
protocol data unit (PDU)	OSI term equivalent to packet, containing protocol control information and, possibly, user data. This chapter uses the term packet interchangeably with PDU.
route tag	A numeric value assigned to the IP addresses on an IS-IS route before the route is propagated to other routers in an IS-IS domain. You can use this tag to control IS-IS route redistribution, route leaking, or route summarization by referencing it in a route map.
routing domain	A collection of connected areas that provide full connectivity to all end systems located within them. A routing domain is partitioned into areas.
system identifier	Uniquely identifies a system within an area
table map	A mechanism for applying a route map to an IS-IS route as a way to filter and manipulate route attributes before the route is added to the routing table.

Figure 18 on page 379 illustrates some of the terms described in Table 53 on page 378.

Figure 18: Overview of IS-IS Topology



ISO Network Layer Addresses

ISO network layer addresses are flexible enough to make routing feasible in a worldwide Internet. Network layer addresses in ISO and IP are hierarchical and clearly identify level 1 and level 2 areas. These addresses can be up to 20 octets long; any packet that contains an address has one additional octet to specify the length of the address.

An ISO address—also known as the NSAP address—is broken into three parts: the area address, the system identifier (ID), and the NSAP selector.

area address

system ID

selector

area address	system ID	selector
--------------	-----------	----------

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The area address defines the routing domain and the area within the routing domain. The length of the ID field can be from 1 to 8 octets and uses a single fixed length for any one routing domain. The selector field is always 1 octet long. Usually, all end systems within the same area have the same area address. Some areas can have multiple addresses. The NSAP address is defined by the network entity title (NET) during configuration.

Level 1 Routing

A level 1 router looks at a packet's area address and compares it with a destination address. If the area portion of the destination address matches its own area's address, the level 1 router uses the ID portion of the address to route the packet. If the area portion of the address does not match, the level 1 router routes the packet to a level 2 router within its area.

Level 2 Routing

Level 2 routers do not look at an area's internal structure, but simply route toward an area based on the area address. It is common for a level 2 router to also be a level 1 router in a particular area; these routers are sometimes referred to as level 1-2 routers. See [Figure 18 on page 379](#).

Dynamic Hostname Resolution

The system identifier of the NSAP address identifies a node in a network. System operators often find symbolic hostnames to be easier to use and remember than the system identifier. However, a static mapping of hostname to system identifier requires every router to maintain a table of the mappings; each table must contain the hostnames and system identifiers of every router in the network. The static mapping must be managed by router operators, and every change or addition of a mapping requires all the tables to be updated. Consequently, the static tables are likely to become rapidly outdated.

The router supports dynamic resolution of hostnames to system identifiers. You can use the **clns host** command to map the hostname to the NSAP address, and therefore to

the system ID. This mapping is inserted in the dynamic hostname type-length-value tuple (TLV type 137), and subsequently advertised when LSPs are transmitted. The value field contains the hostname, preferably the fully qualified domain name (FQDN) of the host, or a subset of the FQDN. You can display the TLV by issuing the **show isis database detail** command.

Authentication

The router supports two authentication methods for IS-IS: simple authentication and hash function–based message authentication code (HMAC) MD5 authentication. These authentication methods prevent unauthorized routers from injecting false routing information into your network or forming adjacencies with your router.

By default, IS-IS authentication is disabled on the router until you enable it with the commands described in the following sections.

Simple Authentication

Simple authentication uses a text password (authentication key) that can be entered in encrypted or unencrypted form. The receiving router uses this authentication key to verify the packet.

You can configure the password for simple authentication by using the following commands:

- The **area-authentication-key** command assigns a password used by neighboring routers to authenticate IS-IS level 1 link-state PDUs (LSPs), complete sequence number PDUs (CSNPs), and partial sequence number PDUs (PSNPs). This command also enables simple authentication of level 1 LSPs.
- The **domain-authentication-key** command assigns a password used by neighboring routers to authenticate IS-IS level 2 LSPs, CSNPs, and PSNPs. This command also enables simple authentication of level 2 LSPs.
- The **isis authentication-key** command assigns a password associated with a specific interface for authentication of IS-IS level 1 or level 2 hello packets. This command also enables simple authentication of level 1 or level 2 hello packets.

These commands enable simple authentication of LSPs and (for the **isis authentication-key** command) hello packets only; they do not enable authentication of CSNP and PSNP packets. To enable authentication of CSNPs or PSNPs, you must issue either the **area-authentication** command or the **domain-authentication** command. For information, see [“Enabling and Disabling Authentication of CSNPs and PSNPs” on page 384](#).



NOTE: The router supports simple authentication for compatibility with existing IS-IS implementations. However, we recommend that you do *not* use the simple authentication method because it is insecure (the text can be “sniffed”).

HMAC MD5 Authentication

When you enable IS-IS HMAC MD5 authentication (also referred to as MD5 authentication), the router creates secure digests of the packets, encrypted according to the HMAC MD5 message-digest algorithms. The digests are inserted into the packets from which they are created. Depending on the commands you issue, the digests can be inserted into hello packets, link-state PDUs, complete sequence number PDUs, and partial sequence number PDUs.

You can configure an HMAC MD5 authentication key by using the following commands:

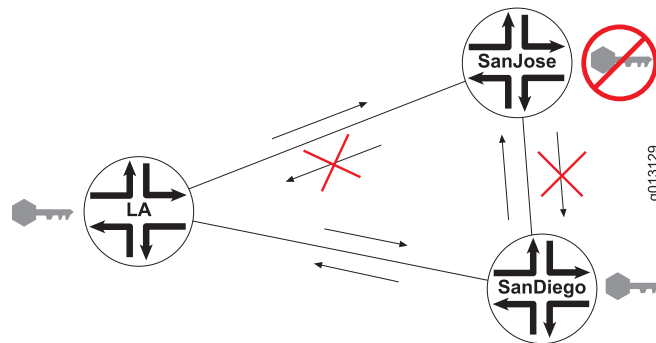
- The `area-message-digest-key` command specifies an HMAC MD5 key that the router uses to create a message digest of each level 1 packet—LSPs, CSNPs, and PSNPs—transmitted by area routers. Using MD5 authentication for area routers protects against unauthorized routers injecting false routing information into the area portions of your network. This command also enables MD5 authentication of level 1 LSPs.
- The `domain-message-digest-key` command specifies an HMAC MD5 key that the router uses to create a message digest of each level 2 packet—LSPs, CSNPs, and PSNPs—transmitted by domain routers. Using MD5 authentication for domain routers protects against unauthorized routers injecting false routing information into the routing domain portions of your network. This command also enables MD5 authentication of level 2 LSPs.
- The `isis message-digest-key` command specifies an HMAC MD5 key that the router uses to create a message digest of level 1 or level 2 hello packets on the interface. Level 1 packets are the default. Using MD5 authentication on interfaces protects against intrusion by preventing unauthorized routers from forming adjacencies with your router. This command also enables MD5 authentication of level 1 or level 2 hello packets.

These commands enable MD5 authentication of LSPs and (for the **isis message-digest-key** command) hello packets only; they do not enable authentication of CSNP and PSNP packets. To enable authentication of CSNPs or PSNPs, you must issue either the **area-authentication** command or the **domain-authentication** command. For information, see [“Enabling and Disabling Authentication of CSNPs and PSNPs” on page 384](#).

MD5 Authentication Example

In the example shown in [Figure 19 on page 383](#), authentication is configured on router LA and router SanDiego, but not on router SanJose. Router LA and router SanDiego accept packets from each other because they contain message digests generated by an accepted key. Router SanJose accepts packets from router LA and router SanDiego, and simply ignores the message digest included in their packets. Router LA and router SanDiego reject packets from router SanJose because those packets do not include a message digest.

Figure 19: Packet Flow Between Routers With and Without Authentication Set



Specifying MD5 Start and Stop Timing

With each of the MD5 commands, you can specify when the router will start and stop *accepting* packets that include a digest made with this key. You can also specify when the router will start and stop *generating* packets that include a digest made with this key. If you specify a time for any of these actions, you can further specify the day, month, and year. The default times are as follows:

- Start accepting keys (startAcceptTime)—Current time
- Stop accepting keys (stopAcceptTime)—Never
- Start generating keys (startGenTime)—Current time plus 2 minutes
- Stop generating keys (stopGenTime)—Never

If you specify times, you must follow these guidelines to achieve appropriate timing between the actions:

- startAcceptTime must be less than startGenTime.
- stopGenTime must be less than stopAcceptTime.
- When a new key replaces an old one, the startGenTime time for the new key must be less than or equal to the stopGenTime time of the old key.

For example, suppose you configure authentication on router A and router B. If the startGenTime for router A is earlier than the startAcceptTime for router B, router B does not accept packets from router A until the current time matches its startAcceptTime.

The router accepts any packet authenticated with a key you have defined if the packet is received within the period defined for the key by its startAcceptTime and stopAcceptTime. If more than one key has been defined for that period, the router determines which key to use by comparing the startGenTime with the current time. When the startGenTime of a key matches the current time, the router starts using this key to transmit packets and stops using the previous key.

Example

The following commands configure both key 1 and key 2 to be accepted between 08:00:00 and 23:00:00. When the current time reaches 09:00:00, the router begins

using key 1 to transmit packets. When the current time reaches 10:00:00, the router begins using key 2 to transmit packets; key 1 is no longer used. Key 2 will continue to be used until a new key is configured and the new key's startGenTime matches the current time on the router.

```
host1(config-router)#area-message-digest-key 1 hmac-md5 mr942s7n start-accept
08:00:00 start-generate 9:00:00 stop-accept 23:00:00 stop-generate 22:59:59
host1(config-router)#area-message-digest-key 2 hmac-md5 dsb38h5f start-accept
08:00:00 start-generate 10:00:00 stop-accept 23:00:00 stop-generate 22:59:59
```

Halting MD5 Authentication

To prevent key expiration from causing your network to revert to an unauthenticated condition, you cannot halt MD5 authentication by using the timers. When the stopGenTime time for a key is reached, the router does not stop generating the key if it was the last key issued. You must delete all keys to halt authentication. Use the **no** version of the command to delete a key.

Managing and Replacing MD5 Keys

A key has an infinite lifetime if you do not specify stopGenTime and stopAcceptTime. (As noted previously, if the last key expires, the router continues to generate that key.) Many system operators choose to change their keys on a regular basis, such as every month. If you determine that a key is no longer secure, configure a new key immediately. We recommend the following practice for configuring new keys:

1. Configure the new key on all routers in the IS-IS network.
2. Verify that the new key is working.
3. Delete the old key from every router.

Each key has an associated key-ID that you specify. The key-ID is sent with the message digest, so that the receiving routers know which key was used to generate the digest. You also use the key-ID to delete a key.

Enabling and Disabling Authentication of CSNPs and PSNPs

When the E Series router interoperates with other vendors' routers in the same network, you might want to enable or disable (suppress) authentication for some PDU types but not for others. For example, some vendors' routing software might not authenticate any PDUs, whereas other vendors' routing software might authenticate CSNPs and PSNPs separately from LSPs.

To facilitate interoperability with other vendors' routers, the E Series router allows you to enable and disable authentication of CSNPs and PSNPs separately from authentication of LSPs by using the following commands:

- The area-authentication { **csnp** | **psnp** } command enables or disables simple authentication or HMAC MD5 authentication of IS-IS level 1 CSNP packets or PSNP packets. By default, authentication of CSNPs and PSNPs is disabled.

- The domain-authentication { **csnp** | **psnp** } command enables or disables simple authentication or HMAC MD5 authentication of IS-IS level 2 CSNP packets or PSNP packets. By default, authentication of CSNPs and PSNPs is disabled.

When you suppress authentication of CSNPs, the router does not authenticate CSNP packets that it receives from neighboring routers, nor does it include authentication information in CSNP packets that it sends to other routers. Similarly, when you suppress authentication of PSNPs, the router neither authenticates PSNP packets that it receives nor sends authentication information in PSNP packets that it transmits.

Extensions for Traffic Engineering

The router supports *new-style* TLV tuples described in the Internet draft, *IS-IS Extensions for Traffic Engineering*. The router ID TLV (TLV type 134) contains the ID of the router that originates the LSP, providing a stable address that can always be referenced regardless of the state of node interfaces.

The extended IP reachability TLV (type 135) carries IP prefixes and is similar to the IP reachability TLVs (types 128 and 130). The extended IS reachability TLV (type 22) contains information about a series of IS neighbors and is similar to the IS neighbor TLV (type 2).

The older TLVs—2, 128, 130—each have a narrow metric field, providing for metric values ranging only from 0–63. The new TLVs—22 and 135—have a new data structure that includes a wide metric field of 3 bytes (extended IS reachability; configurable) or four bytes (extended IP reachability; calculated). Both new TLVs provide for the use of sub-TLVs to carry more information about IS neighbors; however, only the extended IS reachability TLV currently has defined sub-TLVs, such as IPv4 interface and neighbor addresses.

Use the **metric-style** commands to configure what style the router generates and accepts. The following behaviors are supported:

- Generates and accepts only old-style metrics
- Generates only old-style metrics, but accepts old style and new style
- Generates and accepts both old-style and new-style metrics (this option consumes the most system resources)
- Generates only new-style metrics, but accepts old style and new style
- Generates and accepts only new-style metrics

Refer to the Internet draft, *IS-IS Extensions for Traffic Engineering*, for more information about these extensions.

Integrated IS-IS

The E Series router supports the Integrated IS-IS version of IS-IS. Integrated IS-IS provides a single routing algorithm to route both TCP/IP and OSI Connectionless Network Protocol (CLNP) packets. This design adds IP-specific information to the OSI IS-IS routing protocol. It supports IP subnetting, variable subnet masks, type of service (ToS), and external routing.

Integrated IS-IS allows for the mixing of routing domains; that is, IP-only routers, OSI-only routers, and dual (IP and OSI) routers. OSI and IP packets are forwarded directly over the link-layer services without needing mutual encapsulation. The E Series router supports IS-IS only for the routing and forwarding of TCP/IP packets. Forwarding of OSI packets is not supported.

Equal-Cost Multipath

IS-IS supports equal-cost multipath (ECMP) and installs into the routing table multiple entries for paths to the same destination. Each of these multiple paths to a given destination must have the same cost as the others, but a different next hop.

Static PPP Interfaces

When IS-IS has been configured on a static PPP interface, the IS-IS neighbor does not come up if you remove the IP address from the interface and then add the IP address back to the interface. Consequently, when you remove and add back the IP address, you must also remove the IS-IS configuration from the interface and then add the configuration back to the interface by issuing the **no router isis** and **router isis** commands.

Route Tags

E Series routers support the use of route tags, also known as administrative tags, as a means of tagging the IP addresses on an IS-IS route before the route is propagated to other routers in an IS-IS domain. You must reference the tag in a route map to apply administrative policies to the IS-IS route that matches this tag.

Route Tag Applications

An administrative policy controls how a router handles the routes it receives from and sends to neighboring routers, and governs the installation of routes in the routing table. Examples of the types of administrative policies that you might apply with a route tag include:

- Policies for redistributing routes received from other protocols in the routing table to IS-IS
- Policies for redistributing routes between levels in an IS-IS routing hierarchy; this is also referred to as *route leaking*
- Policies for summarizing routes redistributed into IS-IS or within IS-IS by creating aggregate (summary) addresses

Route Tag Structure

On E Series routers, an IS-IS route tag is a 32-bit (4-octet) nonzero number that is stored as sub-TLV 1 inside the extended IP reachability TLV (type 135). TLV type 135, in turn, is part of an IS-IS LSP. The route tag is therefore advertised when LSPs are transmitted in an IS-IS network.

Because TLV type 135 is a new-style TLV tuple, it has a data structure that includes a wide metric field of four octets. As a result, to use IS-IS route tags you must issue the

metric-style wide command (in Router Configuration mode) to specify that the router generate and accept only new-style TLV tuples.

For a discussion of IS-IS support for TLV tuples, see [“Extensions for Traffic Engineering” on page 385](#).

Setting Route Tags

You can set IS-IS route tags in any of the following ways:

- Tagging a route for IP addresses on an IS-IS passive interface
- Tagging a route for IP addresses on an IS-IS interface
- Tagging IS-IS routes by using an associated route map to set the tag
- Tagging an IS-IS summary address

For instructions and examples on configuring IS-IS route tags, see the sections listed in [Table 54 on page 387](#).

Table 54: Configuration Tasks for Setting IS-IS Route Tags

To Learn About	Using This Command	See
Setting a route tag for an IS-IS passive interface	“passive-interface” on page 404	“Configuring Passive Interfaces” on page 404
Setting a route tag for an IS-IS interface	“isis tag” on page 406	“Configuring Route Tags for IS-IS Interfaces” on page 406
Setting a route tag for a route redistributed from another protocol to IS-IS by using an associated route map	“redistribute” on page 413	“Configuring Redistribution” on page 411
Setting a route tag for a route redistributed from one IS-IS level to another IS-IS level by using an associated route map	“redistribute isis ip” on page 414	“Redistributing Routes Between Levels” on page 413
Setting a route tag for an IS-IS default route by using an associated route map	“default-information originate” on page 419	“Configuring Default Routes” on page 419
Setting a route tag for an IS-IS summary address	“summary-address” on page 422	“Summarizing Routes” on page 421

Using Route Tags

You can set only a single route tag per IS-IS route. However, setting a tag for an IS-IS route has no effect by itself. To use the route tag to apply administrative policies such as route redistribution, route summarization, or route leaking, you must reference the tag value in a route map by issuing the **match tag** command (in Route Map Configuration mode). The route map must also include one or more **set** commands that modify

attributes of the routes matching the tag value. These routes can reside on a different router than the one on which you set the route tag.

For example, the following commands define a route map to modify the metric and metric type attributes of IS-IS routes configured with a route tag value of 221. The **redistribute isis ip** command, as described in [“Redistributing Routes Between Levels” on page 413](#), applies this route map when redistributing the routes from level 1 into level 2.

```
host1(config)#route-map map1 permit 5
host1(config-route-map)#match tag 221
host1(config-route-map)#set metric 10
host1(config-route-map)#set metric-type external
host1(config-route-map)#exit
host1(config)#router isis engineering
host1(config-router)#redistribute isis ip level-1 into level-2 route-map map1
```

Alternatively, you can use a route map to set the tag for an IS-IS route by issuing the **set tag** command (in Route Map Configuration mode). For example, the following commands define a route map that sets route tag 33 for those IS-IS routes configured with an administrative distance of 25:

```
host1(config)#route-map map2 permit 10
host1(config-route-map)#match distance 25
host1(config-route-map)#set tag 33
host1(config-route-map)#exit
host1(config)#router isis marketing
host1(config-router)#table-map map2
```

The **table-map** command, described in [“Configuring Table Maps” on page 431](#), applies this route map to the IS-IS routes before they are added to the routing table. For details about configuring and using route maps, see *JunosE IP Services Configuration Guide*.

Unsupported Features

E Series routers do not currently support the following route tag features:

- Multiple route tags for a single IS-IS route
Although the router accepts IS-IS routes with multiple route tags and propagates these routes in LSPs, it uses only the first route tag assigned to a route to determine routing policy.
- 64-bit (8-octet) route tags
Although the router accepts IS-IS routes with 64-bit route tags and propagates these routes in LSPs, it does not use 64-bit route tags to determine routing policy.
- Mathematical (ordered) set operations on multiple route tags

Table Maps

E Series routers support the use of table maps to filter and manipulate the attributes of an IS-IS route before the route is installed in the routing table. Issuing the **table-map** command (in Router Configuration mode) applies a specified route map as a policy filter on the route before the route is installed in the routing table.

For IS-IS routes, the route map you apply by using the **table-map** command contains one or more **set** commands that can modify the following route attributes:

distance	origin
level	preference
metric	route type
metric type	tag

The router applies the specified route map to all routes currently and subsequently installed in the routing table. If any previously redistributed routes are changed as a result of applying the route map, the router redistributes these routes again with the changes caused by the route map.

For details about configuring and using route maps, see *JunosE IP Services Configuration Guide*.

Graceful Restart

E Series routers support IS-IS graceful restart as defined in RFC 3847—Restart Signaling for Intermediate System to Intermediate System (IS-IS) (July 2004). Graceful restart is also known as nonstop forwarding (NSF). When graceful restart is enabled on an IS-IS router, it allows the router to restart with minimal routing disruption to the network.

Features

When a router running in an IS-IS domain restarts, it typically causes routers in that domain to reset their adjacencies, thus generating unnecessary LSP flooding and shortest-path-first (SPF) calculations throughout the domain. Enabling graceful restart minimizes these effects by providing a mechanism by which a restarting router can do the following:

- Notify neighboring IS-IS routers that it is restarting and request help resynchronizing its LSP database. Neighbors with active adjacencies to the restarting router can thereby reestablish these adjacencies without having to reset them.
- Determine when complete LSP database synchronization with its neighbors has occurred.
- Optimize the process of LSP database synchronization while minimizing temporary routing disruption.

IS-IS graceful restart on E Series routers supports both restart and helper capabilities. These capabilities mean that an E Series router can not only notify neighboring IS-IS routers that it is restarting and request help resynchronizing its LSP database, but can also cooperate with other restarting routers to help them with the restart process.

How Graceful Restart Works

Graceful restart is disabled on the router by default. When you enable graceful restart by issuing the **nsf ietf** command, the router sends restart requests to neighboring routers

to notify them that it is restarting. The restarting router includes the restart TLV (type 211) in its hello PDUs to signal the other routers that it supports graceful restart and to request help resynchronizing its LSP database. Including the restart TLV in hello packets also ensures that neighboring routers will maintain their active adjacencies to the restarting router and keep the restarting router in the network topology.

Graceful restart uses a set of configurable timers to support the restart mechanism. [Table 55 on page 390](#) briefly describes these timers and lists the associated commands that you can use to configure the timer values on the router.

Table 55: IS-IS Graceful Restart Timers

Timer	Description	Associated Command
Interface wait	Sets the maximum time (in seconds) that the router waits for all interfaces with IS-IS adjacencies to come up before completing the restart process	“nsf interface wait” on page 434
T1	Sets the time interval (in seconds) between restart requests sent by the router, and the number of times that the router resends unacknowledged restart requests	“nsf t1” on page 434
T2	Sets the maximum time (in seconds) that the router waits for the LSP database to synchronize	“nsf t2” on page 434
T3	Sets the maximum time (in seconds) that the restarting router waits before setting the overload bit to indicate that graceful restart has failed	“nsf t3” on page 435

For details about configuring graceful restart, see [“Configuring Graceful Restart” on page 432](#).

IS-IS for IPv6

E Series routers support IPv6 routing for IS-IS. The IPv6 Reachability TLV propagates reachability information by flooding and is used in SPF calculations. The IPv6 Interface TLV is used for next hop calculation and is exchanged by means of IS-IS hello packets. A single SPF calculation computes both IPv6 and IPv4 routing tables.

IS-IS routers learn about their neighbors' support for IPv6 through the ISO network layer IPv6 protocol identifier, NLPID 142. The NLPID is contained in the NLPID TLV and is sent out in IS-IS hello packets when IS-IS IPv6 routing is enabled on an interface. A mismatch in support prevents an IS-IS adjacency from being established, because both neighbors must run the same protocols.

IPv6 aggregation, leaking, redistribution, export policies and import policies are supported similarly as for IP, but must be configured within the IS-IS IPv6 address family.

Graceful restart is supported for IS-IS IPv6 traffic depending on the availability of IPv6 high availability. It does not affect IP traffic.

Platform Considerations

For information about modules that support IS-IS on the ERX7xx models, ERX14xx models, and the ERX310 Broadband Services Router:

- See *ERX Module Guide, Table 1, Module Combinations* for detailed module specifications.
- See *ERX Module Guide, Appendix A, Module Protocol Support* for information about the modules that support IS-IS.

For information about modules that support IS-IS on the E120 and E320 Broadband Services 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 IS-IS.

References

For more information about the IS-IS protocol, consult the following resources:

- *JunosE Release Notes, Appendix A, System Maximums*—See the Release Notes corresponding to your software release for information about maximum values.
- ISO International Standard 8473-1:1993—Information technology – Protocol for providing the connectionless-mode network service
- 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)
- 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)
- Extended Ethernet Frame Size Support—draft-ietf-isis-ext-eth-01.txt (November 2001 expiration)
- Management Information Base for IS-IS—draft-ietf-isis-wg-mib-16.txt (January 2005 expiration)
- Point-to-point operation over LAN in link-state routing protocols—draft-ietf-isis-igp-p2p-over-lan-05.txt (January 2005 expiration)
- RFC 1195—Use of OSI IS-IS for Routing in TCP/IP and Dual Environments (December 1990)
- RFC 2763—Dynamic Hostname Exchange Mechanism for IS-IS (February 2000)
- RFC 2966—Domain-wide Prefix Distribution with Two-Level IS-IS (October 2000)

- RFC 2973—IS-IS Mesh Groups (October 2000)
- RFC 3277—Intermediate System to Intermediate System (IS-IS) Transient Blackhole Avoidance (April 2002)
- RFC 3373—Three-Way Handshake for Intermediate System to Intermediate System (IS-IS) Point-to-Point Adjacencies (September 2002)
- RFC 3784—Intermediate System to Intermediate System (IS-IS) Extensions for Traffic Engineering (TE) (June 2004)
- RFC 3847—Restart Signaling for Intermediate System to Intermediate System (IS-IS) (July 2004)
- A Policy Control Mechanism in IS-IS Using Administrative Tags—draft-ietf-isis-admin-tags-02.txt (January 2005 expiration)



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.

Features

Some of the major IS-IS features supported by the router include:

- Optimization of route leaking from level 1 to level 2
- Equal-cost paths maximum 16 equal paths
- Adjacency and LSP overrun
- Dynamic resolution of hostnames to system IDs
- Mesh groups
- Configurable LSP transmit and throttle intervals
- Route redistribution policies based on access lists between IS-IS levels
- Three-way handshake for point-to-point adjacencies
- Simple text and HMAC MD5 authentication
- Support for bigger metric TLVs
- Domain-wide prefix distribution
- Traffic engineering for MPLS
- 32-bit (4-octet) route tags
- Table maps
- Graceful restart
- IPv6 routing

Before You Run IS-IS

At least one IP address/router ID must be configured on your router for IS-IS to run.

Configuration Tasks

Configure Integrated IS-IS by completing the following tasks in the order presented. You must enable IS-IS. All other tasks are optional.

1. Enable IS-IS.
2. Configure selected IS-IS interface-specific parameters.
3. Configure selected global IS-IS parameters.
4. Configure selected IS-IS parameters for monitoring and debugging purposes.
5. Configure IS-IS parameters to enable CLNS packets to be recognized by your router and to monitor CLNS information.

Enabling IS-IS for IP Routing

When enabling IS-IS, you must create an IS-IS routing process and assign it to specific interfaces rather than to networks. You can specify only a single IS-IS process per router.

To enable IS-IS routing, enter Global Configuration mode, and follow this procedure:

1. Specify an IS-IS process for IP. In this example, `floor12` is specified as the tag name.

```
host1(config)#router isis floor12
```

The router is now in Router Configuration mode.

2. Configure a Network Entity Title (NET) for the routing process that specifies the ISO network address.

```
host1(config-router)#net 47.0010.0000.0000.0000.0001.0001.1111.1111.1111.00
```

3. Enter Interface Configuration mode, and specify the interface that you want to actively route IS-IS.

```
host1(config)#interface atm 2/0
```

4. Specify the IS-IS process to apply to the interface. Use the same tag name that you specified with the **router isis** command.

```
host1(config-if)#ip router isis floor12
```

You can repeat Steps 3 and 4 to apply the IS-IS process to multiple interfaces.

ip router isis

- Use to configure an IS-IS routing process on an IP interface.
- Before the IS-IS router process is useful, you must assign a NET with the **net** command, and enable some interfaces with IS-IS.

- Use the tag parameter to specify a meaningful name for a routing process. It must be unique among all IP routing processes for a given router. If you choose not to specify a tag name, a null tag is assumed, and the process is referenced with a null tag. Use the same tag name for **ip router isis** as you did for the **router isis** command.
- Example

```
host1(config-if)#ip router isis floor12
```
- Use the **no** version to disable IS-IS for IP on the interface.
- See ip router isis

net

- Use to configure a NET for a specified routing process. The NET defines the ISO address and consists of an area address or ID, a system ID, and a selector.
- You must configure a minimum of one NET.
- You can have a maximum of three NETs per router.
- You can manually add multiple area IDs by adding multiple NETs with the same system ID.
- There is no default value; **net** must be configured for an IS-IS process to start.
- Multiple NETs can be temporarily useful when there has been a network reconfiguration where either multiple areas are merged, or one area is in the process of being split into more areas. Multiple area addresses enable you to renumber an area slowly, without needing to set aside time to renumber areas all at once.
- When you use IS-IS to do IP routing only, a NET must be configured to instruct the router about its system ID and area ID.
- Example—The following commands configure a router with the area ID 47.0005.80ff.f800.0000.0001.0001 and the system ID 0000.0c11.1111. The last byte of the NET is the N-selector byte and is always 0.

```
host1(config-router)#net 47.0010.0000.0000.0000.0001.0001.1111.1111.00
```
- Use the **no** version to remove a specific NET. Remember that you must specify the NET. The last NET cannot be removed.
- See net

router isis

- Use to enable the IS-IS routing protocol and to specify an IS-IS process for IP.
- Specify only one IS-IS process per router.
- Use the tag parameter to specify a meaningful name for a routing process. If you choose not to specify a tag name, a null tag is assumed, and the process is referenced with a null tag.
- Example

```
host1(config)#router isis floor12
```

- Use the **no** version to disable IS-IS routing.
- See router isis

Summary Example

```

host1(config)#router isis floor12
host1(config-router)#net 47.0010.0000.0000.0000.0001.0001.1111.1111.00
host1(config-router)#exit
host1(config)#interface atm 2/0
host1(config-if)#ip router isis floor12
host1(config-router)#exit
host1(config-if)#interface atm 2/1
host1(config-if)#ip router isis floor12

```

Enabling and Configuring IS-IS for IPv6 Routing

When enabling IS-IS IPv6, you must create an IS-IS IPv6 routing process and assign it to specific interfaces rather than to networks. You can specify only a single IS-IS process per router.



NOTE: IS-IS obtains the router ID for routing processes using either the router ID configured using the `ip router-id` command or using the IPv4 address configured on the loopback interface. If you configure the router ID for IS-IS routing using both the `ip-router-id` command and also configure an IPv4 address on the loopback interface, the configured router ID takes precedence over the address of the loopback interface. In such a scenario, if you remove the router ID by using the `no ip router-id` command and also unconfigure all the IPv4 addresses from the interfaces, the IS-ISv6 adjacency is not reset and remains static. This behavior is expected because the router ID for IS-IS is not reset after you remove the all the IPv4 addresses of interfaces and the explicitly configured router ID.



NOTE: If you remove the last remaining IPv6 address from an interface, and no IS-IS IPv4 configuration exists, the IS-ISv6 neighbor adjacency is brought down. However, if an interface is present with an IPv4 address when you remove the last IPv6 address from the interface, the adjacency is not brought down because enabling IPv6 for the interface also enables IPv4 for that interface. In such a case, a reference to the IS-IS IPv4 routing process is still active.

To enable IS-IS routing, enter Global Configuration mode, and follow this procedure:

1. Access Global Configuration mode and specify an IPv6 license.

```
host1(config)#license ipv6 license-value
```

2. Configure an IP address on the router to serve as the router ID.

```
host1(config)#interface loopback0
host1(config-if)#ip address 10.6.5.4/32
```

3. Configure the lower-layer interfaces over which the IPv6 traffic flows.

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

4. Configure an IPv6 address on the interface.

```
host1(config-if)#ipv6 address 2008::1/48
```

5. Specify the IS-IS IPv6 process to apply to the interface. Use the same tag name that you specify with the **router isis** command for the VR.

```
host1(config-if)#ipv6 router isis floor12
```

Repeat Steps 3–5 for all desired IPv6 interfaces.

6. Specify an IS-IS process globally for the VR. Use the same tag name that you specify with the **ipv6 router isis** command on the interface.

```
host1(config)#router isis floor12
```

7. Configure a Network Entity Title (NET) for the routing process that specifies the ISO network address.

```
host1(config-router)#net 47.0010.0000.0000.0000.0001.0001.1111.1111.1111.00
```

8. Create the IS-IS IPv6 address family for the interface.

```
host1(config-router)#address-family ipv6 unicast
```

9. Configure any of the following desired IS-IS options for the address family:
redistributing routes from other protocols, redistributing IS-IS IPv6 routes between levels, distributing level 2 routing information to level 1 routers throughout the IS-IS routing domain, summarizing IPv6 routes, applying a route map to modify routes before they are installed in the routing table,

```
host1(config-router-af)#redistribute ospf level-1-2
host1(config-router-af)#redistribute isis level-2 into level-1
host1(config-router-af)#distribute-domain-wide
host1(config-router-af)#summary-prefix 2001:2000::0/8 level-1 metric 10 tag 100
host1(config-router-af)#table-map ospfFilter
```

10. Exit the IS-IS IPv6 address family.

```
host1(config-router-af)#exit-address-family
```



NOTE: Enabling IPv6 for the interface also enables IPv4 for that interface. However, this interface does not participate in IS-IS IPv4 routing.

address-family

- Use to configure IS-IS to exchange IPv6 addresses by creating the IPv6 address family.
- Use the **unicast** keyword to exchange unicast addresses. Use the **multicast** keyword to exchange multicast addresses. Use the **unicast** and **multicast** keywords together, or omit both of them to exchange both unicast and multicast addresses.
- Examples

```
host1(config)#address-family ipv6 unicast
```

- Use the **no** version to disable the exchange of IPv6 addresses.
- See address-family

exit-address-family

- Use to exit Address Family Configuration mode and access Router Configuration mode.
- Example

```
host1:vr1(config-router-af)#exit-address-family
```

- There is no **no** version.
- See exit-address-family

ipv6 router isis

- Use to configure an IS-IS routing process on an IPv6 interface.
- Before the IS-IS router process is useful, you must assign a NET with the **net** command, and enable some interfaces with IS-IS.
- Use the tag parameter to specify a meaningful name for a routing process. It must be unique among all IPv6 routing processes for a given router. If you choose not to specify a tag name, a null tag is assumed, and the process is referenced with a null tag. Use the same tag name for **ipv6 router isis** as you did for the **router isis** command.
- Example—Enables ISIS for IPv6 on an interface.

```
host1(config-if)#ipv6 router isis bldg1
```

- Use the **no** version to disable IS-IS on the interface.
- See ipv6 router isis

Summary Example

```
host1(config)#license ipv6 license-value
host1(config)#interface loopback0
host1(config-if)#ip address 10.6.5.4/32
host1(config-if)#interface fastEthernet 1/0
host1(config-if)#ipv6 address 2008::1/48
host1(config-if)#ipv6 router isis floor12
host1(config)#router isis floor12
host1(config-router)#net 47.0010.0000.0000.0000.0001.1111.1111.00
host1(config-router)#address-family ipv6 unicast
host1(config-router-af)#redistribute ospf level-1-2
host1(config-router-af)#redistribute isis level-2 into level-1
host1(config-router-af)#distribute-domain-wide
host1(config-router-af)#summary-prefix 2001:2000::0/8 level-1 metric 10 tag 100
host1(config-router-af)#table-map ospfFilter
```

Configuring IS-IS Interface-Specific Parameters

You can change IS-IS interface–specific parameters; most can be configured independently of other attached routers. You are not required to alter any interface parameters; however, some parameters must be consistent across all routers in your network. If you change certain values from the defaults, you must configure them on multiple interfaces and routers.

In the following command guidelines, many parameters are preset to a default value. If that parameter has been modified from its default, use the **no** version of the command to restore its default value.

Configuring Authentication

You can set a password to authenticate IS-IS hello packets, and you can configure HMAC MD5 authentication for IS-IS interfaces.

isis authentication-key

- Use to specify a password associated with an interface for authentication of IS-IS hello packets, and to enable simple authentication of level 1 or level 2 hello packets.
- You can specify whether the password is for level 1 or level 2 hellos.
- Example

```
host1(config-if)#isis authentication-key 0 red5flower6
```
- Use the **no** version to delete the password.
- See *isis authentication-key*

isis message-digest-key

- Use to configure HMAC MD5 authentication for an interface, and to enable MD5 authentication of level 1 or level 2 hello packets.
- Generates a secure, encrypted message digest of level 1 or level 2 hello packets and inserts the digest into the packet from which it is created. Level 1 is the default.
- You can specify whether the key is entered in unencrypted or encrypted format. If you do not specify which, the string is assumed to be unencrypted.
- Example

```
host1(config-if)#isis message-digest-key 3 hmac-md5 wdi6c3s39n level-2
```
- For point-to-point interfaces, configure keys only for level 1, because only one hello packet is sent (at level 1), not one at level 1 and one at level 2. Keys configured at level 2 are ignored for point-to-point interfaces.
- Use the **no** version to delete the MD5 key, specified by the key ID, from the interface.
- See *isis message-digest-key*

Configuring Link-State Metrics

You can configure the routing metric (cost) for an IS-IS interface. Routes with lower total path metrics are preferred over those with higher path metrics.

isis metric

- Use to configure a cost for a specified interface.
- You can select a number in the range 0–63 if you configured the router with the **metric-style narrow** command. You can select a number in the range 0–16277215 if you configured the router with the **metric-style transition** or the **metric-style wide** command.
- The default value is 10. The default metric is the value assigned when no quality of service (QoS) routing is performed.
- You can configure the default metric for a specified interface by selecting level 1 or level 2 routing. This resets the metric only for level 1 or level 2 routing, respectively. If you do not specify a level, the command specifies both level 1 and level 2 by default.
- We recommend that you configure a reference bandwidth if you want the default cost on interfaces to be related to link speed. If you do not, the default IS-IS metrics are simply hop-count-like metrics.
- Example

```
host1(config-if)#isis metric 20 level-2
```
- Use the **no** version to restore the default value, 10.
- See isis metric

Configuring a Reference Bandwidth to Set a Default Metric

By default, all IS-IS interfaces without a configured metric have the same routing metric, 10. However, when you configure a reference bandwidth for IS-IS, the default metric is calculated differently for each IS-IS interface. The default routing metric in this case is the reference bandwidth divided by the bandwidth of the particular interface.

For example, if you set the IS-IS reference bandwidth to 50,000,000, the default metric for a 10-Mbps interface is calculated as 5. Interfaces with lower bandwidths have higher default metrics than this interface. Similarly, links with higher bandwidths have lower default metrics than this interface.

reference-bandwidth

- Use to set a reference bandwidth from which a default metric can be calculated by IS-IS for interfaces without a configured metric.
- Example

```
host1(config-router)#reference-bandwidth 100000000
```

- Use the **no** version to remove the reference bandwidth. When you do so, the default metric reverts to 10.
- See reference-bandwidth

Setting the CSNP Interval

You can set the advertised complete sequence number PDU (CSNP) interval for an IS-IS interface.

isis csnp-interval

- Use to configure the **isis csnp-interval** level for a specified interface. The level can be configured independently for level 1 and level 2.
- For LAN interfaces: the default value is 10 seconds, which you probably do not need to change. For WAN interfaces: the default value is 0 seconds or disabled.
- On point-to-point subinterfaces use **isis csnp-interval** with the **isis mesh-group** command.
- Completed sequence number PDUs are sent by the designated router to maintain database synchronization.
- Example

```
host1(config-if)#isis csnp-interval 30 level-1
```
- Use the **no** version to restore the default value.
- See isis csnp-interval

Configuring Hello Packet Parameters

You can set the hello interval and the hello multiplier for IS-IS hello packets.

isis hello-interval

- Use the **isis hello-interval** command to set the length of time (in seconds) between hello packets sent on a specific interface. Configure independently for level 1 and level 2, except on point-to-point interfaces because only a single type of hello packet is sent on serial links. For this reason, it is independent of levels 1 and 2. For example, you can specify an optional level for Frame Relay multiaccess networks.

The hello-interval is equal to the *hello multiplier* times the *hello interval seconds* and is advertised as the *holdtime* in the hello packets transmitted. The range is 0–65535; the default value is 10 seconds.



NOTE: The hello-interval value must be the same for all routers attached to a common network. With smaller hello intervals, topological changes are detected faster, but there is more routing traffic.

isis hello-multiplier

- Use the **isis hello-multiplier** command to set a number by which to multiply the hello interval seconds. This number determines the total *holding time* transmitted in the IS-IS hello packet. The default is 3. Use when hello packets are frequently lost and IS-IS adjacencies are failing unnecessarily.

The advertised hold time in IS-IS hellos is set to the hello-multiplier times the hello-interval. Neighbors declare an adjacency to this router to be down after not having received any IS-IS hellos during the advertised hold time.

- The hold time (and thus the hello-multiplier and the hello-interval) can be set on a per interface basis, and can be different between different routers in one area.
- Using a smaller hello-multiplier will give fast convergence, but can result in more routing instability.
- Increment the hello-multiplier to a larger value to help network stability when needed.



CAUTION: Never configure a hello-multiplier lower than the default.

- Holding time—Time a neighbor waits for another hello packet before declaring the neighbor is down. It determines how quickly a failed link or neighbor is identified so that routes can be recalculated.
- Raise the hello multiplier and lower the hello interval simultaneously to make the hello protocol more reliable without increasing the time required to detect a link failure.
- Example

```
host1(config-if)#isis hello-interval 6 level-1
host1(config-if)#isis hello-multiplier 10 level-1
```

- Use the **no** version to restore a default value.
- See isis hello-interval
- See isis hello-multiplier

Padding IS-IS Hello Packets

You can use the **isis hello padding** command to configure IS-IS hello packet padding. Padding the hello packets promotes early error detection due to transmission problems with large frames or due to mismatched MTUs on adjacent interfaces.

When disabled (default), IS-IS hello packets are padded to the full MTU size until an adjacency is formed with the adjacent interface. After the adjacency is formed, the hello packets are no longer padded. When enabled, IS-IS hello packets are always padded.

isis hello padding

- Use to pad IS-IS hello packets to their full maximum transmission unit (MTU) size.
- Example

```
host1(config-if)#isis hello padding
```

- Use the **no** version to restore the hello padding to its default, no padding.
- See isis hello padding

Configuring LSP Parameters

You can configure the transmission interval, retransmission interval, and retransmission throttle interval for LSPs on an interface-specific basis.

isis lsp-interval

- Use to configure the delay between successive IS-IS link-state PDU (LSP) transmissions.
- You can choose an interval in the range 1–4294967295 milliseconds. For example, setting 100 milliseconds allows 10 packets per second.
- The default value is 33 milliseconds.
- If your network has many IS-IS neighbors and interfaces, a particular router may have difficulty with the CPU load imposed by LSP transmission and reception. If this is the case, you can reduce the LSP transmission rate by issuing this command.
- Example

```
host1(config-if)#isis lsp-interval 100
```
- Use the **no** version to restore the default value, 33 milliseconds.
- See isis lsp-interval

isis retransmit-interval

- Use to configure the number of seconds between the retransmission of IS-IS LSPs with the same LSP ID for point-to-point links.
- You can select an interval in the range 1–65535 seconds.
- The default value is 5 seconds.
- Specify a number greater than the expected round-trip delay between any two routers on your network.
- Always specify conservatively; otherwise, excessive retransmission can result.
- Because retransmissions occur only when LSPs are dropped, when you set **isis retransmit-interval** to a higher value, it has little effect on reconvergence.
- Set to a higher value when routers have many neighbors or more paths over which LSPs can be flooded.
- Use a large value for serial lines.
- Example

```
host1(config-if)#isis retransmit-interval 60
```
- Use the **no** version to restore the default value, 5 seconds.
- See isis retransmit-interval

isis retransmit-throttle-interval

- Use to configure the maximum rate at which IS-IS LSPs are retransmitted on point-to-point links. The interval is the number of milliseconds between packets.
- You can choose an interval in the range 0–65535 milliseconds.
- The default delay value is 33 milliseconds.
- The **isis retransmit-throttle-interval** is the maximum rate at which IS-IS LSPs are retransmitted. It is different from **isis lsp-interval**, which is the rate at which LSPs are transmitted on the interface; and it is different from **isis retransmit-interval**, which is the period between successive retransmissions of the *same* LSP. Use all three commands with each other to control the load of routing traffic from one router to its neighbors.
- Typically, you can set this interval for very large networks with many LSPs and many interfaces as a way of controlling LSP retransmission traffic.
- Example


```
host1(config-if)#isis retransmit-throttle-interval 300
```
- Use the **no** version to restore the default value, 33 milliseconds.
- See `isis retransmit-throttle-interval`

Setting the Designated Router Priority

You can set the priority for the designated IS-IS router that you have elected to use.

isis priority

- Use to set the priority of use for your designated router.
- You can configure an individual priority for level 1 and level 2 by choosing a priority level in the range 0–127.
- The default priority level is 64.
- Specifying the **level 1** or **level 2** keyword resets the priority only for level 1 or level 2 routing, respectively.
- Priorities are used to determine which router in the network is the designated intermediate system (DIS); the router with the highest priority becomes the DIS. Priorities are advertised in hellos.
- IS-IS has no backup designated router. Setting the priority to 0 reduces the chance of this router becoming the DIS, but does not prevent it. If a router with a higher priority is identified, it takes over the role from the current DIS. When priorities are equal, the highest MAC address breaks the tie and becomes the DIS.
- Example


```
host1(config-if)#isis priority 80 level-1
```
- Use the **no** version to restore the default value, 64.
- See `isis priority`

Configuring Passive Interfaces

You can configure an IS-IS passive interface. A passive interface only advertises its IP address in its LSPs; it does not send or receive IS-IS packets.

Optionally, you can set a route tag for an IS-IS passive interface by including the **tag** keyword and a numeric tag value in the **passive-interface** command.

Passive interfaces have a metric of zero by default. You can set a different metric for a particular passive interface by specifying the value along with the **metric** keyword. A global default metric set with the **metric** command does not affect any passive interface. Similarly, configuring a reference bandwidth for IS-IS has no effect on passive interfaces. Metrics specified for a passive interface apply to both level 1 and level 2 interfaces unless you restrict the metric to a single level.

If you configure an interface for IP processing without any explicit IP address assigned to it as an unnumbered interface and if you also define it to be a loopback interface to send packets back to the router for local processing by using the **ip unnumbered loopback interfaceSpecifier** command on a physical interface that is assigned to be a passive interface in an IS-IS instance, the IS-IS application verifies whether the index of the interface is unnumbered. If the IS-IS instance detects that the IS-IS passive interface is an unnumbered interface, IS-IS does not perform a lookup on the local address time. The IS-IS application performs a lookup to check whether the passive interface has a valid IP address and subnet mask only if it is a numbered interface.

If you configure an interface with only an IPv6 address in IS-IS Router Configuration mode, the UID of the interface is used to perform a binding to the IPv6 interface table. This binding determines if the interface entry is present in the table. If the interface already exists, the interface is configured as a passive interface.

passive-interface

- Use to configure an IS-IS interface so that its IP address is advertised in its link-state PDUs but no IS-IS packets are sent from or received on the interface.
- Use the optional **tag** keyword to specify a tag value for an IS-IS passive interface before the route is propagated to other routers in an IS-IS domain. The tag value must be a number in the range 1–4294967295.
- Use the optional **metric** keyword to specify a metric value for an IS-IS passive interface. The metric value must be a number in the range 1–16777215. This value overrides the default metric of zero.
- You can also accomplish the equivalent of the **passive-interface** command by using the **redistribute** command to redistribute a connected route to level 1.
- Example 1—Configures loopback 0 as a passive interface and enable IS-IS on subinterfaces ATM 2/0.1 and ATM 2/1.1. IS-IS advertises the IP address of loopback 0 in its link-state PDUs, but runs only on ATM 2/0.1 and ATM 2/1.1:

```
host1(config)#router isis floor12
host1(config-router)#net 47.0010.0000.0000.0000.0001.0001.1111.1111.00
host1(config-router)#passive-interface loopback 0
```

```

host1(config-router)#exit
host1(config)#interface atm 2/0.1
host1(config-subif)#ip router isis floor12
host1(config-subif)#exit
host1(config)#interface atm 2/1.1
host1(config-subif)#ip router isis floor12

```

You can override the passive-interface configuration simply by issuing the complementary command. For example, suppose you issue the following commands after the previous configuration:

```

host1(config-router)#passive-interface atm 2/0.1
host1(config-router)#exit
host1(config)#interface loopback 0
host1(config-if)#ip router isis floor12

```

Now IS-IS advertises the IP address of ATM 2/0.1 in its link-state PDUs, but runs only on loopback 0 and ATM 2/1.1.

- Example 2—Sets a route tag on the IS-IS passive interface configured in Example 1.

```

host1(config)#router isis floor12
host1(config-router)#passive-interface loopback 0 tag 12

```

- Example 3—Sets a metric and level on the IS-IS passive interface configured in Example 1.

```

host1(config)#router isis floor12
host1(config-router)#passive-interface loopback 0 metric 45 level-2

```

- Use the **no** version to delete the passive interface, or to remove the tag, metric, or both.
- See passive-interface

Configuring Adjacency

You can configure the type (level) of adjacency you want to use on an IS-IS interface.

isis circuit-type

- Use to specify adjacency levels on a specified interface; however, normally, you do not need to use this command.
- Configure a router as a level 1-only, a level 1–level 2 system, or a level 2-only system.
- Configure some interfaces to be level 2-only for routers that are between areas. This prevents wasting bandwidth by sending out unused level 1 hellos.
- On point-to-point interfaces, the level 1 and level 2 hellos are in the same packet.
- Level 1-2 is the default.
- Example


```

host1(config-if)#isis circuit-type level-2-only

```
- Use the **no** version to restore the default value, level-1-2.
- See isis circuit-type

Configuring Route Tags for IS-IS Interfaces

To configure a route tag for the IP addresses on an IS-IS interface:

1. Specify an IS-IS routing process, and access Router Configuration mode.

```
host1(config)#router isis engineering
host1(config-router)#
```

2. Configure a NET for the IS-IS process.

```
host1(config-router)#net 47.0010.0000.0000.0000.0001.0001.1111.1111.00
```

3. Configure the router to accept and generate only new-style TLV tuples with a wider metric field. New-style TLV tuples include TLV type 135, which contains the route tag.

```
host1(config-router)#metric-style wide
```

4. Exit Router Configuration mode.

```
host1(config-router)#exit
```

5. Specify the interface on which you want to route IS-IS.

The procedure assumes that at least one IP address is already configured on this interface.

```
host1(config)#interface atm 2/2.1
```

6. Configure a route tag for the interface.

```
host1(config-subif)#isis tag 221
```

7. Specify the IS-IS process to apply to the interface.

```
host1(config-subif)#ip router isis engineering
```

8. (Optional) Access Privileged Exec mode, and verify the route tag assignment.

```
host1(config-subif)#exit
host1(config)#exit
host1#show isis database detail
```

isis tag

- Use to set a route tag for the IP addresses on an IS-IS interface before the route is propagated to other routers in an IS-IS domain.
- Specify a numeric tag value in the range 1–4294967295.
- To make use of the route tag to modify route attributes or redistribute routes, you must reference the tag value in a route map.
- Example

```
host1(config)#interface atm 3/0
host1(config-if)#isis tag 45
```

- Use the **no** version to remove the route tag from the interface.
- See *isis tag*

Configuring Point-to-Point-over-LAN Circuits

You can deploy IS-IS on broadcast and point-to-point circuits. IS-IS treats these circuits differently in several ways, such as when establishing neighbor adjacencies or flooding link-state information.

Broadcast circuits use designated routers and are represented as virtual nodes in the network topology. They require periodic database synchronization. By default, IS-IS treats the broadcast link as LAN media and tries to bring up the LAN adjacency even when the interface is configured as unnumbered or only a single neighbor exists on that link.

In contrast, point-to-point circuits have less overhead, because they do not use designated routers, the link-state database has no representation of the pseudonode or network LSA, and they do not require periodic database synchronization. However, if more than two routers are connected on the LAN media, routing information in the network is reduced.

Although broadcast circuits are intended to handle more than two devices, in some circumstances you might connect only two routers over the physical or virtual LAN. Even though only two routers are connected, IS-IS treats the circuit as a broadcast circuit that has many more connected routers, with all the associated broadcast overhead but without the benefits of reduced routing information and of optimized flooding that result from having more than two routers on the LAN.

You can use the **isis network point-to-point** command to configure IS-IS to operate using point-to-point connections on a broadcast circuit when only two routers are on the circuit. This configuration is known as a point-to-point-over-LAN or P2P circuit. This interface configuration tears down the current LAN adjacency that IS-IS has over this interface. IS-IS then reestablishes the adjacency as a point-to-point connection and regenerates the LSPs. The broadcast link is thereafter treated as simple point-to-point interface.

Treating the LAN as a P2P circuit reduces the amount of information that IS-IS has to maintain and manage. For example, there is no need to elect a designated router for the interface. LSP flooding is performed as in P2P links without the need for using periodic CSNPs.

This circuit configuration can be advantageous even when many routers are on the LAN. For example, you might want to organize the routers into multiple smaller VLANs so that you can assign different costs to the IS-IS neighbors. You can apply this configuration to any such VLAN that has only two routers. IS-IS then views the LAN as a mesh of point-to-point connections.

The use of IP unnumbered interfaces makes the most of scarce IP address resources and provides for simpler network management and configuration. This configuration enables IP processing on a point-to-point interface without an explicit IP address. The IP unnumbered interface borrows the IP address of another interface on the node. Point-to-point-over-LAN circuits separate the concept of network type from media type, and enable you to apply unnumbered interface configurations to LANs.

The point-to-point-over-LAN feature requires the following:

- The LAN must have only two routers.
- Both routers must support the feature.
- You must configure the interface at each end as a P2P connection.
- If you are using numbered interfaces, both ends must be in same IPv4 subnet.
- If you are using unnumbered interfaces, both ends require static ARP entry configuration.

isis network point-to-point

- Use to specify that the broadcast circuit is to be treated as a point-to-point circuit.
- Issuing this command tears down existing adjacencies, originates or flushes LSPs, and establishes new adjacencies
- Example

```
host1(config-intf)#isis network point-to-point
```
- Use the **no** version to restore the default value, treating the circuit as a broadcast circuit.
- See *isis network point-to-point*

Summary Example

```
host1(config-router)#passive-interface loopback 0
host1(config-if)#interface atm 8/0
host1(config-if)#isis tag 55
host1(config-if)#isis metric 20 level-2
host1(config-if)#isis csnp-interval 30 level-1
host1(config-if)#isis hello-interval 6 level-1
host1(config-if)#isis hello-multiplier 10 level-1
host1(config-if)#isis lsp-interval 100
host1(config-if)#isis retransmit-interval 60
host1(config-if)#isis retransmit-throttle-interval 300
host1(config-if)#isis priority 80 level-1
host1(config-if)#isis circuit-type level-2-only
host1(config-intf)#no isis network point-to-point
```

Configuring Global IS-IS Parameters

This section describes the commands you can use to globally configure optional IS-IS parameters.

In the following command guidelines, many parameters are preset to a default value. Use the **no** version of those commands to restore default values.

Setting Authentication Passwords

You can configure simple authentication or HMAC MD5 authentication for either an area or a domain.

area-authentication-key

- Use to specify a password used by neighboring routers for authentication of IS-IS level 1 LSPs, CSNPs, and PSNPs.
- Issuing this command enables simple authentication of level 1 LSPs only. To enable simple authentication of level 1 CSNPs or PSNPs, use the `area-authentication` command.
- You can specify whether the key is entered in unencrypted or encrypted format. If you do not specify which, the string is assumed to be unencrypted.
- Example

```
host1(config-router)#area-authentication-key 0 bigtree
```
- Use the **no** version to delete the password.
- See `area-authentication-key`

area-message-digest-key

- Use to configure HMAC MD5 authentication for an area.
- Generates a secure, encrypted message digest of level 1 packets (LSPs, CSNPs, and PSNPs) and inserts the digest into the packet from which it is created.
- Issuing this command enables MD5 authentication of level 1 LSPs only. To enable MD5 authentication of level 1 CSNPs or PSNPs, use the `area-authentication` command.
- You can specify whether the key is entered in unencrypted or encrypted format. If you do not specify which, the string is assumed to be unencrypted.
- Example

```
host1(config-router)#area-message-digest-key 1 hmac-md5 kd4s8hnEK
```
- Use the **no** version to delete the MD5 key specified by the key ID.
- See `area-message-digest-key`

domain-authentication-key

- Use to specify a password used by neighboring routers for authentication of IS-IS level 2 LSPs, CSNPs, and PSNPs.
- Issuing this command enables simple authentication of level 2 LSPs only. To enable simple authentication of level 2 CSNPs or PSNPs, use the `domain-authentication` command.
- You can specify whether the key is entered in unencrypted or encrypted format. If you do not specify which, the string is assumed to be unencrypted.
- Example

```
host1(config-router)#domain-authentication-key 8 4kl6n39us
```
- Use the **no** version to delete the password.
- See `domain-authentication-key`

domain-message-digest-key

- Use to configure HMAC MD5 authentication for a domain.
- Generates a secure, encrypted message digest of level 2 packets (LSPs, CSNPs, and PSNPs) and inserts the digest into the packet from which it is created.
- Issuing this command enables MD5 authentication of level 2 LSPs only. To enable MD5 authentication of level 2 CSNPs or PSNPs, use the `domain-authentication` command.
- You can specify whether the key is entered in unencrypted or encrypted format. If you do not specify which, the string is assumed to be unencrypted.
- Example

```
host1(config-router)#domain-message-digest-key 4 hmac-md5 4bFjt7es
```
- Use the **no** version to delete the MD5 key specified by the key ID.
- See `domain-message-digest-key`

Configuring Authentication of CSNPs and PSNPs

You must enable and disable authentication of CSNP packets and PSNP packets separately from authentication of LSP packets.

area-authentication

- Use to enable or disable (suppress) simple authentication or HMAC MD5 authentication of IS-IS level 1 CSNP packets or PSNP packets.
- When authentication is enabled, it uses either the simple text password specified by the **area-authentication-key** command, or the HMAC MD5 key specified by the **area-message-digest-key** command.
- You must specify either the **csnp** keyword to enable authentication of level 1 CSNP packets, or the **psnp** keyword to enable authentication of level 1 PSNP packets.
- Example

```
host1(config-router)#area-authentication csnp
```
- Use the **no** version to restore the default behavior, in which authentication of level 1 CSNPs and PSNPs is disabled. When authentication of level 1 CSNPs or PSNPs is suppressed, the router does not authenticate these packets when it receives them, nor does it send authentication information in these packets when it transmits them.
- See `area-authentication`

domain-authentication

- Use to enable or disable (suppress) simple authentication or HMAC MD5 authentication of IS-IS level 2 CSNP packets or PSNP packets.
- When authentication is enabled, it uses either the simple text password specified by the **domain-authentication-key** command, or the HMAC MD5 key specified by the **domain-message-digest-key** command.
- You must specify either the **csnp** keyword to enable authentication of level 2 CSNP packets, or the **psnp** keyword to enable authentication of level 2 PSNP packets.

- Example

```
host1(config-router)#domain-authentication csnp
```

- Use the **no** version to restore the default behavior, in which authentication of level 2 CSNPs and PSNPs is disabled. When authentication of level 2 CSNPs or PSNPs is suppressed, the router does not authenticate these packets when it receives them, nor does it send authentication information in these packets when it transmits them.
- See domain-authentication

Configuring Redistribution

You can specify how IS-IS redistributes routes received from other routing protocols, redistributes routes according to new policies, and controls redistribution of routes with access lists and route maps.

Optionally, when you issue the **redistribute** command and specify a route map, you can use the map to set a route tag for a route redistributed from another protocol to IS-IS. Make sure the route map you specify includes the **set tag** command that defines a tag value for the routes destined for IS-IS. For details about configuring and using route maps, see *JunosE IP Services Configuration Guide*.

To redistribute IPv6 routes, issue the **redistribute** command from within the IS-IS IPv6 address family.

access-list

route-map

- Use the **access-list** command to create a standard or extended access list.
- Use the **route-map** command to create a route map.
- For detailed information about configuring access lists and route maps, see *JunosE IP Services Configuration Guide*.
- Example—For IP route redistribution the access list filters IP routes; for IPv6 route redistribution, the access list must filter IPv6 routes.

1. Configure three static routes:

```
host1(config)#ip route 10.20.20.0 255.255.255.0 192.168.1.0
host1(config)#ip route 10.20.21.0 255.255.255.0 192.168.1.0
host1(config)#ip route 10.21.0.0 255.255.255.0 192.168.1.0
```

2. Configure an access list with filters on routes 10.20.20.0/24 and 10.20.21.0/24:

```
host1(config)#access-list boston permit 10.20.0.0 0.0.255.255
```

3. Configure a route map that matches the previous access list and applies an internal metric type:

```
host1(config)#route-map 1
host1(config-route-map)#match ip address 1
host1(config-route-map)#set metric-type internal
```

4. Configure redistribution into IS-IS of the static routes with route map 1:

```
host1(config)#router isis testnet
host1(config-router)#redistribute static ip route-map 1
```

5. Use the **show isis database** command to verify the effect of the redistribution (that two static routes matching the route map are redistributed as level 2 internal routes):

```
host1#show isis database detail l2
IS-IS Level-2 Link State Database
LSPID LSP Seq Num  LSP Checksum  LSP Holdtime  ATT/P/OL
0000.0000.6666.00-00  0x000002B7   0x3E1F 1198 0/0/0
  Area Address: 47.0005.80FF.F800.0000.0001.0001
  NLPID:      0xcc
  IP Address: 192.168.1.105
  Metric: 10 IS 0000.0000.6666.01
  Metric: 10 IS 0000.0000.3333.00
  Metric: 10 IS 0000.0000.7777.00
  Metric: 30 IP 10.20.21.0 255.255.255.0
  Metric: 30 IP 10.20.20.0 255.255.255.0
```

- Use the **no** version of the **access-list** command to remove the access list or the specified entry in the access list.
- Use the **no** version of the **route-map** command to remove an entry.
- See access-list
- See route-map

clear ip isis redistribution

clear isis ipv6 redistribution

- Use to clear all the routes that have been previously redistributed into IS-IS and to redistribute them using the current policy configured. Use the IP version to redistribute IP routes. Use the IPv6 version to redistribute IPv6 routes.
- Use when you have made changes to route maps or access lists that affect how routes are redistributed to IS-IS.
- Example

```
host1#clear ip isis redistribution
```

- There is no **no** version.
- See clear ip isis redistribution
- See clear isis ipv6 redistribution

disable-dynamic-redistribute

- Use to halt the dynamic redistribution of routes that are initiated by changes to a route map.
- Dynamic redistribution is enabled by default.
- Example

```
host1(config-router)#disable-dynamic-redistribute
```

- Use the **no** version to reenab le dynamic redistribution.
- See disable-dynamic-redistribute

redistribute

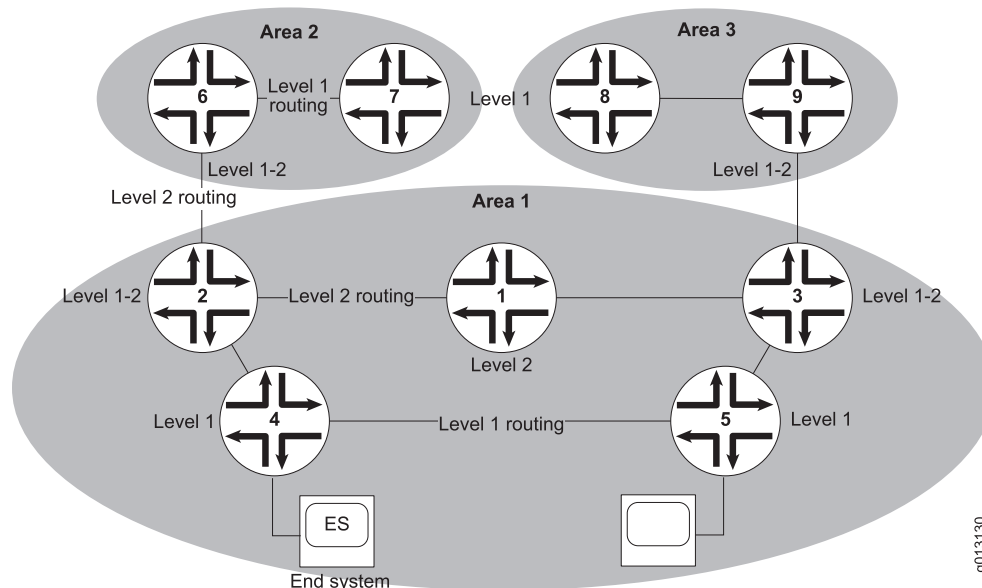
- Use to redistribute routes from other routing protocols in the routing table to IS-IS. IS-IS advertises these routes as level 1 only, level 2 only, or both. Level 2 only is the default.
- To redistribute IPv6 routes, you must issue the command from within the IS-IS IPv6 address family.
- The default is no source protocol defined for redistribution.
- This command can accomplish the same results as the **passive-interface** command by redistributing a connected route to level 1.
- Optionally, you can specify a route map and use it to set a route tag for routes redistributed to IS-IS.
- Example 1—Redistributing static IP routes with a route map

```
host1(config-router)#redistribute static ip route-map 10
```
- Example 2—Redistributing IPv6 routes from OSPF into IS-IS level 1 and level 2

```
host1(config-router-af)#redistribute ospf level-1-2
```
- Use the **no** version to disable redistribution.
- See redistribute

Redistributing Routes Between Levels

The two-level routing hierarchy of IS-IS can lead to suboptimal path selection in certain situations. Because a level 1 router by default has knowledge only of level 1 routes, traffic from a level 1 router to a router in another area passes through the nearest level 1-2 router as its next hop. Consider the topology shown in [Figure 20 on page 413](#).

Figure 20: Example of Level 1 and Level 2 Routing

In this example, Router 4 in Area 1 considers Router 2 to be its next hop for interarea traffic, and Router 5 considers Router 3 to be its next hop for interarea traffic. Traffic from Router 4 to Router 8 passes through Router 2, requiring a total of five hops to the destination: Routers 2, 1, 3, 9, and 8. Similarly, five hops are required for traffic from Router 5 to Router 7.

Neither of these paths is optimal. For example, it would be shorter for traffic from Router 4 to take the four-hop path: Routers 5, 3, 9, and 8.

You can configure IS-IS to redistribute routes between the routing levels; this is sometimes known as route leaking between levels. The **redistribute isis ip** command enables you to specify a route filter (an access list) and the direction of leakage, as shown in the following example:

```
host1(config)#access-list leakList permit ip 100.0.0.0 0.255.255.255 any
host1(config)#router isis 1
host1(config-router)#redistribute isis ip level-1 into level-2 distribute-list leakList
host1(config-router)#redistribute isis ip level-2 into level-1 distribute-list leakList
```

When you issue the **redistribute isis ip** command and include the **route-map** keyword, you can use the map to set a route tag for a route redistributed from one IS-IS level to another. Make sure the route map you specify includes the **set tag** command that defines a tag value for the IS-IS routes to be redistributed. For details about configuring and using route maps, see *JunosE IP Services Configuration Guide*.

To redistribute IPv6 routes from one IS-IS level to another, use the **redistribute isis** command from within the IS-IS IPv6 address family.

redistribute isis

- Use to redistribute IS-IS IPv6 routes from level 1 to level 2 or from level 2 to level 1.
- Use the **route-map** keyword to specify the route map to be applied. You can use the route map to set a route tag for redistributed routes.
- Example

```
host1(config-router-af)#redistribute isis level-1 into level-2
```

- Use the **no** version to stop redistribution of IPv6 routes between the specified levels.
- See redistribute isis

redistribute isis ip

- Use to redistribute IS-IS IP routes from level 1 to level 2 or from level 2 to level 1.
- Specify one of the following:
 - Use the **distribute-list** keyword to specify the IP access list used to filter routes between levels. Issue the **access list** command to create a route filter to apply to the redistribution.
 - Use the **route-map** keyword to specify the route map to be applied. You can use the route map to set a route tag for redistributed routes.
- Example 1—Redistributes IS-IS IP routes between levels, filtered by an access list.

```
host1(config-router)#redistribute isis ip level-1 into level-2 distribute-list leakList
```

- Example 2—Redistributes IS-IS IP routes between levels, filtered by a route map.

```
host1(config-router)#redistribute isis ip level-2 into level-1 route-map boston01
```

- Use the **no** version to stop redistribution of IP routes between the specified levels.
- See redistribute isis ip

Advertising IPv4 and IPv6 Prefixes of Passive Interfaces

Convergence is the process in which all routers in a network calculate the optimal routes for the network. Whenever there is any change in network topology, routing update messages flood the network to enable the routers to recalculate optimal routes, which increases network convergence time. You can configure IS-IS to advertise IPv4 and IPv6 prefixes that belong to only passive interfaces and exclude prefixes of connected networks from the LSP. This feature reduces network convergence time between two integrated IS-IS systems by allowing only connected passive interfaces to be advertised.

Enabling the advertisement of passive interfaces feature causes only connected passive IPv4 and IPv6 prefixes to be retained in the LSP database. All other entries are removed from the LSP database. However, redistributed routes are maintained without any modification. Disabling this feature restores all the entries in the LSP database, thus allowing all IP prefixes to be advertised.

advertise-passive-only

- Use to advertise IPv4 and IPv6 prefixes that belong to only passive interfaces.
- The default value is disabled.
- Use the **show isis database detail** command to verify the displayed IPv4 and IPv6 prefixes.
- Example 1: To configure advertisement of IPv4 prefixes, do the following:

1. Specify an IS-IS routing process and access Router Configuration mode.

```
host1(config)#router isis
host1(config-router)#
```

2. Configure advertisement of only passive interfaces.

```
host1(config-router)#advertise-passive-only
```

3. Exit Router Configuration mode.

```
host1(config-router)#exit
```

4. (Optional) Access Privileged Exec mode and verify the advertised IPv4 prefixes.

```
host1(config)#exit
host1#show isis database detail
```

- Example 2: To configure advertisement of IPv6 prefixes, do the following:

 1. Specify an IS-IS routing process and access Router Configuration mode.

```
host1(config)#router isis R2
```

2. Access Address Family Configuration mode for IPv6 prefixes.

```
host1(config-router)#address-family ipv6
```

3. Configure advertisement of only passive interfaces.

```
host1(config-router-af)#advertise-passive-only
```

4. Exit the Address Family Configuration and Router Configuration modes.

```
host1(config-router-af)#exit  
host1(config-router)#exit
```

5. (Optional) Access Privileged Exec mode and verify the advertised IPv6 prefixes.

```
host1(config)#exit  
host1#show isis database detail
```

- Use the **no** version to disable the command.
- See advertise-passive-only

Controlling Granularity of Routing Information

You can force the distribution of level 2 routing information to level 1 routers in other areas to improve the quality of the resulting routes, but at the cost of reduced scalability.

distribute-domain-wide

- Use to increase the granularity of routing information within a domain.
- Domainwide prefix distribution enables a routing domain running with both level 1 and level 2 IS-IS routers to distribute IP prefixes from level 2 to level 1 between areas.
- The major advantage for using domainwide prefix distribution is to improve the quality of the resulting routes within a domain by distributing more specific information.
- The major disadvantage of using domainwide prefix distribution is that it affects the scalability of IS-IS. When used, it increases the number of prefixes throughout the domain, causing increased memory consumption, transmission requirements, and computation requirements throughout the domain.
- A trade-off decision must be made between scalability and optimality.
- Issue this command from within the IS-IS IPv6 address family to increase the granularity of IPv6 routing information within a domain.
- Example

```
host1(config-router)#distribute-domain-wide
```

- Use the **no** version to halt the distribution of routes from level 2 to level 1.
- See distribute-domain-wide

Configuring a Global Default Metric

You can use the **metric** command to specify a global default metric that applies to all active IS-IS interfaces. This command enables you to avoid configuring the desired metric on each active interface individually when you want all IS-IS interfaces to have the same metric, but a different value than the individual default of 10. The global default metric applies to both level 1 and level 2 interfaces unless you restrict it to one level.

If you have configured a nondefault metric on any IS-IS interface with the **isis metric** command, that value overrides the global default metric.

Reference bandwidth takes precedence over both individual and global default metrics. If you have configured a reference bandwidth, the **metric** command has no effect on interface metrics.

You can use the following commands to verify configuration of the global default metric:

- **show configuration**
- **show clns interface**
- **show clns protocol**
- **show isis database detail**

metric

- Use to apply the same default metric value to all active IS-IS interfaces. The command affects both IPv4 and IPv6 interfaces.
- Specify whether the command applies to level 1 or level 2 interfaces. If you do not specify a level, then the metric is applied to both level 1 and level 2 interfaces.
- Example

```
host1(config-router)#metric 50 level-1
```
- Use the **no** version to remove the global default value. This restores the default value of 10 to all active IS-IS interfaces except for interfaces that have been individually configured with another metric value.
- See **metric**

Configuring Metric Type

Extensions to IS-IS traffic engineering enable the use of bigger metrics. You can specify whether your router accepts, generates, or accepts and generates only old-style metrics, only new-style metrics, or both.

metric-style narrow

- Use to specify that the router generates and accepts only old-style TLV tuples.
- *Old-style TLVs* refers to TLVs having metrics with a narrow (six-bit) field with a value in the range 0–63. *New-style TLVs* refers to TLVs having metrics with a wider field, as provided for in current extensions to IS-IS traffic engineering.

- Use the **transition** option to *accept* old-style and new-style metrics; only old-style metrics are *generated*.
- Specify whether the command applies to level 1, level 2, or both.
- Example

```
host1(config-router)#metric-style narrow level-2
```
- Use the **no** version to restore the default, which is to generate and accept only old-style TLVs with narrow (six-bit) metric fields.
- See metric-style narrow

metric-style transition

- Use to specify that the router generates and accepts both old-style and new-style TLV tuples.
- *Old style* refers to TLVs having metrics with a narrow (six-bit) field with a value in the range 0–63. *New style* refers to TLVs having metrics with a wider field, as provided for in current extensions to IS-IS traffic engineering.
- Specify whether the command applies to level 1, level 2, or both.
- Example

```
host1(config-router)#metric-style transition level-1
```
- Issuing this command results in more resource usage than issuing the **metric-style narrow** or **metric-style wide** commands.
- Use the **no** version to restore the default, which is to generate and accept only old-style TLVs with narrow (six-bit) metric fields.
- See metric-style transition

metric-style wide

- Use to specify that the router generates and accepts only new-style TLV tuples.
- *Old style* refers to TLVs having metrics with a narrow (six-bit) field with a value in the range 0–63. *New style* refers to TLVs having metrics with a wider field, as provided for in current extensions to IS-IS traffic engineering.
- Use the **transition** option to *accept* old-style and new-style metrics; only new-style metrics are *generated*.
- Specify whether the command applies to level 1, level 2, or both.
- Before you set a route tag for an IS-IS interface, you must issue the **metric-style wide** command to configure the router to generate and accept TLV type 135, which is a new-style tuple that contains the route tag.
- Example

```
host1(config-router)#metric-style wide level-1-2
```

- Use the **no** version to restore the default, which is to generate and accept only old-style TLVs with narrow (six-bit) metric fields.
- See metric-style wide

Setting the Administrative Distance

You can indicate the dependability of a routing information source by configuring the administrative distance for learned routes.

distance ip

- Use to configure the administrative distance for IS-IS learned routes.
- The distance indicates the dependability of a routing information source. A higher relative value indicates lower dependability. Preference is always given to the routes with smaller values.
- Select a value in the range 1–255. A value of 255 means discard the route.
- Example

```
host1(config-router)#distance ip 50
```
- Use the **no** version to restore the default value, 115.
- See distance ip

Configuring Default Routes

You can specify a default route within IS-IS routing domains. You can also suppress the installation of a default route to level 1-2 routers by level 1 routers.

Optionally, when you issue the **default-information originate** command and specify a route map, you can use the map to set a route tag for the default route. Make sure the route map you specify includes the **set tag** command, which defines a tag value for the default route within the IS-IS domain. For details about configuring and using route maps, see *JunosE IP Services Configuration Guide*.

default-information originate

- Use to generate a default route into an IS-IS routing domain.
- When you specify a route map with this command and the router has a route to 0.0.0.0 in the routing table, IS-IS originates an advertisement for 0.0.0.0 in its LSPs.
- When you do not specify a route map, the default route is advertised only in level 2 LSPs.
- If you specify a route map, you can use the map to set a route tag for the default route.
- For level 1 routing, look for the closest level 1-2 router to find the default route. The closest level 1-2 router is found by looking at the attach bit (ATT) in level 1 LSPs.
- The default value is disabled.
- Example1

`host1(config-router)#default-information originate`

- Example 2

`host1(config-router)#default-information originate route-map map3`

- Use the **no** version to disable the command.
- See default-information originate

suppress-default

- Use to prevent level 1 routers from automatically installing a default route to a level 1-2 router in order to reach destinations outside the area.
- Suppresses the level 1-2 router from indicating to level 1 routers that it can reach other areas. Consequently, the level 1 routers do not consider the level 1-2 router to be the nearest attached level 2 router and do not install default routes to it.
- This command is useful, for example, if you issue the distribute-domain-wide command, which causes the level 2 routes to be leaked into the level 1 area. The level 1 routers then have knowledge of the routes outside the area and will not need to rely on the nearest attached level 2 router for any unknown destination.
- Example

`host1(config-router)#suppress-default`

- Use the **no** version to disable suppression of default routes.
- See suppress-default

Disregarding the Attach Bit in Level 1 LSPs

You can configure IS-IS to disregard the Attach Bit (ATT) in level 1 LSPs in a multiarea environment. In level 1 routing, the closest level 1-2 router is used to find default routes within IS-IS routing domains. The closest level 1-2 router is found by examining the attach bit in the level 1 LSP. Disregarding the attach bit prevents default routes from being installed.

The ability to disregard the attach bit has the following benefits:

- Enables selective route leaking from level 2 to level 1. Selective route leaking allows all traffic that is not reachable from level 1 to be dropped at level 1 instead of dropping them at higher levels.
- Suboptimal routing can be prevented when a level 1 router has adjacencies to two different attached level 1-2 routers.
- Enables you to effectively advertise only loopback addresses reachability.

ignore-attached-bit

- Use to disregard the attach bit.
- The default value is disabled.
- Use the **show ip route** command to check whether the default route is displayed.

- Example
 1. Specify an IS-IS routing process and access Router Configuration mode.


```
host1(config)#router isis
host1(config-router)#
```
 2. Configure IS-IS to disregard the attach bit.


```
host1(config-router)#ignore-attached-bit
```
 3. Exit Router Configuration mode.


```
host1(config-router)#exit
```
 4. (Optional) Access Privileged Exec mode and verify the display of a default route.


```
host1(config)#exit
host1#show ip route
```
- Use the **no** version to disable the command.
- See ignore-attached-bit

Setting Router Type

You can specify whether the router behaves as an IS-IS station router, area router, or both.

is-type

- Use to configure the router to act as either a station router (level 1), an area router (level 2), or as both a station router and an area router (level-1-2).
- Always configure the type of IS-IS router.
- Level-1-2 is the default.
- Example


```
host1(config-router)#is-type level-2-only
```
- Use the **no** version to restore the default value, level-1-2.
- See is-type

Summarizing Routes

You can summarize routes redistributed into IS-IS or within IS-IS by creating aggregate addresses for the routes. Use the **summary-address** command for IP routes and the **summary-prefix** command for IPv6 routes.

Optionally, you can set a route tag for an IS-IS aggregate (summary) address by including the **tag** keyword and a numeric tag value in the command.

summary-address

- See `summary-address`

summary-prefix

- Use to create aggregate addresses of routes that are redistributed from other protocols in the routing table or distributed between level 1 and level 2 by a summary address. This process is called *route summarization*.
- A single summary address includes groups of addresses for a given level.
- Use the **summary-address** command for IP routes. Use the **summary-prefix** command for IPv6 routes.
- The metric value is used when the router advertises the summary address. When the metric value is not used, the value of the lowest cost route (the default) is used.
- This command reduces the size of the neighbor's routing table and improves stability because a summary advertisement depends on many more specific routes.
- A disadvantage of summary addresses is that other routes might have less information to calculate the optimal routing table for all individual destinations.
- Use the optional **tag** keyword to specify a tag value for an IS-IS summary address. The tag value must be a number in the range 1–4294967295.
- Example 1—For IP routes

```
host1(config-router)#summary-address 10.2.0.82 255.255.0.0 level-1-2 tag 34
```
- Example 2—For IPv6 routes

```
host1(config-router-af)#summary-prefix 2001:2000::0/8 level-1 metric 10 tag 100
```
- Use the **no** version to restore the default, the value of the lowest-cost route.
- See `summary-prefix`

Avoiding Transient Black Holes

When you start or reload a transit router that is running both IS-IS and BGP, the router is temporarily unavailable to the routing domain. Other routers in that routing domain must select alternative paths to destinations that used the transit router. When the transit router becomes available again, the other routers soon select it again as the optimal path to those destinations.

The other routers select the transit router again before it has loaded the complete BGP routing table. Because the transit router does not yet have all the reachability information that is needed to reach some external destinations, traffic to destinations that were not learned by means of the IGP is dropped until the transit router has complete external reachability information again. This condition is known as a *transient black hole*.

You can use the overload bit to avoid these black holes. When the overload bit is set in the LSP header, other routers in the domain do not include the transit router in their SPF calculations and thus do not use that router for traffic forwarding.

When the transit router boots, it begins establishing adjacencies with its neighbors. As soon as it establishes an adjacency, it creates (or updates) its LSP, sets the overload bit in the LSP header, and transmits the LSP with the current neighbor information. By sending the updated LSP with the overload bit set immediately after forming the first adjacency, IS-IS reduces the convergence time across the network.

If IS-IS waits for all adjacencies to be up before it sends the updated LSP with the overload bit set, the other routers in the domain still have the transit router's old LSP and continue to forward transit traffic to the transit router until all adjacencies are formed. That traffic is lost.

Waiting for BGP Convergence

When BGP converges, the transit router again has the reachability information it needs to forward traffic to destinations that are not directly connected. Typically, you then want the transit router to clear the overload bit in its LSP and retransmit the LSP to inform the other routers in the domain that they can use it as a transit router.

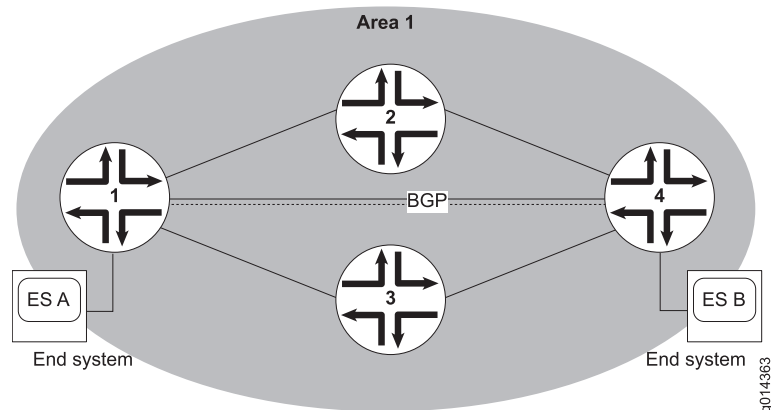
BGP is assumed to have converged when all of the following conditions have been met:

- 90 percent of BGP peers have reached an established state,
- The transit router has received an end-of-rib marker from all IBGP peers that advertise the graceful-restart capability.
- The average rate of learning new routes has dropped to a low level.

Example Topology

Figure 21 on page 423 shows a sample topology where source end system A is communicating with destination end system B through routers 1, 2, 3, and 4.

Figure 21: Transit Router Topology



The transit routers, 2 and 3, learn the route to B from BGP. In a steady state environment, the BGP routing tables are synchronized on all the transit routers.

Suppose the traffic forwarding path is currently A → 1 → 2 → 4 → B. If transit router 2 goes down, the network converges to the alternative path, A → 1 → 3 → 4 → B. Because

transit router 3 already had synchronized its BGP routing tables, traffic forwarding continues without delay.

When transit router 2 reloads, it establishes adjacencies with routers 1 and 4, and sends out its LSP advertising its neighbors. While router 2 begins to synchronize its BGP routes, the network reconverges to the original path of A → 1 → 2 → 4 → B. Traffic from A to B is forwarded to router 2. Typically, BGP has not converged by then, so router 2 does not have the BGP route that it needs to forward the traffic, and drops the packets, resulting in a black hole until the BGP convergence is complete.

You can avoid this black hole by configuring the overload bit for the transit router. In this circumstance, router 2 sends out its LSP with the overload bit set in its header as soon as it reloads, before it establishes all adjacencies. The bit set in the header indicates to all the routers in the domain that router 2 is overloaded and not to use it to carry transit traffic. The forwarding path continues to be the alternative path, A → 1 → 3 → 4 → B, even after router 2 reloads.

When BGP convergence is complete at router 2, router 2 sends out a new LSP with the overload bit cleared. The other routers then include router 2 in their SPF calculations and revert to the original path, of A → 1 → 2 → 4 → B.

Suppression for IS-IS Graceful Restart

When graceful restart is configured on the transit router, the black hole avoidance feature is suppressed.

Configuration

You can configure the transit router to set the overload bit when it reloads and to then wait for a specified interval before it clears the bit and retransmits its LSP. More commonly, and to avoid the transient black holes, you configure the transit router to wait for BGP to converge, and specify an interval it waits after convergence before it clears the bit and retransmits its LSP.

set-overload-bit

- Use to configure the router to set the overload bit in the header of its nonpseudonode LSPs.
- While the overload bit is set, other routers in the domain do not include this router in their shortest-path-first (SPF) calculations. Consequently, the other routers do not detect any paths through this router and do not forward traffic through this router. However, IP prefixes directly connected to this router are still reachable. When the bit is cleared, the router is again included in SPF calculations.
- You can set the overload bit for a number of reasons, including the following:
 - To prevent traffic through the router from disappearing into transient black holes.
 - To reduce routing table inaccuracies caused by router problems such as memory shortage.
 - To prevent real traffic from flowing through a router to an IS-IS network, such as might be the case for a test router connected to a production network.

- Use the **on-startup** keyword to set the overload bit when the router reboots and to specify a period in seconds that IS-IS waits after the reboot before it clears the overload bit.
- Use the **on-startup wait-for-bgp** keywords to instruct IS-IS to set the overload bit when the router reboots and then wait until BGP has completed convergence after the reload before IS-IS clears the overload bit. You can specify a maximum interval that IS-IS waits for BGP notification. When that interval passes, IS-IS clears the overload bit. If you do not specify an interval, IS-IS waits a default 600 seconds and then clears the overload bit.
- If you issue the **on-startup** keyword but do not issue the **wait-for-bgp** keyword, then you must specify the number of seconds that IS-IS waits after a reload before clearing the overload bit.
- If you issue both the **on-startup** keyword and the **wait-for-bgp** keyword, you cannot specify a time interval for **on-startup** but can optionally do so for **wait-for-bgp**.
- By default, the overload bit is not set.
- Example 1

```
host1(config-router)#set-overload-bit
```
- Example 2

```
host1(config-router)#set-overload-bit on-startup 900
```
- Example 3

```
host1(config-router)#set-overload-bit on-startup wait-for-bgp 450
```
- Use the **no** version to disable the setting.
- See set-overload-bit

Ignoring LSP Errors

You can configure the router to ignore rather than purge LSPs received with errors.

ignore-lsp-errors

- Use to enable your router to ignore rather than purge IS-IS LSPs that are received with internal checksum errors.
- Under normal conditions, the IS-IS protocol definition requires that received LSPs with incorrect data link checksums are to be purged by the receiver. This causes the LSP initiator to regenerate LSPs. If a network link causes data corruption while still delivering LSPs with correct data link checksums, a continuous cycle of regenerating and purging LSPs may result. This can render the network nonfunctional. Enabling this command prevents this continuous cycle from occurring because LSPs are ignored rather than purged.
- Example

```
host1(config-router)#ignore-lsp-errors
```

- Use the **no** version to disable the function.
- See ignore-lsp-errors

Logging Adjacency State Changes

You can configure the router to log messages that track when adjacencies change state between up and down.

log-adjacency-changes

- Use to generate log messages that track IS-IS adjacency state changes (up or down).
- The default is not to log adjacency state changes.
- Recommended for monitoring large networks.
- The system logs messages by using the router error message facility.
- Specify the minimum severity (0–7) or verbosity (low, medium, high) of this log category's messages.
- You can also use the **system log** command to generate the desired log messages.
- Example

```
host1(config-router)#log-adjacency-changes severity 3 verbosity low
```
- Use the **no** version to disable the function.
- See log-adjacency-changes

Configuring LSP Parameters

You can specify the following parameters for LSPs:

- Maximum transmission unit (MTU)
- Transmission rate
- Generation rate
- Maximum lifetime

lsp-gen-interval

- Use to set the minimum interval rate that LSPs are generated on a per-LSP basis.
- You can set an interval value in the range 0–120 seconds.
- The default interval value is 5 seconds. When a link is changing state at a high rate, the default value limits the signaling of the changing state to once every 5 seconds. Because the generation of an LSP may cause all routers in the area to perform the SPF calculation, controlling this interval can have an areawide effect.
- When you raise this interval, you reduce the load on the network imposed by a rapidly changing link.
- Example

```
host1(config-router)#lsp-gen-interval level-2 30
```

- Use the **no** version to restore the default value, 5.
- See `lsp-gen-interval`

lsp-mtu

- Use to specify the MTU LSP size in bytes. The size must be less than or equal to the smallest MTU of any link in the area.
- Use this command to limit the size of LSPs generated by this router only. The router can receive LSPs of any size up to the maximum.
- You can set the value in the range 128–9180.
- The default LSP MTU value is 1497.
- When a very large amount of information is generated by a single router, we recommend that you increase the LSP MTU. However, the default MTU is usually sufficient.
- If the MTU of a link is lowered to less than 1500 bytes, the LSP MTU must be lowered accordingly on each router in the network. If this is not done, routing may become unpredictable.
- Example

```
host1(config-router)#lsp-mtu 1500
```

- Use the **no** version to restore the default value, 1497.
- See `lsp-mtu`

lsp-refresh-interval

- Use to set the LSP rate at which locally generated LSPs are periodically transmitted.
- The refresh interval determines the rate at which the router software periodically transmits the route topology information that it originates. These transmissions refresh the link-state information, reaffirming that the router is still up and that the link-state information in the LSP is still valid.
- You can set the interval rate in the range 1–65535 seconds; the default is 900 seconds.
- LSPs must be periodically refreshed before their lifetimes expire. The refresh interval must be less than the LSP lifetime specified by **max-lsp-lifetime**.
- In the unlikely event that link state database corruption is undetected, reducing the refresh interval reduces the amount of time that the corruption can persist.
- Increasing the interval reduces the link utilization caused by the flooding of refreshed packets.
- Example

```
host1(config-router)#lsp-refresh-interval 1000
```

- Use the **no** version to restore the default value, 900 seconds.
- See `lsp-refresh-interval`

max-lsp-lifetime

- Use to set the maximum time that LSPs persist without being refreshed.
- You can select a maximum time in the range 1–65535 seconds.
- The default value is 1200 seconds (20 minutes).
- You might need to adjust the maximum LSP lifetime if you change the LSP refresh interval with the **lsp-refresh-interval** command. The maximum LSP lifetime must be greater than the LSP refresh interval.
- Example

```
host1(config-router)#max-lsp-lifetime 1500
```
- Use the **no** version to restore the default value, 1200 seconds.
- See max-lsp-lifetime

Specifying the SPF Interval

You can configure how often the router performs the shortest-path-first (SPF) calculation. IS-IS runs SPF calculations in response to any change in its link-state database. Because SPF calculation is processor intensive, increasing the SPF interval reduces the processor load of the router, but can slow down the rate of convergence.

Topology changes in a network cause all routers involved in the change to regenerate their LSDB and flood new LSPs throughout the network. Therefore, a router that receives a new LSP is likely to receive more LSPs in the following seconds. An immediate response to a given change is going to miss the subsequent topology changes and spend CPU time. When many changes are taking place, a slower response to each change makes more sense.

IS-IS enables the router to respond quickly to an isolated network event, but to slow the response exponentially when many triggering events are taking place in rapid succession. SPF calculations are performed at exponentially increasing intervals until the maximum interval set by the **spf-interval** command is reached.

The first SPF calculation is performed immediately when the LSDB changes. If another calculation-triggering event occurs, the router waits 1 second before performing the SPF calculation. If another event occurs, the router waits 2 seconds before performing the SPF calculation. The interval between a triggering event and the corresponding SPF calculation continues to increase exponentially: 4 seconds, 8 seconds, 16 seconds, and so on. When the maximum configured interval is reached, the interval reverts back to immediate response mode for the next triggering event.

If no calculation-triggering network events have occurred by the end of any given back-off interval, the router reverts back to immediate response mode.

spf-interval

- Use to set the maximum interval between SPF calculations.
- You can select an interval value in the range 0–120 seconds.

- The default value is 5 seconds.
- If you do not specify **level-1** or **level-2**, the interval applies to both level 1 and level 2.
- SPF calculations are performed only when the topology of the area changes. They are not performed when external routes change.
- Example


```
host1(config-router)#spf-interval level-2 30
```
- Use the **no** version to restore the default value, 5 seconds.
- See `spf-interval`

Defining the SPF Route Calculation Level

The IS-IS protocol uses the Dijkstra's algorithm to compute IP node metrics when a change occurs within the IS-IS network. This calculation results in the IS-IS router containing a shortest-path tree (SPT) that maps the shortest path to each node in the IS-IS network.

By default, the router uses a partial route calculation (PRC) SPF to determine the next hop (when required). This partial computation occurs when the router receives link-state PDUs (LSPs) with only changes relating to IP prefixes (for example, the addition of a new IP prefix, change in attributes of an existing IP prefix, or the removal of an existing IP prefix).

Because changes in IP prefixes happen more frequently than other events, using the PRC SPF results in faster IS-IS convergence and saves router resources. However, you can also specify that the router always use full SPF, recalculating the entire SPT, when resolving any IS-IS state changes.

full-spf-always

- Use to enable and disable full SPF calculations for IS-IS network changes.
- Example


```
host1(config-router)#full-spf-always
```
- Use the **no** version to restore partial route calculation (PRC) mode for SPF calculations.
- See `full-spf-always`

Setting CLNS Parameters

You can specify transmission rates for ES and IS hello packets, the period for which the router considers ES and IS hello packets to be valid, and name-to-network service access point mappings.

clns configuration-time

- Use to specify the rate (in seconds) at which ES hello and IS hello packets are sent.
- The hello packet recipient creates an adjacency entry for the router that sent it. If the next hello packet is not received within the specified interval, the adjacency times out, and the adjacent node is determined to be unreachable.
- In most cases, leave these parameters at their default value, which is 10 seconds.
- Example

```
host1(config)#clns configuration-time 240
```
- Use the **no** version to restore the default value, 10 seconds.
- See `clns configuration-time`

clns holding-time

- Use to enable sender of an ES hello or IS hello packet to specify the length of time you consider the information in these packets to be valid.
- In most cases, leave these parameters at their default value, which is 30 seconds.
- Example

```
host1(config)#clns holding-time 900
```
- Use the **no** version to restore the default value, 30 seconds.
- See `clns holding-time`

clns host

- Use to define a name-to-NSAP mapping that can then be used with commands requiring NSAPs.
- The default is that no mapping is defined.
- The assigned NSAP name is displayed, where applicable, in **show** commands.
- The first character can be either a letter or a number.
- This command is generated after all other CLNS commands when the configuration file is parsed. As a result, the NVRAM version of the configuration cannot be edited to specifically change the address defined in the original `clns host` command. You must specifically change any commands that refer to the original address. This affects commands that accept names, such as the **net** command.
- Enables dynamic resolution of hostnames to system IDs (within the NSAP address). The hostname mapping is sent in the LSPs within the Dynamic Hostname type-length-value (TLV type 137). Display the TLV by issuing the **show isis database detail** command.
- Use the **show hosts** command to display the mapping.
- Example

```
host1(config)#clns host
```
- Use the **no** version to restore the default state of no mapping defined.
- See `clns host`

Setting the Maximum Parallel Routes

You can configure how many parallel routes IS-IS supports to a destination.

maximum-paths

- Use to control the maximum number of parallel routes IS-IS can support.
- You can select a number of routes (or paths) in the range 1–16.
- The default number for IS-IS is 4 paths.
- Example


```
host1(config-router)#maximum-paths 12
```
- Use the **no** version to restore the default value, 4.
- See maximum-paths

Configuring a Virtual Multiaccess Network

You can specify that interfaces within a given mesh group act as a virtual multiaccess network.

isis mesh-group

- Use when you want interfaces in the same mesh group to act as a virtual multiaccess network.
- LSPs seen on one interface in a mesh group are not flooded to another interface in the same mesh group.
- Example


```
host1(config-if)#isis mesh-group blocked
```
- Use the **no** version to disable the feature.
- See isis mesh-group

Configuring Table Maps

You can use the **table-map** command to apply a specified route map as a policy filter on an IS-IS route before the route is installed in the routing table. The route map you apply must contain one or more **set** commands to modify route attributes.

table-map

- Use to apply a policy to modify distance, level, metric, metric type, origin, preference, route type, or tag values of IS-IS routes about to be added to the IP routing table.
- The router applies the new route map to all routes currently in the forwarding table and those about to be installed in the forwarding table.
- If any previously redistributed routes are changed as a result of applying the route map, the router redistributes these routes again with the changes caused by the route map.

- The router removes from the forwarding table any old routes that are now disallowed by the specified route map.
- Issue the command from the IS-IS IPv6 address family to apply a specified route map as a policy filter on an IS-IS IPv6 route before the route is installed in the routing table. IS-IS IPv6 supports only a single table map.
- Example

The following commands apply a policy (route map) named `metricTypeExt` to modify the metric type of IS-IS routes configured with a route tag value of 33.

```
host1(config)#route-map metricTypeExt permit 5
host1(config-route-map)#match tag 33
host1(config-route-map)#set metric-type external
host1(config-route-map)#exit
host1(config)#router isis marketing
host1(config-router)#table-map metricTypeExt
host1(config-router)#exit
host1(config)#exit
```

- Use the **no** version to halt application of the route map.
- See `table-map`

Configuring Graceful Restart

To enable IS-IS graceful restart (also known as nonstop forwarding, or NSF) on the router, you must first issue the **nsf ietf** command (in Router Configuration mode). You can then configure one or more optional timing parameters for graceful restart on the router.

To enable IS-IS graceful restart and configure optional graceful restart parameters:

1. Specify a previously configured IS-IS routing process to access Router Configuration mode. (For information about enabling IS-IS on the router, see [“Enabling IS-IS for IP Routing” on page 393.](#))

```
host1(config)#router isis engineering
host1(config-router)#
```

2. Enable the IS-IS graceful restart mechanism for the router.

```
host1(config-router)#nsf ietf
```

3. (Optional) Configure one or more of the following timing parameters for the restarting router:

- Set the maximum time in seconds that the router waits before completing the restart process.

```
host1(config-router)#nsf interface wait 30
```

- Set the time interval in seconds between restart requests sent by the router.

```
host1(config-router)#nsf t1 interval 60
```

- Set the number of times that the router resends unacknowledged restart requests.

```
host1(config-router)#nsf t1 retry-times 3
```


- Set the maximum time in seconds that the router waits for the LSP database to synchronize. You must configure this parameter separately for each IS-IS level at which the router operates.

```
host1(config-router)#nsf t2 level-1 70
host1(config-router)#nsf t2 level-2 50
```

- Set the maximum time in seconds that the restarting router waits before setting the overload bit to indicate that the graceful restart operation has failed. You can use either of the following methods:

- Set the wait time manually to the specified number of seconds.

```
host1(config-router)#nsf t3 manual 80
```

- Specify that router obtain the wait time from neighboring IS-IS routers to which it has active adjacencies.

```
host1(config-router)#nsf t3 adjacency
```

4. (Optional) Issue the `show isis nsf` command from Privileged Exec mode to verify the graceful restart configuration.

```
host1(config-router)#exit
host1(config)#exit
host1#show isis nsf
```

For more information about monitoring graceful restart, see [“show isis nsf” on page 449](#) command description in [“Monitoring IS-IS Parameters” on page 440](#) and the [“show clns neighbors” on page 460](#) command description in [“Displaying CLNS” on page 452](#).



NOTE: For information about configuring hold timers for IS-IS graceful restart in scaled environments, see the *Configuring Hold Timers for Successful Graceful Restart in Scaled Scenarios* section in the *JunosE BGP and MPLS Configuration Guide*

nsf ietf

- Use to enable the IS-IS graceful restart mechanism on the router.
- Graceful restart, which is also known as nonstop forwarding (NSF), allows an IS-IS router to restart with minimal routing disruption to the network.

- Example

```
host1(config-router)#nsf ietf
```

- Use the **no** version to restore the default state for IS-IS graceful restart on the router, disabled.
- See `nsf ietf`

nsf interface wait

- Use to specify the maximum amount of time, in seconds, that an IS-IS process on a restarting router waits for all interfaces with IS-IS adjacencies to come up before completing the restart process.
- You can specify a value in the range 5–120 seconds.
- Example

```
host1(config-router)#nsf interface wait 45
```
- Use the **no** version to restore the default maximum wait time, 10 seconds.
- See nsf interface wait

nsf t1

- Use to specify either the interval between IS-IS restart requests sent by the router or the number of times that the router resends unacknowledged restart requests.
- Use the **interval** keyword to specify the number of seconds, in the range 5–300, between restart requests sent by the router on a particular IS-IS interface to neighboring IS-IS routers in the network.
- Use the **retry-times** keyword to specify the number of times, in the range 1–10, that the router tries to resend unacknowledged restart requests.
- The restarting router stops sending restart requests after it receives an acknowledgment.
- Example 1

```
host1(config-router)#nsf t1 interval 90
```
- Example 2

```
host1(config-router)#nsf t1 retry-times 2
```
- Use the **no** version to restore the default time interval, 5 seconds, or the default number of retry attempts, 3.
- See nsf t1

nsf t2

- Use to specify the maximum amount of time, in seconds, that a restarting router waits for the LSP database to synchronize.
- You must configure independent instances of the T2 timer for each IS-IS level at which the router operates. This requirement means that for a level 1-2 router, you must issue this command twice: first to configure the timer for level 1, and a second time to configure it for level 2.
- Use either the **level-1** keyword to set the T2 wait time for level 1 routing, or the **level-2** keyword to set the wait time for level 2 routing.
- You can specify a value in the range 5–600 seconds for each level.
- Example—Configures the T2 wait time for a level 1-2 IS-IS router

```
host1(config-router)#nsf t2 level-1 70  
host1(config-router)#nsf t2 level-2 50
```

- Use the **no** version to restore the default T2 wait time, 100 seconds.
- See `nsf t2`

nsf t3

- Use to specify the maximum amount of time, in seconds, that the restarting router waits before setting the overload bit.
- The restarting router sets the overload bit to indicate that the LSP database has not been synchronized and the IS-IS graceful restart operation has failed.
- You must use one of the following methods to set the T3 wait time:
 - Use the **manual** keyword and a value in the range 5–900 seconds to set the T3 wait time manually.
 - Use the **adjacency** keyword to specify that the restarting router should obtain its T3 wait time from neighboring IS-IS routers that have active adjacencies to this router. This option sets the wait time to the minimum of the remaining times specified in the restart TLVs contained in the hello packets that the router receives from its neighbors.
- Example 1


```
host1(config-router)#nsf t3 manual 120
```
- Example 2


```
host1(config-router)#nsf t3 adjacency
```
- Use the **no** version to restore the default T3 wait time, 200 seconds.
- See `nsf t3`

Summary Example

```
host1(config)#router isis floor12
host1(config-router)#net 47.0010.0000.0000.0000.0001.0001.1111.1111.1111.00
host1(config-router)#exit
host1(config)#interface atm 0/1
host1(config-if)#ip router isis floor12 tag 24
host1(config-if)#isis mesh-group blocked
host1(config-if)#exit
host1(config)#interface atm 1/0
host1(config-if)#ip router isis floor12
host1(config-router)#distribute-domain-wide
host1(config-router)#distance 100 ip
host1(config-router)#default-information originate route-map 9
host1(config-router)#is-type level-1-2
host1(config-router)#summary-address 10.2.0.82 255.255.0.0 level-1-2 tag 90
host1(config-router)#set-overload-bit on-startup wait-for-bgp 450
host1(config-router)#ignore-lsp-errors
host1(config-router)#log-adjacency-changes
host1(config-router)#lsp-mtu 1500
host1(config-router)#lsp-refresh-interval 1000
host1(config-router)#lsp-gen-interval level-2 30
host1(config-router)#max-lsp-lifetime 1500
```

```
host1(config-router)#spf-interval level-2 30
host1(config-router)#maximum-paths 16
host1(config-router)#redistribute static ip route-map 5
host1(config-router)#nsf ietf
host1(config-router)#nsf t2 level-1 70
host1(config-router)#nsf t2 level-2 50
host1(config-router)#nsf t3 adjacency
host1(config-router)#exit
host1(config)#clns configuration-time 120
host1(config)#clns holding-time 600
```

Configuring IS-IS for MPLS

IS-IS has several commands to provide support for MPLS. See *JunosE BGP and MPLS Configuration Guide*, for a detailed discussion of MPLS. If you configure your tunnel with the **tunnel mpls autoroute announce isis** command, MPLS attempts to register the tunnel endpoint with IS-IS. You must enable this registration with IS-IS by issuing the **mpls traffic-eng** command.

When you configure a node as the downstream endpoint of an LSP, you must provide a stable interface as the router ID for the endpoint. Typically you select a loopback interface because of its inherent stability. Use the **mpls traffic-eng router-id** command to specify the router ID.

By default, IS-IS always uses the MPLS tunnel to reach the MPLS endpoint. Best paths determined by IS-IS SPF calculations are not considered. You can enable the consideration of best paths by issuing the **mpls spf-use-any-best-path** command. As a result, IS-IS considers metrics for IGP paths and the tunnel metric, and might forward traffic along a best path, through the MPLS tunnel, or both.

Several **show** commands enable monitoring of MPLS information. See [“Monitoring IS-IS” on page 439](#) for more information.

MPLS traffic engineering requires that IS-IS generate the new-style TLVs that enable wider metrics. Use the **metric-style wide** command to generate the new-style TLVs. If you are using some IS-IS routers that still do not understand the new-style TLVs, use the **metric-style transition** command. See [“Extensions for Traffic Engineering” on page 385](#) and [“Configuring Global IS-IS Parameters” on page 408](#) for detailed information about using the **metric-style** commands.

mpls spf-use-any-best-path

- Use to enable SPF calculations to consider the IGP (IS-IS) best paths as well as the MPLS tunnel for forwarding traffic to the MPLS endpoint.
- By default, the MPLS tunnel is always selected for traffic to the tunnel endpoint; IGP paths are not considered. For traffic beyond the endpoint, the tunnel is considered equally with any other path.
- Example

```
host1(config-router)#mpls spf-use-any-best-path
```

- Use the **no** version to disable the use of IGP best paths.
- See `mpls spf-use-any-best-path`

mpls traffic-eng

- Use to enable flooding of MPLS traffic engineering link information into the specified IS-IS level. Flooding is disabled by default.
- Example

```
host1(config-router)#mpls traffic-eng level-1
```
- Use the **no** version to disable flooding.
- See `mpls traffic-eng`

mpls traffic-eng router-id

- Use to specify a very stable interface to be used as a router ID for MPLS traffic engineering. Typically you specify a loopback interface to provide the greatest stability, because this is flooded to all nodes. The interface acts as the destination node for tunnels originating at other nodes.
- Example

```
host1(config-router)#mpls traffic-eng router-id loopback 0
```
- Use the **no** version to remove the interface as a router ID.
- See `mpls traffic-eng router-id`

Using IS-IS Routes for Multicast RPF Checks

You can use the **ip route-type** command to specify whether IS-IS routes are available for only unicast forwarding protocols or only multicast reverse-path forwarding (RPF) checks. Routes available for unicast forwarding appear in the unicast view of the routing table, whereas routes available for multicast RPF checks appear in the multicast view of the routing table.

ip route-type

- Use to specify whether IS-IS routes are available only for unicast forwarding, only for multicast reverse-path forwarding checks, or for both.
- Use the **show ip route** command to view the routes available for unicast forwarding.
- Use the **show ip rpf-routes** command to view the routes available for multicast reverse path forwarding checks.
- By default, IS-IS routes are available for both unicast forwarding and multicast reverse path forwarding checks.
- Example

```
host1(config)#router isis  
host1(config-router)#ip route-type unicast
```

- Use the **no** version to restore the default value, both.
- See `ip route-type`

Configuring the BFD Protocol for IS-IS

The **isis bfd-liveness-detection** command configures the Bidirectional Forwarding Detection (BFD) protocol for IS-IS. The BFD protocol uses control packets and shorter detection time limits to more rapidly detect failures in a network. Also, because they are adjustable, you can modify the BFD timers for more or less aggressive failure detection.

When you issue the **isis bfd-liveness-detection** command on an IS-IS peer, the peer establishes BFD liveness detection with all BFD-enabled IS-IS peers. When the local peer receives an update from a remote IS-IS peer—if BFD is enabled and if the session is not already present—the local peer attempts to create a BFD session to the remote peer.

Each adjacent pair of peers negotiates an acceptable transmit interval for BFD packets. The negotiated value can be different on each peer. Each peer then calculates a BFD liveness detection interval. When a peer does not receive a BFD packet within the detection interval, it declares the BFD session to be down and purges all routes learned from the remote peer.



NOTE: Before the router can use the **isis bfd-liveness-detection** command, you must specify a BFD license key. To view an already configured license, use the **show license bfd** command.

For general information about configuring and monitoring the BFD protocol, see *JunosE IP Services Configuration Guide*.

isis bfd-liveness-detection

- Use to enable BFD (bidirectional forwarding detection) and define BFD values to more quickly detect IS-IS data path failures.
- The peers in an IS-IS adjacency use the configured values to negotiate the actual transmit intervals for BFD packets.
 - You can use the **minimum-transmit-interval** keyword to specify the interval at which the local peer proposes to transmit BFD control packets to the remote peer. The default value is 300 milliseconds.
 - You can use the **minimum-receive-interval** keyword to specify the minimum interval at which the local peer must receive BFD control packets from the remote peer. The default value is 300 milliseconds.
 - You can use the **minimum-interval** keyword to specify the same value for both of those intervals. Configuring a minimum interval has the same effect as configuring the minimum receive interval and the minimum transmit interval to the same value. The default value is 300 milliseconds.

- You can use the **multiplier** keyword to specify the detection multiplier value. The calculated BFD liveness detection interval can be different on each peer. The multiplier value is roughly equivalent to the number of packets that can be missed before the BFD session is declared to be down. The default value is 3.
- For details on liveness detection negotiation, see *JunosE IP Services Configuration Guide*.
- You can change the BFD liveness detection parameters at any time without stopping or restarting the existing session; BFD automatically adjusts to the new parameter value. However, no changes to BFD parameters take place until the values resynchronize with each peer.
- Example


```
host1(config)#isis bfd-liveness-detection minimum-interval 800
```
- Use the **no** version to disable BFD on the IS-IS interface.
- See `isis bfd-liveness-detection`

Disabling the IS-IS Protocol

The **protocol shutdown** command disables the IS-IS protocol but does not remove any IS-IS configuration. In addition, even though the router does not participate in IS-IS routing after you issue the **protocol shutdown** command, you can continue to configure IS-IS.

Issuing the **protocol shutdown** command:

- Clears the LSP database
- Removes all IS-IS routes in the routing information database (RIB)
- Deletes all adjacencies with the IS-IS instance



NOTE: Rebooting the router does not affect the state of the IS-IS protocol.

protocol shutdown

- Use to disable the IS-IS protocol without removing the IS-IS configuration.
- Example


```
host1(config-router)#protocol shutdown
```
- Use the **no** version to reenab the IS-IS protocol.
- See `protocol shutdown`

Monitoring IS-IS

The CLI has commands available for monitoring IS-IS parameters and CLNS parameters.

System Event Logs

To troubleshoot and monitor IP, use the following system event logs:

- `isisAdjChange`—IS-IS adjacency up or down events
- `isisAdjPackets`—IS-IS adjacency hello packets
- `isisBfdEvents`—IS-IS interactions with BFD
- `isisChecksumErr`—IS-IS checksum errors
- `isisGeneral`—IS-IS system notifications
- `isisHelloGeneral`—IS-IS system notifications
- `isisHelloPackets`—IS-IS hello packets
- `isisip6Log`—IS-IS IPv6 notifications
- `isisLdpEvents`—IS-IS interactions with LDP
- `isisLocalUpdate`—IS-IS local LSP packets
- `isisMplsTeAdvertisements`—IS-IS MPLS traffic engineering advertisements
- `isisMplsTeEvents`—IS-IS MPLS traffic engineering
- `isisNsfEvents`—IS-IS nonstop forwarding events during warm starts
- `isisProtocolErr`—IS-IS protocol errors
- `isisSnPackets`—IS-IS complete sequence numbers PDU (CSNP) and partial sequence numbers PDU (PSNP) packets
- `isisSpfEvents`—IS-IS Shortest Path First (SPF)
- `isisSpfStatistics`—IS-IS SPF timing and statistic data
- `isisSpfTriggers`—IS-IS SPF triggering
- `isisUpdate Packets`—IS-IS LSP packets sent or received

For more information about using event logs, see the *JunosE System Event Logging Reference Guide*.

Monitoring IS-IS Parameters

You can monitor the IS-IS link-state database and IS-IS debug information. Use the commands in this section to:

- Display router information.
- Display information about SPF calculations.
- Monitor IS-IS summary address information.
- Display debug information.
- Display host.
- Display information about MPLS tunnels.

- Clear adjacencies.
- Display paths to intermediate systems.
- Display information about the settings for IS-IS graceful restart.

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 *JunosE System Basics Configuration Guide*, for details.

clear isis adjacency

- Use to remove entries from the adjacency database.
- Specify a hostname or the system ID of a neighbor to clear only adjacencies with that neighbor.
- Specify no options to remove all adjacencies from the database.
- Example

```
host1#clear isis adjacency
```
- There is no **no** version.
- See clear isis adjacency

debug isis

- Use to obtain debug-related information about certain parameters.
- This command manipulates the same log as the Global Configuration **log** commands.
- You can select from these parameters:
 - **adj-packets**—IS-IS adjacency-related packets
 - **mpls traffic-eng advertisements**—MPLS traffic-engineering agent advertisements
 - **mpls traffic-eng agents**—MPLS traffic-engineering agents
 - **snp-packets**—IS-IS CSNP/PSNP packets
 - **spf-events**—IS-IS Shortest Path First events
 - **spf-statistics**—IS-IS SPF timing and statistic data
 - **spf-triggers**—IS-IS SPF triggering events
 - **update-packets**—IS-IS update-related packets
- Example

```
host1#debug isis adj-packets
```
- Use the **no** version to disable debugging display.
- See debug isis

show hosts

- Use to display the name-to-NSAP mappings defined with the **clns host** command.
- Field descriptions
 - Static Host Table
 - name—Name assigned to the host
 - ip address—Host IP address
 - type—Type of host
 - username—Username necessary to access the host
 - password—Password necessary to access the host
 - Clns Host Alias Table
 - name—Name of the host alias
 - area address—Area address of the host alias
 - system ID—Six-byte value of the host alias
 - type—Type of host alias
- Example

```
host1:abc#show hosts
```

```
Static Host Table
```

```
-----
name   ip address   type   username   password
-----
jkk    10.10.0.73    ftp    anonymous  null
```

```
Clns Host Alias Table
```

```
-----
name   area address               system ID               type
-----
fred   47.0005.80FF.F800.0000.0001.0001 0000.0000.0011.00 static
karen  47.0005.80FF.F800.0000.0001.0001 0000.0000.0012.00 static
```

- See show hosts

show isis database

- Use to display IS-IS link-state database information.
- Request specific **show isis database** statistics by selecting from these options:
 - *lspid*—Link-state protocol ID in form xxxx.xxxx.xxxx.yy-zz
 - *hostname*—Link-state database information for the specified hostname
 - **detail**—Detailed link-state database information; if this option is not specified, a summary display is provided
 - **l1**—Level 1 routing link-state database
 - **l2**—Level 2 routing link-state database

- **level-1**—Level 1 routing link-state database
- **level-2**—Level 2 routing link-state database
- Each option can be entered in an arbitrary string within a single command entry.
- Field descriptions
 - LSPID—LSP identifier
 - LSP Seq Num—Sequence number for the LSP. Enables other routers to determine if they have received the latest information from source.
 - LSP Checksum—Checksum of the LSP packet
 - LSP Holdtime—Number of seconds that the LSP remains valid
 - ATT—Attach bit; indicates that the router is a level 2 router and can reach other areas
 - P—P bit; detects whether intermediate system is capable of area partition repair
 - OL—Overload bit; determines whether intermediate system is congested
 - Area Address—Area addresses that can be reached from the router
 - NLPID—ISO network layer protocol identifier
 - IP Address—IP address of the interface
 - Hostname—Hostname of the router
 - Router ID—ID configured on the router
 - Metric —Metric that indicates either of the following costs:
 - Cost of adjacency between the originating router and the advertised neighbor
 - Cost between the advertising router and the advertised destination
 - IPv4 Interface Address—Address of the interface
 - IPv4 Neighbor Address—Address of a neighbor
 - Maximum link bandwidth—Bandwidth capacity of the link in bits per second
 - Reservable link bandwidth—Amount of bandwidth reservable on the link (whether reserved or not)
 - Unreserved bandwidth—Amount of bandwidth available for reservation on the link
 - TE default metric—Traffic engineering default metric value
 - Tag value(s)—Route tag assigned to the IS-IS interface, if configured
- Example 1

```
host1#show isis database
IS-IS Level-1 Link State Database
```

LSPID	LSP	Seq Num	LSP Checksum	LSP Holdtime	ATT/P/OL
0000.0000.004E.00-00		0x000013F5	0x8BAA	1198	0/0/0
0000.0000.3333.00-00*		0x0000020F	0xEA1E	1199	0/0/0
0000.0000.3333.02-00		0x00000007	0x8C30	1199	0/0/0
0000.0000.7500.00-00		0x0000308D	0x5EDF	1198	0/0/0
0090.1A00.B000.00-00		0x00000011	0xB082	1195	1/0/0
0090.1A00.C000.00-00		0x0000005F	0x9860	1196	0/0/0

IS-IS Level-2 Link State Database

LSPID	LSP	Seq Num	LSP Checksum	LSP Holdtime	ATT/P/OL
0000.0000.004E.00-00		0x00001355	0x0DA7	1198	0/0/0
0000.0000.3333.00-00*		0x00000257	0x566B	1199	0/0/0
0000.0000.3333.02-00		0x00000007	0x8C30	1199	0/0/0
0000.0000.7500.00-00		0x00003315	0x3627	1198	0/0/0
0010.7B36.5FF7.00-00		0x00000BAF	0x187A	1183	0/0/0
0090.1A00.B000.00-00		0x00000016	0xD624	1195	1/0/0
0090.1A00.C000.00-00		0x00000071	0x9358	1196	0/0/0

• Example 2

host1#show isis database detail

```

LSPID LSP      Seq Num      LSP Checksum LSP Holdtime ATT/P/OL
boston.00-00*0x000001160x4760 6551/0/0
  Area Address: 47.0005.80FF.F800.0000.0000.0004
  NLPID:        0x81 0xcc
  IP Address:   10.1.1.1
  Hostname:    boston
  Router ID:   10.1.1.1
  Metric: 10 IS newyork.00
    IPv4 Interface Address: 10.1.1.1
    IPv4 Neighbor Address: 10.1.1.2
  Metric: 10 IS washington.00
    IPv4 Interface Address: 10.1.3.1
    IPv4 Neighbor Address: 10.1.3.3
  Metric: 10 IP 192.168.1.0/24
  Metric: 10 IP 10.1.1.0/24 tag value(s): 11
  Metric: 10 IP 10.1.3.0/24
  Metric: 20 IP 10.1.2.0/24 tag value(s): 22

```

• Example 3

host1#show isis database verbose

IS-IS Level-1 Link State Database

LSPID	LSP Seq Num	LSP Checksum	LSP Holdtime	ATT/P/OL
zion.00-00*	0x00000011	0xBFAD	487	0/0/0

```

  Area Address: 47.0005.80FF.F800.0000.0000.0003
  NLPID:        0x81 0xcc
  IP Address:   222.9.1.1
  Hostname:    zion
  Router ID:   222.9.1.1
  Metric: 0 ES 2220.0900.1001
  Metric: 10 IS london.00
    Administrative group: 0
    IPv4 Interface Address: 221.1.1.1
    IPv4 Neighbor Address: 221.1.1.2
    Maximum link bandwidth: 50000
    Reservable link bandwidth: 50000
    Unreserved bandwidth:
      Priority 0: 50000
      Priority 1: 50000
      Priority 2: 50000
      Priority 3: 50000
      Priority 4: 30000

```

```

        Priority 5: 30000
        Priority 6: 30000
        Priority 7: 30000
    TE default metric: 0
Metric: 10 IS london.00
    Administrative group: 0
    IPv4 Interface Address: 221.1.6.1
    IPv4 Neighbor Address: 221.1.6.2
    Maximum link bandwidth: 50000
    Reservable link bandwidth: 50000
    Unreserved bandwidth:
        Priority 0: 50000
        Priority 1: 50000
        Priority 2: 50000
        Priority 3: 50000
        Priority 4: 30000
        Priority 5: 30000
        Priority 6: 30000
        Priority 7: 30000
    TE default metric: 0
Metric: 10 IS paris.00
    Administrative group: 0
    IPv4 Interface Address: 221.1.4.1
    IPv4 Neighbor Address: 221.1.4.4
    Maximum link bandwidth: 0
    Reservable link bandwidth: 0
    Unreserved bandwidth:
        Priority 0: 0
        Priority 1: 0
        Priority 2: 0
        Priority 3: 0
        Priority 4: 0
        Priority 5: 0
        Priority 6: 0
        Priority 7: 0
    TE default metric: 0
Metric: 10 IP 221.1.1.0/24
Metric: 10 IP 221.1.6.0/24
Metric: 10 IP 221.1.4.0/24
Metric: 0 IP 222.9.1.1/32

```

- Example 4

```

host1#show isis database Getafix:v2
IS-IS Level-1 Link State Database
LSPID          LSP Seq Num  LSP Checksum  LSP Holdtime  ATT/P/OL
Getafix:v2.00-00*  0x00000001  0xEB53       1097          0/0/0

IS-IS Level-2 Link State Database
LSPID          LSP Seq Num  LSP Checksum  LSP Holdtime  ATT/P/OL
Getafix:v2.00-00*  0x00000001  0x456D       1097          0/0/0

```

- Example 5

```

host1#show isis database Getafix:v2 detail
IS-IS Level-1 Link State Database
LSPID          LSP Seq Num  LSP Checksum  LSP Holdtime  ATT/P/OL
Getafix:v2.00-00*  0x00000001  0xEB53       967           0/0/0
    Area Address: 22
    NLPID:        0x81 0xcc
    IP Address:   1.1.1.2
    Hostname: Getafix:v2
    Metric: 10 IS Getafix:v2.01

```

```

Metric: 0 ES Getafix:v2
Metric: 10 IP 1.1.1.0 255.255.255.0

IS-IS Level-2 Link State Database
LSPID          LSP Seq Num  LSP Checksum  LSP Holdtime  ATT/P/OL
Getafix:v2.00-00* 0x00000001  0x456D        967           0/0/0
Area Address: 22
NLPID:         0x81 0xcc
IP Address:    1.1.1.2
Hostname: Getafix:v2
Metric: 10 IS Getafix:v2.01
Metric: 10 IP 1.1.1.0 255.255.255.0

```

- Example 6—For IS-IS IPv6 configuration

```

host1:2#show isis database detail
IS-IS Level-1 Link State Database
LSPID          LSP Seq Num  LSP Checksum  LSP Holdtime  ATT/P/OL
sw-rex320-19:R3.00-00*0x0000FAE 0x7B21        13           0/0/0
Area Address: 39.840F.8011.3963.0000.0001.9262
NLPID:         0x81 0xcc
IP Address:    2.2.2.2
Hostname: sw-rex320-19:R3
Metric: 10 IS sw-rex320-19:R3.01
Metric: 0 ES sw-rex320-19:R3
Metric: 10 IP 5.5.5.0 255.255.255.0
Metric: 0 IP 3.3.3.0 255.255.255.0
Metric: 0 IPv6 Internal Up 3::/64
sw-rex320-19:R3.01-00*0x0000FA7 0x52F0        13           0/0/0
Metric: 0 IS sw-rex320-19:R3.00
Metric: 0 IS sw-rex320-22:R3.00
sw-rex320-22:R3.00-00 0x0000118 0x8CFB        4           0/0/0
Area Address: 39.840F.8011.3963.0000.0001.9262
NLPID:         0x81 0xcc
IP Address:    8.8.8.8
Hostname: sw-rex320-22:R3
Metric: 10 IS sw-rex320-19:R3.01
Metric: 0 ES sw-rex320-22:R3
Metric: 10 IP 5.5.5.0 255.255.255.0
Metric: 0 IP 9.9.9.0 255.255.255.0
Metric: 10 IPv6 Internal Up 5::/64
Metric: 0 IPv6 Internal Up 9::/64
3 LSPs

```

- See show isis database

show isis mpls adjacency-log

- Use to display a log of the last 20 IS-IS adjacency changes.
- Field descriptions
 - When—Amount of time since recording the log entry
 - Neighbor ID—Identifier for the neighbor
 - IP Address—IP address of the neighbor
 - Interface—Interface from which neighbor was learned

- Status—Adjacency status, Up or Down
- Level—IS-IS routing level
- Example

```
host1#show isis mpls adjacency-log
IS-IS MPLS TE log
When      Neighbor ID      IP Address  Interface Status Level
02:25:47  2220.0900.2002.00 221.1.1.2  at2/0.1   Up      L1
02:25:47  2220.0900.2002.00 221.1.6.2  at2/0.6   Up      L1
02:25:47  2220.0900.4004.00 221.1.4.4  at2/1.5   Up      L1
```

- See show isis mpls adjacency-log

show isis mpls advertisements

- Use to display the last record flooded from MPLS.
- Field descriptions
 - System ID—Name or system ID of the MPLS tail-end (destination) router
 - Router ID—Router ID for the router
 - Link Count—Number of links that MPLS advertises
 - Neighbor System ID—Identifier of the remote system in an area
 - Administrative group—TLV administrative group or color assigned to the link
 - Interface IP address—IP address of the interface
 - Neighbor IP Address—IP address of the neighbor
 - Maximum link bandwidth—Bandwidth capacity of the link in bits per second
 - Reservable link bandwidth—Amount of bandwidth reservable on the link (whether reserved or not)
 - Unreserved bandwidth—Amount of bandwidth available for reservation on the link
 - TE default metric—Traffic engineering default metric value
 - Affinity Bits—Attributes flooded for the link
- Example

```
host1#show isis mpls advertisements
System ID: zion.00
Router ID: 222.9.1.1
Link[1]
Neighbor System ID: london.00
Administrative group: 0
IPv4 Interface Address: 221.1.1.1
IPv4 Neighbor Address: 221.1.1.2
Maximum link bandwidth: 50000
Reservable link bandwidth: 50000
Unreserved bandwidth:
Priority 0: 50000
```

```

        Priority 1: 50000
        Priority 2: 50000
        Priority 3: 50000
        Priority 4: 30000
        Priority 5: 30000
        Priority 6: 30000
        Priority 7: 30000
    TE default metric: 0
Link[2]
  Neighbor System ID: london.00
  Administrative group: 0
  IPv4 Interface Address: 221.1.6.1
  IPv4 Neighbor Address: 221.1.6.2
  Maximum link bandwidth: 50000
  Reservable link bandwidth: 50000
  Unreserved bandwidth:
    Priority 0: 50000
    Priority 1: 50000
    Priority 2: 50000
    Priority 3: 50000
    Priority 4: 30000
    Priority 5: 30000
    Priority 6: 30000
    Priority 7: 30000
  TE default metric: 0
Link[3]
  Neighbor System ID: paris.00
  Administrative group: 0
  IPv4 Interface Address: 221.1.4.1
  IPv4 Neighbor Address: 221.1.4.4
  Maximum link bandwidth: 0
  Reservable link bandwidth: 0
  Unreserved bandwidth:
    Priority 0: 0
    Priority 1: 0
    Priority 2: 0
    Priority 3: 0
    Priority 4: 0
    Priority 5: 0
    Priority 6: 0
    Priority 7: 0
  TE default metric: 0
```

- See `show isis mpls advertisements`

show isis mpls tunnel

- Use to display information about tunnels used in the calculation of IS-IS next hops.
- Field descriptions
 - System Id—Name or system ID of the MPLS tail-end (destination) router
 - Tunnel Name—Name of the MPLS tunnel interface
 - Nexthop—Destination IP address of the MPLS tunnel
 - Metric —Metric of the MPLS tunnel
 - Mode—Metric mode, either absolute or relative

- Example

```
host1#show isis mpls tunnel
System Id      Tunnel Name  Nexthop  Metric  Mode
dakota-router1.00 Tunnel1    2.2.2.2  -3      Relative
                Tunnel2    2.2.2.2  11      Absolute
jersey-router2.00 Tunnel3    3.3.3.3  -1      Relative
                Tunnel4    3.3.3.3
```

- See show isis mpls tunnel

show isis nsf

- Use to display information about the configured and operational settings on the router for IS-IS graceful restart, which is also known as nonstop forwarding (NSF).
- Field descriptions
 - Configured Timer Values—Displays the following values configured for IS-IS graceful restart on the router, as described in [“Configuring Graceful Restart” on page 432](#) :
 - Graceful Restart—Setting for IS-IS graceful restart on the router: Enabled or Disabled
 - T3 Timer—Method by which the restarting router obtains the T3 wait time: Manual or Derive from adjacency
 - T3 Timeout Value—Maximum time, in seconds, that the restarting router waits before setting the overload bit to indicate that IS-IS graceful restart has failed
 - T2 Timeout Value—Maximum time for IS-IS level 1 routing and level 2 routing, in seconds, that the restarting router waits for the LSP database to synchronize
 - T1 Timeout Value—Time interval, in seconds, between IS-IS restart requests sent by the restarting router on this interface to neighboring routers
 - T1 Retry Count—Number of times the restarting router resends unacknowledged restart requests on this interface at the specified interval
 - Adj. Wait Time—Maximum time, in seconds, that an IS-IS process on the restarting router waits for all interfaces with IS-IS adjacencies to come up before completing the restart process
 - Operation Timer Values—Displays the following currently remaining timer settings, in seconds, for IS-IS graceful restart during the restart process:
 - T3 Timer—Remaining time before the restarting router sets the overload bit to indicate that graceful restart has failed
 - T2 Timeout Value—Remaining time for level 1 routing and level 2 routing that the restarting router waits for the LSP database to synchronize
 - Adj. Wait Time—Remaining time that the restarting router waits for all adjacencies to come up before completing the restart process

- Restart Ack Recv Adj Count—Number of neighboring IS-IS routers for level 1 routing and level 2 routing that have acknowledged the restart requests sent by the router
- LAN If DIS Wait Count—Number of interfaces on which the restarting router is waiting to receive election of the designated intermediate system (DIS)
- Restart CSNP Adj Recv Count—Number of adjacencies for level 1 routing and level 2 routing that have sent complete sequence number PDUs (CSNPs) to provide information about LSP database synchronization
- Local LSP Wait Count—Number of level 1 and level 2 LSPs for which the restarting router is awaiting complete synchronization
- Example

```

host1#show isis nsf
Configured Timer Values
-----
Graceful Restart      : Enabled
T3 Timer              : Manual
T3 Timeout Value      : 80
T2 Timeout Value      : 70(level-1)
                      : 70(level-2)
T1 Timeout Value      : 60
T1 Retry Count        : 3
Adj. Wait Time        : 30

Operation Timer Values
-----
T3 Timer              : 0
T2 Timeout Value      : 0(level-1)
                      : 0(level-2)
Adj. Wait Time        : 0
Restart Ack Recv Adj Count : 0(level-1)
                      : 0(level-2)
LAN If DIS Wait Count : 0
Restart CSNP Adj Recv Count: 0(level-1)
                      : 0(level-2)
Local LSP Wait Count  : 0(level-1)
                      : 0(level-2)

```

- See `show isis nsf`

show isis spf-log

- Use to display how often and why the router has run a full SPF calculation.
- Field descriptions
 - When—Amount of time since a full SPF calculation took place, given in hours:minutes:seconds. The previous 20 calculations are logged.
 - Duration—Number of seconds to complete this SPF run. The elapsed time is in actual clock time, not CPU time.
 - First Trigger LSP—Whenever a full SPF calculation is triggered by a new LSP, the LSP ID is stored in the router

- SpfType—Type of SPF run
- Triggers—List of causes that triggered the SPF calculation

- Example 1

```
host1#show isis spf-log
Level 1 SPF log
When      Duration      First Trigger LSP      SpfType  Triggers
00:01:45  0.000                0000.0000.0000.00-00 Full      LSP Add
00:01:36  0.000                0000.0000.0000.00-00 Full      LSP Add
00:01:31  0.000                0000.0101.0101.00-00 Full      LSP Add
00:00:08  0.000                0000.0101.0101.00-00 PRC       LSP Sequence Update
```

- Example 2

```
host1#show isis spf-log detail
Level 1 SPF log
When      Duration      First Trigger LSP      SpfType  Triggers
00:01:53  0.000                0000.0000.0000.00-00 Full      LSP Add
      RTupdt 0.000
      RtLeak 0.000
00:01:44  0.000                0000.0000.0000.00-00 Full      LSP Add
      RTupdt 0.000
      RtLeak 0.000
00:01:39  0.000                0000.0101.0101.00-00 Full      LSP Add
      RTupdt 0.000
      RtLeak 0.000
00:00:16  0.000                0000.0101.0101.00-00 PRC       LSP Sequence Update
      RTupdt 0.000
      RtLeak 0.000
```

- See show isis spf-log

show isis summary-addresses

- Use to display the status of IS-IS aggregate addresses.
- Field descriptions
 - Address—Aggregate addresses advertised by summarization process
 - Mask—IP subnet masks used for the summary routes
 - Level—Level for which multiple groups of addresses can be summarized
 - Metric—Metric used to advertise the summary
 - State—State of the summary address
 - Prefix—IPv6 prefix
 - Tag—Number in the range 1–4294967295 that identifies the route tag assigned to the IS-IS IPv6 interface
- Example 1—For IS-IS IP addresses

```
host1#show isis summary-addresses
Address      Mask      Level      Metric      State
-----
```

3.0.0.0	255.0.0.0	LEVEL-1	0	ENABLED
4.0.0.0	255.0.0.0	LEVEL-1-2	5	ENABLED

- Example 2—For IS-IS IPv6 addresses

```
host1#show isis summary-addresses
```

Prefix	Level	Metric	Tag	State
-----	-----	-----	-----	-----
2008::0/8	LEVEL-2	0	100	ENABLED

- See show isis summary-addresses

show isis topology

- Use to display the paths to all intermediate systems or specific types of intermediate systems.
- Field descriptions
 - System ID—Name or system ID of the intermediate system
 - Metric—Metric of the path to the intermediate system
 - Next Hop—Destination IP address of the intermediate system
 - Interface—Interface from which neighbor was learned
 - SNPA—Subnetwork point of attachment; for a LAN circuit, it is the MAC address; not meaningful for a point-to-point circuit.
- Example

```
host1#show isis topology level-1
```

IS-IS paths for level-1 routers

System-ID	Metric	Next Hop	Intf	SNPA
-----	-----	-----	-----	-----
barcelona:vr2	10	barcelona:vr2	at2/0.12	

- See show isis topology

undebg isis

- Use to cancel the display of information about a selected event.
- The same IS-IS variables can be designated as in the **debug isis** command.
- Example


```
host1#undebg isis adj-packets
```
- There is no **no** version.
- See undebg isis

Displaying CLNS

You can display the following information related to the CLNS protocol:

- CLNS information about interfaces
- Information about router adjacencies
- Information about ES and IS neighbors
- Protocol-specific information for each routing process
- Information about CLNS packets
- Global CLNS configurations

You can set a statistics baseline for CLNS using the **baseline clns** command.

baseline clns

- Use to set a statistics baseline for CLNS.
- The router 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.
- Use the optional *interface-specifier* parameter to specify an interface; otherwise the command sets a baseline for all interfaces.
- You cannot set a baseline for groups of interfaces.
- When baselining is requested, the time since the last baseline was set is displayed in days, hours, minutes, and seconds.
- Use the optional **delta** keyword with the **show clns traffic** command to specify that baselined statistics are to be shown.
- Example

```

host1#show clns traffic detail
IS-IS: Baseline last set 0 days, 0 hours, 1 minutes, 41 seconds
IS-IS: Corrupted LSPs: 0
IS-IS: L1 LSP Database Overloads: 0
IS-IS: L2 LSP Database Overloads: 0
IS-IS: Area Addresses Dropped: 0
IS-IS: Attempts to Exceed Max Sequence: 0
IS-IS: Sequence Numbers Skipped: 6
IS-IS: Own LSPs Purged: 1
IS-IS: System ID Length Mismatches: 0
IS-IS: Maximum Area Mismatches: 0

Interface: atm2/1.3
IS-IS: Baseline last set 0 days, 0 hours, 1 minutes, 43 seconds
IS-IS: Protocol PDUs (in/out): 32/36
IS-IS: Init Failures: 0
IS-IS: Adjacencies Changes: 1
IS-IS: Adjacencies Rejected: 0
IS-IS: Bad LSPs: 0
IS-IS: Level-1 Designated IS Changes: 0
IS-IS: Level-2 Designated IS Changes: 0
IS-IS: Invalid 9542s: 0
host1#baseline clns atm 2/1.3
host1#show clns traffic detail delta
IS-IS: Baseline last set 0 days, 0 hours, 2 minutes, 27 seconds
IS-IS: Corrupted LSPs: 0
IS-IS: L1 LSP Database Overloads: 0

```

```

IS-IS: L2 LSP Database Overloads: 0
IS-IS: Area Addresses Dropped: 0
IS-IS: Attempts to Exceed Max Sequence: 0
IS-IS: Sequence Numbers Skipped: 6
IS-IS: Own LSPs Purged: 1
IS-IS: System ID Length Mismatches: 0
IS-IS: Maximum Area Mismatches: 0

Interface: atm2/1.3
IS-IS: Baseline last set 0 days, 0 hours, 0 minutes, 8 seconds
IS-IS: Protocol PDUs (in/out): 2/1
IS-IS: Init Failures: 0
IS-IS: Adjacencies Changes: 0
IS-IS: Adjacencies Rejected: 0
IS-IS: Bad LSPs: 0
IS-IS: Level-1 Designated IS Changes: 0
IS-IS: Level-2 Designated IS Changes: 0
IS-IS: Invalid 9542s: 0

```

- There is no **no** version.
- See baseline clns

clear isis database

- Use to delete all entries from the IS-IS link-state database, or only the entries associated with the specified neighbor.
- Field descriptions
 - LSPID—LSP identifier
 - LSP Seq Num—Sequence number for the LSP. Enables other routers to determine if they have received the latest information from source.
 - LSP Checksum—Checksum of the LSP packet
 - LSP Holdtime—Number of seconds that the LSP remains valid
 - ATT—Attach bit; indicates that the router is a level 2 router and can reach other areas
 - P—P bit; detects whether intermediate system is capable of area partition repair
 - OL—Overload bit; determines whether intermediate system is congested
- Example

```

host1#show isis database
IS-IS Level-1 Link State Database
LSPID      LSP Seq Num  LSP Checksum  LSP Holdtime  ATT/P/OL
rtr1.00-00* 0x00000009   0x568F        1188          0/0/0
rtrtwo.00-00 0x00000005   0xEC9B        444          0/0/0

IS-IS Level-2 Link State Database
LSPID      LSP Seq Num  LSP Checksum  LSP Holdtime  ATT/P/OL
rtr1.00-00* 0x00000010   0xF630        1193          0/0/0
rtrtwo.00-00 0x0000000C   0xF8DA        1188          0/0/0

host1#clear isis database
host1#show isis database
IS-IS Level-1 Link State Database
LSPID      LSP Seq Num  LSP Checksum  LSP Holdtime  ATT/P/OL

```

IS-IS Level-2 Link State Database

LSPID	LSP Seq Num	LSP Checksum	LSP Holdtime	ATT/P/OL
-------	-------------	--------------	--------------	----------

- There is no **no** version.
- See clear isis database

show clns

- Use to display global CLNS information about the router.
- Field descriptions
 - Interfaces Enabled for CLNS—Number of interfaces that have the CLNS routing protocol enabled
 - Configuration Timer—Interval (in seconds) after which the router sends out IS hello packets
 - Default Holding Timer—Length of time (in seconds) that hello packets are remembered
 - Packet Lifetime—Default value used in packets sourced by this router
 - Intermediate system operation enabled (forwarding allowed)—Indicates whether this router is configured to be an ES or an IS
 - IS-IS Level-1-2 Router—Shows whether IS-IS is running in this router, gives tag information, and shows whether it is running level 1 or level 1-2
 - Routing for Area—ISO (NSAP) address for the network
 - Distribute domain wide enabled—Indicates whether distribute-domain-wide is enabled
 - Area Authentication—Displays the following fields if area authentication is enabled:
 - PSNP/CSNP PDU authentication enabled—Indicates whether authentication of level 1 PSNP packets and/or level 1 CSNP packets has been enabled by means of the **area-authentication** command
 - Key-id—Numeric identifier for the authentication key
 - Type—Type of authentication: hmac-md5 or password; an asterisk after the type indicates that the key is active
 - Start Accept—Date and time that the router starts accepting packets created with this password
 - Start Generate—Date and time that the router starts inserting this password into packets

- Stop Accept—Date and time that the router stops accepting packets created with this password
- Stop Generate—Date and time that the router stops inserting this password into packets
- Domain Authentication—Displays the following fields if domain authentication is enabled:
 - PSNP/CSNP PDU authentication enabled—Indicates whether authentication of level 2 PSNP packets and/or level 1 CSNP packets has been enabled by means of the **domain-authentication** command
 - Key-id—Numeric identifier for the authentication key
 - Type—Type of authentication: hmac-md5 or password; an asterisk after the type indicates that the key is active
- Start Accept—Date and time that the router starts accepting packets created with this password
- Start Generate—Date and time that the router starts inserting this password into packets
- Stop Accept—Date and time that the router stops accepting packets created with this password
- Stop Generate—Date and time that the router stops inserting this password into packets
- Use the **es-neighbors** keyword to display information for IS-IS end-system adjacencies or the **is-neighbors** keyword to display information for IS-IS intermediate-system adjacencies. Neighbor entries are sorted according to the area in which they are located. The following fields are displayed when any of these keywords is used:
 - System Id—Six-byte value of router
 - Interface—Interface on which the router was discovered
 - State—Adjacency state, either Up or Init
 - Up—Believes that the ES or IS is reachable
 - Init—Router is an IS and is waiting for an IS-IS hello message. IS-IS regards the neighbor as not adjacent.
 - Type—Level 1, level 2, and level 1-2 type adjacencies
 - L1—Router adjacency for level 1 routing only
 - L1L2—Router adjacency for level 1 and level 2 routing
 - L2—Router adjacency for level 2 only

- Priority—IS-IS priority that the respective neighbor is advertising. The highest-priority neighbor becomes the designated IS-IS router for the interface.
- Circuit Id—Neighbor's idea of what the designated IS-IS router is for the interface
- Add the **detail** keyword to display area addresses and IP addresses.
- Example 1—For IS-IS IP configuration

```
host1#show clns
Global CLNS Information:
  3 Interfaces Enabled for CLNS
  NET: 47.0005.80FF.F800.0000.0001.0001.0000.0000.3333.00
  Configuration Timer: 10, Default Holding Timer: 30, Packet Lifetime: 1200
  Intermediate system operation enabled
  IS-IS level-1-2 Router: testnet
  Routing for Area: 47.0005.80FF.F800.0000.0001.0001
  Distribution domain wide enabled
  Area Authentication:
  PSNP PDU authentication enabled
  Key-id: 1 Type: hmac-md5
  Start Accept: FRI JAN 14 09:57:41 2000
  Start Generate: FRI JAN 14 09:59:41 2000
  Stop Accept: 0
  Stop Generate: 0
  Domain Authentication:
  PSNP PDU authentication enabled
  CSNP PDU authentication enabled
  Key-id: 1 Type: hmac-md5*
  Start Accept: WED JAN 12 19:01:52 2000
  Start Generate: WED JAN 12 19:03:52 2000
  Stop Accept: 0
  Stop Generate: 0
```

- Example 2—For IS-IS IPv6 configuration

```
host1:2#show clns
Global CLNS Information:
  3 Interfaces Enabled for CLNS
  NET: 49.0001.0040.0400.4002.00
  Configuration Timer: 10, Default Holding Timer: 30, Packet Lifetime: 30
  Intermediate system operation enabled
  IS-IS level-1-2 Router:
  Routing for Area: 49.0001
  Ip route-type both
```

- Example 3—For IS-IS adjacencies

```
host1#show clns is-neighbors
System Id      Interface    State  Type Priority  Circuit Id
0000.0000.7500 atm2/0.111  up     L1L2 127      0000.0000.0000.00
```

- Example 4—For detailed information on IS-IS adjacencies

```
host1#show clns is-neighbors detail
System Id      Interface    State  Type Priority  Circuit Id
0000.0000.7500 atm2/0.111  up     L1L2 127      0000.0000.0000.00
Area Address(es): 47.0005.80FF.F800.0000.0001.0001
Ip Address(es): 172.30.245.33
```

- See show clns

show clns interface

- Use to display CLNS-specific information about each interface.
- Field descriptions
 - interface—Status of interface
 - line protocol—Status of the line protocol, up or down
 - Checksums—Status of checksum, enabled or disabled
 - MTU—Maximum transmission size for a packet on this interface
 - Encapsulation—Encapsulation used by CLNP packets on this interface
 - Next ESH/ISH—When the next ES hello or IS hello is sent on this interface
 - Routing Protocol—One or more areas that this interface is in. In most cases, an interface is in only one area.
 - Circuit type—Whether the interface has been configured for local routing (level-1), area routing (level-2), or local and area routing (level-1-2)
 - Interface number—Number of the interface
 - local circuit ID—Local circuit ID of the interface
 - Authentication Level-1—If area authentication is enabled, lists key-id, type of authentication, start and stop accept times, and start and stop generate times for the key. An asterisk after the type indicates the key is active.
 - Authentication Level-2—If domain authentication is enabled, lists key-id, type of authentication, start and stop accept times, and start and stop generate times for the key. An asterisk after the type indicates the key is active.
 - Level 1 and level 2 metrics—Metric value for each level
 - DIS priority—DIS priority value assigned to the IS-IS router at each level
 - Priority—Priority value assigned to the IS-IS router at each level
 - Circuit ID—Circuit ID of the IS-IS router at each level
 - Number of active level 1 and level 2 adjacencies—Number of adjacencies active at each level
 - Designated IS—Name of the designated IS-IS router at each level
 - Next IS-IS LAN level Hello—Amount of time (in seconds) before the next IS-IS LAN level 1 or level 2 hello message occurs
 - BFD—State of BFD for IS-IS, enabled or disabled
 - Mesh Group—Status of the mesh group, Active or Inactive
 - LDP-IGP Synchronization—Status of synchronization, Achieved or Pending

- When you specify the **brief** keyword, the output includes the following fields.
 - interface—Name of the interface
 - state—State of the interface, up or down
 - level—Configured interface level, level-1, level-2, or level-1-2
 - DIS(L-1)—Level-1 designated intermediate system (DIS) in a multiaccess network
 - DIS(L-2)—Level-2 designated intermediate system (DIS) in a multiaccess network
 - l1/l2 Metric—Metric for the interface

- Example 1

```

host1#show clns interface
FastEthernet4/1 is up, line protocol is up
  Checksums Enabled, MTU 1500, Encapsulation SNAP
  Next ESH/ISH is 5 seconds
  Routing Protocol: IS-IS
    Circuit Type: level-1-2
    Interface number 0x10, local circuit ID 0x1
    Level-1 Metric: 10, DIS Priority: 0, Priority: 64,
      Circuit ID: 0000.0000.0000.01
      Designated IS: Getafix:v2.01 (us)
    Number of active level-1 adjacencies: 0

    Level-2 Metric: 10, DIS Priority: 0, Priority: 64,
      Circuit ID: 0000.0000.0000.01
      Designated IS: Getafix:v1.01 (Not Us)
    Number of active level-2 adjacencies: 1
    Next IS-IS LAN Level-1 Hello in 7 seconds
    Next IS-IS LAN Level-2 Hello in 6 seconds
    BFD disabled
    Mesh Group Inactive
      LDP is configured through LDP autoconfig
      LDP-IGP Synchronization: Achieved

```

- Example 2

```

host1#show clns interface brief

```

```

Clns Intf brief Table
-----

```

interface	state	level	DIS(L-1)	DIS(L-2)	l1/l2 Metric
loopback1	up	level-1-2	Point to Point	Point to Point	10/10
ATM3/1.1	up	level-1-2	Point to Point	Point to Point	10/10
FastEthernet1/1	up	level-1-2	nemo:2.03	nemo:2.03	10/10
3 interfaces up in 3 interfaces					

- See show clns interface

show clns neighbors

- Use to display information about ES and IS neighbors.
- Use the **detail** keyword to display area addresses, IP addresses, and the ES or IS neighbor's graceful restart capability and restarting state.
- Field descriptions
 - System Id—Six-byte value of router
 - SNPA—Subnetwork point of attachment, which is the data link address; not meaningful for a point-to-point circuit
 - Interface—Interface the router was learned from
 - State—State of the ES or IS
 - Init—Router is an IS and is waiting for an IS-IS hello message. IS-IS regards the neighbor as not adjacent.
 - Up—ES or IS is considered reachable
 - Holdtime(rem)—Remaining number of seconds before this adjacency entry times out
 - Type—One of the following adjacency types:
 - ES—End-system adjacency either discovered by means of the ES-IS protocol or statically configured
 - IS—Router adjacency either discovered by means of the ES-IS protocol or statically configured
 - L1—Router adjacency for level 1 routing only
 - L1L2—Router adjacency for level 1 and level 2 routing
 - L2—Router adjacency for level 2 only
 - Proto—Protocol through which the adjacency was learned. Valid protocol sources include ES-IS, IS-IS, and Static.
 - Area Address(es)—Area addresses of the ES or IS
 - Ip Address(es)—IP addresses of the ES or IS
 - Graceful Restart Capable—Whether graceful restart is enabled (yes) or disabled (no) on the ES or IS
 - Neighbor Restarting—Whether the ES or IS is currently restarting: yes or no
 - BFD session—State of any BFD session for this neighbor
- Example 1—For IS-IS IP configuration

```
host1#show cns neighbors detail
```

System Id	SNPA	Interface	State	Holdtime(rem)	Type	Proto
1111.1111.1111		A5/0.1	up	30(29)	L1L2	IS-IS

Area Address(es): 11.1111.1111.1111.1111.1111

```

Ip Address(es): 172.100.11.1
Graceful Restart Capable: yes
Neighbor Restarting: yes
BFD session is not-up

```

- Example 2—For IS-IS IPv6 configuration

```

host1:2#show clns neighbors detail
System Id      SNPA      Interface  State  Holdtime(rem)  Type  Proto
host1:1        0090.1A41.081A  F1/1      up     30(25)         L1    IS-IS
  Area Address(es): 49.0001
  Ip Address(es):   4.4.4.1
  Graceful Restart Capable: no
  Neighbor Restarting: no
host1:3        0090.1A41.081C  F1/1      up     30(27)         L1    IS-IS
  Area Address(es): 49.0001
  Ip Address(es):   4.4.4.3
  Graceful Restart Capable: no
  Neighbor Restarting: no

```

- See show clns neighbors

show clns protocol

- Use to display protocol-specific information about a routing process.
- Field descriptions
 - IS-IS Router—IS-IS router name
 - System ID—Six-byte value of router
 - IS-Type—Routing level (level 1, level 2, or both) that is enabled on the router
 - Manual area addresses—Configured area addresses
 - Routing for area address(es)—Identified for level 1 routing processes. For level 2 routing processes, lists the domain address.
 - Interfaces supported by IS-IS—Interfaces and type
 - Distance—Configured distance value
 - Redistributing—Protocols being redistributed into IS-IS
- Example

```

host1:2#show clns protocol
IS-IS Router:
  System Id: 0040.0400.4002.00  IS-Type: level-1-2
  Operational State: Up
  Manual area address(es):
    49.0001
  Routing for area address(es):
    49.0001
  Interfaces supported by IS-IS:
    loopback1 - IP
    FastEthernet1/1 - IP,IPv6
    ATM3/1.1 - IP, IPv6
  Distance: 115

```

Redistributing:
static

- See show clns protocol

show clns traffic

- Use to display all CLNS packets the router sees.
- Use the optional **delta** keyword to specify that baselined statistics are to be shown.
- Field descriptions
 - IS-IS: Baseline last set—Time since the baseline was set
 - IS-IS: Corrupted LSPs—Number of LSPs received with errors
 - IS-IS: L1 LSP Database Overloads—Number of overloads in level 1
 - IS-IS: L2 LSP Database Overloads—Number of overloads in level 2
 - IS-IS: Area Addresses Dropped—Number of area addresses that the router dropped
 - IS-IS: Attempts to Exceed Max Sequence—Number of sequence wraps over maximum
 - IS-IS: Sequence Numbers Skipped—Number of LSPs received out of order
 - IS-IS: Own LSPs Purged—Number of LSPs deleted
 - IS-IS: Other LSPs Purged—Number of received LSPs deleted
 - IS-IS: System ID Length Mismatches—Number of unmatched system ID lengths
 - IS-IS: Maximum Area Mismatches—Number of rejected hellos due to area mismatches
 - IS-IS: Area/Domain Authentication Failures—Number of authentication failures on received level 1 and level 2 LSP/SNPs
 - IS-IS: Level-1 LSPs Sent Rcvd Dropped—Number of level 1 LSPs sent, received, and dropped
 - IS-IS: Level-2 LSPs Sent Rcvd Dropped—Number of level 2 LSPs sent, received, and dropped
 - IS-IS: LSP checksum errors received—Number of LSP checksum errors received
- When you specify an interface, reports include the following additional fields:
 - Interface—IS-IS interface for which details are displayed
 - IS-IS: Protocol PDUs (in/out)—Number of packets in/out on interface
 - IS-IS: Init Failures—Number of rejected hellos on interface
 - IS-IS: Adjacencies Changes—Number of times adjacencies have transitioned from down to up

- IS-IS: Adjacencies Rejected—Number of times hellos are rejected because of an incompatibility
- IS-IS: Bad LSPs—Number of LSPs received with errors
- IS-IS: Level-1 Designated IS Changes—Number of times the level 1 designated router has changed
- IS-IS: Level-2 Designated IS Changes—Number of times the level 2 designated router has changed
- IS-IS: Invalid 9542s—Number of rejected ES hello packets
- IS-IS: Malformed PDUs received—Number of malformed packets received
- IS-IS: Authentication Failures—Number of authentication failures on received level 1 and level 2 hello packets
- When you specify the **detail** keyword, the output includes the following additional fields that show packet statistics and LSP statistics. The hello, CSNP, and PSNP statistics are shown only when you issue the **detail** keyword. When the interface is Ethernet, L1 and L2 hello counts are displayed; otherwise the point-to-point hello count is displayed.
 - IS-IS: Level-1 Hellos (in/out/dropped)—Number of level 1 hellos received, sent, and dropped
 - IS-IS: Level-2 Hellos (in/out/dropped)—Number of level 2 hellos received, sent, and dropped
 - IS-IS: Level-1 CSNPs (in/out)—Number of level 1 CSNPs received and sent on the interface
 - IS-IS: Level-2 CSNPs (in/out)—Number of level 2 CSNPs received and sent on the interface
 - IS-IS: Level-1 PSNPs (in/out)—Number of level 1 PSNPs received and sent on the interface
 - IS-IS: Level-2 PSNPs (in/out)—Number of level 2 PSNPs received and sent on the interface
 - IS-IS: LSP Retransmissions—Number of LSPs retransmitted on the interface
- Example 1

```

host1#show clns traffic
IS-IS: Baseline last set 0 days, 21 hours, 12 minutes, 15 seconds
IS-IS: Corrupted LSPs: 0
IS-IS: L1 LSP Database Overloads: 0
IS-IS: L2 LSP Database Overloads: 0
IS-IS: Area Addresses Dropped: 0
IS-IS: Attempts to Exceed Max Sequence: 0
IS-IS: Sequence Numbers Skipped: 5
IS-IS: Own LSPs Purged: 0
IS-IS: Other LSPs Purged: 0

```

```
IS-IS: System ID Length Mismatches: 0
IS-IS: Maximum Area Mismatches: 0
IS-IS: Area/Domain Authentication Failures: 0
IS-IS: Level-1 LSPs Sent: 1 Rcvd: 6769 Dropped: 6769
IS-IS: Level-2 LSPs Sent: 1 Rcvd: 6769 Dropped: 6769
IS-IS: LSP checksum errors received: 0
```

- Example 2

```
host1#show clns traffic fastEthernet 4/0 detail
Interface: FastEthernet4/0
IS-IS: Baseline last set 5 days, 0 hours, 3 minutes, 31 seconds
IS-IS: Protocol PDUs (in/out): 10421/5862
IS-IS: Level-1 Hellos (in/out/dropped): 610046/610456/0
IS-IS: Level-2 Hellos (in/out/dropped): 610046/610456/0
IS-IS: Level-1 CSNPs (in/out): 0/0
IS-IS: Level-2 CSNPs (in/out): 0/0
IS-IS: Level-1 PSNPs (in/out): 0/0
IS-IS: Level-2 PSNPs (in/out): 0/0
IS-IS: Init Failures: 0
IS-IS: Adjacencies Changes: 1
IS-IS: Adjacencies Rejected: 0
IS-IS: Bad LSPs: 0
IS-IS: LSP Retransmissions: 0
IS-IS: Level-1 Designated IS Changes: 1
IS-IS: Level-2 Designated IS Changes: 1
IS-IS: Invalid 9542s: 0
IS-IS: Malformed PDU received: 0
IS-IS: Authentication Failures: 0
```

- Example 3

```
host1#show clns traffic detail
IS-IS: Baseline last set 5 days, 0 hours, 3 minutes, 31 seconds
IS-IS: Corrupted LSPs: 0
IS-IS: L1 LSP Database Overloads: 0
IS-IS: L2 LSP Database Overloads: 0
IS-IS: Area Addresses Dropped: 0
IS-IS: Attempts to Exceed Max Sequence: 0
IS-IS: Sequence Numbers Skipped: 0
IS-IS: Own LSPs Purged: 0
IS-IS: Other LSPs Purged: 0
IS-IS: System ID Length Mismatches: 0
IS-IS: Maximum Area Mismatches: 0
IS-IS: Area/Domain Authentication Failures: 0
IS-IS: Level-1 LSPs Sent: 1 Rcvd: 6769 Dropped: 6769
IS-IS: Level-2 LSPs Sent: 1 Rcvd: 6769 Dropped: 6769
IS-IS: LSP checksum errors received: 0

Interface: FastEthernet4/0
IS-IS: Baseline last set 5 days, 0 hours, 3 minutes, 31 seconds
IS-IS: Protocol PDUs (in/out): 10421/5862
IS-IS: Level-1 Hellos (in/out/dropped): 610046/610456/0
IS-IS: Level-2 Hellos (in/out/dropped): 610046/610456/0
IS-IS: Level-1 CSNPs (in/out): 0/0
IS-IS: Level-2 CSNPs (in/out): 0/0
IS-IS: Level-1 PSNPs (in/out): 0/0
IS-IS: Level-2 PSNPs (in/out): 0/0
IS-IS: Init Failures: 0
IS-IS: Adjacencies Changes: 1
IS-IS: Adjacencies Rejected: 0
IS-IS: Bad LSPs: 0
IS-IS: LSP Retransmissions: 0
```



```
IS-IS: Level-1 Designated IS Changes: 1
IS-IS: Level-2 Designated IS Changes: 1
IS-IS: Invalid 9542s: 0
IS-IS: Malformed PDU received: 0
IS-IS: Authentication Failures: 0

Interface: FastEthernet4/1
IS-IS: Baseline last set 5 days, 0 hours, 3 minutes, 31 seconds
IS-IS: Protocol PDUs (in/out): 10421/5862
IS-IS: Level-1 Hellos (in/out/dropped): 609946/610056/0
IS-IS: Level-2 Hellos (in/out/dropped): 609946/610056/0
IS-IS: Level-1 CSNPs (in/out): 0/0
IS-IS: Level-2 CSNPs (in/out): 0/0
IS-IS: Level-1 PSNPs (in/out):0/0
IS-IS: Level-2 PSNPs (in/out):0/0
IS-IS: Init Failures: 0
IS-IS: Adjacencies Changes: 1
IS-IS: Adjacencies Rejected: 0
IS-IS: Bad LSPs: 0
IS-IS: LSP Retransmissions: 0
IS-IS: Level-1 Designated IS Changes: 1
IS-IS: Level-2 Designated IS Changes: 1
IS-IS: Invalid 9542s: 0
IS-IS: Malformed PDU received: 0
IS-IS: Authentication Failures: 0
```

- See show clns traffic

PART 3

Index

- [Index on page 469](#)

Index

A

- ABRs (area border routers), OSPF
 - configuring area range.....308
 - defined.....294
- access lists, IP
 - monitoring.....94
- access-list command
 - IS-IS.....411
 - OSPF.....329
- address commands, OSPF
 - address area.....309
 - address authentication key.....323
 - address authentication message-digest.....323
 - address authentication-none.....323
 - address cost.....309
 - address dead-interval.....309
 - address hello-interval.....309
 - address message-digest-key.....323
 - address network.....339
 - address passive-interface.....309
 - address priority.....309
 - address retransmit-interval.....309
 - address transmit-delay.....309
- address commands, RIP
 - address.....264
 - address authentication key.....264
 - address authentication mode.....264
 - address receive version.....264
 - address send version.....264
- address ranges
 - IS-IS.....422
- Address Resolution Protocol. *See* ARP
- address-family command.....396
- adjacencies, clearing IS-IS.....440
- adjacency levels, IS-IS.....404
 - displaying information on.....455
 - logging changes between.....426
- adjacency, OPSF.....294
- administrative distance
 - IS-IS.....418
 - OSPF.....334
 - RIP.....264
- administrative status change of interfaces
 - from down to up state
 - and transmission of GARP packets.....28
- aggregate addresses
 - IS-IS.....422
 - OSPF routing.....309
- area border routers. *See* ABRs, OSPF
- area commands
 - area.....319
 - area default-cost.....318
 - area nssa.....318
 - area range.....308
 - area stub.....318
- area IDs (OSPF packets).....294
- area virtual-link commands
 - area virtual-link.....319
 - area virtual-link authentication
 - message-digest.....323
 - area virtual-link authentication-key.....323
 - area virtual-link authentication-none.....323
 - area virtual-link dead-interval.....319
 - area virtual-link hello-interval.....319
 - area virtual-link message-digest-key
 - md5.....323
 - area virtual-link retransmit-interval.....319
 - area virtual-link transmit-delay.....319
- area-authentication command.....410
- area-authentication-key command.....409
- area-message-digest-key command.....382, 409
- areas, IS-IS.....378
- areas, OSPF.....294
 - configuring.....318, 319
 - defining.....298, 303
 - stub areas.....297, 319
- ARP
 - dynamic binding of
 - IP address to the MAC address.....26
- ARP (Address Resolution Protocol)
 - ARP protocol.....95
 - hosts.....20
 - physical and logical addresses.....9
- ARP cache
 - updating for GARP replies.....26
 - updating with information from GARP packets
 - by receiving devices.....26

arp commands		
arp.....	22	
arp timeout.....	23	
AS (autonomous system).....	295	
AS boundary router		
default route and.....	334	
OSPF.....	295	
authentication		
configuring, OSPF.....	323	
IS-IS HMAC MD5.....	398, 409	
IS-IS key commands.....	398	
IS-IS MD5 packet timing.....	383	
IS-IS MD5 start and stop timing.....	383	
IS-IS, halting.....	384	
managing and replacing IS-IS keys.....	384	
OSPF.....	294	
OSPF modes.....	299	
RIP.....	261	
type.....	295	
authentication commands		
authentication key.....	279	
authentication message-digest.....	343	
authentication mode.....	279	
authentication-key command.....	344	
authentication-none command.....	344	
autocost, OSPF routing.....	329	
automatic virtual link, OSPF.....	319	
automatic virtual-link command.....	319	
autonomous system boundary router (AS boundary router). See AS boundary router		
B		
B-RAS applications		
creating an IP profile.....	16	
creating an IPv6 profile.....	160	
backbone area, OSPF.....	318	
bandwidth		
OSPF interface cost by.....	329	
baseline commands		
baseline clns.....	452	
baseline ip.....	84	
baseline ip ospf.....	329	
baseline ip rip.....	283	
baseline ip udp.....	85	
baseline ipv6.....	190	
baseline ipv6 interface.....	190	
baseline ipv6 local pool.....	191	
baseline tcp.....	85, 191	
BFD (Bidirectional Forwarding Detection)		
RIP, configuring for.....	278	
BFD commands		
ip route bfd-liveness-detection.....	41	
ipv6 route.....	171	
BFD next-hop verification for IPv6		
overview.....	170	
BGP (Border Gateway Protocol)		
community lists.....	100	
OSPF routing with.....	300	
BGP/MPLS VPNs		
interaction with OSPF.....	343	
black holes, avoiding IS-IS.....	422	
black holing		
packets for non-existent hosts		
reaching null 0 static routes.....	166	
border routers, OSPF.....	354	
broadcast addressing.....	29	
broadcast circuits, IS-IS.....	406	
broadcast storms.....	29	
C		
CIDR (Classless Interdomain Routing).....	12, 295	
classes of IP addresses.....	9	
Classless Interdomain Routing. See CIDR		
clear arp command.....	24	
clear ip commands		
clear ip interface.....	58	
clear ip isis redistribution.....	411	
clear ip ospf redistribution.....	334	
clear ip routes.....	61	
clear ipv6 ospf redistribution.....	334	
clear ipv6 commands		
clear ipv6 interface	173	
clear ipv6 ospf counters.....	329	
clear ipv6 ospf process.....	329	
clear isis commands		
clear isis adjacency.....	440	
clear isis database.....	329, 452	
clear isis ipv6 redistribution.....	411	
CLNP (Connectionless Network Protocol).....	378	
CLNS (Connectionless Network Service Protocol)		
defined.....	378	
displaying.....	452	
clns commands.....	427	
clns configuration-time.....	427	
clns holding-time.....	430	
clns host.....	430	
See also show clns commands		

community lists, BGP.....100
 complete sequence number PDU. *See* CSNP
 connection-oriented protocols.....4
 Connectionless Network Protocol. *See* CLNP
 Connectionless Network Service Protocol. *See*
 CLNS
 connectionless protocols.....4, 150
 conventions
 notice icons.....xxi
 text and syntax.....xxii
 cost
 IS-IS interface.....398
 OSPF routing.....313
 autocost.....329
 default cost.....318
 equal-cost multipath.....300
 cost command.....344
 cryptographic authentication, OSPF.....299
 CSNP (complete sequence number PDU).....378
 CSNP interval, IS-IS interface.....398
 customer support.....xxiii
 contacting JTAC.....xxiii

D

data path failure
 detecting RIP.....278
 database, OSPF.....354
 datagrams, IP
 defined.....4
 fragmenting and reassembling.....5, 30
 dead interval, OSPF.....314, 319
 dead-interval command.....345
 debounce-time command.....264
 debug commands.....283, 353
 debug ip ospf.....353
 debug ip rip.....283
 debug isis.....440
 debug-related information, IS-IS.....440, 449
 default routes
 cost, OSPF.....318
 IP routing.....48
 IS-IS routing.....419
 OSPF routing.....334
 suppressing IS-IS.....419
 default-information originate command
 IS-IS.....419
 OSPF.....334
 RIP.....264
 default-metric command.....268

description
 adding to IP interfaces.....60
 adding to IPv6 interfaces.....177
 destination MAC addresses
 same as primary MAC addresses
 in GARP packets.....26
 DHCPv6 Prefix Delegation
 IPv6 local address pools and
 baseline ipv6 local pool command.....191
 setting a baseline.....191
 show ipv6 local pool command.....244
 viewing parameters.....244
 directed broadcast packets.....29
 directed broadcasts, enabling.....30
 directly connected networks.....259
 disable command.....269
 disable-dynamic-redistribute command
 IS-IS.....411
 OSPF.....334
 RIP.....264
 disable-incremental-external-spf command.....349
 discarded packets
 for static routes with null 0 interfaces
 disabling the sending of ICMP
 unreachables.....167
 enabling the sending of ICMP
 unreachables.....167
 viewing the count of, for which
 unreachables are not sent.....166
 viewing the count of, for which
 unreachables are sent.....166
 viewing the number of ICMP unreachable
 sent.....166
 distance commands.....264
 distance.....34
 distance ip.....34, 418
 distance ospf.....334
 distance, RIP administrative.....264
 distribute-domain-wide command.....416
 distribute-list command.....269, 280
 documentation set
 comments on.....xxiii
 domain, OSPF.....295
 domain-authentication command.....410
 domain-authentication-key command.....409
 domain-message-digest-key command.....382, 410
 domain-wide prefix distribution.....416
 dropped packets, troubleshooting.....102

DRs (designated routers)	
IS-IS routing.....	398
OSPF routing.....	295
dynamic hostname resolution, IS-IS.....	430
dynamic route redistribution, disabling	
in IS-IS.....	411
in OSPF.....	334
in RIP.....	264

E

E Series routers	
IP features.....	8
IPv6 features.....	150
ECMP (equal-cost multipath)	
IP.....	63, 185
IS-IS.....	385, 430
OSPF.....	300, 334, 342
RIP.....	261, 264
end system. <i>See</i> ES	
entry, routing table.....	33
equal-cost multipath. <i>See</i> ECMP	
ES (end system)	
hello packet rate.....	427
neighbor information.....	460
Ethernet commands, interface fastEthernet.....	45
Ethernet controllers.....	9
exit-address-family command.....	397
exit-remote-neighbor command.....	281
exponential back-off SPF calculation, IS-IS.....	427
external routes, OSPF.....	299
E Series routers	
IS-IS features.....	392

F

fabric congestion.....	102
failover	
to secondary link of redundant port on GE-2	
and GE-HDE LMs	
transmission of GARPs.....	28
flooded broadcast packets.....	29
flooding.....	295
forwarding controller	
black holing oversized ping packets	
arriving at null 0 static routes.....	166
discarding packets for null 0 interfaces with	
static routes	
creating an exception to the SRP module	
for dropped packets.....	166
forwarding table.....	32

fragmenting IP datagrams.....	5, 31
frequency command.....	76
full spf, IS-IS.....	427
full-spf-always command.....	427

G

GARP	
definition of	
relation to ARP.....	26
transmission of packets	
controlling.....	26
default number.....	26
overview.....	26
GARP packets	
avoiding a large number of	
with many secondary IP addresses on an	
interface.....	27
configuration procedure	
for setting transmission parameters.....	28
disabling the transmission of.....	27
for interfaces with VRRP enables.....	28
frequency of transmission of.....	27
prerequisites for controlling transmission of	
adding a VLAN major interface.....	27
IP address not added to the physical	
interface.....	27
reducing the transmission of	
and improving performance.....	27
scenarios in which default settings override	
manual configuration	
failover occurs to the redundant port of	
the secondary link on GE modules.....	27
VRRP is enabled on an interface.....	27
scenarios of transmission	
addition of IP addresses to an	
interface.....	27
change in the IP address associated with	
a numbered interface.....	27
transition of interface to the up state.....	27
when an unnumbered interface is	
added.....	27
setting the transmission parameters	
on Ethernet interfaces.....	27
tuning the number of transmitted	
default value.....	26
gateways.....	5
global default metric, IS-IS.....	416
global IP routing table.....	32

- graceful restart, IS-IS
 - commands. *See* nsf commands
 - configuring.....432
 - monitoring.....449, 460
 - overview.....385
 - timers.....385, 434
- Gratuitous Address Resolution Protocol *See* GARP
- group (multicast) addressing.....10
- H**
 - hash functions.....323
 - hashcheck process.....323
 - hello interval
 - IS-IS interface.....398, 427
 - OSPF interface.....314, 319
 - hello multiplier, IS-IS interface.....398
 - hello packet validity rate, IS-IS.....430
 - Hello protocol.....295
 - hello-interval command.....345
 - HMAC MD5
 - authentication, IS-IS.....382
 - IS-IS area-wide password.....409
 - IS-IS domain-wide password.....410
 - IS-IS password on the interface.....398
 - hold time
 - IS-IS.....398
 - IS-IS SPF.....427
 - SPF.....338
 - hop count.....259
 - hops, verifying for IPv6 static routes.....170
 - overview.....170
 - hops, verifying for static routes.....40
 - configuring
 - example.....43
 - steps for.....45
 - overview.....40
 - hops-of-statistics-kept command.....77, 80
 - host access routes on PPP interface.....57
 - hosts.....5
- I**
 - ICMP (Internet Control Message Protocol)
 - echo request packets
 - IP.....73
 - IPv6.....173
 - ICMP messages and.....71
 - ICMP unreachable messages
 - for packets reaching interfaces other than null
 - 0
 - dependence on the IP unreachable setting
 - on the interface.....166
 - sending to originator for packets reaching null
 - 0 static routes
 - and synchronizing RADIUS settings with
 - client network.....166
 - sent to the originator for discarded packets at
 - null 0 routes
 - viewing the number of.....166
 - icmp update-source command.....72
 - ignore-attached-bit command.....420
 - ignore-lsp-errors command.....425
 - IGP (interior gateway protocol).....295
 - incremental SPF.....349
 - Integrated IS-IS routing.....385
 - interarea routes, OSPF.....299
 - interface commands
 - interface fastEthernet.....45
 - interface ip.....67, 69
 - interface ipv6.....175
 - interface loopback.....45
 - interface-event-disable command.....264
 - interfaces
 - IPv6, enabling and disabling.....173
 - interior gateway protocol. *See* IGP
 - Intermediate System-to-Intermediate System. *See* IS-IS
 - intermediate system. *See* IS
 - Internet addresses.....9
 - Internet Control Message Protocol. *See* ICMP
 - internet layer (TCP/IP).....6
 - interval rate, LSP (IS-IS).....426
 - intra-area routes, OSPF.....299
 - IP.....3, 83
 - ARP protocol.....9, 20
 - assigning router IDs.....36
 - broadcast addressing.....29, 30
 - E Series router features.....8
 - ECMP.....63, 185
 - functions of.....5
 - ICMP and.....71, 72
 - layers of.....5
 - monitoring.....83
 - profile.....17
 - reachability commands.....73

routing.....	32	ip unnumbered loopback.....	57
source address verification.....	48, 164	ip unreachable.....	71
IP addresses.....	9	no ip interface.....	58
classes of.....	9	See also show ip commands	
interfaces without (unnumbered).....	57	IP interfaces	
multinetting.....	14	adding a description.....	60, 177
OSPF routing costs and.....	313	clearing.....	58
primary		creating.....	67, 69
adding.....	13	primary.....	66
deleting.....	13	removing IP configuration.....	58
router IDs and.....	36	setting a baseline.....	84
secondary		shared.....	66
adding.....	14	sharing.....	66
deleting.....	14	shutting down.....	58
ip commands.....	17	unnumbered.....	57
clear ip ospf neighbor.....	329	ip ospf commands.....	323
ip access-routes.....	18, 57	ip ospf authentication message-digest.....	323
ip address.....	18, 45	ip ospf authentication-key.....	323
ip alwaysup.....	59	ip ospf authentication-none.....	323
ip broadcast-address.....	30	ip ospf bfd-liveness-detection.....	328
ip debounce-time.....	63	ip ospf cost.....	313
ip description.....	60	ip ospf dead-interval.....	314
ip directed-address.....	30	ip ospf hello-interval.....	314
ip directed-broadcast.....	18	ip ospf message-digest-key.....	323
ip disable-forwarding.....	59	ip ospf network.....	339
ip icmp update-source.....	72	ip ospf priority.....	315
ip ignore-df-bit.....	18, 31	ip ospf retransmit-interval.....	316
ip irdp.....	71	ip ospf shutdown.....	334
ip mask-reply.....	71	ip ospf transmit-delay.....	316
ip mtu.....	18, 31	See also show ip ospf commands	
ip multipath round-robin.....	64	IP profile, B-RAS.....	17
ip proxy-arp.....	24	IP profile, creating	
ip redirects.....	18, 71	access routes.....	18
ip refresh-route.....	61	address.....	18
ip route.....	36	auto-configure.....	17
ip route verify rtr.....	43, 47	auto-detect.....	17
ip route-type.....	277, 342, 437	directed broadcast.....	18
ip router isis.....	393, 396	filter-options-all.....	17
ip router-id.....	36	IGMP.....	17
ip sa-validate.....	18, 48, 164	ignore-df-bit.....	18
ip sa-validate trap-enable.....	49	inactivity-timer.....	17
ip share-interface.....	67, 69, 175	inspection.....	17
ip share-nexthop.....	68, 69	mtu (maximum transmission unit).....	18
ip shutdown.....	58	nat.....	17
ip source- route.....	62	policy.....	17
ip speed.....	61	redirects.....	18
ip split-horizon.....	264	route-maps.....	17
ip tcp adjust-mss.....	18, 50	source address validation.....	18
ip unnumbered.....	18, 45	tcp adjust-mss.....	18

unnumbered.....	18	static routes and.....	165
virtual router.....	18	traceroute and.....	155
IP redirects, enabling.....	71	ipv6 commands	
ip rip commands.....	264	clear ipv6 neighbor.....	188
ip rip.....	264	clear ipv6 routes.....	187
ip rip authentication key.....	264	ipv6.....	154
ip rip authentication mode.....	264	ipv6 address.....	161
ip rip bfd-liveness-detection.....	278	ipv6 description.....	177
ip rip receive version.....	264, 276, 277	ipv6 enable.....	173
ip rip send version.....	264	ipv6 mtu.....	161
<i>See also</i> show ip rip commands		ipv6 nd.....	161, 252
IP routing. <i>See</i> routing, IP		ipv6 nd dad attempts.....	255
IPv6		ipv6 nd managed-config-flag.....	252
address, defining.....	161	ipv6 nd ns-interval.....	252
addressing		ipv6 nd prefix-advertisement.....	252
compression and.....	152	ipv6 nd ra-interval.....	252
prefix.....	152	ipv6 nd reachable-time.....	252, 254
scope.....	152	ipv6 nd suppress-ra.....	252
structure.....	152	ipv6 nd suppress-ra-source-link-layer.....	252
types of.....	152	ipv6 neighbor.....	187, 329
understanding.....	152	ipv6 neighbor proxy.....	254
configuring neighbor discovery.....	251	ipv6 route.....	165
configuring neighbor discovery with		ipv6 router isis.....	396
profiles.....	252	ipv6 unnumbered.....	161
configuring neighbor discovery with		ipv6 virtual-router.....	161
RADIUS.....	252	IPv6 interfaces	
E Series router features.....	150	creating.....	175
enabling and disabling.....	173	sharing.....	175
headers		IPv6 local address pools	
extensions.....	152	baseline ipv6 local pool command.....	191
standard.....	151	for DHCPv6 Prefix Delegation	
ICMP and.....	155	viewing parameters.....	244
instance, creating an.....	154	monitoring	
interfaces		details for a single pool.....	244
clearing.....	173	details for all configured pools.....	244
managing.....	173	statistics for a single pool.....	244
unnumbered.....	161	viewing	
license.....	160	baseline statistics.....	244
monitoring.....	189	ipv6 nd commands	
neighbor discovery and profiles.....	161	ipv6 nd.....	252
neighbor discovery, defining.....	252	ipv6 nd active-solicitations.....	252
neighbors, clearing.....	188	ipv6 nd dad attempts.....	255
neighbors, creating.....	187	ipv6 nd managed-config-flag.....	252
overview.....	150	ipv6 nd ns-interval.....	252
packet headers.....	151	ipv6 nd reachable-time.....	252
ping and.....	155	IPv6 neighbor discovery commands	
profile.....	160	ipv6 nd.....	161
references.....	159, 250		
source address verification.....	164		

ipv6 ospf commands.....	309
ipv6 ospf area.....	309
ipv6 ospf bfd-liveness-detection.....	328
ipv6 ospf cost.....	313
ipv6 ospf dead-interval.....	314
ipv6 ospf hello-interval.....	314
ipv6 ospf mtu-ignore.....	314
ipv6 ospf network.....	314
ipv6 ospf priority.....	315
ipv6 ospf retransmit-interval.....	316
ipv6 ospf shutdown.....	334
ipv6 ospf transmit-delay.....	316
See also show ipv6 ospf commands	
IPv6 profile, creating	
address.....	161
ipv6-virtual-router.....	161
mld (multicast listener discovery).....	160
mtu (maximum transmission unit).....	161
nd (neighbor discovery).....	161
policy.....	160
sa-validate.....	161
unnumbered.....	161
IPv6 routing with IS-IS.....	385
IPv6 static routes	
verifying next hops for.....	170
IRDP (ICMP Router Discovery Protocol), enabling	
ICMP messages and<.....	71
IS (intermediate system).....	378
hello packet rate.....	427
neighbor information.....	460
IS-IS (Intermediate System-to-Intermediate System)	
adjacencies, clearing.....	440
advertising	
passive interfaces.....	415
avoiding black holes.....	422
broadcast circuits.....	406
circuit type.....	406
configuring	
default routes.....	419
for MPLS.....	436
global parameters.....	408
interface-specific parameters.....	398
redistribution.....	411
configuring the router to be ignored.....	422
displaying CLNS.....	452
Disregarding	
attach bit.....	420
dynamic hostname resolution.....	430
ECMP.....	385
enabling.....	393
enabling for IPv6.....	395
exponential back-off SPF calculation.....	427
features.....	392
global default metric	
for active interfaces.....	416
for passive interfaces.....	404
graceful restart	
and black hole avoidance.....	423
configuring.....	432
monitoring.....	449, 460
overview.....	385
timers.....	385, 434
hello packet validity rate.....	430
HMAC MD5 authentication	
for level 1 packets.....	410
for level 2 packets.....	409
on the interface.....	398
Integrated IS-IS.....	385
IPv6 routing.....	385
level 1 routing.....	380
level 2 routing.....	380
LSPs. See LSPs, IS-IS	
metric, global default.....	416
monitoring.....	440
MPLS and.....	436
network entity title.....	393, 396
overload bit.....	422
point-to-point circuits.....	406
point-to-point-over-LAN circuits.....	406
redistributing routes between levels.....	413
route leaking.....	413
route tags	
and route maps.....	385
configuring.....	385
defined.....	379
for default routes.....	419
for IS-IS interfaces.....	406
for passive interfaces.....	404
for redistribution.....	411, 413
for summary routes.....	421
monitoring.....	440
overview.....	385
unsupported features.....	385
using.....	385
router type.....	419

- routes
 - summarizing.....421
 - using for multicast RPF checks.....437
 - routing levels/layers.....378, 398, 421
 - SPF calculation.....427
 - starting and stopping MD5 packets.....383
 - suboptimal paths, correcting.....413
 - summarizing routes.....421
 - suppressing default routes.....419
 - system identifier.....379
 - table maps
 - configuring.....431
 - defined.....379
 - overview.....385
 - topology elements.....379
 - traffic engineering.....436
 - troubleshooting.....440
- IS-IS protocol, OSPF routing with.....300
- is-type command.....421
- isis commands.....406
 - isis authentication-key.....398
 - isis bfd-liveness-detection.....438
 - isis circuit-type.....404
 - isis csnp-interval.....398
 - isis hello padding.....398
 - isis hello-interval.....398
 - isis hello-multiplier.....398
 - isis lsp-interval.....398
 - isis mesh-group.....430
 - isis message-digest-key.....398
 - isis metric.....398
 - isis network point-to-point.....406
 - isis priority.....398
 - isis retransmit-interval.....398
 - isis retransmit-throttle-interval.....398
 - isis tag.....406
- See also show isis commands
- ISO 10589. See IS-IS
- ISO address.....379
- L**
 - leakage, OSPF route.....300
 - level 1 routing, IS-IS.....378
 - level 2 routing, IS-IS.....378
 - levels of IS-IS routing.....378, 398, 421
 - license commands
 - license ipv6 command.....160
 - limited broadcast packets.....29
- line modules
 - forwarding table on.....32
- link-state advertisements. See LSAs
- link-state metrics, IS-IS.....398
- link-state packets. See LSPs, IS-IS
- liveness detection
 - RIP and BFD.....278
- local routing table.....32
- log-adjacency-changes command.....426
- logical addresses.....9
- LSAs (link-state advertisements).....295
 - opaque LSAs.....300
- retransmit interval and transmit
 - delay.....316, 319
- LSDB (link-state database).....298
- lsp-gen-interval command.....426
- lsp-mtu command.....427
- lsp-refresh-interval command.....427
- LSPs (link-state packets), IS-IS
 - disregarding attach bit.....420
 - ignoring errors.....425
 - interval rate.....426
 - MTU.....427
 - overload bit.....422
 - refresh interval.....427
 - retransmission interval.....398
 - retransmission throttle interval.....398
 - transmission interval.....398
- M**
 - MAC (media access control) addresses
 - and ARP.....20
 - defined.....9
 - manuals
 - comments on.....xxiii
 - match commands
 - match-set summary prefix-tree.....264
 - max-lsp-lifetime command.....427
 - max-response-failure command.....77, 80
 - maximum transmission unit. See MTU
 - maximum-paths command
 - IP.....63, 185
 - IS-IS.....430
 - OSPF.....334
 - RIP.....264
 - MD5 authentication
 - enabling.....323
 - IS-IS.....382
 - OSPF.....323

mesh group, setting (IS-IS).....	430	network service access point. See NSAP	
message digests.....	323	network, OSPF routing.....	314
message-digest-key md5 command.....	345	next-hop verification	
metric		configuring	
IS-IS global default.....	416	example.....	43
IS-IS interface.....	398	steps for.....	45
OSPF default.....	338	overview.....	40
metric commands		no area command.....	319
metric.....	416	no ipv6 command.....	186
metric-style commands		nonbroadcast networks.....	296
metric-style narrow.....	417	nonstop forwarding. See graceful restart, IS-IS	
metric-style transition.....	417	not-so-stubby area, OSPF. See NSSA	
metric-style wide.....	418	notice icons.....	xxi
mpls commands		NSAP (network service access point).....	379, 430
mpls spf-use-any-best-path (IS-IS).....	436	NSF (nonstop forwarding). See graceful restart,	
mpls spf-use-any-best-path (OSPF).....	340	IS-IS	
mpls traffic-eng (IS-IS).....	436	nsf commands	
mpls traffic-eng area.....	340	nsf ietf.....	432
mpls traffic-eng router-id.....	340	nsf interface wait.....	434
mpls traffic-eng router-id (IS-IS).....	436	nsf t1.....	434
MTU (maximum transmission unit)		nsf t2.....	434
IP.....	5, 31	nsf t3.....	435
IPv6.....	161	NSSA (not-so-stubby area), OSPF.....	296, 318
IS-IS.....	427	null authentication, OSPF.....	299
OSPF.....	309	null interfaces	
multicast		as next-hop points for static routes	
addressing.....	9	discarding received IPv6 packets.....	166
multihomed hosts.....	5	data sink	
multinetting.....	13	created by default, uneditable	
		configuration.....	166
		packets reaching and being discarded	
		not sending ICMP unreachable to the	
		originator.....	37
		not sending ICMPv6 unreachable to the	
		originator.....	165
		sending ICMP unreachable to the	
		originator.....	37
		sending ICMPv6 unreachable to the	
		originator.....	165
		O	
		opaque LSAs, OSPF.....	300
		Open Shortest Path First. See OSPF	
		operations-per-hop command.....	77
		OSPF (Open Shortest Path First).....	293
		ABRs.....	294
		adjacency.....	294
		aggregate cost, optimizing.....	322
		areas.....	309, 328

- areas, defining.....298
- AS boundary router.....295
- authentication
 - MD5.....323
 - simple password.....299, 323
- autocost.....329
- automatic virtual links.....319
- backbone area.....318
- BGP and.....300
- BGP/MPLS VPNs and.....343
- configuring
 - areas.....318
 - authentication.....323
 - incremental SPF.....349
 - interfaces.....309
 - NBMA networks.....339
 - remote neighbors.....343
 - traps.....350
- creating interfaces.....303
- database.....354
- dead interval.....314
- default cost.....318
- deleting interfaces.....303
- domain.....295
- ECMP.....300
- enabling.....303
- interaction with BGP/MPLS VPNs.....343
- link-local states.....354
- MD5 authentication.....323
- metrics, default.....338
- MIB.....300
- monitoring.....353
- neighbor histories.....370
- neighbor uptime tracking.....370
- optimizing aggregate costs.....322
- password authentication, simple.....299, 323
- route leakage.....300
- routes, using for multicast RPF checks.....342
- routing costs.....313
- routing priority.....298
- SPF hold time interval.....338
- stub area.....297
- topology elements.....297
- traffic engineering.....340
- transmit delay.....316, 319
- troubleshooting.....353
- virtual links.....299
- ospf commands.....306
 - log-adjacency-changes.....334
 - ospf auto-cost reference-bandwidth.....329
 - ospf enable.....306
 - ospf log-adjacency-changes.....354
 - ospf shutdown.....334
 - See also show ip ospf commands; show ipv6 ospf commands
- OSPFv3 (Open Shortest Path First Version 3)
 - configuring
 - traps.....350
- overload bit, IS-IS.....422
- owner command.....77
- P**
- packet-switching networks.....4
- packets, IP.....4
 - broadcast packets.....29
 - echo request and trace packets.....73
 - ICMP messages and.....71
 - IPv6 echo request and trace.....174
- parallel routes, maximum number of
 - IP.....63, 185
 - IS-IS.....430
 - OSPF.....334
 - RIP.....264
- partial sequence number PDU. See PSNP
- passive-interface command.....273, 336, 404
- passwords
 - IS-IS area authentication.....409
 - IS-IS authentication.....398
 - IS-IS domain authentication.....410
 - OSPF MD5 authentication.....323
 - OSPF simple password
 - authentication.....299, 323
- PDU (protocol data unit).....379
- physical addresses.....9
- ping command.....73, 155
- ping packets
 - arriving at null 0 interface static routes
 - sending of ICMPv4 unreachable to the originator disabled.....37
 - sending of ICMPv4 unreachable to the originator enabled.....37
 - ICMP-based and UDP-based
 - arriving at null 0 static routes.....166
 - destined for non-existent hosts.....166
 - reaching null 0 interfaces and black holed.....166

point-to-point circuits, IS-IS.....	406	remote neighbors	
Point-to-Point Protocol. <i>See</i> PPP		OSPF.....	343
point-to-point-over-LAN circuits, IS-IS.....	406	RIP.....	279
PPP (Point-to-Point Protocol)		remote-neighbor command.....	281, 345
host access routes.....	57	request messages, RIP.....	259
primary IP addresses.....	13	request-data-size command.....	77
primary IP interface.....	66	response messages, RIP.....	259
priority		Response Time Reporter. <i>See</i> RTR	
IS-IS designated router.....	398	restart, graceful. <i>See</i> graceful restart, IS-IS	
OSPF routing.....	298, 315	retransmission interval, IS-IS.....	398
profile commands		retransmission throttle interval, IS-IS.....	398
profile.....	17, 19, 161, 163	retransmit interval	
profiles		and transmit delay.....	316, 319
assigning.....	19, 163	OSPF.....	316, 319
creating.....	17, 161	retransmit-interval command.....	346
protocol data unit. <i>See</i> PDU		RIB (routing information base).....	32
protocol number.....	5	RIP (Routing Information Protocol).....	259
PSNP (partial sequence number PDU).....	379	authentication.....	261
		BFD liveness detection and.....	278
R		configuring.....	264
reachability commands		debounce interval.....	264
IP.....	73	detecting path failures.....	278
reassembling IP datagrams.....	5	disabling dynamic route distribution.....	264
receive version command.....	281	ECMP.....	261
receive-interface command.....	44, 77, 81	maximum number of parallel routes.....	264
receiving interface, setting for RTR probes.....	81	message types.....	259
redirects, IP.....	71	monitoring.....	282
redistribute command		purging learned routes.....	278
IS-IS.....	413	purging the routing table.....	264
OSPF.....	300, 337	remote neighbors.....	279
RIP.....	273	request messages.....	259
redistribute isis ip command.....	414	response messages.....	259
redistributing routes between IS-IS levels.....	413	route specificity.....	274
redistribution policy (IP), monitoring.....	113, 116	route tags.....	261
redistribution policy (IPv6), monitoring.....	223	split horizon mechanism.....	261
redistribution routes		subnet masks.....	261
clearing all (IS-IS).....	411	summarizing routes.....	261
clearing all (OSPF).....	334	triggered updates, disabling.....	274
disabling dynamic (IS-IS).....	411	troubleshooting.....	282
disabling dynamic (OSPF).....	334	using routes for multicast RPF checks.....	277
disabling dynamic (RIP).....	264	route leakage, OSPF.....	300
setting.....	273, 337, 413	route leaking between IS-IS levels.....	413
redundant port		route maps	
failover for physical link failure on GE-2 and		and IS-IS route tags.....	385
GE-HDE LMs		IP, monitoring.....	147
and transmission of GARPs.....	28	route tags, IS-IS	
reference-bandwidth command.....	398	and route maps.....	385
refresh interval, LSP (IS-IS).....	427	configuring.....	385
reliable protocols.....	71, 155	defined.....	379

- for default routes.....419
 - for IS-IS interfaces.....406
 - for passive interfaces.....404
 - for redistribution.....411
 - for summary routes.....421
 - monitoring.....440
 - overview.....385
 - unsupported features.....385
 - using.....385
- route tags, RIP.....261
- route-map command.....273, 329, 411
- router commands
 - router isis.....393
 - router ospf.....306, 307
 - router rip.....274
- router IDs.....36, 297
- router type, IS-IS.....419
- routes
 - summarizing IS-IS.....421
 - summarizing RIP.....261
 - using IS-IS.....437
 - using OSPF.....342
 - using RIP.....277
- routing information base. *See* RIB
- Routing Information Protocol. *See* RIP
- routing table
 - entry.....33
 - global IP.....32
 - local.....32
- routing, IP.....3, 32
 - adding host route to peer on PPP interface.....57
 - default routes.....48
 - disabling forwarding of packets.....59
 - identifying a router.....36
 - maximum number of parallel routes.....63, 185
 - monitoring.....101, 116, 120, 202
 - next-hop verification.....40
 - routing operations.....35
 - routing tables.....32
 - source address validation.....48, 164
 - static routes.....36, 40
 - See also* IP
- routing, IPv6.....172
 - assigning route tags.....169
 - assigning route tags to IPv6 static routes.....168
 - BFD next-hop verification.....170
 - hop limit.....172
 - IPv6 route tags.....168
 - monitoring.....218, 224, 226
 - redistributing IPv6 static routes.....169
 - route tags.....168
 - source address validation.....164
 - static routes.....165
 - See also* IPv6
- routing, IS-IS.....377
 - clearing redistribution information.....411
 - default route and routing domain.....419
 - designated routers.....398
 - integrated.....385
 - layers/levels of.....378, 398
 - maximum number of parallel routes.....430
 - OSPF routing with.....300
 - route summarization.....422
 - routing domains.....379
 - setting redistribution routes.....413
 - specifying type (level).....421
 - See also* IS-IS
- routing, OSPF.....354
 - area.....309
 - clearing redistribution information.....334
 - cost.....313
 - autocost.....329
 - default routing cost.....318
 - equal-cost multipath.....300
 - default route and routing domain.....334
 - displaying information about.....354
 - intra-area, interarea, external routes.....299
 - leakage.....300
 - maximum number of parallel routes.....334
 - network.....314
 - priority.....298, 315
 - See also* OSPF
- routing, RIP.....259
 - debounce interval.....264
 - maximum number of parallel routes.....264
 - purging the routing table.....264
 - route specificity.....274
 - triggered updates, disabling.....274
 - See also* RIP
- RTR (Response Time Reporter).....75
 - collecting history.....80
 - collecting statistics.....80
 - configuring.....75
 - monitoring.....88
 - next-hop verification.....42
 - options.....76

probe		show ip as-path-access-list.....	95
configuring.....	75	show ip community-list.....	100
scheduling.....	79	show ip forwarding-table.....	101, 202
shutting down.....	81	show ip interface.....	102
reaction conditions.....	78	show ip interface shares.....	108
setting receiving interface.....	81	show ip protocols.....	113
rtr commands		show ip redistribute.....	116
rtr.....	75	show ip route.....	116
rtr reaction-configuration action-type.....	78	show ip route slot.....	120
rtr reaction-configuration		show ip socket statistics.....	120
operation-failure.....	78	show ip static.....	126
rtr reaction-configuration path-change.....	78	show ip tcp statistics.....	234
rtr reaction-configuration test-completion.....	78	show ip udp statistics.....	145
rtr reaction-configuration test-failure.....	78	show ipv6 redistribute.....	223
rtr reset.....	81	show ip ospf commands	
rtr schedule.....	79	show ip ospf.....	354
rtr schedule life.....	79	show ip ospf border-routers.....	354
rtr schedule restart-time.....	79	show ip ospf database.....	354
rtr schedule start-time.....	79	show ip ospf database link-local.....	354
		show ip ospf database opaque-area.....	354
		show ip ospf interface.....	354
		show ip ospf internal-statistics.....	354
		show ip ospf neighbors.....	370
		show ip ospf remote-neighbor interface.....	371
		show ip ospf spf-log.....	371
		show ip ospf traffic.....	371
		show ip ospf virtual-links.....	371
		show ip rip commands	
		show ip rip.....	283
		show ip rip brief.....	283
		show ip rip database.....	283
		show ip rip network.....	283
		show ip rip stats.....	283
		show ip rip summary-address.....	283
		show ipv6 commands	
		show ipv6.....	193
		show ipv6 address.....	194
		show ipv6 interface.....	203
		show ipv6 local pool.....	244
		show ipv6 neighbors.....	218
		show ipv6 protocols.....	221
		show ipv6 route.....	224
		show ipv6 routers.....	226
		show ipv6 static.....	227
		show ipv6 traffic.....	229
		show ipv6 udp statistics.....	233
		show ipv6 ospf commands.....	306
		show ipv6 ospf.....	354
		show ipv6 ospf database.....	354
S			
samples-of-history-kept command.....	77, 80		
secondary IP addresses.....	14		
send version command.....	281		
send-more-specific-routes-disable			
command.....	274		
set-overload-bit command.....	424		
setting			
administrative distance.....	34		
shared IP interfaces			
configuring.....	69		
primary interface.....	66		
shared interface.....	66		
shared IPv6 interfaces			
configuring.....	176		
shared interface.....	175		
show access-list command.....	94		
show arp command.....	95		
show clns commands			
show clns.....	455		
show clns interface.....	458		
show clns neighbors.....	460		
show clns protocol.....	461		
show clns traffic.....	462		
show forwarding-table route-holddown.....	102		
show hosts command.....	440		
show ip commands			
show ip.....	96		
show ip address.....	97		

- show ipv6 ospf interface.....354
- show ipv6 ospf internal-statistics.....354
- show ipv6 ospf neighbors.....370
- show ipv6 ospf summary-prefix.....371
- show isis commands
 - show isis database.....440
 - show isis mpls adjacency-log.....440
 - show isis mpls advertisements.....440
 - show isis mpls tunnel.....440
 - show isis nsf.....449
 - show isis spf-log.....449
 - show isis summary-addresses.....449
 - show isis topology.....449
- show profile commands
 - show ip profile.....145
 - show ipv6 profile.....220
 - show profile brief.....147
- show route-map command.....147
- show rtr commands
 - show rtr application.....88
 - show rtr collection-statistics.....88
 - show rtr configuration.....89
 - show rtr history.....91
 - show rtr hops.....93
 - show rtr operational- state.....93
- show tcp commands
 - show tcp ack-rst-and-syn128
 - show tcp path-mtu-discovery128
 - show tcp paws.....129
 - show tcp resequence-buffers129
 - show tcp statistics.....131
- simple password authentication, OSPF.....299, 323
- snmp commands
 - snmp trap ip link-status.....60
- source address validation traps.....49
- source address verification.....48, 164
- source MAC addresses
 - same as destination MAC addresses
 - in GARP packets.....26
- SPF (shortest path first) calculations.....371, 449
 - IS-IS.....427
- SPF hold time
 - interval.....338
 - IS-IS.....427
- SPF, incremental.....349
- spf-interval command.....427
- split horizon mechanism.....261
- split-horizon command.....282
- SRP modules
 - global IP routing table on.....32
- starting IS-IS MD5 packets.....383
- static routes.....165, 227
 - establishing.....36
 - monitoring.....126
 - on null 0 interfaces
 - creating an exception to the SRP
 - module.....37, 165
 - disabling the sending of ICMP
 - unreachables.....37, 38
 - disabling the sending of ICMPv6
 - unreachables.....167
 - discarding IPv4 packets at the forwarding
 - plane.....37
 - discarding IPv6 packets at the forwarding
 - plane.....165
 - discarding received packets and not
 - sending ICMP unreachable.....37
 - discarding received packets and not
 - sending ICMPv6 unreachable.....165
 - discarding received packets and sending
 - ICMP unreachable.....37
 - discarding received packets and sending
 - ICMPv6 unreachable.....165
 - dropping of received IPv4 packets.....37
 - dropping of received IPv6 packets.....165
 - enabling the sending of ICMP
 - unreachables.....37, 38
 - enabling the sending of ICMPv6
 - unreachables.....167
 - verifying next hops for.....40
- stopping IS-IS MD5 packets.....383
- stub areas, OSPF.....297, 319
- subnet addressing.....11
- summarizing RIP routes.....261
- summary addresses
 - IS-IS routing.....422
 - OSPF routing.....309
- summary-address command.....309, 422
- summary-prefix command.....309, 422
- supernets.....12
- support, technical See technical support
- suppress-default command.....420
- suppressing IS-IS default routes.....419
- system identifier, IS-IS.....379

T

table	
forwarding.....	32
global IP routing.....	32
local routing.....	32
table maps, IS-IS	
configuring.....	431
defined.....	379
overview.....	385
table-map command	
IS-IS.....	431
OSPF.....	337
RIP.....	274
tag command.....	77
TCP commands	
tcp ack-rst-syn.....	53, 181
tcp mss.....	50, 178
tcp path-mtu-discovery.....	51, 179
tcp path-mtu-discovery	
black-hole-detect-threshold.....	52, 181
tcp path-mtu-discovery max-mtu.....	52, 180
tcp path-mtu-discovery min-mtu.....	52, 180
tcp paws-disable.....	53, 182
tcp resequence-buffers	
connection-maximum.....	55, 184
tcp resequence-buffers	
default-connection-maximum.....	55, 184
tcp resequence-buffers	
default-vr-maximum.....	55, 183
tcp resequence-buffers	
global-maximum.....	55, 183
tcp resequence-buffers vr-maximum.....	55, 183
TCP/IP protocol suite	
defined.....	4
layers of.....	5
technical support	
contacting JTAC.....	xxiii
text and syntax conventions.....	xxii
time-to-live command.....	282
timeout command.....	78
timers	
IS-IS graceful restart.....	385, 434
RIP.....	274
timers commands	
timers.....	274
timers spf.....	338
TLV (type-length-value) for resolution of IS-IS	
dynamic hostname.....	430

topology	
IS-IS.....	379
OSPF.....	297
tos command.....	78
trace packets.....	74, 174
traceroute command.....	74, 155, 174
traceroute packets	
arriving at null 0 interface static routes	
sending of ICMPv4 unreachable to the	
originator disabled.....	37
sending of ICMPv4 unreachable to the	
originator enabled.....	37
ICMP-based and UDP-based	
arriving at null 0 static routes.....	166
reaching null 0 interfaces and black	
holed.....	166
traffic engineering	
and IS-IS.....	436
and OSPF.....	340
traffic, IP.....	16
transmission of GARP packets	
default number of.....	27
failover	
to secondary link of redundant port on	
GE-2 and GE-HDE LMs.....	28
frequency of.....	27
modifying settings for.....	27
with maximum secondary IP addresses on an	
interface	
large number of GARPs are sent.....	27
transmit delay, OSPF.....	316, 319
transmit-delay command.....	346
transport layer (TCP/IP).....	6
traps command.....	350, 352
traps, OSPF.....	350
traps, OSPFv3.....	350
triggered-update-disable command.....	274
troubleshooting	
dropped packets.....	102
IS-IS.....	440
OSPF.....	353
RIP.....	282
ttl command.....	346
type command.....	75
type-length-value for resolution of IS-IS dynamic	
hostname.....	430
U	
UDP (User Datagram Protocol).....	259

undebg commands
 undebg ip ospf.....354
 undebg ip rip.....283
 undebg ipv6 ospf.....354
 undebg isis.....449
unnumbered interface
 IP.....57
 IPv6.....161
unreachable messages (ICMP).....71
unreliable protocols.....4, 71, 155
update-source command.....282, 346
User Datagram Protocol. See UDP

V

validating source addresses.....48, 164
verifying next hops for IPv6 static routes.....170
verifying next hops for static routes.....40
virtual links, OSPF.....297, 299, 319
virtual-router command.....18
VLAN encapsulation
 setting up on Ethernet interfaces
 for controlling sending of GARPs.....27
VLAN major interfaces
 configuring on physical interfaces
 for configuring transmission of GARPs.....27
VRRP interface ID
 associated with an interface
 transmission of GARPs.....28

